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EFFECT OF POTASSIUM AND BORN ON GROWTH AND PRODUCTIVITY OF BROAD BEAN IN SANDY SOIL - BALOZA-NORTH SINAI

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ABSTRACT

The experimental field is located at 31̊ 3′ 0" N 32̊ 36′ 0" E. Broad bean crop is cultivated in winter season 2019.The objective of this work was to study the effect of B and K as foliar application at rates of 50, 75 ppm for B while 1000 and 2000 ppm for K as silicate and K sulphate on growth and productivity of broad bean grown sandy soil at Baloza station-North Sinai. The obtained results indicated that the yields components of broad bean were improved with increasing B application. The K –forms took the same behavior of B where the K2 showed the higher effect on the yield parameters than K1. The K silicate had the priority than sulphate. The nutrients concentrations increased with increasing rates of K and the silicate forms gave higher values than sulphate forms. Also N, P, K and B uptake had the same behavior as nutrients concentrations. The most efficient treatment was found where using the second rate of both B and K silicate form which achieved 2.92 and 1.11 ton/ fed of shoots and seeds broad bean plants and noticed that highest K- utilization of yields (shoot + seeds) with K- silicate form addition.

INTRODUCTION

Faba bean (*Vicia faba*, L.) is one of the most important leguminous crops used as a human diet in many countries. Sandy soils encourage rapid loss of added fertilizers and hence, they are mostly poor in their nutrient contents.

B is one of the essential elements for plant growth and productivity, especial importance in retaining flowering and fruit setting. It is leachable in sandy soils. Researches have been done on Boron foliar application near pod setting and seed –filling stages (**Zhang, 2001**). **Shaaban, *et al.*, (2004)** reported that the boron deficiency found to affect plant growth and reduced yields. Better growth and good yields were obtained when crops were supplied with boron (**Gupta, 1989** & **Li and Liang, 1997**). **Shaaban and El-Fouly, (2001)** reported that boron application increased phosphorus uptake by faba bean roots. **Mola, *et al.*, (1998)** reported that the Ca, B and K/Na ratios declined in leaves of faba bean as a response of boron application. Boron has a synergetic effect on nitrogen and other nutrients uptake and utilization by faba bean plants, in sandy soil **(Mahmoud, *et al.*, 2006**).

Potassium is an important nutrient for plant growth and physiological functions, including regulation of water and gas exchange in plants, protein synthesis, enzyme activation, and photosynthesis and carbohydrate translocation in plants. Potassium has favorable effects on metabolism of nucleic acids, proteins, vitamins and growth substances **(Bednarz and Oosterhuis, 1999**). **Wang, *et al.*, (2013)** and **Salami and Saadat, (2013)** pointed out that the K plays an essential roles in enzyme activation, protein synthesis, photosynthesis, osmoregulation, stomata movement, energy transfer, phloem transport, cation-anion balance and stress resistance. The foliar applications of K can improve yield and quality, especially in heavy clay or in sandy soils where K is not readily available for the plants (**Marchand and Bourrie, 1999**). Various sources of K salts are used for plants nutrition such as potassium chloride (KCl), potassium sulphate (K_2SO_4), mono potassium phosphate (KH_2PO_4), and potassium nitrate (KNO_3) (**Magen, 2004**). Also potassium silicate ($K_2O.4SiO_2$) caused very good results to improve the growth and yield of plants under saline conditions (**Salim, *et al.*, 2011** & **2013** and **Salim, 2014**). Sufficient potassium help plants resist frost, drought and certain diseases. **Tahir, *et al.*, (2006)** reported that potassium has a significant role in improving plant water status and mitigating the toxic effects of Na.

Silicon has not been proven to be an essential element for higher plants, but its beneficial effects on growth have been reported in a wide variety of crops, including rice, wheat, barley and cucumber. Si fertilizer is applied to crops in several countries for increased productivity and sustainable production **(Ma, *et al.*, 2001).** The amount of Si in soil may vary considerably from 1 % to 45 % **(Sommer, *et al.*, 2006).** Most Si is present in the soil as insoluble oxides or silicates, but plants can easily absorb silicic acid Si $(OH)_4$ from soil. Silicic acid is generally found in the range of 0.1-0.6 mM in soils **(Epstein, 1994 & 1999)** The agricultural benefits of silicon amendments on a soil ecosystem are well established. Silicon has been shown to mitigate adverse effects of water, mineral deficiency **(Ma, *et al.*, 2001)** and alleviate the effects of biotic stresses including salt stress, metal toxicity and nutrient imbalance (**Ma, 2004).**

Pandey and Yadav, (1999) reported that spraying silicon increased grain yield/plant of wheat. As well as increase in plant water status, chlorophyll content, biological yield and harvest index, coupled with reduced values of water potential, increase in dry matter accumulation, dry matter production rate, leaf area/ plant at the flowering stage, productive tillers, grains and grain yield/main spike and per plant and transpiration rate coupled with a decrease in stomata conductance. Silicon application correct to some extent the negative effects of salinity either on growth, yield, nutrients uptake.

Concerning the nutrients effect on other nutrients concentration and uptake, **Ati and Ali, (2011)** reported that the nitrogen and phosphorus percentage (%) of dry weight and as uptake by beans increased with increasing rate of boron applications. **Hossain, *et al.*, (2011)** reported that the effect of B on the nutrient uptake of six elements followed the order K> N> S> P> B> Zn and these were significantly influenced by increasing B application. **Khattab, *et al.*, (2016)** reported that the spray foliar application of boron (150 ppm), potassium sulphate (2%) and potassium phosphate (1.5%) significantly increased all the studied characters, with superiority the interaction of boron 150 ppm and potassium phosphate 1.5% which caused the highest increases in all the studied characters. **Taha, *et al.*, (2016)** decided that the mean values of vegetative growth parameters as (plant height, fresh and dry weight as well as leaf area), fresh weight of pods and seeds of faba bean, N, P, K, Fe in plant foliage and seeds were increased significantly with increasing rates of potassium fertilizers. **Siam, *et al.*, (2018)** stated that the N, P and K content and uptake by shootss, and grains increased by Si addition as they compared with those without Si addition.

Fertilizer efficiency is an objective for all involved in agriculture, the fertilizer industry, and researchers to helping farmers to increase crop yield. This describes between yield, nutrient efficiency, and the environment was soundly suitable by **Dibb (2000).** The Present investigation aimed to study the effect of Boron (B) as foliar application and some sources of potassium (K) fertilization (sulphate and silicate) and their interaction on yield and yield component as well as the chemical composition of shoots, seeds and their K –utilization efficiency of broad bean plants grown in sandy soil under drip irrigation system at Baloza station at North Sinai.

MATERIAL AND METHODS

A field experiment was carried out at Baloza Research Station of the Desert Research Center, Egypt, located at 31° 3′ 0" N 32° 36′ 0" E. Using Broad bean crop in winter season 2019.The main target is to study the effect of B and K as foliar application at rate 50, 75 ppm for B as (Boric acid 17% B) while 1000 and 2000 ppm for K as (silicate or sulphate) [K_2SO_4 (contained 50% K_2O) or K_2SiO_3 (contained 10% K_2O and 25% SiO_2)] on growth and productivity of broad bean grown in sandy soil at Baloza station, North Sinai.

The studied treatments are compared with farmer treatment in the region. The treatments (B) and (K) were added foliarly after 25 & 50 and 75 days after sowing (DAS). Broad bean seeds were sown at 1 November, 2018, in rows spacing 70 cm .w and 20 cm between seeds/hills (30,000 plant/fed). All treatments received 30 kg P_2O_5/fed as ordinary superphosphate, 75 kg N/fed as ammonium sulphate (20.5% N) and half douse of potassium sulphate (25% K2o). Compost as organic manure at rate of 20 m^3/ fed and P were added during soil preparation .While nitrogen fertilizer was applied in three equal doses at sowing and after 25 & 50 and 75 days from planting.

The experiment was carried out in a split plot design with three replications (**Snedecor and Cochran, 1967**), where the main factor was the foliar application of B and sub main was K sources. The experiment was irrigated using drip irrigation system. Some physical and chemical properties of the studied soil were determined acceding to **Page *et al.*, (1982)** and **Klute (1986)**, as recorded in Table (1).

Table (1). Initial status of some physical and chemical properties of the experimental soil

Soil depth (cm)	pH Soil past	E. C dsm^{-1}	Soluble Cations (me/l)				Soluble Anions (me/l)			Texture class
			Ca^{++}	Mg^{++}	Na^+	K^+	HCO_3^-	$SO4^=$	Cl^-	
0 - 30	8.04	1.07	2.24	3.17	4.66	0.64	4.13	3.18	3.40	Sandy
Available nutrients (ppm)	N		P		K		Fe	Mn	Zn	Cu
	34		3.2		46		5.52	2.18	0.97	0.28

pH: Acidity **E.C**.: Electrical conductivity **me/l**: mille equivalent per liter.

Chemical analysis of the irrigation water was presented in Table (2). It is clear that such water having pH value of 7.23, which mean that it enriched with soluble alkaline ions. It is also having EC value of 2.60 dS/m and SAR value of 3.06, which mean that, it is suitable for irrigation **Ayers and Westcot (1985)**.

Table (2). Chemical analysis data of the used irrigation water.

Parameters	pH	E.C (dSm^{-1})	Soluble cations (me/l)				Soluble anions (me/l)			SAR
			Ca^{++}	Mg^{++}	Na^+	K^+	HCO_3^-	Cl^-	$SO_4^=$	
Values	7.23	2.60	13.90	0.43	8.20	3.50	6.0	15.20	4.80	3.06

At maturity (150 days after sowing) the plants were harvested. Number of pods per plant, number of seeds per pod, seed yield/ (Fed) and shoots yield (ton/Fed) were determined of the seeds and shoots were ground and wet digested using mixture of H_2SO_4 and $HClO_4$ as recommended by **Peterburgski (1968)** and the following chemical analyses were carried out:

- Total nitrogen was determined using Microkjeldahl method, Phosphorus was calorimetrically determined using ascorbic acid and ammonium Molybdate **(Jackson, 1958)**. Potassium was determined by flame Photometric and (B) by atomic absorption spectrophotometry, all were determined according to the methods described by **Chapman and Pratt, (1961)**.
- Protein content was calculated by multiplying the N concentration with factor 6.25.
- The equation used for calculating K- utilization efficiency (KUTE) according to **Graham, *et al.*, (1992).**
- (KUTE) = (kg dry matter /kg uptake).

  Nitrogen, P, K and B available in soil at the end experiment were determined according to the methods described by **Klute (1889)**.

RESULTS AND DISCUSSION

Effect of foliar Boron and K on yield components of broad bean:

Data in table (3) showed that the yield components of broad bean were increased with increased B application. The K –forms took the same behavior where the K2 showed the higher effect on yield parameters than K1. The K silicate showed superior effect on yield components than sulphate. The superior treatment was the 1st rate of B and the 2nd rate of K silicate which achieved 2.92 tons seeds per fed. This variation in the yield may be due to the potassium forms. These results agreed with the obtained by **Marchand and Bourrie, (1999); Salim *et al.*, (2011); Abou-Baker *et al.*, (2011); Salim, (2014)** and **Mahmoud *et al.*, (2019).**

Also, the increasing effect of potassium silicate may be due to the positive impact of due to its role in improving physical, chemical and biological condition of soil, its direct effect attributed to its metabolic activity in plant growth. Therefore when plants were treated with potassium, chlorophyll contents were increased which enhanced overall photosynthetic activities of plants and thereby yield. These results are in agreement with **(Abdo *et al.*, 2001)** who reported that the addition of 1 kg K_2O/fed, as foliar spray, to bean plants significantly increased number of pods/plant, weight, seed yield/plant and seed yield/ (Fed). Silicate solutions had the superiority effect compared with sulphate solutions. This may be refer to silicon which promotes the growth of various higher plant species **(Zhu *et al.*, 2004),** although there is a plenty supply of sulphate by addition of all commercial fertilizers and rarity of silicate supply.

Table (3). Effect of treatments on yield parameters at harvesting of broad bean plants

*B Rates	K Forms	*K Rates	No. of Plant		Weight (g plant^{-1})		Weight (ton fed^{-1})	
			Pods	Seeds	Pods	Seeds	Shoots	Seeds
Control			1.50	1.37	9.01	7.99	0.61	0.24
B1	Sulphat	1	3.67	3.33	21.97	19.50	1.48	0.58
		2	5.00	4.33	27.10	25.37	2.07	0.76
	Silicate	1	4.33	3.67	27.53	25.20	1.69	0.76
		2	5.33	4.67	32.30	30.80	2.31	0.94
B2	Sulphat	1	5.00	4.67	30.70	28.47	2.17	0.85
		2	5.67	5.33	32.40	30.64	2.38	0.91
	Silicate	1	5.33	4.67	35.40	32.78	2.69	0.98
		2	6.33	5.00	40.27	37.17	2.92	1.11
Farmer			3.33	2.67	17.53	12.96	1.13	0.41
Means of Treatments								
Means of B rates		1	4.58	4.00	27.2	25.2	1.89	0.760
		2	5.58	4.92	34.7	32.3	2.54	0.963
Means of K	Sulphat	1	4.34	4.00	26.3	24.0	1.83	0.715
		2	5.34	4.83	29.8	28.0	2.23	0.835
	Silicate	1	4.83	4.17	31.5	29.0	2.19	0.870
		2	5.83	4.84	36.3	34.0	2.62	1.03
LSD $_{(0.05)}$								
LSD $_{(0.05)}$ Boron			0.655	Ns	0.618	0.748	35.7	28.5
K-forms			Ns	Ns	0.222	0.690	7.33	22.8
K-rates			0.720	0.544	0.604	0.539	9.03	18.4
Boron x K-forms			2.54	Ns	0.314	Ns	10.4	Ns
Boron x K-rates			Ns	Ns	0.854	0.762	12.8	26.0
K-forms x K-rates			1.02	Ns	0.854	Ns	12.8	26.0
Boron x K-forms x K-rates			Ns	Ns	1.21	1.08	Ns	Ns

***B Rates as B1, 2= 50, 75 mgL^{-1} or *K Sulphate or Silicate Rates as1, 2= 1000, 2000 ppm.**

Effect of foliar Boron and K on nutrients concentrations of broad bean

Data in table (4) clearly showed that nutrients concentration were increased with increasing, also rates of both B and K silicate forms showed the high effect on nutrients concentrations than sulphate forms. The most efficient treatment was the addition of the 2nd rate of boron and potassium silicate which achieved highest concentrations of nutrients as following 1.34 and 2.58% of N, 0.17 and 0.31% of P, 1.70 and 164% of K and 18.80 and 24.40 ppm of B ppm in shoots and seeds respectively. The provirus results are agreed with the obtained by **Mola *et al.*, (1998); Shaaban and El-Fouly, (2001); Shaaban *et al.*, (2004)**; **Mahmoud *et al.*, (2006)** and **Mahmoud *et al.*, (2019).**

Table (4). Effect of treatments on nutrients concentration in shoots and seeds of broad bean plants

*B Rates	K Forms	*K Rates	N (%)		P (%)		K (%)		B (ppm)	
			Shoots	Seeds	Shoots	Seeds	Shoots	Seeds	Shoots	Seeds
Control			0.34	0.86	0.06	0.09	0.56	0.46	0.23	0.34
B_1	Sulphat	1	0.83	2.10	0.14	0.22	1.36	1.11	15.97	19.30
		2	0.87	2.13	0.14	0.23	1.43	1.21	16.40	19.73
	Silicate	1	1.15	2.43	0.15	0.26	1.51	1.41	16.70	20.37
		2	1.17	2.49	0.16	0.26	1.56	1.48	17.87	21.07
B_2	Sulphat	1	0.93	2.24	0.15	0.24	1.46	1.31	16.93	20.70
		2	1.09	2.33	0.15	0.25	1.48	1.37	17.63	22.93
	Silicate	1	1.29	2.52	0.17	0.27	1.64	1.58	18.43	21.17
		2	1.34	2.58	0.17	0.31	1.70	1.64	18.80	24.40
Farmer			0.75	2.06	0.16	0.22	1.13	0.97	6.55	7.91
Means of treatments										
Means of B Rates		1	1.01	2.29	0.148	0.243	1.47	1.30	16.7	20.1
		2	1.16	2.42	0.160	0.268	1.57	1.48	17.9	22.3
Means of K	Sulphat	1	0.88	2.17	0.145	0.230	1.41	1.21	16.5	20.0
		2	0.98	2.23	0.145	0.240	1.46	1.29	17.0	21.3
	Silicate	1	1.22	2.48	0.160	0.265	1.58	1.50	17.6	20.8
		2	1.26	2.54	0.165	0.285	1.63	1.56	18.3	22.7
$LSD_{(0.05)}$										
Boron			0.020	0.038	0.0024	0.0013	0.018	0.011	0.459	0.542
K-forms			0.029	0.041	0.0013	0.0028	0.019	0.011	0.362	0.406
K-rates			0.012	0.016	0.0012	0.0019	0.008	0.015	0.252	0.269
Boron x K-forms			Ns	0.058	0.0019	0.004	0.027	Ns	Ns	Ns
Boron x K-rates			0.017	Ns	Ns	0.0026	0.012	Ns	Ns	0.380
K-forms x K-rates			0.017	Ns	0.0017	0.0026	Ns	Ns	Ns	0.380
Boron x K-forms x K-rates			0.025	0.031	Ns	0.0037	0.017	Ns	0.504	Ns

*B Rates as B1, 2= 50, 75 mgL^{-1} or *K Sulphate or Silicate Rates as1, 2= 1000, 2000 ppm.

Data presented in Table (5) showed that, effect of foliar application K form (sulphat and silicate) on K- utilization by dry matter yields (shoot + seeds) in Broad bean plants. As for the effect of K foliar on k-utilization they are found that, highest K-utilization on yields of Broad bean were with K – silicate form addition high rate and were 62.32 kg/ fed compared with control treatments. And noticed that, low K-utilization with K-sulfate form addition and were 70.98 kg with low rate of K sulphate form addition.

Table (5). Effect of treatments on Potassium utilization in shoots and seeds of broad bean plants.

*B Rates	K Forms	*K Rates	Yield	K Uptake	K Uti.
Control			849.70	4.52	188.04
B1	K Sulphate	1	2061.00	26.57	77.57
		2	2834.33	38.79	73.08
	K Silicate	1	2446.00	36.15	67.67
		2	3250.67	49.93	65.11
B2	K Sulphate	1	3024.00	42.83	70.62
		2	3293.33	47.82	68.88
	K Silicate	1	3677.00	59.80	61.49
		2	4036.33	67.81	59.52
Farmer			1540.00	16.75	91.96
Means of treatments					
Means of B Rates		1	2648.00	37.86	70.86
		2	3507.67	54.56	65.13
Means of K	K Sulphate	1	2542.50	34.70	74.09
		2	3063.83	43.30	70.98
	K Silicate	1	3061.50	47.98	64.58
		2	3643.50	58.87	62.32
*B Rates as B1, 2= 50, 75 mgL^{-1} or *K Sulphate or Silicate Rates as1, 2= 1000, 2000 ppm.					

Effect of foliar Boron and K on nutrients uptake (kg fed^{-1}) by broad bean

Data in figures (1- 4) showed the N (Fig. 1), P (Fig. 2), K (Fig. 3) and B (Fig. 4) uptakes. It is noticed the that the effect of the studied treatments indicated the same effect as showed in these concentrations, where increasing application of both B and K increased the uptake of N, P, K and B. Also, Silicate form indicated the high values compared with sulphate form of K. These results are in agreement with **Ati and Ali (2011); Hossain *et al.*, (2011); Khattab *et al.*, (2016); Taha *et al.*, (2016); Siam *et al.*, (2018)** and **Mahmoud *et al.*, (2019).**

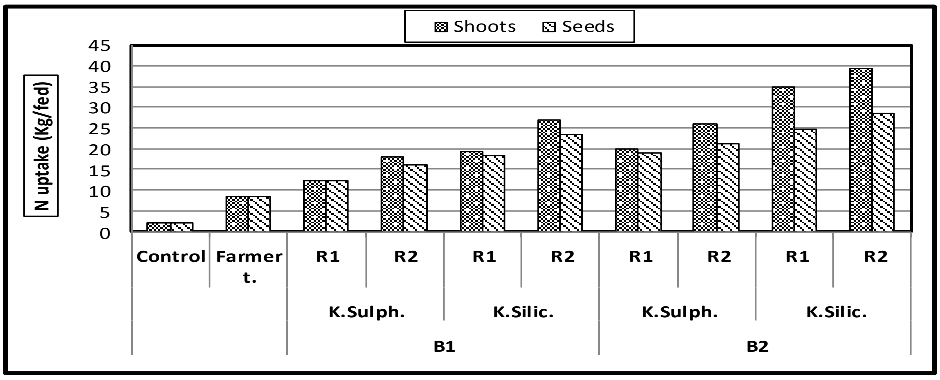

Fig. (1). Effect of treatments on N uptake in shoots and seeds of broad bean plants.
***B Rates as B1, 2= 50, 75 mgL^{-1} or *K Sulphate or Silicate Rates as1, 2= 1000, 2000 ppm.**

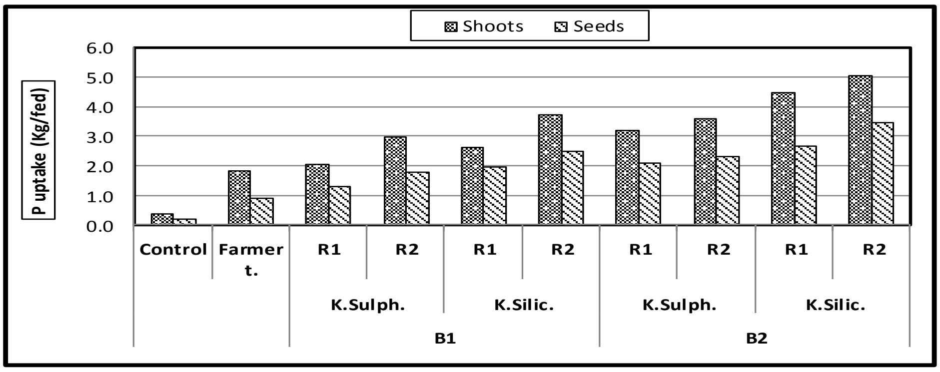

Fig. (2). Effect of treatments on P uptake in shoots and seeds of broad bean plants.
***B Rates as B1, 2= 50, 75 mgL^{-1} or *K Sulphate or Silicate Rates as1, 2= 1000, 2000 ppm.**

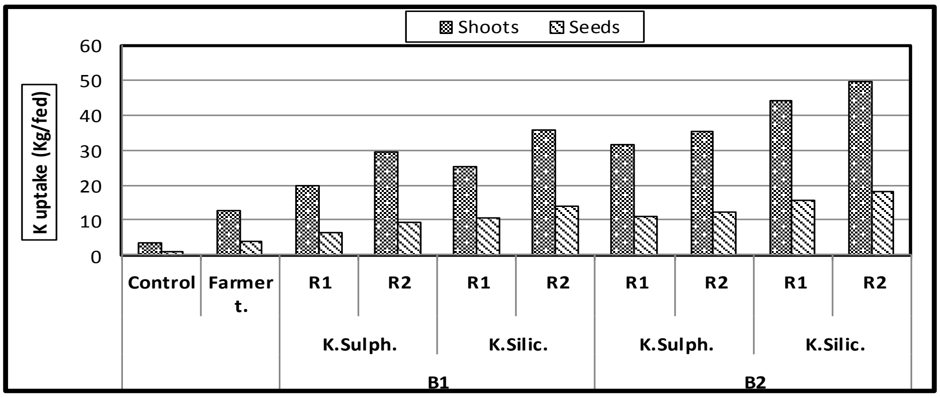

Fig. (3). Effect of treatments on K uptake in shoots and seeds of broad bean plants.
***B Rates as B1, 2= 50, 75 mgL^{-1} or *K Sulphate or Silicate Rates as1, 2= 1000, 2000 ppm.**

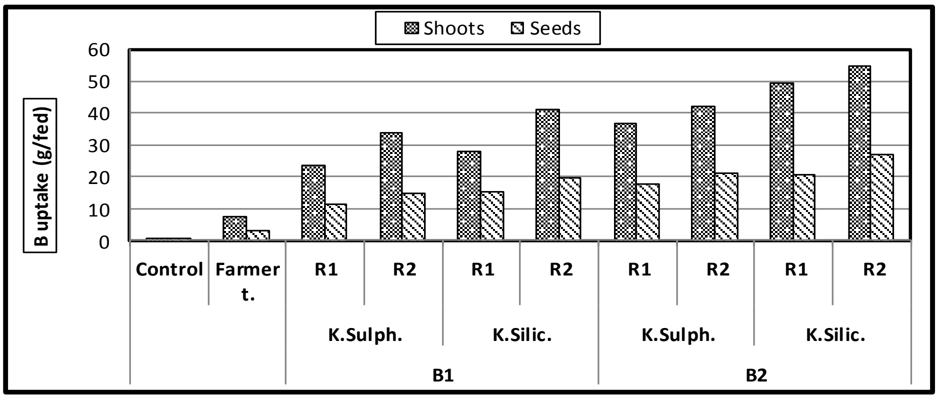

Fig. (4). Effect of treatments on B uptake in shoots and seeds of broad bean plants.
***B Rates as B1, 2= 50, 75 mgL^{-1} or *K Sulphate or Silicate Rates as1, 2= 1000, 2000**

Effect of foliar Boron and K on protein content (%) by broad bean:

At figure (5) it is noticed that bean increased with increasing rates of both B and K. Also, Silicate form of K showed the superior effect compared with sulphate form. Those facts are agreed with the obtained results by **Ati and Ali (2011); Hossain *et al.*, (2011); Khattab *et al.*, (2016); Taha *et al.*, (2016)** and **Siam *et al.*, (2018).**

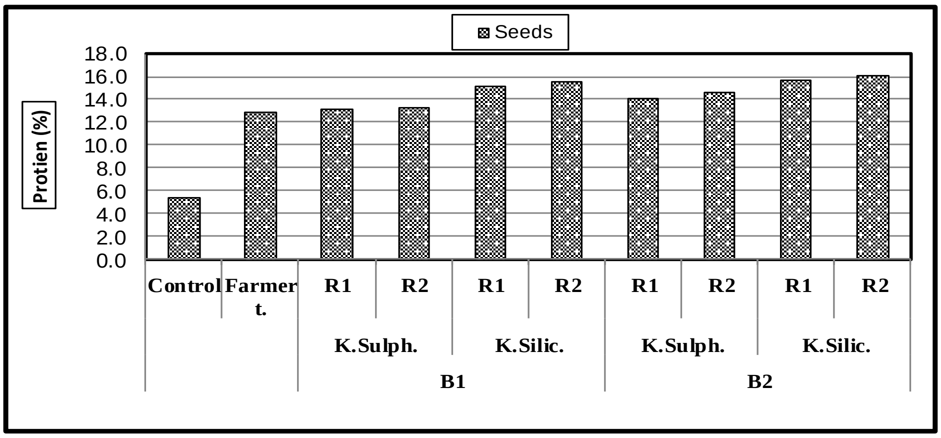

Fig. (5). Effect of treatments on protein content in seeds of broad bean plants.
***B Rates as B1, 2= 50, 75 mgL^{-1} or *K Sulphate or Silicate Rates as1, 2= 1000, 2000 ppm.**

Mineral content in soil after harvesting:

The sandy soil had a much lower exchange capacity and concentration of elements such as N, P, K and B than heavier soil. And suffer from loss of elements by leaching. Data in table (6) showed that the studied available elements after harvesting reveal the flowing: Addition of K fertilization form associated with B increased the extractable amounts of N, P, K and B this increase of elements in soil after harvesting may be due to B and K addition increases nodes of roots hair by Broad bean plants and compost analysis in soil after harvesting. Although, this increase had no arrived to adequate elements of N, P, K and B in soil after harvesting. The following Tables give an interpretation of the index values for P and K for the DTPA soil test **(Soltanpour *et al.*, 1979);** and N by **(Jackson, 1958).**

Category	**P** (mg/kg)	**K** (mg/kg)	**N** (mg/kg)
Low	0 - >4	0 - >60	0 - 40
Marginal	4 -7	60-120	40 - >80
Adequate	<7	<120	<80 - 160

While being the highest extractable amounts of N, P, K and B in soil after harvesting were 40.6 ppm for N, 5.4 ppm for P and 43.4 ppm for K and 0.75 ppm for B at addition of high level of B and K silicate form. It is concluded that plants grown at higher K level and sufficient B had better development of nodules and consequently higher nitrogen fixation, it is due to increase of nutrients in the soil after harvesting.

Table (6). Effect of treatments on available N, P, K and B (ppm) after harvesting broad bean plants.

B Rates	K Forms	K Rates	N	P	K	B
			(ppm)			
Control			12.4	1.1	14.4	0.11
B_1	Sulphat	1	35.4	3.2	41.2	0.62
		2	35.8	3.7	41.3	0.64
	Silicate	1	36.3	4.3	42.4	0.69
		2	37.1	4.5	42.7	0.71
B_2	Sulphat	1	36.2	3.5	41.5	0.66
		2	36.7	4.2	41.6	0.67
	Silicate	1	38.2	4.8	43.1	0.74
		2	40.6	5.4	43.4	0.75
Farmer			24.8	3.3	26.5	0.51
$LSD_{(0.05)}$						
$LSD_{(0.05)}$ Boron			0.37	0.043	0.61	0.021
K-forms			0.49	0.112	0.55	0.010
K-rates			0.66	0.077	0.81	0.011
Boron x K-forms			0.20	0.047	0.23	0.004
Boron x K-rates			0.91	0.106	1.13	0.014
K-forms x K-rates			0.93	0.108	1.14	0.016
Boron x K-forms x K- rates			0.90	0.104	1.10	0.015

CONCLUSION

The aim of work is studding the effect of B and K as foliar application K silicate or K sulphate on growth and productivity of broad bean grown in sandy soil at Baloza station, North Sinai. The yield parameters were increased with B increasing application. The K –forms took the same behavior in the rates where the K2 showed higher effect on yield parameters than K1. The K silicate showed the superior of effect on yield parameters than sulphate. The nutrients concentrations and uptake increased with increasing rates of K and the silicate forms give the better results than sulphate forms. The most efficient treatment was B_2K_2 as silicate which achieved 2.92 ton seeds fed of bean broad.

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تاثير البوتاسيوم والبورون على نمو وانتاجية الفول الرومى بالاراضى الرملية – بالوظة – شمال سيناء

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أقيمت تجربة حقلية على محصول الفول الرومى في فصل الشتاء 2019 وكان الهدف من التجربة هو دراسة تأثير رش البورن والبوتاسيوم على نمو وإنتاجية الفول الرومى في الارض الرملية بمحطة بحوث بالوظه– شمال سيناء وكانت الاضافات بمعدل 50، 75ملجم بورون /لتر والبوتاسيوم 1000، 2000 كجم بوتاسيوم /فدان على صورتين هما سيليكات والكبريتات.

أظهرت النتائج زيادة مكونات المحصول بزيادة معدل رش البورون.كما تأخذ صورالبوتاسيوم المضافة نفس السلوك حيث كان للتركيز الثانى من البوتاسيوم المضاف أعلى تأثير على الإنتاجية من التركيز الاول. وأظهرت سيليكات K التاثير الكبير على مكونات المحصول من تأثير الكبريتات. ولخصت النتائج أن أكثر المعاملات فاعلية في هذه الدراسة كانت إضافة 75 ملجم /لتر من البورون مع 2 كجم /فدان من سيليكات البوتاسيوم حيث أعطت تلك المعاملة 2.92 طن بذور/فدان من الفول مقارنة بالمعاملات الاخرى. كما لوحظ أن أعلى استفادة من السماد البوتاسى بالرش على المحصول (القش + البذور) كان مع البوتاسيوم فى صورة سيليكات .