

Effects of phosphorus fertilization and *Pseudomonas fluorescens* bacteria on the growth and nutrient uptake of faba bean (*Vicia faba* L.) cultivars

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Abstract:

A field experiment was conducted during 2016 to evaluate the effect of high phosphorus fertilizer (P) and Pseudomonas fluorescens bacteria isolate on the growth and macro-elements uptake of two faba bean cultivars. The experiment used a randomized complete block design(RCBD) with factorial treatment arrangement and three replicates, the experimental factors were phosphorus application (0 ,50 and 100)% from recommendation p fertilizer (120kg.h⁻¹), P. fluorescens bacteria (inoculated and non inoculated) and two variant of faba baen (Taka357 375 and spinach) on the growth parameter and macro-elements uptake.

Result show that there were significant differences between faba bean cultivars in plant height, leaves number ,branches number, fresh and dry weight of shoot system after 90 days from planting date. Moreover, it is clear that Taka357 cultivar exceeded significantly spinach cultivar in all previous growth characters except plant height. As recorded 72 leaves, 7 branch, 84.1gm and 9.2gm respectively. Results showed the superiority significant to full recommendation p fertilizer in growth indicator , which included number of leaves ,

*branches number and dry weight of shoots system and shoot system content plant of elements N,P and k indicators, at the same time that the faba bean cultivars provided with half recommendation fertilizer with the addition of *Pseudomonas fluorescens* bacteria given the results of the above indicators were not significantly different from the treatment plant the processing with full recommendation P fertilizer.*

Results also showed a significant superiority for the combination treatment between cultevar of Taka357 When supplied full recommendation fertilizer in all plant growth indicators and content of N, P, and K element nutrients in shoot system .

*At the same time, the plant treatment supplied with half the fertilizer recommendation with the addition of *P. fluorescens* bacteria, given the results of the above indicators were not significantly different from the treatment plant is equipped with all the fertilizer recommendation.*

Key words: fertilization, *Pseudomonas fluorescens*, faba bean cultivar.

INTRODUCTION

With protein contents of 12% to 32%, legume crops play an important role in human nutrition. Faba bean (*Vicia faba* L.) is an annual winter crop in temperate and subtropical regions; it was cultivated globally over an area of 7.3 million hectares in 2012 and produced a mean yield of 1174 kg ha⁻¹ [1], in Iraq it is an important feeding crop grown in winter season.

Faba bean has four main functions in agro-ecosystems: (1) providing food and feed that is rich in protein; (2) supplying N to agro-ecosystems by symbiotic N₂fixation with *Rhizobium* bacteria to increase soil fertility; (3) diversifying the crop system to reduce constraints on growth and yield by the other crops in the rotation; and (4) reducing fossil energy consumption for crop production [2].

Phosphorus is a major nutrient, especially for legumes. It is considered the second essential nutrient element for both plants and microorganisms. In spite of the considerable addition of phosphorus to soil, the amount available for plant is usually low. Phosphate dissolving bacteria and soil microorganisms can play an important role in improving plant growth and phosphate uptake efficiency by releasing phosphorus from rock or tri-calcium phosphate. Many researchers showed positive effect of phosphorus fertilization on faba bean, significant increases were achieved in faba bean yield and its attributes by increasing phosphorus fertilization [3,4]

Microorganisms can play an important role in the availability of phosphorus in the soils. More phosphorus is proved to be taken by the plant in the presence of phosphate dissolving microorganisms [5]. Many investigators reported that phosphate dissolving bacteria enhance crop growth, improve seed and straw yields and increase nutrient uptake [6,7].

Metabolic processes of faba bean plant are greatly governed by both internal, i.e. genetic make up of the plant and external conditions which involve two main factors namely climatic and edaphic environmental factors. The yield potential of faba bean could be regulated through alternation of genetically make up and reconstitution of genetical structure through breeding programs and or by modification of environmental through cultural treatments. Thus the objective of this study is to investigate effect of bio- and mineral phosphorus fertilizer on the growth, productivity and nutritional value of two faba bean cultivars in Field conditions.

MATERIALS AND METHODS:

Experiment included 12 treatments which were the combination of two faba bean cultivars, Taka357 and spinach and 6 treatments representing the interaction between mineral NPK(18:46:0) use by (50,100) recondition and bio-fertilizer (*Pseudomonas fluorescens*)

This study carried out in laboratories and fields of the Ministry of Science and Technology - Baghdad - Iraq, during 2016 .to study effect of bio-mineral phosphorus fertilizer on the growth, productivity and nutritional value of tow faba bean cultivars (Takq110 and spinach), The soil of the experimental field was sandy loam having 7.1 PH. The experiment was laid out in Randomized Completely Block Design with three replications involving 12 treatments. The plot size was 2.5 x2.0 m. A spacing of 150 x 90 cm was followed. The half/full recommended dose of triple super phosphate (340 kg/ha), Phosphobacteria *pseudomonas fluorescens* (2 gm/plant) were applied as per the treatments, the bio fertilizers were mixed with soil and organic manure before seed sowing . Added fertilizer superphosphate and a single dose before the lines of agriculture and the mixing with the soil before planting the seed.

The cultivar used in this study was ‘Taka357 110 and spinach’ are characterized by good growth and high productivity and succeed grown under conditions of Agriculture convertibles in Iraq.

Data Collected: At harvest, five guarded plants were taken at random from the central ridge to estimate: plant height (cm), number of branches, number of leaves, shoot fresh and dry weight and uptake of (N,P and K) were determined from the three central ridges. Moreover, samples of faba bean fresh plant were oven dried at 60-70°C for 48 hours ground to estimate mineral elements in the shoot system in laboratories

of the Department of Environment research / Ministry of Science and Technology.

Nutrient uptake = concentration of the element × dry weight of shoot system.

Data Analysis

All data were statistically analysed using the analysis of variance (ANOVA) procedure in the Genstat program to assess the effects of different treatments. Means were compared using the least significant difference (LSD) test when the ANOVA showed significant fertilizer effects ($P \leq 0.05$).

4- RESULTS AND DISCUSSIONS

A-Growth Characters:

A-1. Varietal Differences: Data presented in Table 1 showed that there were significant differences between faba bean cultivars in plant height, leaves number, branches number, fresh and dry weight of shoot system, Moreover, it is clear that Taka357 cultivar exceeded significantly spinach cultivar in all previous growth characters except plant height. As recorded 72 leaves, 7 branch, 84.1gm and 9.2gm respectively.

The differences among faba bean cultivars in growth characters may be due to the differences in number of nodules formed on the root of the tested cultivar, consequently, the growth of each cultivar may depended mainly on nitrogen fixation [8] also to the differences in partition and migration of photosynthetic between cultivars [9] and the endogenous hormones content [10].

It could be mentioned that the results of the cultivar differences in growth characters, herein, are confirmed with those obtained by [9,11].

A-2. Effect of Bio-P-Fertilizer:

Table 2 observed that application of phosphate solubilizing phosphobacteria *P. fluorescens* (PSB) improved plant growth expressed as plant height, leaves number, branches number, fresh and dry weight of shoot system significantly affected by addition of *P. fluorescens* (PSB),

It could be concluded that application of this bacteria enhanced phosphorous solubilization [12], and the effect of nutrients mobilizing microorganisms which help in availability of metals increased levels of extractable mineral [13] and / or secretion of hormones organization plant growth (Karnwal, 2009)[14]. And and/or production of siderophore [15].

The obtained results agreed with those of [16] who; mentioned that phosphates dissolving bacteria presses the ability to bring a soluble phosphate in soluble forms by secreting organic acids which lower the pH and bring about the dissolution of bonds forms of phosphate and render then available for plants growing. The results of bio-P- fertilizer in growth parameters obtained in this study ware agreement with those obtained by [17,18,19]

The addition of mineral phosphorous fertilizer at rate 100% recommended fertilization resulted in a significant increase in all growth characters(plant height, leaves number, branches number, fresh and dry weight of shoot system) after 90 days from planting of faba bean plants compared with 50% recommended P fertilizer and control treatment . (Table 1).

The positive effect of phosphorus fertilizer on growth characters, herene, may be due to the physiological role of P on the meristem tic activity of plant tissues and consequently increasing plant growth, also, its function as a part of enzyme system having a vital role of the synthesis of other foods from carbohydrate, It could be concluded that our results are in harmony with those obtained by [20,21].

Falih Hasan Saeed, Usama Abdalla Alwan, Abed Al-Rahman Suhail, Qassim M. Zameil- **Effects of phosphorus fertilization and *Pseudomonas fluorescens* bacteria on the growth and nutrient uptake of faba bean (*Vicia faba* L.) cultivars**

Table 1. The effect of fertilizers and genetic structures in some faba bean plants growth indicators

Treatments	plant height (cm)	leaves number	Branches number	shoot fresh weight (gm)	system weight	dry weight of shoot system
P1	45.7	72.9	7.0	84.1		9.1
P2	55.9	65.9	3.0	70.1		8.3
L.S.D. $P \leq 0.05$	1.125	2.35	0.451	6.442		10.11
F1	41.0	40.7	3.67	44.5		4.67
F2	56.7	81.5	6.51	88.7		10.63
F3	52.7	75.7	5.81	82.8		9.77
F4	47.8	56.7	5.62	61.5		6.58
F5	57.3	82.3	6.31	96.2		11.2
F6	55.6	79.2	6.11	86.8		10.2
L.S.D. $P \leq 0.05$	2.253	6.151	0.881	3.721		1.732
P1 + F1	33.3	44.0	4	51.0		5.33
P1 + F2	52.1	79.0	7.8	96.8		10.93
P1 + F3	47.0	58.7	7.1	93.0		10.10
P1 + F4	39.7	54.0	6.8	61.3		6.63
P1 + F5	52.6	80.2	8.1	100.2		11.80
P1 + F6	50.0	63.1	7.6	95.0		10.70
P2 + F1	48.0	41.0	2.6	52.2		4.03
P2 + F2	61.3	76.1	4.0	87.2		10.30
P2 + F3	58.6	72.2	3.9	75.0		9.40
P2 + F4	56.0	48.8	3.2	60.1		6.51
P2 + F5	62.5	77.0	4.0	84.5		10.50
P2 + F6	60.0	73.0	4.0	79.2		9.63
L.S.D. $P \leq 0.05$	3.123	8.015	1.021	9.443		2.451
P1= Taka357 P2= spanich F1= control F2= 100% P F3=50% P F4= <i>P.floresens</i> F5= 100% P + <i>P.floresens</i> F5= 50% P + <i>P.floresens</i>						

A-3 Effect of Mineral P. Fertilizer:

The addition of mineral phosphorous fertilizer at rate 100% recommended p fertilization (F2) resulted in a significant increase in all growth characters of faba bean plants compared with other fertilizer treatments and control treatment (Table 1).

The positive effect of phosphorus fertilizer on growth characters, may be due to the physiological role of P on the meristematic activity of plant tissues and consequently increasing plant growth, also, its function as a part of enzyme system having a vital role the synthesis of other foods from carbohydrate.

It could be concluded that our results are in harmony with those obtained by [22,23].

A-4. Effect of the Interactions:

Table 1 indicate that the interaction between cultivars \times bio-fertilizer significantly affected growth character (plant height, leaves number ,branches number, fresh and dry weight of shoot system. Generally, it observed that the highest values of the previous growth parameters were recorded by Taka357 cultivar treated with Bio-P. fertilizer (*P.fluoresens*), regarding with the interaction between cultivars \times mineral fertilizers in two dose, also the cultivar Taka357 had the highest significant values of growth characters With the level of mineral fertilization. With respect of bio-P and mineral P. fertilizer interaction, it could be noticed that the effect of interaction on growth characters was significant. Generally, it could be concluded that the highest significant values of growth characters were resulted by plants treated with bio-P. fertilizer and supplied with two mineral p fertilizer doses.

It is noteworthy to mention, that the three-way interaction between cultivar \times bio-P. fertilizer \times mineral-P. fertilizer significantly affected all growth of plant parameter, it could be summarized the results of the three way interaction as the most favorable treatments to produce the highest values of the studied growth parameters were got by Taka357 cultivar treated with Bio-P. fertilizer and supplied with maximum rate of 100% fertilizer recommendation .

The results also show that processing plant with 50% of the recommended mineral phosphorus fertilizer with bio-fertilizer resulted in all growth indicators did not defriend significantly comparison the processing of plants with full recommendation of the mineral phosphorus fertilizer, and this has significant benefits environmental, as well as reduced the cost of production.

Generally These results are similar to findings [22,24].

B- Nutritional Values of shoot system :

The Results in table 2 showed the effect of bio-fertilizer, chemical fertilizer and genetic composition and interaction between them on absorption of most macro- elements in vegetative part of Broad bean plant, the results showed superiority Taka357101 cultivar in quantity of absorbed from P and N elements In shoot system as it recorded 43.8, 3.2 and 20.3 respectively , these results were consistent with Rughem et al (2012) were found a significant variation between two genetic composition of broad bean In absorption of some elements in shoot fertilized with the same elements .

Chemical fertilization treatment recorded the highest values of elements uptake of shoot system of faba bean plant, and superior on the other fertilization treatments significantly, when fertilized in full recommendation of phosphorus it recorded N(52.9),P(3.9) and k(25.1) followed by 50% of the recommendation of p fertilizer + bio-fertilizer treatment, these results are in consonance with the findings of Many of the researcher, including [11,24].

Interaction Treatment between cultivar and fertilizer results showed superiority of Taka357 cultivar fertilized by full recommendation in macro elements uptake in shoots system it recorded (54.0) N, (4.20)P and (25.9)K compared with spinach cultivar which recorded (54.0) N and (3.7)P and (24.3)K, With the superiority of this treatments on other combination

treatment in these indicators, at the same time the results showed addition of half fertilizer recommendation to faba bean plant from mineral phosphorus with addition of solubility of mineral phosphorus bacteria (*P. flouresens*) the macro-elements recorded absorption of values but not significantly different compared with plants provided with full recommendation from mineral phosphorus fertilizer With both cultivar Broad bean plant. The results confirm the effectiveness of bacteria solubility of mineral phosphorus to compensate for about half of the mineral phosphorus added to plants with no negative impact on the accumulation of nutrients in the shoots system faba bean .These results are consistent with [5,7].

Table 2. The effect of fertilizers and genetic structures in some macro-element uptake.

Treatments	N mg/g dry matter	P mg/g dry matter	K mg/g dry matter
P1	43.8	3.02	20.3
P2	42.3	2.96	19.2
L.S.D. $P \leq 0.05$	2.969	0.203	n.s
F1	21.8	0.52	10.0
F2	52.9	3.95	25.1
F3	47.0	3.32	21.2
F4	29.1	2.13	15.0
F5	55.1	4.27	26.5
F6	52.3	3.77	21.1
L.S.D. $P \leq 0.05$	1.714	0.117	0.438
P1 + F1	21.2	0.53	10.3
P1 + F2	54.7	4.20	25.9
P1 + F3	48	3.13	21.3
P1 + F4	28.5	2.02	15.3
P1 + F5	58	4.40	27.0
P1 + F6	53	3.83	21.3
P2 + F1	22.3	0.50	9.7
P2 + F2	54.0	3.70	24.3
P2 + F3	46	3.50	21.0
P2 + F4	29.7	2.23	14.7

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P2 + F5	52.3	4.13	26.0
P2 + F6	51.7	3.70	20.9
L.S.D. $P \leq 0.05$	4.199	0.288	1.531
P1= Toples F4= <i>P.flouresens</i>	P2= F5= 100% N,P + <i>P.flouresens</i>	F1= control F5= 50% N,pP + <i>P.flouresens</i>	F2= 100% N,P F3=50% N,P

Interaction Treatment between cultivar and fertilizer results showed superiority of Taka357 cultivar fertilized by full recommendation in macro elements uptake in shoots system it recorded (54.0) N, (4.20)P and (25.9)K mg/g dry matter compared with spinach cultivar which recorded (54.0) N and (3.7)P and (24.3)K mg/g dry matter, With the superiority of this treatments on other combination treatment in these indicators, at the same time the results showed addition of half fertilizer recommendation to faba bean plant from mineral phosphorus with addition of solubility of mineral phosphorus bacteria (*P. flouresens*) the macro-elements recorded absorption of values but not significantly different compared with plants provided with full recommendation from mineral phosphorus fertilizer With both cultivar Broad bean plant , The results confirm the effectiveness of bacteria solubility of mineral phosphorus to compensate for about half of the mineral phosphorus added to plants with no negative impact on the accumulation of nutrients in the shoots system faba bean .These results are consistent with [5 , 7].

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Falih Hasan Saeed, Usama Abdalla Alwan, Abed Al-Rahman Suhail, Qassim M. Zameil- **Effects of phosphorus fertilization and *Pseudomonas fluorescens* bacteria on the growth and nutrient uptake of faba bean (*Vicia faba* L.) cultivars**

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