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RESPONSE OF FABA BEAN YIELD (*Visia faba* L.) TO PHOSPHORUS AND POTASSIUM UNDER DIFFERENT METHODS OF APPLICATIN IN SANDY SOILS

Ismail, K. M. and A. A. Hagag
Soils, Water and Environment Research Institute, ARC, Giza, Egypt

ABSTRACT

Two field trials were conducted at Ismailia Agricultural Research Station in 2001/2002 and 2002/2003 growing seasons to study the effect of foliar spray and seeds soaking application of 2% super-phosphate and 2% potassium sulphate (singly or in combination) on faba bean yield and its seed protein, phosphorus and potassium content under sprinkler irrigation system in sandy soil. The obtained results indicated that:

1- The application of P and /or K as foliar spray or seeds soaking treatments induced significant increases in seeds and straw yield of faba bean as well as seed protein, P and K contents during the two growing seasons compared with the control treatment.
2- Seed index (weight of 100 seeds) was not significantly affected by all studied treatments.
3- Foliar application of 2% super-phosphate was the best treatment used for increasing the quantity and quality of faba bean yield, followed by the mixture of (2% P + 2% K) foliar spray treatment with no significant differences in most cases.
4- Under the same conditions, faba bean plants should be foliar sprayed 2 times (45 days after planting and 15 days later) with 2% super-phsphate singly or in combination with 2% potassium sulphate with the addition of recommended soil fertilization.

INTRODUCTION

The production of faba bean (*Visia faba L.*) in Egypt is still limited and fails to face the increasing local consumption of the crop. Therefore, increasing the crop production is one of the major targets of the agricultural policy and can be realized by increasing the cultivated area with faba bean through introduction the crop into new areas. In Egypt, the horizontal expansion of cultivated area which mainly depends on the reclamation of the adjacent sandy and calcareous sandy soils of the Eastern and Western deserts, which initially poor in their content of available macro and micro-nutrients. It is not difficult to raise crops on these sandy soils, as long as, they are supplied with appropriate level and balance of essential plant nutrients.

Phosphorus and/or potassium application usually increase the yield of grain legumes and improve its quality. The response of leguminous crops to P and/or K fertilization was previously investigated by several workers; Ibrahim and Ali, 1984; Farouk and Ali,1986; Singh and saxena,1986; and Khadr *et al.*, 1987 on faba bean crop; Yakout *et al.*, 1982; Zahran *et al.*,1998 and Nassar and Ismail, 1999 on lupin crop. Similar results were also obtained on lentil by El-Ghareib and Kadry,1989.

Phosphorus is probably the most limiting nutrient for production of leguminous crops, possibly by its influence on the activity of rhizobium bacteria and nodule formation (Mengel and kirkby,1982; and Hattar, 1986). Okaz *et al.*(1994) found that P fertilization induced significant increases in seeds, straw, seed protein and P contents of lentil crop. Also, Abd-El-Hadi *et al.*(1984) showed that P and K fertilization produced significant increases in soybean yield, protein content, P and K uptake by 25, 13 and 26%, respectively, over the control treatment. The same was obtained by Assey *et al.*(1992). On mungbean, Abd-El-Lateef (1996) found that P fertilization induced significant increases in its yield and yield components, while protein content was not affected by either soil P fertilization or foliar potassium application.

On the other hand, Bochniarz *et al.*(1987) found that potassium fertilization had significant beneficial effect on seeds yield on soil poor in K contents. El-Fouly and Fawzi (1989) suggested that, potassium might be a limiting factor under conditions of high yield, addition of 120 kg K_2O/ha. gave considerable yield increases. However, Okaz *et al.* (1994) stated that yield components of lentil were not significantly affected by K soil application in sandy soils, while seed K content was significantly increased. Also, Nowak *et al.* (1995) found that P and K fertilizers did not affect seed yields of faba bean, whereas the straw yield, N, P and K uptake were increased.

Phosphorus and potassium fertilization are usually added to crops as soil application by which considerable amounts either fixed by soils or leached by high amounts of irrigation water. El-Deeb (1989) found that the phosphorus content in plants is strikingly low, even when P was applied to the soil. This was revealed by soil analysis, which showed the accumulation of phosphorus on the topsoil above the plant roots.

Recently, nutrient elements are supplied to plants with different methods, seed soaking, seed coating and foliar spraying as a mean of correcting their deficiency. The above mentioned methods are in addition to (not a substitute for) soil fertilization practices. It is thought that these methods may provide more efficient utilization of fertilizers, especially in sandy soils. Hussein *et al.*(1993) reported that foliar application of 2% super-phosphate resulted in the highest faba bean yield components and seed yield as well as seed crude protein content. Hewedy *et al.* (1994) pointed out that spraying plants of common bean with potassium sulphate increased seed yield. Also, El-Gizy *et al.*(1995) found that seed yield of cowpea was increased by 20.7 and 8.5% by foliar application of 3% super-phosphate and 2% potassium sulphate, respectively, he added that P and K treatments increased seed protein content.

The main purpose of the present work is to study the effect of phosphorus and potassium, alone or in combination as foliar spray and seed soaking on seed and straw yields, seed index, seed protein, P and K contents of faba bean yield grown on sandy soils.

MATERIAL AND METHODS

Two field experiments were carried out at Ismailia Agricultural Research Station during the two growing seasons 2001/2002 and 2002/2003 to study the effect of foliar spray and seeds soaking of super-phosphate (P) and potassium sulphate (K) applications, singly or in combination on yield, seed index and seed chemical composition of faba bean crop under sprinkler irrigation system in sandy soil.

Representative surface soil samples (0 – 30 cm) were taken before performance of the experiment. Some characteristics of the soil samples were determined according to the methods described by Chapman and Pratt (1961) and Jackson (1973) as indicated in Table 1.

Table (1): Some physical and chemical properties of the investigated soils.

Soil properties	1st season	2nd season
Physical properties:		
Coarse sand (%)	72.37	69.13
Fine sand (%)	21.19	24.32
Silt (%)	2.88	3.61
Clay (%)	3.56	2.94
Soil texture	Sandy	Sandy
$CaCO_3$ (%)	1.34	1.08
Organic matter (%)	0.68	0.44
Chemical properties:		
PH (1 : 2.5 susp.)	7.80	7.60
EC dS / m (1:5 ext.)	0.16	0.21
Available N (ppm)	23.50	19.70
Available P (ppm)	6.40	4.90
Available K (ppm)	59.30	54.50

Seeds and plants were treated as follows:

1-seed soaking in water (control)
2-seed soaking in water + foliar spray with 2% super-phosphate (P)
3-seed soaking in water + foliar spray with 2% K- sulphate (K)
4-seed soaking in water + foliar spray with (2% P + 2% K)
5-seed soaking in 2% super-phosphate
6-seed soaking in 2% K-sulphate
7-seed soaking in (2% P + 2% K)

Seeds of faba bean were soaked in 2% P and/or 2% K as pre-treatments to full cover the seeds for 6 hours. The plants were foliar sprayed 2 times (45 days after planting and 15 days later). The volume of each spray was 300 and 400 liter/fed. for the 1st and 2nd spray, respectively, using Triton B as wetting agent (0.5 ml/liter)

A randomized complete blocks design with four replicates was used. The size of each plot was 10.5 m^2 (3 x 3.5m) with 6 rows, faba bean seeds (Giza 2) were sown in rows 50 cm apart and hills spaced 20 cm and

inoculated with specific rhizobia. Primary addition of N, P and K fertilizers was practiced as soil application for all plots. Nitrogen was added at the rate of 20 kg N/fed. as ammonium sulphate (20.6% N) after 15 days from sowing. Phosphorus at the rate of 30 kg P_2O_5/fed. as super-phosphate (15% P_2O_5) and potassium at the rate of 24 K_2O/fed. as potassium sulphate (48% K_2O) were added at sowing.

After full maturity, seeds and straw yields of each plot were weighted. Composite seed samples were taken, dried at 70 °C, ground and 0.5 g was subjected to wet ashing. Aliquots were taken for N determination using the micro-Kjeldahl method as described by A.O.A.C. (1970), then multiplied by 6.25 to obtain protein percentage. Phosphorus was determined colourimeterically and potassium was estimated by Flame-photometer according to Jackson (1973). Data were also statistically analyzed according to Snedecor and Cochran (1971).

RESULTS AND DISCUSSION

Faba been yield:

Data presented in Table 2 show that application of P and K (singly or in combination) treatments as foliar spray or seeds soaking treatments significantly increased the seeds and straw yield of faba bean compared with control treatment during the two growing seasons.

The average increment percentages of seeds yield were 29, 14 and 27%, while they were 38, 28 and 38% for the straw yield over control treatment due to the foliar spray of P, K and their mixture, respectively, and the average relative increases due to seed soaking of the same nutrients were, 21, 17 and 19% for the seed yield, and were 33, 43 and 43 % for the straw yield over the control treatment, respectively. These data show that difference obtained in straw yield in case of foliar spray and seed soaking treatments was not significant during the two growing seasons. The results also show that the foliar spray with P alone or in combination with K were more effective than the same nutrients used as seed soaking treatments in regard to faba bean yield. The two previous treatments (P and P+K foliar spray) gave higher mean values than those obtained by seed soaking treatments. These results could be explained on the basis of the positive effect or the important role of P application as energy storage and its transfers in the plant. Moreover, P application enhanced the nodule formation on the roots of leguminous crops (Mengel and kirkby, 1982 and Hattar, 1986). These results were in agreement with Hussein *et al.* (1993) on faba bean, El-Gizy *et al.*(1995) on cowpea, and Zahran *et al.*(1998) on lentil and lupin, who found that foliar application with super-phosphate increased yield and its components.

Seed index:

The seed index of faba bean yield is shown in table 2, application of P and/or K as foliar spray as well as seed soaking, induced increases in seed index during the two seasons compared with the control treatment, but these increases were not significant.

Table (2): Effect of the different methods of super-phsphate and potassium sulphate application on faba bean yield and seed index during 2001/2002 and 2002/2003 growing seasons.

Treatments	Seeds yield (ardab/fed.)				Straw yield (ton/fed.)				(Seed index) 100 seeds weight (g)			
	1st season	2nd season	Mean	Relative seed yield	1st season	2nd season	Mean	Relative straw yield	1st season	2nd season	Mean	Relative seed index
Sw (control)	5.11	4.54	4 83	100	0.93	1.15	1.04	100	55.33	57.29	56.31	100
Sw + F with 2% P	6.19	6.27	6.23	129	1.42	1.46	1.44	138	57.11	58.42	57.82	103
Sw + F with 2% K	5.46	5.59	5.52	114	1.29	1.37	1.33	128	56.08	57.11	56.60	101
Sw +F with(2%P+2%K)	5.96	6.33	6 15	127	1.44	1.42	1.43	138	58.73	58.69	58.71	104
S in 2% P	5.77	5.92	5.85	121	1.37	1.39	1.38	133	58.06	57.24	57.65	102
S in 2% K	5.44	5.85	5.65	117	1.52	1.46	1.49	143	58.44	57.91	58.18	103
S in (2% P + 2% K)	5.65	5.87	5.76	119	1.47	1.50	1.49	143	57.11	58.37	57.74	102
L.S.D at 0.05	0.24	0.32	-	-	0.24	0.15	-	-	NS	NS	-	-

Notes:
S = Seed soaking
F = Foliar spray
Sw = Seed soaking in water
P = Super-phosphate
K = Potassium sulphate

These data might indicate that application of these nutrients produced faba bean seeds with better quality due to the positive effect on raising the efficiency of plants to photosynthesis metabolic and also, enhancing the activity of rhizobia (Hattar, 1986). These results were nearly in line with those obtained by Ibrahim and Ali (1984) and Farouk and Ali (1986) on faba bean, Zahran *et al.* (1998) on lentil and lupin, and Nassar and Ismail (1999) on lupin yield.

Protein yield:

The protein yield of faba bean seeds was significantly increased due to foliar spray and seed soaking with P and /or K treatments compared to the control one in both seasons, as shown in Table 3. the effect of P as foliar spray either alone or in combination with K was more pronounced than other treatments, it was noticed that foliar spray with P alone or with K, gave the highest protein yield (39 and 35 %, respectively) compared to control treatment. This could be due to the inadequacy of available phosphorus in sandy soil. Similar results were obtained by Hussein *et al.* (1993) indicated that foliar application of P2O5 gave the highest significant increase in crude protein percentage of faba bean seeds. Also, El-Gizy *et al.*(1995) reported that foliar application of super-phosphate and potassium sulphate increased potassium content of cowpea seeds.

Table (3): Effect of the different methods of phosphorus and potassium applications on seed protein content of faba bean yield during 2001/2002 and 2002/2003 growing seasons.

Treatments	Nitrogen %		Protein (kg/fed.)		Mean Protein (Kg/fed.)	Relative Protein yield
	1st Season	2nd Season	1st Season	2nd Season		
Sw (control)	3.23	3.41	159.9	149.9	154.9	100
Sw + F with 2% P	3.61	3.52	216.5	213.8	215.2	139
Sw + F with 2% K	3.19	3.38	168.8	183.0	175.9	114
Sw + F with (2%P+2%K)	3.55	3.47	205.0	212.7	208.8	135
S in 2% P	3.64	3.59	203.4	205.9	204.7	132
S in 2% K	3.43	3.37	180.8	190.9	185.9	120
S in (2% P + 2% K)	3.56	3.43	194.8	195.0	194.9	126
L.S.D at 0.05	-	-	17.3	15.9	-	-

Notes:
S = Seed soaking **P = Super-phosphate** **F = Foliar spray**
K = Potassium sulphate **Sw = Seed soaking in water**

Seed contents of phosphorus and potassium:

P and K taken up by faba bean seeds as affected by P and K application methods are presented in Table 4. Application of P and (P+K) as foliar spray treatments significantly increased the P uptake by seeds, the average relative increases were 74 and 61%, respectively, while K uptake with the same treatments were 30 and 35%, respectively, over that obtained from the control treatment.

Table (4): Effect of the different methods of super-phsphate and potassium sulphate applications on phosphorus and potassium uptake by faba bean seed yield during 2001/2002 and 2002/2003 growing seasons.

Treatments	Phosphorus						Potassium					
	1st season		2nd season		Mean uptake Kg/fed	Relative P uptake	1st season		2nd season		Mean uptake Kg/fed	Relative K uptake
	%	Uptake Kg/fed.	%	Uptake Kg/fed.			%	Uptake Kg/fed.	%	Uptake Kg/fed.		
Sw (control)	0.32	2.53	0.39	2.74	2.64	100	1.77	14.02	1.81	12.74	13.38	100
Sw + F with 2%P	0.44	4.22	0.51	4.96	4.59	174	1.83	17.56	1.77	17.20	17.38	130
Sw + F with 2%K	0.39	3.30	0.42	3.64	3.47	131	1.92	16.25	2.03	17.59	16.92	126
Sw +F with(2%P+2%K)	0.42	3.88	0.47	4.61	4.25	161	1.85	17.09	1.94	19.03	18.06	135
S in 2%P	0.46	4.11	0.46	4.22	4.17	158	1.80	16.10	1.82	16.70	16.40	123
S in 2%K	0.42	3.54	0.45	4.08	3.81	144	2.02	17.03	2.17	19.68	18.36	137
S in (2%P + 2%K)	0.46	4.03	0.48	4.37	4.20	159	1.88	16.46	1.85	16.83	16.65	124
L.S.D at 0.05	-	0.63	-	0.59	-	-	-	1.08	-	1.37	-	-

Notes:
S = Seed soaking
F = Foliar spray
P = Super-phosphate
K = Potassium sulphate
Sw = Seed soaking in water

These findings were in agreement with those obtained by Abd-El-Hadi *et al.*, (1984) on soybean, Okaz *et al.*, (1994) on lentil and Nowak *et al.*, (1995) on faba bean, who found that P and K application increased P and K uptake by faba bean plant. On the other hand, Zahran *et al.*, (1998) found that foliar spray with the mixture of P and K induced significant increases in seed potassium content of lentil crop. Also, Nassar and Ismail (1999) reported that phosphorus application increased P uptake in lupin seeds.

Finally, it could be concluded from the previous discussion that, the foliar spray of P alone or with K is the best treatments for increasing the seed yield, as well as protein content of faba bean yield grown under similar conditions.

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استجابة محصول الفول البلدى للطرق المختلفة لإضافة الفوسفور والبوتاسيوم فى الأراضى الرملية

كمال مصطفى إسماعيل و عاطف عبد العظيم حجاج
معهد بحوث الأراضى والمياه والبيئة – مركز البحوث الزراعية – الجيزة – مصر

أقيمت تجربتان حقليتان فى محطة البحوث الزراعية بالإسماعيلية أثناء موسمى الزراعة ٢٠٠١/٢٠٠٢ ، ٢٠٠٢/٢٠٠٣ وذلك لتقييم تأثير بعض الطرق المختلفة لإضافة السوبر فوسفات بتركيز ٢% وكذلك كبريتات البوتاسيوم بتركيز ٢% (معا أو كل على حده) على إنتاجية محصول الفول البلدى ومحتوى البذور من البروتين والفوسفور والبوتاسيوم تحت نظام الرى بالرش فى الأراضى الرملية، وذلك عن طريق نقع البذور أو الرش الخضرى بمحاليل هذه العناصر (منفردة أو مختلطة معا).

وقد أظهرت النتائج ما يلى:

١- أن معاملة نقع بذور الفول البلدى أو الرش الخضرى على النباتات بمحلول السوبر فوسفات بتركيز ٢% أو بمحلول كبريتات البوتاسيوم بتركيز ٢% أو هما معا ، قد أحدثت زيادة معنوية فى محصول الفول البلدى ومحصول القش وكذلك محتوى البذور من البروتين والفوسفور والبوتاسيوم خلال موسمى الزراعة عند مقارنتهما بمعاملة الكنترول.

٢- لم يتأثر وزن ١٠٠ بذرة معنويا بإضافة المعاملات موضوع الدراسة.

٣- تفوقت معاملة الرش الخضرى بمحلول السوبر فوسفات بتركيز ٢% على جميع المعاملات المستخدمة فى تأثيرها على المحصول وجميع صفاته المحصولية بالمقارنة بمعاملة الكنترول، تليها معاملة الرش الخضرى بمخلوط السوبر فوسفات وكبريتات البوتاسيوم (كل بتركيز ٢%) حيث لا توجد فروق معنوية بينهما على المحصول وصفاته.

٤- ينصح تحت نفس ظروف التجربة أن يضاف السوبر فوسفات بتركيز ٢% مع أو بدون كبريتات البوتاسيوم بتركيز ٢% رشا على المجموع الخضرى لمحصول الفول البلدى مرتين (بعد ٤٥ يوم من الزراعة ثم بعد ١٥ يوم من الرشة الأولى) وذلك بالإضافة الى التسميد الارضى الموصى به.