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Influence of Potassium Fertilization Rates and Spraying with Magnesium on Production and Quality of Faba Bean Yield

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ABSTRACT

The objective of this study was to investigate the influence of spraying with magnesium [0, 100 and 150 ppm] and potassium fertilization rates (35, 50 and 65 kg K_2O /fad.) on *Vicia faba,L* yield and seeds quality. Two field trials were carried out at the Experimental Farm of Agricultural Res., Center, Al-Azhar University, Assuit Governorate, Egypt during two successive seasons of 2016/2017 and 2017/2018 using faba bean cultivar Giza-843. Split plot design was used with three replicates; where potassium fertilization rates were assigned to the main plot, while spraying with magnesium were distributed randomly in the sub plot. Results revealed that the mean values of no. of branches/plant, no. of pods/plant, 100-seed weight, seed and straw yields/fad. and protein percentage of seeds were increased significantly with increasing rates of potassium fertilizers. The highest values were recorded with using 65 kg K_2O / fed. Magnesium spraying with increasing application concentration increased from 0, 100 to 150 ppm had significant increased in all studied characters in both season. The interaction between of potassium fertilization and magnesium spraying improved yield and yield components, of faba bean. Therefore, this study recommends that adding potassium fertilization at the rate of 65 kg K_2O/fad., and spraying with magnesium (150 ppm) in order to improve the production of faba bean under the conditions of Assiut Governorate, Egypt.

INTRODUCTION

Faba bean one of the oldest legume crops in the world with high protein content (about 25% in dry seeds) is also a good source of starch, cellulose and vitamin C. Therefore, they have an increasing importance for human food and animal feed in the future. Consume fresh beans as bean seeds, seeds, beans, conservative beans, and dried seeds.

Potassium plays a vital role as a major nutrient in plant growth and sustainable crop production (Baligar *et al.*, 2001). It maintains cell pressure necessary to expand cells. Helps regulate the osmo of the plant cell, and helps in opening and closing stomata. Plays a key role in activating more than 60 enzymes Bukhsh *et al.*(2011). Objectives aimed at increasing crop productivity and improving quality aim to increase the supply of potassium or the most effective use of potassium. Mohamed and Waleed (2010) showed that the potassium fertilizer with increasing the quantity of K increased significantly the values of no. of the branches/plant, no. of pods/plant, 100-seeds weight, seed yield g/plant. Kasem, Fatma (2012) indicted that seed yield of faba bean / fad. Significantly increased with increasing the level of K fertilization, where 24 kg K_2O /fed. surpassed 12 kg K_2O /fad., level in both seasons. Khattab *et al.*, (2016) found that increased weight of plant, number of branches/plant, number of pods, weight of 100 seed, seed yield (Ton/fad.), straw yield (Ton/fad.) and Protein with increasing amount of potassium fertilization applied the importance of potassium application for good quality yield. Taha *et al.* (2016) results revealed that the mean values weight of pods and seeds, and protein percentage increased significantly with increasing rates of potassium fertilizers. The highest numbers were recorded with using 62.5 kg K_2O./fad. Magda *et al.* (2017) regarding the effect of potassium rates on faba bean plants; yield and its attributes (no. branches and pods /plant, seed index, seed yield g/ plant and Straw yield) and Crude protein % per seeds responded significantly to potassium fertilization. Bezabih (2018) reported that the increase in potassium fertilizer significantly increased the number of pods/plant and 100-seeds weight.

Magnesium is a central part of the chlorophyll molecule and therefore plays a fundamental role in photosynthesis Sun *et al.* (2001). In addition, many metabolic processes are directly affected by magnesium availability. These include numerous enzymatic reactions of photosynthesis, cellular pH control, Ribonucleic acid polymerization and adenosine try phosphate synthesis Laing *et al.* (2000). Magnesium affects the rate of protein biosynthesis. Magnesium also plays a key role in phloem loading and carbohydrate partitioning (Marschner 1995). Yuda and Sergey (2004) indicted that treatment with Mg concentrations (from 1 to 200 ppm) significant increases in seed yield/plant(g).

Thalooth *et al.* (2006) showed that foliar application of magnesium significantly increased number of pods/plant, seed dry wt. g./plant, seed index, seed yield Kg./fad., and straw yield Kg./fad., of Mungbean. Saad *et al.* (2014). Results indicated that Mg significantly increased number of branches/ plant, number of pods/ plant, 100-seed weight and seed yields/fad. of pea. Jarecki *et al.*, (2016) indicated that foliar with magnesium significantly increased crude protein in seeds.

The objective of this study was to investigate increasing faba bean productivity by improving the effect of using potassium fertilization and spraying with magnesium under Assiut, Governorate conditions.

MATERIALS AND METHODS

Two field trials were conducted in at the Agricultural Research Center Farm of Al-Azhar Univ., at Assiut, during 2016/2017 and 2017/2018 seasons to study the influence of spraying with magnesium [0, 100 and 150 ppm] and potassium fertilization rates (35, 50 and 65 kg K_2O /fad.) on faba bean production and seeds quality. A randomized completed blocks design in split plot arrangement with three replications was used, where potassium fertilization rates were assigned at the main plot and magnesium was allocated in the sub plots.

The experimental unit comprised five rows, each 3.5m long and 0.6 m wide (10.5 m^2 in area = 1/400 /fad.

faddan = 4200 m^2). Seeds in a population of 140 thousand plants/fad. were sown on the two sides of rows, in hills 20 cm apart, then thinned to two plants/hill. Seed were sown on October 21st and 19th in 2016/2017 and 2017/2018 seasons, respectively. The preceding summer crop was maize in both seasons. Potassium rates under test as potassium sulphate (48 % K_2O). magnesium was used as magnesium sulphate (Mg SO_4 16%) a source of magnesium and then applied as spraying application at 30 and 60 days after sowing. All other practices were uniformly applied as recommended for faba bean production in the region. The physical and chemical analyses of the experimental site are presented in Table 1.

Table 1. physical and chemical properties of top soil (0 – 30 cm) of the experimental site in 2016 / 2017 and 2017 / 2018 seasons.

Physical analysis	2016/2017	2017/2018	Chemical analysis	2016/2017	2017/2018
Sand (%)	23.70	26.50	Organic matter (%)	0.96	1.03
Silt (%)	38.90	38.40	Available N (ppm)	72.40	74.50
Clay (%)	37.40	35.10	Available P(ppm)	8.60	9.56
			Available K (ppm)	330.15	323.25
Soil texture	Clay loam		pH (s.p. 65)	7.70	7.79
			E.C. (ds. m^{-1})	1.14	1.13
			Total $CaCo_3$ (%)	2.76	2.51

Studied characters:-

A- Yield and yield components:

At harvest, samples of 10 plants were chosen randomly from the inner rows and the following characters were recorded:

1- No. of branches / plant.

2- No. of pods / plant.

3- 100- seed weight (gm):

4- Seed yield (ard./fad.) (ard. = 155 kg).

5- Straw yield (ton/fad.). Seed and straw yields were recorded on the basis of all plants/ plot. The recorded values were used to estimate the corresponding values per fad.

B- Chemical analysis:

At harvesting, seed samples were ground and kept for chemical analysis.

Protein percentage:-

Total nitrogen content in seeds were estimated by using microkjeldahl method as described by A.O.A.C (1980) and percentage of protein was calculated by multiplying the nitrogen percentage by 6.25.

Statistical analysis:-

All data were statistically analyzed according to the technique of analysis variance (ANOVA) as well as significant difference (L.S.D) at 5 % level of probability was computed to defect the differences among the factor means and their interactions according to procedure outlined by Gomez and Gomez, (1984). All statistical analyses were performed using analysis of variance technique by means of MSTAT-C Computer Software.

RESULTS AND DISCUSSION

A- Yield and yield components:

1 – influence of potassium fertilization:

The data shown in the spreadsheet has the following numbers 2, 3, 4, 5 and 6 indicate that increasing potassium fertilization rates from 35, 50 to 65 kg K_2O /fad. Significantly increased yield and yield attributes in both seasons. The maximum values of number of branches / plant, number of pods / plant, 100-seed weight, seed yield (ardab./fad.) and straw yield (ton/fad.) were observed with adding 65 kg K_2O /fad.

These results can be attributed to the role of the potassium element in the metabolism and many processes necessary to maintain and promote plant growth and vegetative development. Furthermore, K plays a key role in many physiological and biochemical processes such as cell division, elongation, carbohydrate metabolism and protein compounds Marschner, (1995). These data were obtained from the following researchers Kasem, Fatma (2012), Khattab *et al.*, (2016), Taha *et al.*, (2016) and Bezabih (2018).

2 – influence of spraying with magnesium:

Data in Tables 2, 3, 4, 5 and 6 reveal that spraying faba bean plants with magnesium significantly increased yield and its components (number of branches / plant, number of pods / plant, 100- seed weight, seed yield (ardab/fad.) and straw yield (ton/fad.).) in both seasons. The highest mean values are recorded in plants treated with magnesium 150 ppm. The positive effect of magnesium on yield and its components may be attributed the importance of a central part of the chlorophyll molecule and therefore plays an essential role in photosynthesis In addition, many metabolic processes are directly affected by Mg availability. These include numerous enzymatic reactions of photosynthesis, cellular pH control, Ribonucleic acid polymerization and adenosine try phosphate synthesis. Magnesium also plays a key role in phloem loading and carbohydrate partitioning Marschner (1995). These values and results are consistent with Thalooth *et al.* (2006) and Saad *et al.* (2014).

3 – Interaction effects:

Data in Tables 2, 3, 4, 5 and 6 declare that the interaction between (potassium x magnesium) had no significant effect on number of branches/plant, seed yield and straw yield/fad. in both seasons. Moreover, the no. of pods per plant and the weight of the seed index were significantly affected by the interaction between potassium fertilization and spraying with magnesium in the first season only.

Table 2. influence of potassium fertilization rates, spraying with magnesium and their interactions on number of branches/plant of faba bean in 2016/2017 and 2017/2018 seasons.

Seasons	2016/2017				2017/2018			
potassium fertilization	spraying with Mg			Mean	spraying with Mg			Mean
Kg K_2O /fad.	Control	100ppm	1500ppm		Control	100ppm	1500ppm	
35	2.18	2.97	3.12	2.76	2.32	3.13	3.51	2.99
50	2.80	3.86	4.20	3.62	3.13	4.21	4.60	3.98
65	3.77	4.52	4.81	4.37	3.57	4.66	5.15	4.46
Mean	2.92	3.78	4.04	3.58	3.00	4.00	4.42	3.81

Seasons	2016/2017		2017/2018	
	F test	L.S.D.	F test	L.S.D.
potassium (K)	*	0.08	*	0.30
magnesium (Mg)	*	0.14	*	0.37
K X Mg	N.S	-	N.S.	-

Table 3. influence of potassium fertilization rates, spraying with magnesium and their interactions on number of pods/plant of faba bean in 2016/2017 and 2017/2018 seasons.

Seasons	2016/2017				2017/2018			
potassium fertilization	spraying with Mg			Mean	spraying with Mg			Mean
Kg K_2O /fad.	Control	100ppm	1500ppm		Control	100ppm	1500ppm	
35	13.02	14.14	14.48	13.88	13.39	14.00	14.88	14.09
50	13.43	14.60	14.95	14.33	13.97	14.27	15.65	14.63
65	14.64	15.31	16.20	15.39	15.01	15.31	17.00	15.78
Mean	13.70	14.68	15.21	14.53	14.12	14.53	15.85	14.83

Seasons	2016/2017		2017/2018	
	F test	L.S.D.	F test	L.S.D.
potassium (K)	*	0.20	*	0.88
magnesium (Mg)	*	0.14	*	0.51
K X Mg	*	0.24	N.S.	-

Table 4. influence of potassium fertilization rates, spraying with magnesium and their interactions on 100-seed weight (gm) of faba bean in 2016/2017 and 2017/2018 seasons.

Seasons	2016/2017				2017/2018			
potassium fertilization	spraying with Mg			Mean	spraying with Mg			Mean
Kg K_2O /fad.	Control	100ppm	1500ppm		Control	100ppm	1500ppm	
35	62.91	66.89	68.98	66.26	64.09	67.22	68.99	66.77
50	68.09	71.98	73.88	71.32	68.02	72.05	73.94	71.34
65	70.29	73.13	73.77	72.40	69.99	72.93	74.10	72.34
Mean	67.09	70.67	72.21	69.99	67.37	70.73	72.34	70.15

Seasons	2016/2017		2017/2018	
	F test	L.S.D.	F test	L.S.D.
potassium (K)	*	0.91	*	0.97
magnesium (Mg)	*	0.66	*	0.64
K X Mg	*	1.15	N.S.	-

Table 5. influence of potassium fertilization rates, spraying with magnesium and their interactions on seed yield (ard./fad.) of faba bean in 2016/2017 and 2017/2018 seasons.

Seasons	2016/2017				2017/2018			
potassium fertilization	spraying with Mg			Mean	spraying with Mg			Mean
Kg K_2O /fad.	Control	100ppm	1500ppm		Control	100ppm	1500ppm	
35	8.16	8.52	8.80	8.49	8.23	8.69	9.10	8.67
50	9.96	10.87	11.52	10.78	9.99	10.97	11.72	10.89
65	10.80	11.73	12.45	11.66	10.93	11.50	12.15	11.53
Mean	9.64	10.37	10.92	10.31	9.72	10.38	10.99	10.36

Seasons	2016/2017		2017/2018	
	F test	L.S.D.	F test	L.S.D.
potassium (K)	*	0.70	*	0.78
magnesium (Mg)	*	0.41	*	0.46
K X Mg	N.S.	-	N.S.	-

Table 6. influence of potassium fertilization rates, spraying with magnesium and their interactions on straw yield (ton/fad.) of faba bean in 2016/2017 and 2017/2018 seasons.

Seasons	2016/2017				2017/2018			
potassium fertilization	spraying with Mg			Mean	spraying with Mg			Mean
Kg K_2O /fad.	Control	100ppm	1500ppm		Control	100ppm	1500ppm	
35	2.14	2.34	2.57	2.35	2.21	2.41	2.67	2.43
50	2.38	2.47	2.70	2.52	2.41	2.54	2.76	2.57
65	2.62	2.73	2.88	2.74	2.59	2.69	2.79	2.69
Mean	2.38	2.52	2.72	2.53	2.41	2.55	2.74	2.56

Seasons	2016/2017		2017/2018	
	F test	L.S.D.	F test	L.S.D.
potassium (K)	*	0.10	*	0.12
magnesium (Mg)	*	0.06	*	0.08
K X Mg	N.S.	-	N.S.	-

B- Chemical analysis:-

Protein percentage:-

1 – Influence of potassium fertilization:

The Illustrated results in Table 7 clearly indicate that potassium fertilizer rates had significantly increased protein percentage in both seasons. The highest values 30.23 and 30.46% were obtained when potassium was applied at a rate of 65 kg K_2O /fad. during 2016/2017 and 2017/2018 seasons, respectively. The positive effect of potassium fertilizer on crude protein per dry seeds at harvest date may be due to K ion which considered as one of the main factors affecting the growth characters, chemical constituents and yield and its components through its effect on sugar content, respiration rate, and the absorption capacity for different nutrients Ahmed *et al.* (1994). These results agree with this obtained Khattab *et al.* (2016).

2 – influence of spraying with magnesium:

The results table 7 indicate that magnesium significantly increased protein percentage in faba bean seeds in 2016/2017 and 2017/2018 seasons. The highest values of 29.48 % and 29.27 % were obtained when magnesium was applied at a level of 150 ppm in 2016/2017 and 2017/2018 seasons, respectively. In this respect, high content protein may be a direct result for high rates of photosynthesis with great efficiency. These results agree with this found by Jarecki *et al.* (2016).

3 – Interaction effects:

The presented results Table 7 show that protein percentage was no significantly affected by the interactions of (potassium x magnesium) in both season.

Table 7. Influence of potassium fertilization rates, spraying with magnesium and their interactions on protein percentage of faba bean in 2016/2017 and 2017/2018 seasons.

Seasons	2016/2017				2017/2018			
potassium fertilization	spraying with Mg			Mean	spraying with Mg			Mean
Kg K_2O /fad.	Control	100ppm	1500ppm		Control	100ppm	1500ppm	
35	22.07	23.90	26.67	24.21	23.07	24.23	25.93	24.41
50	25.43	27.93	30.10	27.82	25.67	28.10	29.97	27.91
65	28.13	30.90	31.67	30.23	28.47	31.02	31.90	30.46
Mean	25.21	27.58	29.48	27.42	25.73	27.78	29.27	27.59

Seasons	2016/2017		2017/2018	
	F test	L.S.D.	F test	L.S.D.
potassium (K)	*	0.80	*	0.85
magnesium (Mg)	*	0.57	*	0.79
K X Mg	N.S.	-	N.S.	-

CONCLUSION

The application of potassium fertilization and magnesium spraying improved yield and yield components, of faba bean. Therefore, the study recommends potassium fertilization at the rate of 65 kg K_2O / fad., and spraying with magnesium (150 ppm) in order to improve the production of faba bean under the conditions of Assiut Governorate, Egypt.

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تأثير معدلات مختلفة من التسميد البوتاسي والرش بالمغنسيوم علي إنتاج وجودة محصول الفول البلدي

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الهدف من هذه الدراسة هو دراسة تأثير الرش بالمغنسيوم بتركيزات [كنترول ، ١٠٠ و١٥٠ جزء في المليون] والتسميد البوتاسي بمعدلات (٣٥, ٥٠ و ٦٥ كجم بو٢أ/ فدان) واثر ذلك علي محصول البذور وجودته، حيث أقيمت تجربتان حقليتان بمزرعة كلية الزراعة - جامعة الأزهر بأسيوط خلال موسمي ٢٠١٦/٢٠١٧ و ٢٠١٧/٢٠١٨ وذلك بزراعة صنف الفول البلدي (جيزة - ٨٤٣) وقد استخدم تصميم القطاعات المنشقة مرة واحدة في ثلاث مكررات حيث وزعت معدلات التسميد البوتاسي في القطع الرئيسية بينما وزع الرش بالمغنسيوم علي القطع المنشقة. أوضحت النتائج أن متوسط القيم لعدد الأفرع / النبات ، عدد القرون / النبات ، وزن ١٠٠ بذرة ، محصول البذور والقش/ فدان، ونسبة البروتين بالبذور زادت معنويا مع زيادة معدلات التسميد البوتاسي، حيث تم تسجيل أعلى القيم باستخدام ٦٥ كجم فو٢.أ/فدان أدى الرش بالمغنسيوم مع زيادة تركيزه التطبيق من صفر ،١٠٠ إلى ١٥٠ جزء في المليون إلى زيادة معنوية في جميع الصفات المدروسة في كلا الموسمين. أعطى التفاعل بين التسميد البوتاسي ومعاملات الرش بالمغنسيوم زيادة محصول الفول ومكوناته، لذا توصي الدراسة بإضافة السماد البوتاسي بمعدل ٦٥ كجم بو٢أ / فدان، والرش بالمغنسيوم بتركيز ١٥٠ جزءًا في المليون لتحسين إنتاج وجودة بذور الفول البلدي تحت ظروف محافظة أسيوط ، مصر.