

Effect of Spraying with High Phosphorus Solution and Potassium Sulfate on Growth and Yield of *Vicia faba* L.

Hussein Hameed Abbood AL-Omrani ^{a)} and Evan A. H. M. Ali ^{b)}

Department of Horticulture and Landscape Planning, College of Agriculture, University of Al-Qadisiyah, Iraq.

^{a)} Hussein.abood@qu.edu.iq

^{b)} Corresponding Author: Evan.deabl@qu.edu.iq

Received : 25/1/2022

Acceptance : 21/2/2022

Available online: 1/6/2022

Abstract. The current experiment was conducted during the winter season of 2020/2021 in one of the fields belongs to Horticulture and landscape Engineering Department / College of Agriculture / University of Qadisiyah in order to find out the effect of spraying high phosphorus solution and potassium sulfate on growth and yield of *Vicia faba* cv. local. The experiment included nine factorial treatments: the interaction between spraying with an activator solution contains high phosphorus at concentrations of 0, 1 and 2 g. L⁻¹ and spraying with potassium sulfate at concentrations of 0, 1 and 2 g L⁻¹ also and their interaction in a complete random block design with three replicates. Results showed that spraying with high phosphorus solution at their two concentrations increased all parameters studied especially at a concentration of 2 g.L⁻¹ such as plant height, number of branches, chlorophyll content, number of pods, pod weight, seed weight and plant yield which recorded values of 88.00 cm, 4.48 branches, 43.78 Spad, 14.50, 19.79 g, 3.83 g and 286.95 g, respectively. Same results were found for potassium sulfate, where the highest concentration gave the highest values except the number of pods which did not differ from the control treatment, and the weight of the pod, where the two concentrations were not differ significantly from each other although they exceeded the control treatment in their effect. With regard to the interaction between the two factors, the combination of the higher concentration of both substances was superior in giving the highest values of the parameters studied except for the number of pods which recorded the highest value at the combination treatment of 1 g. L⁻¹ of phosphorus and 0 g. L⁻¹ of potassium.

Keywords. Phosphorus, Potassium sulphate, Number of branches, Weight of pod, Plant yield.

I. INTRODUCTION

Faba bean (*Vicia faba* L.) belongs to fabaceae family, which is considered as a cheap source of food for millions of people in different poor countries of the world because of its high nutrient value such as protein content which reach up to 22-36% and carbohydrates and some mineral elements such as calcium and iron and some vitamins such as A, B1 and B2 (Buras et al., 2011). In addition to its important as a human food crop, it is used as green fodder in many European countries (Shefaq et al., 2008), and as an improvement agent for soil fertility through the fixation of nitrogen by the root nodules (Tang et al., 2018).

The use of foliar application with nutrients is an effective way to improve the vegetative and fruit growth of crops because of easy and quick absorption of nutrients by leaves. Potassium, a positively charged ion, is a major macro-nutrient needed by plants and it is known for his role as a cofactor in chlorophyll biosynthesis, carbohydrate translocation, and an activators for those enzymes responsible for protein synthesis. Therefore, its deficiency resulted in reducing the photosynthesis and thus the accumulation of carbohydrates [1]. It also regulates the water content in the plant cells. It is found in the form of organic or mineral salts, which increases the osmotic pressure of the cell sap and thus helps absorb water and nutrients from the soil [2]. Several studies have shown the positive role of potassium in plant growth. Potassium spraying at a concentration of 5 g. L⁻¹ resulted in a significant increase in the number of branches, leaf area, dry weight of vegetative part, number of seeds per pod, dry weight of pod and plant yield of peas [3]. [4], reported that the use of potassium leaf spray on *Curcuma alismatifolia* increased the plant height and the number of leaves and reduced the period from planting to flowering. [5], found that the addition of potassium sulfate at different concentrations resulted in a marked increase in vegetative and flowering growth of tuberose plant.

Phosphorus is also a macro- nutrient that contributes to increase the vegetative growth and yield and plays a major role in various plant biological and biochemical processes such as converting sugar to starch and cellulose, thus contributing in increasing yield and its components [6]. [7,8], found that phosphate fertilizers had a clear effect on the growth and yield characteristics of faba bean. [9], reported that the use of phosphorus at a level of 60 kg P₂O₅ per hectare significantly

increased the leaf area, number of branches and dry matter, in addition to the number of pods of two varieties of peas; [10], found that the use of phosphate fertilizer at 45 kg P₂O₅ per feddan resulted in increased plant height, number of leaves, leaf area, number of pods per plant, number of seeds per pod, and total yield of peas plants. These increases were attributed to phosphorus contribution to nitrogen fixation in legume plants.

II. MATERIALS AND METHODS

The current experiment was conducted in the fields of Horticulture Department / College of Agriculture/ University of Al-Qadisiyah during the winter season 2020-2021 on *Vicia faba* L. plant local variety. Seeds were sown directly in the field on 19/11/2020 after the preparation of soils according to all required practices. Land was divided into furrows with a distance of 75 cm between each two. There were 27 experimental units with a 30cm distance between two plants. Planted seeds was sown in the upper third part of the furrow and at a depth of 5 cm. Three seeds were placed in each joura and thinned to one plant per joura three weeks after germination. All the agricultural practices used in the production of this crop were carried out such as irrigation, weeding, fertilization, and pest control in a uniform manner for all experimental units in the field.

The experiment included two factors with their interactions: spraying with an organic compound containing high level of phosphorus with three concentrations of 0, 1 and 2 g. L⁻¹ and spraying with potassium sulfate in three concentrations also which were 0, 1 and 2 g. L⁻¹. The first spray was done after one month of planting, and the second before flowering. Spraying was done early in the morning. Treatments were lay out in complete randomized block design with three replicates. The results were analyzed using the variance analysis table and treatment means were compared with the LSD test at a probability level of 0.05. At the end of the growing season, plant height, number of plant branches, plant leaf content of total chlorophyll expressed in Spad unit, number of pods per plant, weight of pod, seed weight and total yield were measured.

III. RESULTS AND DISCUSSION

Results in Table (1) showed that the two concentrations of phosphorus caused significant increase in plant height which reached 82.00 and 88.00 cm for 1 and 2 g. L⁻¹ for the phosphorus, respectively compared to 67.67 cm for the control treatment and with a significant difference between the two concentrations. As for potassium, it was found that the concentrations used also increased plant height, which reached 80.67 cm at the concentration of 1 g. L⁻¹ and 84.56 cm at a concentration of 2 g. L⁻¹ of potassium while plant height was 72.44 cm for control treatment. As for the

TABLE 1. Effect of spray with different concentrations of potassium sulfate (K) and phosphorus (P) and their interaction on plant height of faba bean.

Mean	Potassium sulfate Con. (gm.L-1)		Phosphorus Conc. (gm.L-1)		
	K2	K1	K0		
67.67	73.77	71.33	58.33	P0	
82.00	88.00	83.33	74.67	P1	
88.00	92.33	87.33	84.33	P2	
1.94	2.45	LSD 0.05			
	84.66	80.67	72.44	Mean	
	1.94	LSD 0.05			

interaction between the factors, the highest plant height was recorded at the combination treatment of the higher concentrations of the two substances while the lowest height of the plant (58.33 cm) was recorded at the combination of phosphorus at a concentration of 0 g. L⁻¹ and potassium at a concentration of 0 g. L⁻¹ also.

As for the number of branches, it was clear from the results of Table (2) that phosphorus at both concentrations have significantly increased the number of branches per plant compared to the control treatment. The highest number of branches was (4.48) at a concentration of 2 g. L⁻¹ of phosphorus. The number of branches increased as the concentration of potassium increased which reached 3.66, 3.98 and 4.41 for concentrations of 0, 1 and 2 g. L⁻¹ of potassium respectively. The interaction between the two factors had a significant effect in increasing the number of branches and the highest number of branches was recorded at the combination of the highest concentration of both phosphorus and potassium (4.93) while the lowest number of branches (2.70) was at the control treatment.

TABLE 2. Effect of spray with different concentrations of potassium sulfate (K) and phosphorus (P) and their interaction on number of branches per plant of faba bean.

Mean	Potassium sulfate Con. (gm.L-1)		Phosphorus Conc. (gm.L-1)		
	K2	K1	K0		
3.44	4.03	3.60	2.70	P0	
4.12	4.27	4.03	4.07	P1	
4.48	4.93	4.30	4.21	P2	
0.30	0.52	LSD 0.05			
	4.41	3.98	3.66	Mean	
	0.30	LSD 0.05			

The increase in plant height and number of branches due to the addition of potassium may be attributed to its role in stimulating many physiological processes within plant body, especially the transport and storage of photosynthesis products and its role in preserving the water content of the plant [11], as well as its role in many metabolic processes via activating many enzymes, thereby stimulating cell division and increasing plant growth in general [12], as well as increasing root activity and increasing its efficiency in absorption of nutrients from the soil and the formation of vigor vegetative part [13]. The results for increasing vegetative growth are consistent with the results of [14], which found that the spraying potassium on liliun plant led to an increase in all parameters growth. The stimulating role of phosphorous on plant height and number of branches is due to the fact that phosphorus is a major important nutrient for plant growth, where phosphorus plays a significant role in many biochemical processes and contributes to nitrogen fixation in leguminous plants, and therefore, plant growth [15], results agreed with the result of [16], on peas and [17] on *Phaseolus vulgaris* cv. Contender who used four levels of phosphate fertilizer (0, 40, 80 and 120 kg P₂O₅. Ha⁻¹) and found that the 80 kg P₂O₅. Ha⁻¹ was best treatment in increasing plant height, number of branches and dry matter of the vegetative part of plant in compare with the high level of 120 kg and other levels.

For chlorophyll (Table 3), it was also increased with the increased in concentration of both phosphorus and potassium when they used separately. The chlorophyll content was 43.78 and 42.52 Spad at the high concentration of phosphorus and potassium, respectively. As for the interaction for the two factors, they had a clear effect on the chlorophyll content. The highest content was recorded at the combination of phosphorus at 2 g. L⁻¹ and potassium at 2 g. L⁻¹ which was 49.52 Spad, while the content was 30.03 for the control. The observed increase in chlorophyll leaf content may be due to the fact that potassium is a catalyst chlorophyll biosynthesis via activating the enzymes responsible for its biosynthesis [18].

TABLE 3. Effect of spray with different concentrations of potassium sulfate (K) and phosphorus (P) and their interaction on leaf chlorophyll content (Spad unit) of faba bean.

Mean	Potassium sulfate Con. (gm.L ⁻¹)	Phosphorus Conc. (gm.L ⁻¹)		
	K2	K1	K0	
35.18	39.40	36.01	30.31	P0
39.74	38.90	40.77	39.57	P1
43.78	49.27	42.57	39.50	P2
1.85	3.20	LSD 0.05		
	42.52	39.78	36.40	Mean
	1.85	LSD 0.05		

Results of Table (4) showed that the number of pods increased significantly due to phosphorus treatment, especially at the higher concentration, where the number was 14.50 pods per plant compared to 11.72 for the control. However, the increase in the number of pods due to potassium treatment was insignificant. As for the effect of the spray with phosphorus and potassium together, the combination of the high concentration of both materials recorded the highest number of pods (16.50 pods per plant), which represent twice the number of pods at zero concentration of both materials, where the number was only 8.17 pod.plant⁻¹. The positive role of phosphorus is due to the fact that it is an important factor in carbohydrate transport, which as a result increases the number of pods per plant [19]. These results regarding the increase in number of pods per plant with phosphorus treatment are consistent with the results of [20], who stated that phosphorus significantly increased the leaf area and the number of branches in addition to the number of pods of two varieties of peas; Ater and Dekoko.

TABLE 4. Effect of spray with different concentrations of potassium sulfate (K) and phosphorus (P) and their interaction on number of pods per plant of faba bean.

Mean	Potassium sulfate Con. (gm.L ⁻¹)	Phosphorus Conc. (gm.L ⁻¹)		
	K2	K1	K0	
11.72	12.17	14.83	8.17	P0
13.83	12.33	12.00	17.17	P1
14.50	16.50	14.00	13.00	P2
2.00	3.48	LSD 0.05		
	13.67	13.61	12.78	Mean
	NS	LSD 0.05		

There was also an increase in pod weight and seed weight at the higher concentration of phosphorus and potassium used (Tables 5 and 6). For phosphorus, the recorded pods weights were 14.43, 16.92 and 19.79 g. while seed weights were 3.51, 3.22 and 4.49 g at 0, 1 and 2 g. L⁻¹ of phosphorus, respectively. Similarly, for potassium, there was a marked increase in pod weight and seed weight by treatment with the two concentrations. In terms of the interaction, the highest pod and seed weight were recorded at the combination treatment of the high concentration of both phosphorus and potassium, while the control treatment recorded the lowest weights. This result is consistent with the results of [21], which indicated that the addition of phosphorus by spraying on shoot of cowpea plant at a rate of 120 kg. Ha⁻¹ of P₂O₅ gave the highest weight of 100 seeds.

TABLE 5. Effect of spray with different concentrations of potassium sulfate and phosphorus and their interaction on pod weight (g) of faba bean.

Mean	Potassium sulfate Con. (gm.L-1)		Phosphorus Conc. (gm.L-1)		
	K2	K1	K0		
14.43	16.84	16.30	10.14		P0
16.92	19.75	15.10	15.91		P1
19.79	22.41	18.67	18.28		P2
0.52	0.91	LSD 0.05			
	19.66	16.69	14.78		Mean
	0.52	LSD 0.05			

TABLE 6. Effect of spray with different concentrations of potassium sulfate (K) and phosphorus (P) and their interaction on seed weight (g) of faba bean.

Mean	Potassium phosphate Con. (gm.L-1)		Phosphorus Conc. (gm.L-1)		
	K2	K1	K0		
2.86	3.15	2.97	2.86		P0
2.91	3.22	2.58	2.96		P1
3.83	4.49	3.31	3.69		P2
0.25	0.43	LSD 0.05			
	3.74	2.95	2.92		Mean
	0.25	LSD 0.05			

As for the plant yield, it is clear from the results of table (7) that phosphorus at both concentrations have increased significantly in plant yield which reached the amount of 234.00 and 286.95 g. plant⁻¹ at 1 and 2 g. L⁻¹ of phosphorus, respectively, compared to control treatment (169.11 g. Plant⁻¹). This finding is consistent with the results of [22], which found that the use of phosphorus at three levels has increased the yield of *Vigna raddita* and also with the results of [23], on peas. Potassium was also increased the plant yield as its concentration used increased. The highest yield was achieved at the highest concentration (268.75 g. plant⁻¹) and the lowest was at control treatment (188.88 g. plant⁻¹). These results are consistent with the results of both Hussein and Rabie, (2009) and El-Sayed (2012). Interaction between the two materials had positive effect on yield, where the highest plant yield was achieved at the combination of the two high concentrations of both substances amounted of 369.76 g. plant⁻¹ followed by a combination of 1 g. L⁻¹ of phosphorus and 0 g. L⁻¹ of potassium and which amounted of 273.17 g. plant⁻¹

TABLE 7. Effect of spray with different concentrations of potassium sulfate (K) and phosphorus (P) and their interaction on plant yield (g pods. plant⁻¹) of faba bean.

Mean	Potassium sulfate Con. (gm.L-1)		Phosphorus Conc. (gm.L-1)		
	K2	K1	K0		
169.11	204.94	241.72	82.84		P0
234.00	243.51	181.20	273.17		P1
286.95	369.76	261.38	237.64		P2
9.50	12.15	LSD 0.05			
	268.75	227.15	188.88		Mean
	9.50	LSD 0.05			

It can be concluded from the above results that the spraying of phosphorus and potassium has a positive role in growth and yield characteristics of faba bean plant. The interaction between the two factors also has a greater stimulating effect in increasing the values of the parameters studied.

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