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The Response of the Broad bean crop (*Vicia faba* L.) to phosphate and potassium fertilization and their Effect on the growth and yield characteristics

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ABSTRACT

The study for this research was carried out in Al-Alam district - Salah El-Din Governorate to study the effect of phosphate and potassium fertilizers on the growth and yield of (local) beans for the winter agricultural season 2019-2020. The experiment was implemented according to a R.CBD Randomized Complete Block Design with split plot system, using four phosphate levels (0, 65, 80 and 100 kg P. h^{-1}) and four levels of potassium (0, 75, 90 and 105 kg K. h^{-1}). The best significant superiority was recorded at the level of 100 kg P. h^{-1}, an interference with 105 kg K. h^{-1} in most traits, as it was recorded (98.60 cm) for plant height, (58.92%) for chlorophyll, (11.85 pods. Plant $^{-1}$) for the number of pods, (190.33 g) For the weight of 100 seeds, (3.50 tons. h^{-1}) the seeds yield and (29.31%) for protein. As for the number of branches and the dry weight of the shoots, the level of 100 kg P. h^{-1} by an interference with 90 kg, K. h^{-1}, the highest average was (10.76 branches. Plant^{-1} and 14.64 g) respectively. We conclude from this study that the best interaction combination is between the levels of 100 kg P h^{-1} and 105 kg K. h^{-1} in most of the studied traits. The aim of this study is to determine the best fertilizer level of phosphate and potassium to improve the growth and yield traits of the beans plants and the extent to which the crop benefits from this addition.

Introduction

Vicia faba L. is one of the crops of the legume family Fabacea, which is the main source of food for a large number of the world's population and is cultivated for the purpose of obtaining green pods or dry or soft seeds, which are characterized by the content of their seeds with a high percentage of protein estimated at 25-30% [1]. In addition to its content of carbohydrates, vitamins B1, B2 and C, fats and a percentage of fiber, which increased its nutritional value [2]. As well as its importance in improving fertile soil properties by fixing atmospheric nitrogen in the soil [3]. In order to improve the growth and production of beans, it is necessary to add fertilizers that are suitable for the soil of cultivation, because the excessive addition of chemical fertilizers leads to environmental damage, so the type and quantity of the added fertilizer must be determined [4].

Phosphorous is one of the important elements in plant nutrition, as it contributes to many of its vital activities and is more important in the early stages of its growth, in addition to the fact that the plant root extract fertilized with phosphorus contains less oxin activity than the non-fertilized plant root extract. Therefore, many studies have confirmed the role of Important phosphorus and its effect on improving the growth of bean and seed yield [5,6].. Phosphorus also increases cell elongation and division and plant resistance to drought [7,8]. Potassium is also an important nutrient for plants because of its important role in stimulating more than 65 enzymes by raising the efficiency of the photosynthesis process in addition to the role of the sugar content in the potassium element, which serves to absorb the nitrogen present in the soil and water [9].

Materials and methods

This study was conducted in the Al-Alam / Salah al-Din governorate to study the effect of phosphate and potassium fertilizer on (local) beans plant for the winter season 2019-2020 by plowing the soil with two perpendicular plowing and then smoothing the land and leveling it. I took a sample of the soil for analysis and knowledge of its properties. The experiment was implemented according to the RCBD Randomized Complete Block Design with three replications with the split plot system, where potassium fertilizer occupied the main factor and phosphate fertilizer the secondary factor, and the soil was divided into experimental units. Unit area ($2X3m^2$). On the two sides of the mooring, the distance between the mower and the other is 120 cm, and between the jaw and the other 25 cm, 3 seeds soaked for 24 hours were placed in each groove and nitrogen fertilizer was added in two batches in the form of urea 48% N, the first batch with cultivation and the second batch after 45 days of planting, add fertilizer Phosphate in four levels (0, 65, 80 and 100 kg P. h^{-1}) in the form of triple superphosphate 48% P was added with irrigation water after dissolving it. As for the potassium fertilizer, it was added at the planting and according to the levels prepared for research (0, 75, 90, 105 kg. k. h^{-1}) and in the form of K_2SO_4 (43% K). The plants were thinned to two plants in the gora after complete germination. Soil and plant service operations were conducted, including patching and bush control, and all necessary measures, and two lines were specified in the middle for each experimental unit. From each streak, 5 samples were taken to carry out all the injections Asat required for searching.

The studied traits:

1- Plant height (cm)

The average plant height was measured for five plants selected from the mean two plants for each experimental unit. The measurement was taken from the base of the plant at the soil surface to the top of the terminal leaf.

- Number of branches. Plant $^{-1}$2

The number of branches. Plant^{-1} was calculated a week before harvest by selecting five plants from the middle marzines prepared for measurement.

Chlorophyll percentage (%) 3-

The percentage of chlorophyll was estimated at full blooming by Spectrophotometer by taking a reading of the fourth leaf.

-Number of pods. Plant $^{-1}$4

The number of pods. plant^{-1} was calculated a week before harvest by selecting five plants from the middle marzines prepared for measurement as mentioned above.

-Dry weight of shoots (gm)5

Five samples were taken from each experimental unit, then after that each sample was placed in a paper envelope after being perforated and weighed while it was empty. The samples were placed with the envelopes in an oven at a temperature of 70^om until they were completely dry and then weighed and the weight of the envelope excluded in order to obtain the weight Dry the sample.

6-Weight of 100 seeds (gm)

One hundred seeds were randomly taken from the final yield of each experimental unit and then weighed with a sensitive scale.

7-Total seed yield (tons. h^{-1})

As for the seed yield, the remaining plants were harvested in the average merozo after taking the five plants from them to make measurements on them for each experimental unit. These plants were weighed after being cleaned of impurities. Then the weight of the five plants from which they were taken was added and the weight was converted into a ton. h^{-1}.

8-Protein percentage (%)

The percentage of protein was estimated using the Kejldahl device by [10] method to extract the percentage of nitrogen, including the calculation of the protein percentage, and the protein was calculated according to the following equation.

Protein percentage (%) = Nitrogen percentage (%) x 6.25.

*** statistical analysis**

The statistical analysis was performed according to the randomized complete block design (R.C.B.D) the averages were tested according to the Duncan polynomial test to compare the arithmetic means at a probability level 5% [11].

Table 1: shows some characteristics of the physical and chemical of the soil

Character The	Unit	The value
PH	________	7.41
E.C	ds.m^{-1}	1.93
N (available)	mg. kg^{-1}	21.72
K (available)	mg. kg^{-1}	120.16
P (available)	mg. kg^{-1}	6.08
Organic matter	g. kg^{-1}	10.42
Soil Texture	___	Sandy clay
pH water	_______	7.3
E.C water	ds.m^{-1}	1.40

Results and discussion

1- Plant height (cm)

Table No. (2), which shows the results of the effect of adding phosphate and potassium fertilizers, and the interference between them, indicates the height of the bean plants (cm), where the level of fertilizer for phosphate was significantly increasing higher than 100 kg p. h^{-1} by giving him the highest mean value of (96.61 cm) at all other levels, and on the contrary, the two levels recorded the control treatment and the level of 65 kg p. h^{-1}, the lowest arithmetic mean (87.58 and 88.82 cm), respectively. As for potassium, it was significantly higher than the levels 90 and 105 kg k. h^{-1} gave them the highest mean (93.49 and 93.86 cm), respectively, while the control treatment gave the lowest average (87.87 cm). In terms of interference we notice from the same table a significant superiority of the interaction treatment between the phosphate level 100 kg p. h^{-1} with potassium 105 kg k. h^{-1} by giving it the highest average of (98.60 cm) on all other interfering treatments. As for the lowest average, it was recorded by the interferential control between potassium and phosphate (81.30 cm)

Table 2: shows the effect of potassium and phosphate fertilizers and the interference between them on plant height (cm)

K \ P	P0	P65	P80	P100	Average K
K0	81.30 k	85.45 J	89.99 gh	94.71 d	87.87 c
K75	87.45 i	88.60 H	92.00 e	95.63 c	90.92 b
K90	90.61 g	91.04 F	94.82 d	97.51 b	93.49 a
K105	90.93 fg	90.21 Fg	95.69 c	98.60 a	93.86 a
Average P	87.58 c	88.82 C	93.12 b	96.61 a	

It is likely that the reason for this increasing is due to the soil's response to adding phosphate and potassium due to its poverty of these two elements, as well as phosphates playing an important role through the good division and expansion process in plant cells and the cell wall necessary for the process of division and growth [12] and these results are consistent with what Find it [13 and 14].

2-The number of branches. Plant^{-1}

When considering Table (3), which shows the effect of phosphate and potassium fertilizer levels, and the interference between them, on the characteristic of the number of branches. Plant^{-1}. We note significant increasing of phosphate at 80 kg p. h^{-1}, with a significant difference at the other levels, averaged (8.85 branches. Plant^{-1}) except for the level of 100 kg p. h^{-1} with a value of (8.77 branches. Plant^{-1}). Otherwise, the two levels recorded each of the control treatment and 65 kg p. h^{-1} is the lowest average of (7.22 and 7.34 branches. Plant^{-1}), respectively. With regard to potassium, it was significantly increasing the level of 90 kg k. h^{-1} on all the arithmetic averages of the other levels the highest value was (9.54 branches. Plant^{-1}), while the control treatment recorded the lowest average (7.23 branches. Plant^{-1}). We are still at the same table, where the interaction between phosphate and potassium shows a significant superiority with the highest average for the interference treatment between 100 kg p. h^{-1} with 90 kg k. h^{-1} reached (10.76 branches. Plant^{-1}). The lowest average was recorded for the interference between the control treatment of phosphate and potassium fertilizers was (5.14 branches. Plant^{-1}). Perhaps the reason for this superiority is due to the role of phosphorus and potassium in the plant, as their addition helped to increase their readiness and thus increase the absorption by the plant, which led to the supply of the plant for a longer period of nutrients, which reflected on the growth characteristics and the number of branches well in addition to [6,5]. improving the photosynthesis process and increasing plant growth and this reflected positively on the number of branches.

Table 3: shows the effect of potassium and phosphate fertilizers and the interference between them on the number of branches of the plant

K \ P	P0	P65	P80	P100	Average K
K0	5.14 i	7.24 G	8.74 D	7.79 ef	7.23 b
K75	7.30 fh	7.53 Fg	9.13 cd	7.59 fg	7.89 b
K90	9.32 c	8.07 E	10.01 B	10.76 a	9.54 a
K105	7.12 g	6.52 H	7.52 fg	8.93 cd	7.52 b
Average P	7.22 b	7.34 B	8.85 A	8.77 a	

3- Chlorophyll percentage (%)

We infer from the results of the arithmetic averages shown in Table (4), which includes the effect of different levels of phosphate and potassium on the percentage of chlorophyll, to the presence of significant differences for phosphorus, where the level exceeds 100 kg p. h^{-1} with the highest average (55.57%), and in this way it icreasing all other levels, and with regard to the lowest average, it was recorded by the control treatment, which did not differ significantly from the level of 65 kg p. h^{-1} and its values reached (42.23 and 43.33%) respectively, for potassium, we notice the superiority of 105 kg k. h^{-1} with the highest arithmetic average (50.87%). However, this superiority did not differ significantly from the levels 75 and 90 kg k h^{-1} and their values reached (47.72 and 49.37%) respectively, while the control treatment recorded the lowest average of (43.46%). The table also guides us to the superior interference treatment between of the two levels of 100 kg p. h^{-1} with 105 kg k. h^{-1}, by giving it the best arithmetic mean and significant differences from other interference, its value reached (58.92%). On the contrary, the control treatment of potassium and phosphate fertilizers recorded the lowest average (35.40%). The reason may be due to the role of phosphate in activating a large number of enzymes responsible for building chlorophyll, as its deficiency leads to the destruction of the plastids [16]. in addition to the important role of potassium, which increases the efficiency of the photosynthesis of the leaf by increasing the number of the plastids per cell, the number of cells per leaf and also the leaf area, and for its important role in stimulating more than 65 important enzymes by raising the efficiency of the photosynthesis process [17] and these results are consistent with their [18, 19].

Table 4: shows the effect of potassium and phosphate fertilizers and the interference between them on the percentage of chlorophyll (%)

K \ P	P0	P65	P80	P100	Average K
K0	35.40 m	39.78 L	47.36 g	51.29 e	43.46 b
K75	43.96 jk	42.57 K	49.38 f	54.97 c	47.72 a
K90	44.34 ig	44.63 I	51.40 e	57.11 b	49.37 a
K105	45.21 hi	46.36 Gh	52.98 d	58.92 a	50.87 a
Average P	42.23 c	43.33 C	50.28 B	55.57 a	

4-Number of pods. Plant^{-1}

When looking at Table (5), which shows the results of the effect of phosphate and potassium fertilizers, and the interaction between them in the characteristic of the number of pods. Plant-1. We find significant superiority of phosphates at 100 kg p. h^{-1} with the highest value (11.70 pods. plant^{-1}) on the contrary, it gave the control treatment and the level was 60 kg p. h^{-1} is the lowest value (9.31 and 9.19 pods. Plant^{-1}) respectively. As for potassium, the level was recorded at 105 kg k. h^{-1} the highest average, was (10.94 pods. plant $^{-1}$) on the one side, and on the other side, the control treatment gave the lowest arithmetic mean of (9.62 pods. Plant $^{-1}$). As for the interference, it was significantly higher than the two levels 80 and 100 kg p. h^{-1} interaction with 105 kg k. h^{-1} with the highest average (11.64 and 11.85 pods. Plant^{-1}) respectively. The two lowest mean was between the control treatment for potassium interference, with the control treatment and the level of phosphate 65 kg p. h^{-1} (8.55 and 8.11 pods. plant^{-1}).

The reason may be due to the availability of the appropriate amount of nutrients in the soil , when add of fertilizer which the plant needs, as it was absorbed through the roots, thus providing the plant with the longest period of food, which made an increase in growth and reduced food competition between flowers and newly formed pods, which led to a reduction in the percentage of precipitation in them and thus increased the number Pods that have reached full maturity[20 ,21 , 22].

Table 5: shows the effect of potassium and phosphate fertilizers and the interference between them on the number of pods. Plant^{-1}

K \ P	P0	P65	P80	P100	Average K
K0	8.55 H	8.11 H	9.86 de	11.98 a	9.62 b
K75	8.92 G	9.18 Fg	10.51 bc	11.44 a	10.01 ab
K90	9.50 Ef	9.45 Ef	10.95 B	11.53 a	10.36 ab
K105	10.76 Cd	10.00 D	11.64 A	11.85 a	10.94 a
Average P	9.31 C	9.19 C	10.74 B	11.70 a	

5−Dry weight of shoots (g m)

Table (6) shows the results of the effect of phosphates and potassium, and the interference between them on the dry weight of the shoots of beans (gm). As the addition of different levels of the two elements mentioned above led to a significant superiority in this characteristic, then when adding phosphate, 100 kg p. h^{-1}, gave the highest arithmetic average (12.98 grams). On the contrary, the control treatment gave the lowest average (9.28 grams). When adding potassium, the level was recorded at 90 kg. h^{-1} highest average (12.44 g) and the lowest average was at 105 kg k. h^{-1} (10.40g), which did not differ significantly with the control treatment, and the level was 75 kg k. h^{-1} (10.70 and 10.92 g), respectively. The same table guides us to the, as the significant incerasing interference between phosphate and potassium 100 kg p. h^{-1} with 90 kg k. h^{-1} with the highest average of (14.64 g). This on the one side, and on the other side, the interferenc treatment was recorded when the control treatment for phosphates with 105 kg k. h^{-1} is the lowest average of (8.64 g). Of this, we note the role of phosphate in the increase of dry weight when adding it and benefiting from it as it increases the transport and assembly process of dry matter and delays aging and thus leads to an increase in plant components and the yield and these results are consistent with what he found [23, 8]

Table 6: shows the effect of potassium and phosphate fertilizers and the interference between them on the dry weight of the shoots (gm)

K \ P	P0	P65	P80	P100	Average K
K0	9.21 h	10.02 G	11.12 f	12.44 d	10.70 B
K75	9.04 h	10.40 G	11.16 f	13.09 c	10.92 b
K90	10.14 g	11.11 F	13.87 B	14.64 a	12.44 a
K105	8.74 h	10.14 G	10.97 F	11.74 e	10.40 b
Average P	9.28 d	10.42 C	11.78 B	12.98 a	

6- Weight of 100 seeds (gm)

Table (7), according to Duncan's multi-range test for arithmetic averages, shows the effect of adding different levels of phosphate and potassium, and the interference between them in the weight of 100 seeds, as it was found that there are significant differences for phosphates, withsignificantly incrasing than the level of 100 kg p. h^{-1} with the highest average (181.61 gm). Otherwise, it was the lowest average when control to the treatment, and the level was 65 kg P. h^{-1} averaged (168.09 and 169.36 gm), respectively. For potassium levels, the level was significantly higher than 105 kg k. h^{-1} with the highest average (182.14g), but the lowest average given by the control treatment and a level of 75kg k. h^{-1} was (166.32 and 169.60 gm), respectively. We are still at the same table, which shows the effect of the interference, as the interference treatment was recorded at the level of 100 kg p. h^{-1} with 105 kg k. E-1, the highest average was (190.33gm), and thus it significantly outperformed all other interference treatments, on the other side. The interference record for the control treatment was the lowest average of (158.39 g). From this, the reason for the moral superiority can be explained by the availability of the elements Nutritional substances lead to an increase in the transfer of processed manufactured materials from the leaves to the seeds, which leads to the full filling of the seeds and an increase in their weight, thus increasing the yield [24]. in addition to the need for large bacterial nodes to phosphorous and potassium reflected positively in the weight of 100 seeds and this is [25, 26] consistent with what was stated.

Table 7: shows the effect of potassium and phosphate fertilizers and the interference between them on the weight of 100 seeds (gm)

K \ P	P0	P65	P80	P100	Average K
K0	158.39 k	162.37 J	169.13 H	175.40 ef	166.32 c
K75	165.50 i	164.73 I	171.22 G	176.94 e	169.60 c
K90	172.16 fg	173.50 F	178.28 D	183.78 c	176.93 b
K105	176.28 e	176.83 E	185.10 B	190.33 a	182.14 A
Average P	168.09 c	169.36 C	175.93 B	181.61 a	

7- Seed yield (tons. h^{-1})

From Table (8), which shows the results of the seed yield, we the presence of significant differences for phosphates, with the level gave 100 kg p. h^{-1} with the highest average (2.79 tons. h^{-1}), while the control treatment recorded the lowest arithmetic mean of (2.13 tons. h^{-1}). As for potassium, significant differences appeared between its levels as it gave the levels of 90 and 105 kg k. h^{-1} with the highest average (2.60 and 2.85 tons. h^{-1}) respectively. On the contrary, the control treatment recorded the lowest average (2.00 tons. h^{-1}). The table also shows the best interference treatment was between 100 kg p. h^{-1} with 105 kg k. h^{-1} was significantly superior to all other treatments with the highest mean (3.50 tons. h^{-1}). Otherwise, the interference between the control treatment for phosphate and potassium was recorded with the lowest average (1.86 tons. h^{-1}). Perhaps the reason for this superiority in increasing the yield is due to the role of phosphorus, which increases growth due to its direct role in cell division and most of the vital processes and the formation of phospholipids that enter into the formation of biofilms as well as helps in the formation of nucleic acids and the transfer of sugars from their places of formation to seeds. The addition of potassium also promoted an increase in seed [27]. yield through its role in increasing photosynthesis and increasing nutrient transport [28,29] number. The increase in potassium and phosphate also led to an increase of pods and the weight of 100 seeds, thus increasing the total yield of seeds.

Table 8: shows the effect of potassium and phosphate fertilizers and the interference between them on the seed yield (tons. h^{-1})

K \ P	P0	P65	P80	P100	Average K
K0	1.86 g	1.97 fg	2.08 f	2.09 F	2.00 C
K75	1.96 fg	2.23 e	2.57 cd	2.68 C	2.36 B
K90	2.23 e	2.49 d	2.78 c	2.90 B	2.60 A
K105	2.49 d	2.51 cd	2.91 b	3.50 A	2.85 A
Average P	2.13 C	2.30 bc	2.58 ab	2.79 A	

Table (9) guides us to the results of the effect of phosphate and potassium fertilization and the interference between them in the percentage of protein. We find the two levels gave 80 and 100 kg p. h^{-1} with the highest average reaching (26.87 and 27.79%) respectively. On the contrary, the control treatment recorded the lowest average (24.07%). The results of the table also showed that the addition of potassium gave a significant increasing at the level of 105 kg k. h^{-1} with the highest average amounted to (27.17%), but it did not differ significantly at levels 75 and 90 kg. E-1, which recorded (26.25 and 26.15%) respectively, while the control treatment gave the lowest arithmetic mean of (23.66%). The table also shows us the results of the interference, where the interference between 100 kg p. h^{-1} with 105 kg k. h^{-1} was significant for all the interactions with the highest value (29.31%). In contrast, the interference between the potassium control treatment with the control treatment and the level of 65 kg p. h^{-1} was recorded with the lowest average of (21.67 and 21.82%), respectively. The reason for this superiority is due to the availability of adequate amounts of the two elements in the soil upon addition and their absorption from the roots, it activated the enzymes formed inside the plant tissue, and this is in agreement with [30]. Potassium is also characterized by the percentage of sugar in it, which works to absorb nitrogen in the soil and water, and this increases the percentage of protein formed in the seeds by increasing the building of the amino acids formed. Among the intermediate compounds resulting from the oxidation process [31], this is in agreement with the findings of [32].

Table 9: shows the effect of potassium and phosphate fertilizers and the interference between them on protein percentage (%)

K \ P	P0	P65	P80	P100	Average K
K0	21.67 i	21.82 i	25.30 f	25.85 e	23.66 b
K75	23.69 h	26.10 e	27.62 c	27.57 c	26.25 a
K90	24.76 g	24.36 G	27.06 d	28.43 b	26.15 a
K105	26.16 e	25.72 Ef	27.48 c	29.31 a	27.17 a
Average P	24.07 b	24.50 B	26.87 a	27.79 a	

Conclusions

We conclude from this study that the best fertilizer level for phosphates and potassium can be added in order to improve the performance and quality of most growth characteristics and the yield of bean plants is 100 kg P. h^{-1} and 105 kg K. h^{-1}.

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استجابة محصول الباقلاء (*Vicia faba* L.) للتسميد الفوسفاتي والبوتاسي وأثرهما على صفات النمو والحاصل

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الملخص

نفذت الدراسة الخاصة بهذا البحث في قضاء العلم– محافظة صلاح الدين لدراسة تأثير السماد الفوسفاتي والبوتاسي في نمو وحاصل الباقلاء صنف (محلي) للموسم الزراعي الشتوي 2019–2020. طبقت التجربة وفق تصميم القطاعات العشوائية الكاملة R.C.B. D بنظام الالواح المنشقة و ذلك باستخدام اربع مستويات فوسفات (0 ، 65، 80 و 100 كغمP.هـ$^{-1}$) و اربع مستويات من البوتاسيوم (0 ، 75، 90 و 105 كغمK.هـ$^{-1}$) حيث سجل افضل تفوق معنوي عند المستوى 100كغمP.هـ$^{-1}$ بالتداخل مع 105 كغم K.هـ$^{-1}$ في اغلب الصفات اذ سجل (98.60 سم) لارتفاع النبات, (58.92 %) للكلوروفيل (11.85 قرنة. نبات$^{-1}$) لعدد القرنات, (190.33غم) لوزن 100 بذرة , (3.50 طن .هـ$^{-1}$) حاصل البذور و (29.31 %) للبروتين. بالنسبة لصفتي عدد التفرعات والوزن الجاف للمجموع الخضري فقد سجل المستوى 100كغمP. هـ$^{-1}$ بالتداخل مع 90 كغم K.هـ$^{-1}$ اعلى متوسط بلغ (10.76 فرع. نبات$^{-1}$ و14.64غم) بالتتابع. نستنتج من هذه الدراسة ان أفضل توليفة تداخلية هي بين المستويين 100 كغمP.هـ$^{-1}$ و 105 كغم K.هـ$^{-1}$ في اغلب الصفات المدروسة. الهدف من هذه الدراسة هو تحديد أفضل مستوى سمادي من الفوسفات والبوتاسيوم لتحسين صفات النمو والحاصل لنبات الباقلاء ومدى استفادة المحصول من هذه الاضافة.