

FABA BEAN POTENTIALITIES AS AFFECTED BY IRRIGATION AND POTASSIUM FERTILIZATION TREATMENTS

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ABSTRACT

Two field experiments were carried out in the Research and Experiment Center, Faculty of Agriculture at Moshtohor, Zagazig University during 1997/1998 and 1998/1999 seasons. This investigation aimed to study the effect of irrigation treatments (single, two and three irrigations) and potassium fertilizer rates (0, 16, 32 and 48 kg K₂O/fed) on yield and its components of faba bean.

The results showed that, increasing number of irrigation from single to three irrigations caused significant increases in number of pods/plant, number of seeds/plant, weight of pods/plant, weight of seeds/plant, shelling percentage and weight of 100 seeds. Also, such increase in number of irrigations induced significant increase in seed yield (kg/fed) and testa/seed percentage. Whereas, cotyle/seed percentage was decreased by increasing the number of irrigations in both seasons (from 1 to 3). These results were true in each of the two growing seasons.

Regarding soil potassium application, using a rate of 48 kg/fed recorded the highest significant values of number of pods/plant, number of seeds/plant shelling percentage, weight of 100 seeds and seed yield (kg/fed) and cotyl /seed percentage. Whereas, testa/seed percentage reduced with increasing potassium fertilizer rates in both seasons. It could be concluded that for maximizing seed yield of faba bean and its quality by irrigation three times at 30, 60 and 90 days from planting and addition potassium fertilizer at 48 kg K₂O/fed under the experimental conditions of Kalubia district.

The interaction between number of irrigations and potassium fertilizer significantly affected number of seed/plant, weight of seeds/plant and seed yield (kg/fed) in the first season and weight of pods/plant in the second season. Irrigation three times and increasing potassium fertilizer levels up to 48 kg K₂O/fed significantly maximized number of seed/plant, weight of seeds/plant and seed yield (kg/fed). However, irrigation two or three times and addition 48 kg K₂O/fed produced maximum weight of pods/plant without significant differences.

INTRODUCTION

Faba bean (*Vicia faba*, L.) is one of the most important legume mains crops in Egypt. It is usually used almost daily for human consumption as a dependable source of protein. So, it is important to increase faba bean production either by increasing its cultivated area or increasing its productivity per unit area of land among such practices, two of the most important factors

that may enhance the potentialities of faba bean are the appropriate irrigation and potassium fertilization treatments.

Many investigators studied effect the number of irrigation on faba bean yield and its components. Singh *et al.* (1987) indicated that plant height and number of branches/plant of faba bean plants were lower when irrigated at mid – pod filling stage than the control. Meanwhile, they found that irrigation at all growth stages gave the highest seed yield. Similar trend was obtained by Shahin *et al.* (1989), Ebaid (1990), Abd EL-Haleem and EL-Nabarawy (1993), Salwau (1994), Abd EL-Haleem (1994), Gendy *et al.* (1995), Kortam (1995), Mehasen (1998), Hassanein (2000) and EL-Tawil (2003).

The effect of potassium fertilizer application on faba bean plant constituents were studied by many investigators. Among those were Ziolk (1981), Fawzi *et al.* (1983), EL-Gayar *et al.* (1988), Thalooh *et al.* (1990), Abd EL-All *et al.* (1996) and EL-Naggar *et al.* (1996). They reported that increasing potassium rates caused increase in number of pods/plant, 100-seed weight and faba bean yield/fed in addition to improve in seed quality.

The objective of this investigation improve seed yield and its quality of filed bean through determined the optimum irrigation treatments and the suitable potassium fertilizer rate under the environmental conditions of Kalubia district.

MATERIALS AND METHODS

This investigation was conducted at the Experiment and Research Center, Faculty of Agriculture at Moshtohor, Zagazig University, during the growing seasons of 1997/1998 and 1998/1999 to study the effect of three irrigation treatments and four potassium fertilizer levels on yield and yield attributes of faba bean. The applied irrigation treatments were single irrigation at 30 days after sowing, two irrigations at 30 and 60 days after sowing and three irrigations at 30, 60 and 90 days after sowing. The soil was clay in texture with pH value of 7.9 and the organic matter content was 1.85 %. Each experiment included twelve treatments.

Potassium fertilizer was applied as soil application before the first irrigation (at 30 days from sowing) in the form of potassium sulphate (48 % K₂O) at the rates of 0, 16, 32 and 48 kg K₂O/fed).

The experiment was laid out and implemented in split plot design with four replicates. Irrigation treatments were randomly distributed in the main plots whereas, potassium fertilizer levels were randomly assigned to the sub-plot. Experimental unit area was 10.5 m² (1/400 fed).

The experiment was conducted using Giza 2 faba bean variety which was planted on November 10th and 15th in 1997/1998 and 1998/1999 seasons, respectively. The other approved cultural practices of growing faba bean were applied properly.

Total nitrogen was analysed in seeds using microkjeldahl method according to the A.O.A.C. (1980). Crude protein estimated by multiplying N-concentration by 6.25 (Tripathi *et al.*, 1971).

At harvest stage, the following parameters were measured and recorded: number of pods/plant, weight of seeds/plant, shelling percentage (seed weight X 100 divided over pods weight), weight of 100 seeds and seed yield (kg/fed) as well as testa and cotyl percentage where;

$$\text{Testa percentage} = \frac{\text{Testa weight X 100}}{\text{Whole seed weight}}$$

$$\text{and cotyl percentage} = \frac{\text{Cotyl weight X 100}}{\text{Whole seed weight}}$$

All of the collected data were statistically analysed according to the procedures outlined by Snedecor and Cochran (1967). Least significant differences (L.S.D.) test was used to compare between treatments means (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

A- Effect of irrigation treatments:

Data in Table 1 show that the differences in number of irrigations had significant effect on the number of pods/plant, number of seeds/plant, weight of pods/plant, weight of seeds/plant, shelling percentage, weight of 100 seeds, seed yield (kg/fed) testa/seed as well as cotyle/seed percentage. These results were obtained for the two growing seasons.

Regarding irrigation treatments, three irrigations (after 30, 60 and 90 days from sowing) gave the highest significant values of number of pods/plant, number of seeds/plant, weight of seeds/plant, shelling percentage, weight of 100 seeds and seed yield (kg/fed) in both seasons. Highest weight of pods/plant produced from the treatments of two irrigations (after 30 and 60 days from sowing).

So, it looks to be true that the three irrigations at 30, 60 and 90 days from sowing is the appropriate treatment for enhancing faba bean potentialities in production and quality. This indicates that plants of faba bean received sufficient water at most of the critical stages of growth and development which was reflected on the obtained yield and quality.

The obtained increase in seed yield/fed may be due to the increase in number of pods/plant, weight of pods and seeds/plant and 100-seed weight which were obtained by irrigating faba bean twice and or three times at the referred dates from sowing. These results clearly revealed that increasing irrigations exerted its effect at the later stages of plant development, seed filling period and effective filling period.

This could be explained by the enhancing effect of more water, nutrients, metabolic materials translocation and accumulation of dry matter to faba bean seeds. These findings are in harmony with those obtained by Singh *et al.* (1987), Shahin *et al.* (1989), Ebaid (1990), Abd EL-Haleem (1994), Gendy *et al.* (1995), Kortam (1995) and Hassanein (2000).

It should be also noted that the differences between two and three irrigation treatments were not significant for the above mentioned characters as weight of pods and weight of 100 seeds in the first season, and number of seeds/plant and weight of pods and seeds/plant in the second season (Table 1).

Results in Table 1 indicated that protein percentage in faba bean seeds tended to increase with the increase in watering number without significant differences. Such observation was noticed when comparing the effect of single, two and three irrigations on the studied parameters in the two seasons (Table 1).

Data in Table 1 revealed that the obtained differences in number of irrigations induced significant effect on testa and cotyl percentages in seeds of faba bean in the two growing seasons, respectively. The lowest value of testa seed percentage was recorded when using single irrigation at 30 days after sowing, while, the highest value was obtained from the three irrigations treatment. However, cotyl seed percentage decreased by increasing number of irrigations. Single irrigation significantly induced higher cotyl seed percentage as compared with two and three irrigations in 1997/98 and 1998/99 seasons.

Generally, three irrigations at 30, 60 and 90 days from sowing produced the maximum values of most of the studied characters for yield and its attributes of faba bean plants compared with any of the other irrigation treatments.

B- Effect of potassium fertilizer levels:

Data in Table 2 show that number of pods/plant, number of seeds/plant, weight of pods/plant, weight of seeds/plant, shelling percentage and weight of 100 seeds of faba bean in both seasons were significantly affected by the soil application of potassium sulphate at the rate of 16, 32 and 48 kg/fed compared to the control.

The soil application of K_2O at the rate of 48 kg/fed significantly increased number of pods and seeds/plant, weight of pods and seeds/plant as well as shelling percentage and weight of 100 seeds compared to the unfertilized plots and other potassium treatments of 16 and 32 kg/fed. These results were noticed on the two growing seasons.

It could be noticed from data in Table (2) that increasing K-fertilization levels from zero to 48 kg K_2O /fed caused significant increase in seed yield per feddan as compared with the control and each of the two lower rates of K (16 and 32 kg K_2O /fed). Similar results were obtained in the two growing seasons. Such effect of K application rates may be attributed to the influence of K on some of the main essential physiological function.

It should be noticed that the response of stomatal opening and closing at various stomatal resistance rates on photosynthesis and respiration as well as the movement of the metabolic products within plant organs are controlled with potassium functions.

Table 1: Effect of irrigation treatments on yield and yield components of faba bean during the two growing seasons.

Number of irrigation	Number of pods /plant	Number of seeds /plant	Weight of pods /plant (g)	Weight of seeds /plant (g)	Shelling %	Weight of 100 seeds (g)	Seed yield (kg/fed)	Protein %	Testa %	Coty %
First season (1997/98)										
Single	14.57	33.75	37.36	23.15	62.88	68.91	1258.2	24.3	11.52	88.48
Two	18.38	37.28	40.51	26.01	63.49	69.65	1370.8	23.9	11.87	88.13
Three	23.56	41.13	39.56	28.79	70.45	70.11	1517.6	24.5	13.46	86.54
L.S.D. at 5 %	0.72	1.31	2.64	0.75	1.33	1.23	36.1	NS	0.23	0.30
Second season (1998/99)										
Single	14.02	34.64	36.30	23.77	65.44	66.86	1227.4	23.9	12.73	87.27
Two	17.65	38.08	39.49	26.51	66.99	68.26	1321.5	25.0	14.13	85.87
Three	23.35	39.94	39.41	27.92	69.82	69.54	1435.4	24.5	15.62	84.38
L.S.D. at 5 %	0.89	2.48	1.45	1.47	2.27	1.07	65.78	NS	0.31	0.31

Table 2: Effect of potassium fertilization levels on yield and yield components of faba bean during the two growing seasons.

Potassium Levels (kg K ₂ O/fed)	Number of pods /plant	Number of seeds of pods /plant	Weight of pods /plant (g)	Weight of seeds of pods /plant (g)	Shelling %	Weight of 100 seeds (g)	Seed yield (kg/fed)	Protein %	Testa %	Cotyl %	
											First season (1997/98)
0	16.58	34.03	34.90	22.87	62.47	67.57	1211.4	25.4	12.57	87.43	
16	18.05	35.65	38.33	24.45	63.72	68.53	1340.6	25.5	12.42	87.58	
32	19.52	38.12	40.30	26.73	66.38	70.63	1412.9	24.9	12.13	87.87	
48	21.20	41.73	43.05	29.88	69.18	71.50	1563.8	25.8	11.95	88.05	
L.S.D. at 5 %	0.83	1.51	3.04	0.87	1.53	1.43	41.69	NS	0.27	0.34	
Second season (1998/99)											
0	16.13	34.23	35.35	23.15	65.35	66.50	1163.7	23.4	14.83	85.17	
16	17.55	36.07	37.22	24.60	66.12	67.65	1277.0	24.0	14.44	85.56	
32	19.00	38.40	39.47	26.77	67.67	68.82	1357.5	24.3	13.91	86.09	
48	20.68	41.50	41.53	29.77	70.57	69.92	1514.2	24.2	13.45	86.55	
L.S.D. at 5 %	1.03	2.87	1.67	1.70	2.62	1.24	75.95	NS	0.36	0.36	

In addition, potassium may control and regulate the activities of various essential elements and activates many enzyme which in turn affects plant growth, development and yield. Deb *et al.* (1976) reported that K ion is

considered as one of the main factors affecting the growth and legumes through its effect on sugar content and translocation, respiration and the absorption capacity for different nutrients. These results are in agreement with those obtained by Ziolk (1981), Fawzi *et al.* (1983), el-gayer *et al.* (1988), Thalooh *et al.* (1990), Abd EL-All *et al.* (1996) and El-naggar *et al.* (1996).

Testa and cotyl seed percentages were significantly affected by K fertilizer rates in the two seasons as it is clear from Table (2). Testa seed percentage was the highest for the control treatment in the two successive seasons. While, the highest cotyle seed percentage was obtained from the applied K₂O at the rate of 48 kg K₂O/fed in the two seasons.

Protein percentage was not affected significantly due to K application in the two successive growing seasons.

It could be concluded that increasing potassium application levels in faba bean plots up to 48 kg/fed as K₂O significantly increased seed yield and its components compared with the control (unfertilized). Such effect may be attributed to the stimulating effect of K on the storage capacity of assimilates.

C- The interaction effect:

The interaction between different irrigation treatments and potassium fertilization rates was significant on number of seeds/plant, weight of seeds/plant and seed yield (kg/fed) in the first season (1997/98), and weight of pods/plant in the second season (1998/99) as shown in Table 3. The highest values of these characters were recorded when using three irrigations at 30, 60 and 90 days from sowing and fertilizing with 48 kg K₂O/fed

Table 3: The interaction effect of the number of irrigations and potassium fertilization levels on some faba bean characters during 1997/98 and 1998/99 seasons.

Characters		1997/98			1998/99
Treatments		Number of seeds/plant	Weight of seeds/plant (g)	Seed yield (kg/fed)	Weight of pods/plant (g)
No. of Irrigation	K-levels (Kg K ₂ O/fed)				
Single	0	30.35	20.55	1096.3	32.65
	16	33.60	22.65	1267.5	36.55
	32	35.35	24.25	1288.5	37.65
	48	35.50	24.85	1380.4	38.35
Two	0	33.20	22.40	1220.4	35.75
	16	34.10	23.45	1301.7	36.65
	32	38.78	27.30	1389.5	41.60
	48	43.05	30.90	1571.6	43.85
Three	0	38.35	25.65	1317.5	37.65
	16	39.25	27.25	1452.5	38.45
	32	40.25	28.35	1560.8	39.15
	48	46.65	33.90	1739.5	42.40
L.S.D. at 5 %		2.62	1.51	72.22	2.90

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الكفاءة الإنتاجية للقول البلدى ومدى تأثيرها بمعاملات الري والتسميد البوتاسى
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أقيمت تجربتان حقليتان بمركز البحوث والتجارب الزراعية بكلية الزراعة بمشتهر خلال موسمي ٩٨/١٩٩٧ و ٩٩/١٩٩٨ بهدف دراسة تأثير ثلاثة معاملات للري (رية واحدة، ريتان وثلاث ريات) وأربعة معاملات لإضافة السماد البوتاسى (صفر، ١٦، ٣٢، ٤٨ كجم K_2O /فدان) على الكفاءة الإنتاجية للقول البلدى. وكانت أرض التجربة طينية ورقم الحموضة ٧,٩، ومحتواها من المادة العضوية ١,٨٥%. وباستخدام تصميم القطع المنشق مرة واحدة في أربعة مكررات حيث وزعت معاملات الري عشوائيا في القطع الرئيسية ومعاملات التسميد البوتاسى في القطع الشقية. ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلى:

- ١- أوضحت النتائج أن إضافة ثلاث ريات أدت إلى زيادة معنوية في عدد القرون، عدد البذور، وزن القرون، وزن البذور/نبات وكذلك نسبة التفریط ووزن ١٠٠ بذرة وزيادة محصول البذور للفدان مقارنة برية واحدة أو ريتان وذلك خلال موسمي التجربة. بينما أدى زيادة عدد الريات إلى ثلاث ريات إلى نقص نسبة الفلقات للبذرة بينما زادت نسبة التصرة للبذرة وذلك خلال الموسم الأول والثانى على التوالي.
- ٢- أدى إضافة السماد البوتاسى بمعدل ٤٨ كجم K_2O /فدان إلى زيادة معنوية في عدد القرون، عدد البذور/نبات، وزن ١٠٠ بذرة و محصول البذور للفدان خلال موسمي الدراسة مقارنة بمعدلي ١٦ و ٣٢ كجم K_2O /فدان وكذلك بدون إضافة (معاملة الكنترول).
- ٣- أعلى نسبة للتصرة/بذرة وجنت عند معاملة الكنترول (بنون إضافة بوتاسيوم) خلال الموسمين بينما أعلى نسبة للفلقات/بذرة (عند معدل ٤٨ كجم K_2O /فدان).
- ٤- تأثر عدد البذور ووزن البذور/نبات وأيضا محصول البذور للفدان في الموسم الأول (٩٨/١٩٩٧) وكذلك وزن القرون/نبات في الموسم الثانى (٩٩/١٩٩٨) معنوياً بالتفاعل بين معاملات الري والتسميد البوتاسى. بينما لم تتأثر نسبة البروتين بإضافة معاملات الري أو إضافة السماد البوتاسى خلال موسمي الدراسة.

توصى هذه الدراسة للحصول على أعلى إنتاجية وجودة من وحدة المساحة من القول البلدى وذلك بالري بعد ٣٠، ٦٠، ٩٠ يوم من الزراعة وإضافة ٤٨ كجم ب K_2O /فدان وذلك تحت ظروف الزراعة بمحافظة القليوبية.