# Effect of foliar nutrition of phosphorous and potassium on vegetative growth characteristics and yield of broad bean

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**ABSTRACT**

Factorial field experiment was carried out during the winter season of 2015/2016 season in a private farm located in Al-Hashemia (20 km south of Hilla city), to study the effect of phosphorus and potassium as foliar fertilizer on vegetative growth characteristics and yield of broad bean. Randomized complete block design (RCBD) with factorial experiment and three replications were used, which included three concentrations of potassium ($K_2O$), K1, K2, and K3 (1000, 2000 and 3000 mg.$L^{-1}$ respectively) as well as the control K0( spray distilled water only) which represented the first factor, and three concentrations of phosphorus ($P_2O_5$) , P1, P2 and P3 (1000, 2000 and 3000 mg.$L^{-1}$ respectively) as well as the control P0 (spray distilled water only) which represented the second factor . Broad bean seed were seeded on ridges in15/10/2015. The data were analyzed and the averages were compared according to less significant difference(LSD). The results showed that K3 (3000 mg $K_20.L^{-1}$) caused significant increasing in most vegetative growth traits (plant height, branches.plant$^{-1}$, pod length and pod weight). Spraying phosphorus concentration at 3000 mg $P_2O_5.L^{-1}$ (P3) was superior by giving highest rate of plant height, branches.plant$^{-1}$, while phosphorus concentration at 2000 mg (p2) gave highest rate of pod length and pod weight. The interaction between the factors had a significant effect on all studied traits.

Key words: broad bean, foliar fertilizers , phosphorous, potassium.

# تأثير التغذية الورقية بالفسفور والبوتاسيوم في صفات النمو الخضري وحاصل الباقلاء

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الملخص

نفذت تجربة حقلية عاملية خلال الموسم الشتوي 2015- 2016 في مزرعة خاصة في قضاء الهاشمية الواقعة (20 كم جنوب مدينة الحلة) ، لدراسة تأثير التغذية الورقية بالفسفور والبوتاسيوم في بعض صفات النمو الخضري وحاصل الباقلاء. استعمل تصميم القطاعات العشوائية الكاملة (RCBD)، بتجربة عامليه بثلاث مكررات وتضمنت ثلاثة تراكيز من البوتاسيوم هي K1 وK2 وK3 ( رش 1000 و 2000 و 3000 ملغم K.لتر$^{-1}$ على التتابع) بالإضافة الى معاملة المقارنة (K0 وفيها تم رش ماء مقطر فقط) ، و ثلاثة تراكيز من الفسفور هي P1 وP2 وP3 (رش 1000 و 2000 و 3000 ملغمP.لتر$^{-1}$ على التتابع) بالإضافة الى معاملة المقارنة (P0 وفيها تم رش ماء مقطر فقط). تمت زراعة الصنف الاسباني في 15/ 10 /2015 على مروز، واخذت القراءات وحللت حسب التصميم المتبع واختبرت المتوسطات حسب اختبار اقل فرق معنوي ، وتتلخص أهم النتائج بما يلي: ادى رش البوتاسيوم بتركيز 3000 ملغم K.لتر$^{-1}$ الى زيادة معنوية في ارتفاع النبات وعدد التفرعات وطول ووزن القرنة . كما تفوق رش الفسفور بتركيز 3000 ملغم P .لتر$^{-1}$ بإعطاء اعلى معدل لارتفاع النبات وعدد التفرعات بينما اعطى التركيز 2000 ملغم P .لتر$^{-1}$ اعلى معدل لطول القرنة ووزن القرنة الخضراء، وكان للتداخل بين عوامل الدراسة تأثير معنوي في جميع الصفات المدروسة.

## INTRODUCTION

Broad bean (*Vicia faba* L.) is one of the oldest crops known and used as a food with the beginning of human agriculture knowledge. It is one of winter leguminous crops and its seeds contain a high content of protein estimated up to 40-25% (Natalia et al., 2008). broad bean is planted to produce immature green pods consumption, as in peas and beans or green mature pods for boiler and eating the seeds as well as dry seeds.

Plant nutrition is the most important factors affecting in growth and yield. Phosphorus is an essential nutrient needed for plant because it plays an important role in

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many metabolic processes of the plant, as well as its role in improving the quality of the fruit (Ramadan and Adam, 2007). More than 30% of the world arable land is limited by phosphorous availability (Tesfaye *et al.*, 2007). Phosphorus may be a critical constraint of legumes (Tsvetkova and Georgiev, 2007) as well as its advantage in creating deeper and more abundant roots (Sharma, 2002). Potassium has a role in stimulating more than 65 important enzymes by raising the efficiency of photosynthesis process, configuring the sugars from source to sink and its role in the formation of the protein through increasing nitrogen absorption (Mengle and Kirkby, 1989). Most of Iraqi soils characterized as calcareous soil and the cultivated crops are suffers from deficient of most nutrients, especially phosphorus and potassium not because its total content, but it is not ready (Tisdale et al., 1985). So the studies tended to add foliar nutrients as a complementary process to soil fertilizers to provide the appropriate level of these essential nutrients to the plant, as well as its uses in small amounts, thereby reduce the environmental impact associated with soil fertilization (Haytova, 2013 ). However, the response to foliar spraying is often variable and not reproducible due to the lack of knowledge of many factors related to the penetration of the fertilizers (Fernández and Eichert, 2009) .This study aimed to find out the effect of foliar spraying of phosphorus and potassium on broad bean .

## MATERIALS AND METHODS

Field experiment was carried out during the winter season of 2015- 2016 in Al-Hashemia (20 km south of Babylon governorate) in silt clay soil (Table 1) in order to study the effect of phosphorus and potassium as foliar nutrition on broad bean growth. Randomized complete block design (RCBD) was used with three replication as factorial experiment included four concentrations of potassium (distilled water only as control, and spraying 1000, 2000 and 3000 mg K. $L^{-1}$ which were given symbols K0, K1, K2 and K3 respectively, and their interactions with four phosphorus concentrations (only distilled water as control, and spraying 1000, 2000 and 3000 mg P.$L^{-1}$ and that its code P0, P1, P2 and P3 respectively. One meter was left as space between replications and experimental units to avoid the spread of spray. Spanish variety seeds was cultivated (after soaking in water for 24 hours) in hill 20 cm apart on ridges 70 cm at mid of October 2015. The seedlings were sprayed two times, the first after one month from germination and the second after 45 days. At maturity as average of 10 plants from each experimental unit, plant height, branches number per plant, pod length and pod weight were measured. The data were analyzed and the averages were compared according to $LSD_{0.05}$.

Table 1 : some characterize of the experimental soil

| The character | The value | The character | The value |
|---|---|---|---|
| Sand | 101 g.$kg^{-1}$ soil | N (available) | 35.1 mg.$kg^{-1}$ soil |
| Silt | 534 g.$kg^{-1}$ soil | P (available) | 13.8 mg.$kg^{-1}$ soil |
| Clay | 365 g.$kg^{-1}$ soil | K (available) | 217.6 mg.$kg^{-1}$ soil |
| Texture | Silt clay loam | Ec | 4.6 dS.$m^{-1}$ |
| pH | 7.4 | | |

## RESULTS AND DISCUSSION

Table 2 shows that phosphorous spraying caused a significant increase in plant height with increasing the concentrations and (P3) gave the highest rate (85.6 cm), while P0 gave the lowest rate of 78.3 cm. It could be due to the importance of phosphorus in root growth and development which helps to distribute their spread and increase the absorption of nutrients as well as its important role in photosynthesis processes, cell division and regulation of vital events which is reflected in plant growth and development, thereby increasing plant height (El-Gizawy and

Mehasen , 2009). This is consistent with the results of Doss *et al* (2013) and Jasim and Mohsen (2014) on mung bean. The results also shows that potassium spray caused a significant increases in plant height with increasing the concentration, in which (K3) gave the highest rate of plant height (86.3 cm), while (K0) gave the lowest rate (76.1 cm). This is consistent with Nosser (2011) when sprayed Hyper-K fertilizer which led to increase broad bean plant height, and Doss *et al* (2013) on mung bean. This may be due to the role of potassium in raising the efficiency of photosynthesis process through the formation of the (ATP) and its important role in the formation of protein through increasing the absorption of nitrogen (Sahai, 2004) and its role in the photosynthesis trend with the opening of stomata. This is consistent with the results of Doss *et al* (2013) on mung bean. The results also shows that the interaction between spraying phosphorus and potassium caused a significant effect and P3K1 gave the highest plant height (89.3 cm) without significant differences from P2K2 and P3K3, while P0K0 gave the lowest rate (70.3 cm).

Table 2: Effect of foliar spraying with P and K on plant height at flowering stage (cm)

| K \ P | P0 | P1 | P2 | P3 | Average of K |
|---|---|---|---|---|---|
| K0 | 70.3 | 71.4 | 79.8 | 83.0 | 76.1 |
| K1 | 75.1 | 83.3 | 82.2 | 89.3 | 82.5 |
| K2 | 82.8 | 83.7 | 88.6 | 81.4 | 84.1 |
| K3 | 84.8 | 86.7 | 85.2 | 88.6 | 86.3 |
| Average of P | 78.3 | 81.3 | 84.0 | 85.6 | |
| $LSD_{0.05}$ | K*P =1.46 | | P= 0.73 | | K= 0.73 |

Table 3 shows that spraying P caused a significant increase in branches.plant$^{-1}$ compared to control, and the concentration of 300 mg.L$^{-1}$ (P3) was superior significantly by giving the highest rate (3.6), while (P0) gave the lowest rate (5.3 branches). This increase may be due to the effect of phosphorus in increasing the activity of vital events and meristem cell division which gives a great and high radical vegetative and roots with high efficiency in absorption of other nutrients and thus increase branches (Shafeek et al., 2004). This is consistent with the results of Jasim and Mohsen (2014 b) on mung bean. Potassium spraying also caused significant increase in branches.plant$^{-1}$ and (K3) gave significantly the highest rate (6.2), while (K0) gave the lowest rate (5.5 branches). This results due to the role of potassium in regulating osmotic stress through the process of opening and closing of stomata, and its contributes of photosynthesis process (Govindan and Thirumurugan, 2001). This results agreed with Nosser ( 2011). The interaction between spraying phosphorus and potassium caused a significant effect and the combination of P3K3 gave the highest rate of branches (6.6) while P0K0 gave lowest rate (4.7 branches).

Table 3: Effect of foliar spraying with P and K on branches no.plant$^{-1}$ at flowering stage

| K \ P | P0 | P1 | P2 | P3 | Average of K |
|---|---|---|---|---|---|
| K0 | 4.7 | 5.0 | 5.5 | 4.9 | 5.5 |
| K1 | 5.3 | 5.6 | 6.1 | 6.2 | 5.8 |
| K2 | 5.5 | 5.9 | 5.7 | 6.5 | 5.9 |
| K3 | 5.6 | 6.1 | 6.5 | 6.6 | 6.2 |
| Average of P | 5.3 | 5.7 | 5.9 | 6.3 | |
| $LSD_{0.05}$ | K*P=0.63 | | P=0.31 | | K=0.31 |

Table 4 shows that spraying phosphorus caused a significant increase in pod length compared to control and (P3) gave the highest rate (17.46 cm) without significant difference compared to P2 and P1, while (P0) gave the lowest rate (16.05 cm). This increase in pod length attributed to the role of phosphorus in the process of cell division and cell elongation by providing pressure boggy ideal, as well as its role in the revitalization of many enzymes responsible for the construction of synthetic materials which is used in the construction of the plant structure. This results was agreed with Doss et al (2013) and Jasim and Mohsen (2014 a). The results also showed that spraying potassium caused a significant increase of pod length and (K3) gave the highest rate (17.15 cm), while (K0) gave the lowest rate (16.43 cm). This increase may be attributed to the role of potassium in cell division meristem cell growth and contributes to carbohydrate composition and transmission of material resulting from photosynthesis process and thereby increase the pods. The interactions between spraying phosphorus caused a significant effect, in which P3K2 gave the highest rate (17.89 cm), while P0K0 gave the lowest rate (16.43 cm). This result was consistent with Doss *et al* (2013).

Table 4: Effect of foliar spraying with P and K on mature pod length (cm)

| K \ P | P0 | P1 | P2 | P3 | Average of K |
|---|---|---|---|---|---|
| K0 | 15.80 | 16.18 | 17.00 | 16.74 | 16.43 |
| K1 | 15.98 | 16.80 | 17.10 | 17.58 | 16.87 |
| K2 | 16.21 | 16.70 | 17.74 | 17.89 | 17.14 |
| K3 | 16.20 | 16.96 | 17.79 | 17.64 | 17.15 |
| Average of P | 16.05 | 16.66 | 17.41 | 17.46 | |
| $LSD_{0.05}$ | K*P=1.62 | | P=0.81 | | K=0.81 |

The results in table 5 shows that spray phosphorus caused a significant increase in pod weight compared to control and (P3) gave the highest rate (20.57 g) without significant differences compared to P1 and P2, while P0 gave the lowest rate (19.63 g). It may be due largely to the role of phosphorus in the photosynthesis process through the composition of some rich compounds in energy, such as ATP and NADPH2 also introduces phosphorus in other compounds such as uridine triphosphate (UTP), which enters in the composition of sucrose and callus and guanosine triphosphate (GTP), which contributes to the formation of cellulose (Zafar et al., 2011). The results also shows that spraying potassium caused a significant increase in pod weight compared to control and (K3) gave the highest rate (20.77 g) without significant differences with K1 and K2, while (K0) gave the lowest rate (19.40 g). This results may be due to the role of potassium in stimulate plant enzymes that lead to increase the rate of seed weight, as well as the role of potassium in the formation of sugars, starch, protein, and all this is reflected in increasing pod weight. This results was consistent with the results of Nosser (2011). The interaction between spraying phosphorus and potassium caused a significant effect and P3K3 gave the highest pod weight (21.13 g), while P0K0 gave the lowest rate (19.06 g).

Table 5: Effect of foliar spraying with P and K on mature pod weight (g)

| K \ P | P0 | P1 | P2 | P3 | Average of K |
|---|---|---|---|---|---|
| K0 | 19.06 | 19.50 | 19.50 | 19.54 | 19.40 |
| K1 | 19.26 | 20.44 | 20.74 | 20.61 | 20.26 |
| K2 | 19.87 | 20.58 | 20.75 | 20.99 | 20.55 |
| K3 | 20.33 | 20.76 | 20.85 | 21.13 | 20.77 |
| Average of P | 19.63 | 20.32 | 20.46 | 20.57 | |
| $LSD_{0.05}$ | K*P=1.26 | | P=0.63 | | K=0.63 |

Table 6 shows that spraying phosphorus caused a significant increase in mature green pods yield per plant compared to control and (P3) gave the highest rate of pod weight (135.2 g) without significant differences with P1 and P2, while P0 gave the lowest rate (117.6 g). It may be due to the role of phosphorus in increasing pod weight (table 5). These results are consistent with Abdalla, (2002). The results also shows that spraying potassium caused a significant increase in pod weight compared to control and (K3) gave the highest rate (141.7 g) with a significant differences compared to K1, while (K0) gave the lowest rate (111.3 g). This results may be due to the role of potassium in increasing pod weight (table 5). These results are consistent with Jasim and Obaid, (2014) .The interaction between spraying phosphorus and potassium caused a significant effect and P3K3 gave the highest pod weight (147.3 g), while P0K0 gave the lowest rate (97.5 g).

Table 6: Effect of foliar spraying with P and K on pods yield.plant$^{-1}$ (g)

| K \ P | P0 | P1 | P2 | P3 | Average of K |
|---|---|---|---|---|---|
| K0 | 97.5 | 115.1 | 118.6 | 113.9 | 111.3 |
| K1 | 111.3 | 129.4 | 131.6 | 136.0 | 127.1 |
| K2 | 127.5 | 135.8 | 138.2 | 143.4 | 136.2 |
| K3 | 133.9 | 138.7 | 146.9 | 147.3 | 141.7 |
| Average of P | 117.6 | 129.8 | 133.8 | 135.2 | |
| $LSD_{0.05}$ | K*P= 13.2 | | P= 6.5 | | K= 6.5 |


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