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EFFECT OF PLANT SPACING AND PHOSPHORUS FERTILIZATION ON GROWTH AND PRODUCTIVITY OF FABA BEAN

Ibrahim, M.M.
Dept. of Agronomy, Fac. of Agric., Al- Azhar Univ., Assiut Branch, Egypt.

ABSTRACT

Two field experiments were conducted at Al- Azhar Farm, Faculty of Agriculture Assiut Branch, Egypt during the two winter seasons of 2003/2004 and 2004 / 2005 to study the effect of plant spacing 15, 20 and 25 cm between hills equal 44.4, 33.3 and 26.6 plants/ m^2 ,respectively, with two plants per hill on the two sides of the same ridge and three levels of phosphorus i.e. 0.0, 15.5 and 31.0 kg P_2O_5/fad on growth, yield and yield components of Faba bean, cv. Giza – 40.

Increasing plant spacing up to 25 cm between hills (26.6 plants/ m^2) gave the highest value of number of branches, number of leaves, dry weight of stem and leaves per plant, except plant height was decreased by increasing plant spacing

Plant spacing at 15 cm between hills (44.4 plants/ m^2) gave highly significant increase in plant height (cm) at harvest and biological yield (ton/fad), while plant spacing at 25 cm between hills (26.6 plants / m^2) gave a significant increase in number of branches, number of pods, weight of pods (g), number of seeds and seed yield per plant (g), and 100- seed weight (g) ,while plant spacing at 20 cm between hills (33.3 plants/ m^2) gave a significant increase in seed yield (ardab./ fad). Seed protein as well as P contents were also increased by increasing the distance between hills up to 25 cm.

Application of phosphorus fertilizer up to high rate (30 P_2O_5 kg/fad) significantly increased the growth and yield traits as well as protein and P contents in Faba bean seeds.

The interaction between plant spacing and phosphorus rates was significant on number of seeds per plant and seed yield (ard./ fad) in the two seasons and at the first season respectively.

Keywords: Faba bean G-40, plant spacing, phosphorus fertilizer, interaction, seed yield, yield component, protein and phosphorus %.

INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the most important winter legumes crops for seeds in Egypt. Its importance lies chiefly to its high protein content as it contains about 24% proteins. It is also well supplied with phosphorus (P) and calcium (Ca) in addition, it is relatively not expensive crop to produce. Two of the most important factors in this concern are plant density and phosphorus fertilization rate.

The plant spacing of faba bean is a limited factor to increasing crop yield . Increasing plant spacing may cause an increase of yield per plant that may be due to more spacing between hills, which leads to less competition between hills. Salem and El- Massri (1986 a) found that increasing plant density from 14 to 33 plants/ m^2 increased seed yield / ha by 30.31 and 44.42 % in 1980 and 1981 seasons ,respectively, while the seed yield and number

of pods/ plant were decreased under the same plant spacing. Stringi *et al.* (1988) found that weight of seeds/ plant, number of pods/ plant, number of seeds/ plant and 100- seed weight were sharply decreased with increasing plant density up to 40 plants/m^2 ,while showed a slightly decreased at higher densities. Coelho and Pinto (1989) showed that DM yield was 16.1 and 26.8 t/ha at 20 and 40 plants / m^2. Kitiki *et al.* (1992) showed that the effect of plant density on yield was linear, the most economic plant density was 29 plants/ m^2. Abo-Shetaia (1990) found that 70 000 plans/ fad gave the highest values for pods and seeds/plant, seeds/ pod, seed weight/ plant and seed index , whereas 105 000 plants/ fad. gave taller plants.

El-Douby *et al.* (1996) reported that seed yield of faba bean increased with increasing plant density from 27 to 44 plants/ m^2.

On the other hand, seed yield was increased by increasing plant density up to 33.3 plants/ m^2 (Selim and El-Seessy, 1991; Khalil *et al.,* 1993 and Abdel – Aziz and Shalaby, 1999).

Soil supply with phosphorus is very important practice for legumes, where it is considered the most important nutrient limiting pulse production. A vigorous plant growth, coupled with greater assimilates formation and translocation to plant fruiting parts, resulting in a better development for seed yield and its components, are consequences for supplying legume plants with phosphorus at optimum rates (Parihar and Tripathy, 1989).

A tendency towards increasing yield and yield component of faba bean with increasing phosphorus fertilizer rates has been reported by several investigators (Abo – Shetaia, 1990; El- Habbak and El-Naggar, 1991; El- Gazzar, 1993 and El- Douby *et al.*, 1996). Salem and El- Massri (1986 b) found that increasing P application increased seed yield/ plant, number of pods/plant and 100–seed weight. However, phosphorus application of more or less than optimum was associated with reduction in seed yield due to much rapid or late maturity at the expense of seed filling during maturity period, Abdel – Aziz *et al* (1987) showed that increasing P application increased leaf and stem dry weight (DW).

Increasing the level of phosphorus fertilizer a significant increase in seed yield of faba bean (El- Kalla *et al.,* 1997 and Khalil *et al.,* 2004) an increase in the protein content in the seeds of faba bean (Mwafy, 1995; El-Kalla *et al.*, 1997; and Khalil *et al.*, 2004).

Therefore, the present study aims to investigation the effect of plant spacing and application of phosphorus fertilization on growth, yield and its components of faba bean crop.

MATERIALS AND METHODS

Two field experiments were carried out at the Agriculture Experimental Farm of Al- Azhar University at Assiut the during two successive winter seasons of 2003/2004 and 2004 / 2005 to study the effect of three plants spacing 15, 20 and 25 cm between hills with two plants per hill on the two sides of the same ridge (44.4 , 33.3 and 26.6 plants/ m^2) ,respectively and phosphorus fertilizer levels 0.0, 15.5 and 31.0 kg P_2O_5/fad

on growth and yield of faba bean plants cv.Giza 40, calcium super phosphate (15.5% P_2O_5), fertilizer was added before the first irrigation (Mohya).

Treatments were arranged in split- plot design with three replications. Hill spacing were assigned to main plots and phosphorus fertilizer levels in the sub- plot. The experimental unit was 10.5 m^2 consisted of five ridges, 60 cm apart and 3.5 m length (1/400 fad). Planting was done on the two sides of the same ridge with two plants left per hill.

Faba bean seeds were inoculated with Rhizobia (Rhizobium leguminosarum) before planting. Hand planting took place on ridges , at November, 1 and 11 in the two seasons, respectively. The agricultural practices were applied as recommended.

Some physical and chemical properties of the soil of the Experimental site were analyzed and presented in Table 1 .

Table 1: The physical and chemical analyses of soil field experiments.

Properties	2003/2004	2004/2005
Physical analysis :		
Sand (%)	25.68	26.85
Silt (%)	39.46	38.08
Clay (%)	34.86	35.07
Soil texture	Clay loam	Clay loam
Chemical analysis:		
Organic matter (%)	0.94	1.05
Available N (ppm)	63.50	70.20
Available P (ppm)	9.14	10.20
Available K (ppm)	348.30	355.00
pH (sp 68.7)	7.80	8.02
E.C. (dSm^{-1})	1.15	1.16
Total $CaCO_3$ (%)	2.80	2.50

Data was recorded during plant growth as well as at harvest as follows:

A. During plant growth :

Five plant were chosen at random from each sub plot at 55 and 90 days after sowing to determine the following growth characters:

1. Plant height (cm)
2. Number of branches/ plant
3. Number of leaves / plant
4. Dry weight of stems/ plant (g)
5. Dry weight of leaves / plant (g)

B. At harvest:

Samples of 10 plants were also chosen at random from each sub plot and the following traits were recorded:

1. Plant height (cm)
2. Number of branches/ plant
3. Number of pods / plant
4. Weight of pods/ plant (g)
5. Number of seeds/ plant
6. Seed yield/ plant (g)
7. 100- seed weight (g)
8. Biological yield (ton/ fad)
9. Seed yield (ard/ fad)

C. Chemical analysis

1. Crude protein percentage:

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

2. Phosphorus percentage:

Total Phosphorus was determined in the seeds digests colorimetrically using the Spectrophotometer according to the method described by Chapman and Pratt (1961).

Statistical analysis:

The results were statistically analyzed according to Gomez and Gomez (1984), using MSTAT-C statistical analysis package by Freed *et al.* (1989). The least significant differences (LSD) test at probability level of 0.05 was manually calculated to compare the differences among means.

RESULTS AND DISCUSSION

A. The growth characters:

1. Effect of plant spacing:

Results presented in Tables 2 and 3 revealed that plant height, number of leaves and dry weight of leaves per plant were significantly affected by plant spacing at 55 and 90 days after sowing during the two seasons with the exception dry weight of leaves per plant at 55 days plant age in 2003/ 2004 season. However, number of branches and dry weight of stem per plant was only significantly affected by plant spacing at 90 days after sowing in both seasons.

It is clear from these results that increasing distances between plants increased number of branches, number of leaves, dry weight of stem and dry weight of leaves per plant at 90 days after planting in both seasons, however results in Table 2 cleared that plant height was only increased at 20 cm between hills at 55 days plant age , while at 90 days plant age tended to gradually decrease by increasing plant distance up to wide spacing (25 cm). It is interesting to note that faba bean plants under low population density gained more benefits for light, minerals and water. Similar results were reported by Amer *et al.* (1992), Edris (1994), Abd El- Aziz and Shalaby (1999) and Radwan and Mohamed (2005).

2. Effect of phosphorus fertilizer rates:

Results presented in Tables 2 and 3 indicates that phosphorus fertilizer significantly increased plant height, number of branches number of leaves, dry weights of stem and leaves per plant at 55 and 90 days after sowing during 2003/ 2004 and 2004/2005 seasons, except plant height and number of branches per plant at 55 days plant age in 2003/ 2004 season. Application of high phosphorus rate (31.0 kg P_2O_5/ fad) resulted in an increase in these growth traits in comparison with low or unfertilized with phosphorus fertilization in both growing seasons.

Table 2: Effect of plant spacing and phosphorus fertilizer levels on vegetative growth characters of faba bean plants at 55 and 90 days after sowing during 2003/2004 and 2004/ 2005 seasons.

Plant spacing (cm)	Fertilizer P-levels P_2O_5 kg/fad	Plant height (cm)				Number of branches/ plant				Number of leaves/ plant			
		Days after sowing				Days after sowing				Days after sowing			
		55		90		55		90		55		90	
		2003/4	2004/5	2003/4	2004/5	2003/4	2004/5	2003/4	2004/5	2003/4	2004/5	2003/4	2004/5
15	0.0	41.11	46.33	99.35	108.56	1.44	1.12	1.50	1.49	17.18	11.92	26.50	24.33
	15.5	39.85	47.25	109.96	114.92	1.33	1.33	1.78	2.08	13.65	16.33	29.17	26.98
	31.0	41.78	48.40	117.42	122.75	1.22	2.00	2.33	2.67	14.92	16.51	31.33	29.62
Average		**40.91**	**47.33**	**108.91**	**115.41**	**1.33**	**1.48**	**1.87**	**2.08**	**15.25**	**14.92**	**29.00**	**26.98**
20	0.0	44.34	54.33	96.75	103.93	1.50	1.15	1.62	1.58	15.56	15.94	28.45	25.88
	15.5	46.47	55.50	107.17	112.95	1.44	1.33	1.83	2.42	16.00	14.08	30.97	30.28
	31.0	44.33	58.17	112.52	118.92	2.00	1.65	2.50	3.00	17.06	15.77	33.03	32.83
Average		**45.05**	**56.00**	**105.48**	**111.93**	**1.65**	**1.38**	**1.98**	**2.33**	**16.20**	**15.26**	**30.81**	**29.66**
25	0.0	42.45	43.50	94.53	99.51	1.39	1.50	1.63	1.65	12.62	15.69	30.17	27.73
	15.5	44.74	44.50	102.83	109.58	1.30	1.58	2.58	2.58	13.53	18.15	33.56	31.55
	31.0	46.14	47.53	104.78	111.72	1.75	1.83	3.50	3.17	15.22	17.92	35.51	34.53
Average		**44.44**	**45.18**	**100.71**	**106.94**	**1.48**	**1.64**	**2.57**	**2.47**	**13.79**	**17.25**	**33.08**	**31.27**
Average for all P-levels	0.0	42.63	48.07	96.88	104.00	1.44	1.26	1.50	1.29	15.12	14.52	28.37	25.98
	15.5	43.69	49.08	106.65	112.48	1.36	1.42	2.06	2.36	14.39	16.19	31.23	29.60
	31.0	44.08	51.36	111.57	117.79	1.60	1.83	2.78	2.94	15.73	16.73	33.29	32.33
LSD at 5 % level for	spacing (S)	0.81	1.48	2.29	1.74	NS	NS	0.91	0.36	0.86	1.11	0.85	1.47
	Fertilizer (F)	NS	0.77	1.64	2.64	NS	0.24	0.31	0.36	0.60	0.71	0.55	0.50
	S x F	2.21	NS	NS	NS	NS	NS	NS	NS	1.04	1.23	NS	0.87

Table 3: Effect of plant spacing and phosphorus fertilizer levels on vegetative growth characters of faba bean plants at 55 and 90 days after sowing during 2003/2004 and 2004/ 2005 seasons.

Plant spacing (cm)	Fertilizer P-levels P_2O_5 kg/fad	Dry weight of stem/ plant (g)				Dry weight of leaves/ plant (g)			
		Days after sowing							
		55		90		55		90	
		2003/4	2004/5	2003/4	2004/5	2003/4	2004/5	2003/4	2004/5
15	0.0	1.61	1.83	9.03	9.96	1.29	1.38	4.28	4.68
	15.5	2.06	2.66	11.57	12.59	1.67	2.25	5.69	6.56
	31.0	2.34	3.02	12.48	14.51	1.52	2.35	6.98	7.81
Average		**2.01**	**2.50**	**11.02**	**12.35**	**1.49**	**1.99**	**5.65**	**6.35**
20	0.0	1.42	1.85	9.92	11.24	1.41	1.50	4.97	5.24
	15.5	2.25	2.36	12.56	13.67	1.50	1.68	6.72	7.43
	31.0	2.47	2.95	13.56	15.36	1.94	2.19	8.08	8.82
Average		**2.05**	**2.39**	**12.02**	**13.42**	**1.62**	**1.79**	**6.59**	**7.16**
25	0.0	1.75	1.75	10.77	12.53	1.60	2.25	5.47	6.27
	15.5	2.01	2.42	13.36	14.62	1.71	2.67	7.06	7.94
	31.0	2.79	3.02	14.42	16.17	1.96	2.95	8.73	9.44
Average		**2.18**	**2.39**	**12.85**	**14.44**	**1.76**	**2.62**	**7.09**	**7.88**
Average for all P-levels	0.0	1.60	1.81	9.91	11.24	1.43	1.71	4.91	5.40
	15.5	2.11	2.48	12.50	13.63	1.63	2.20	6.49	7.31
	31.0	2.54	3.00	13.49	15.35	1.81	2.50	7.93	8.69
LSD at 5 % level for	spacing (S)	NS	NS	0.79	0.75	NS	0.42	0.72	0.76
	Fertilizer (F)	0.31	0.35	0.34	0.42	0.10	0.22	0.36	0.39
	S x F	NS	NS	NS	NS	NS	NS	NS	NS

This may be due to that phosphorus fertilizer increased the vegetative growth of Faba bean, due to the role of phosphorus fertilizer in enhancing photosynthesis process. These results are in harmony with those obtained by Mwafy (1995), Abd- Allah and Hamed (2006) and Abd El- Aziz (2007).

3. Effect of interaction:

Data in Tables 2 and 3 also indicate that the significant interaction effect between plant spacing and phosphorus fertilizer treatments was found only on plant height at 55 days in the first season and also on number of leaves per plant at 55 days plant age in both season as well as at 90 days in the second season only respectively, where the highest value was obtained at plant spacing at 25 cm (26.6 plants/ m^2) and 31.0 kg P_2O_5/ fad.

B. Yield and yield components:

1. Effect of plant spacing:

Results in Tables 4 and 5 indicated that plant height , number of branches, number of pods, weight of pods, number of seeds and seed yield / plant and 100-seed weight, biological yield and seed yield ardab /fad were significantly affected by the plant spacing.

Increasing plant spacing up to 25 cm between hills increased that all studied characters, while decreased plant height ,biological and seed yield /fad in the two seasons. Such reduction in biological and seed yields may be attributed to the reduction in plant density in unit area under wider spacing than lower. However, on contrary ,there are a gradually increase in other yield components namely, seed yield / plant, number of pods/plant, number of seeds/ plant and 100-seed weight with increasing the distance between hills from 15 to 20 and/or 25 cm. The increase in these traits with increasing the distance between hills is reflected to compensate the reduction of plant density at wider spacing. Also probably wide hill spacing led to uniform light exposure and shading. Also it may be due to high efficiency of photosynthesis and good weed control. These increases may ascribed to decreased inter plant competition that leads to increased plant capacity for utilizing the environmental in puts in building great amount of metabolites to be used in developing new tissues and increasing its yield components. Similar results were reported by Abo- Shetaia (1990), Selim and El- Seessy (1991), Soheir (2001), Radwan and Mohamed (2005), Abd El- Aziz (2007) and El- Said (2008). However, Khalil *et al.* (1993) and Abdel Aziz and Shalaby (1999) indicated that 20 cm distances between plants (33.3 plans/ m^2) produced the largest seed yield/ fad. Moreover, Abo – El- Zahab *et al.* (1981) reported that the highest yield was recorded from the lowest plant density of (26.6 plants/m^2). On the other hand, Teama (1994) found that no significant differences among plant densities of 24, 33 , 48 or 67 plants/ m^2 for seed yield of G 402 cv.

Seed protein percentage was significantly increased by increasing plant spacing in both seasons. Low plant population (25 cm between hills) gave the highest value of protein (27.47 and 26.76 %) in the first and second seasons, respectively.

Table 4: Effect of plant spacing and phosphorus fertilizer levels on yield and its components of faba bean plants during 2003/2004 and 2004/ 2005 seasons.

Plant spacing (cm)	Fertilizer P-levels P_2O_5 kg/fad	Plant height (cm)		Number of branches/ plant		Number of pods/ plant		weight of pods/ plant (g)		Number of seeds/ plant	
		2003/4	2004/5	2003/4	2004/5	2003/4	2004/5	2003/4	2004/5	2003/4	2004/5
15	0.0	128.03	131.73	1.90	1.83	13.42	13.40	27.85	29.46	31.84	33.46
	15.5	137.89	138.77	2.43	2.35	15.70	16.06	35.39	35.64	39.51	41.52
	31.0	144.64	142.58	2.61	2.58	17.27	18.71	41.70	43.41	43.73	46.56
Average		**136.85**	**137.69**	**2.31**	**2.26**	**15.46**	**16.06**	**34.98**	**36.17**	**38.36**	**40.51**
20	0.0	123.97	129.23	2.10	2.15	14.40	14.63	30.91	32.80	34.65	36.10
	15.5	134.54	136.29	2.91	2.77	16.92	18.15	38.91	39.17	45.08	47.11
	31.0	141.44	139.64	3.07	3.08	19.01	19.78	44.13	45.93	50.32	51.81
Average		**133.32**	**135.05**	**2.69**	**2.67**	**16.77**	**17.52**	**37.98**	**39.30**	**43.35**	**45.01**
25	0.0	121.44	126.58	2.28	2.42	15.58	16.27	35.91	36.18	36.20	38.39
	15.5	131.89	133.47	3.18	3.23	17.90	19.27	41.87	43.23	51.03	52.69
	31.0	138.57	136.88	3.55	3.67	20.11	21.07	47.23	49.55	58.80	60.36
Average		**130.63**	**132.31**	**3.00**	**3.11**	**17.86**	**18.87**	**41.67**	**42.99**	**48.68**	**50.48**
Average for all P-levels	0.0	124.48	129.18	2.09	2.13	14.46	14.76	31.55	32.81	34.23	35.98
	15.5	134.77	136.17	2.84	2.78	16.84	17.83	38.72	39.35	45.21	47.11
	31.0	141.55	139.70	3.08	3.11	18.80	19.85	44.36	46.30	50.95	52.91
LSD at 5 % level for	spacing (S)	1.88	0.30	0.24	0.11	0.74	0.96	0.81	1.09	1.03	1.97
	Fertilizer (F)	0.76	0.48	0.23	0.17	0.58	0.83	0.89	0.80	0.63	1.00
	S x F	NS	NS	NS	NS	NS	NS	NS	NS	1.09	1.73

Table 5: Effect of plant spacing and phosphorus fertilizer levels on yield and its components of faba bean plants during 2003/2004 and 2004/ 2005 seasons.

Plant Spacing (cm)	Fertilizer P-levels P_2O_5 kg/fad	Seed yield/ plant (g)		100- seed weight (g)		Biological yield ton/fad		Seed yield ard*/fad		Protein %		Phosphorus %	
		2003/4	2004/5	2003/4	2004/5	2003/4	2004/5	2003/4	2004/5	2003/4	2004/5	2003/4	2004/5
15	0.0	16.86	17.97	56.67	58.54	3.45	3.54	8.61	9.26	22.29	21.62	0.46	0.46
	15.5	24.95	26.49	67.21	69.17	4.01	4.01	10.89	11.15	25.75	24.78	0.54	0.54
	31.0	30.30	31.43	70.81	72.99	4.44	4.45	12.48	12.58	27.03	25.99	0.58	0.58
Average		**24.04**	**25.29**	**64.90**	**66.90**	**3.97**	**4.03**	**10.66**	**11.00**	**25.03**	**24.13**	**0.53**	**0.53**
20	0.0	18.72	19.48	63.15	64.25	3.25	3.38	9.39	10.00	23.54	22.77	0.47	0.48
	15.5	27.32	28.53	72.69	74.82	3.83	3.90	11.24	11.87	27.30	26.06	0.56	0.57
	31.0	32.78	34.09	75.77	77.36	4.26	4.25	13.83	13.26	28.43	27.31	0.60	0.60
Average		**26.27**	**27.37**	**70.54**	**72.14**	**3.78**	**3.84**	**11.48**	**11.71**	**26.43**	**25.38**	**0.54**	**0.55**
25	0.0	20.16	21.38	66.52	67.03	3.04	3.21	8.47	9.00	25.00	23.74	0.49	0.50
	15.5	29.15	29.94	76.34	75.43	3.63	3.66	10.52	10.78	27.83	27.34	0.58	0.58
	31.0	35.09	35.98	79.76	79.71	4.02	4.04	11.64	12.01	29.58	29.18	0.61	0.61
Average		**28.13**	**29.10**	**74.21**	**74.06**	**3.57**	**3.63**	**10.21**	**10.60**	**27.47**	**26.76**	**0.56**	**0.56**
Average for all P-levels	0.0	18.58	19.60	62.11	63.28	3.25	3.38	8.82	9.42	23.61	22.71	0.48	0.48
	15.5	27.14	28.32	72.08	73.14	3.83	3.89	10.88	11.27	26.96	26.06	0.56	0.56
	31.0	32.72	33.84	75.45	76.69	4.24	4.25	12.65	12.62	28.35	27.49	0.60	0.59
LSD at 5 % level for	spacing (S)	0.37	0.85	1.92	1.19	0.10	0.01	0.29	0.54	0.80	0.42	0.01	0.01
	Fertilizer (F)	0.46	0.56	1.10	1.43	0.06	0.06	0.25	2.26	0.48	0.42	0.01	0.01
	S x F	NS	NS	NS	NS	NS	NS	0.43	NS	NS	NS	NS	NS

*one ardab = 155 kg

High protein content with low plant population could be attributed to the least competition in the surrounding media on nutrients, water, root ramification and light which enhanced the plant efficiently to exploit the solar energy and nutrient absorption and in turn increased the assimilates accumulated in the faba bean seed expressed as crude protein percentage, Yousrya (1995) and Abd-El- Aziz and Shalaby (1999), supported those findings. On contrary Shalaby and Mohamed (1978) reported that significant increase in seed protein content under the dense planting population.

The disagreement between the aforementioned observation may be attributed to the different environmental conditions dominant interim of the experimentation.

Concerning the effect of the plant spacing on phosphorus percentage, in general it was slightly increased by increasing distances between plants in both seasons. The highest phosphorus values (0.56 and 0.56%) were obtained with wider plant spacing 25 cm between hills in both seasons ,respectively. This might be attributes to the fact that high plant densities suffer considerable competition between plants on minerals and water from the surroundings media and this in turn results in the amounts of metabolites synthesizes by faba bean plants. These results are in conformity with the results by Selim and El-Seessy (1991), Radwan and Mohamed (2005) and El- Said (2008) they reported that phosphorus percentage increased by increasing distances between plants.

2. Effect of phosphorus fertilizer rates:

The results in Tables 4 and 5 showed that increasing phosphorus fertilizer rates from 0.0 to 15.5 and/or 31.0 kg P_2O_5/fad significantly increased all studied parameters namely plant height, number of branches, number of pods, weight of pods, number of seeds and seed yield /plant (g) as well as 100- seed weight , seed yield (ard/fad) and biological yield (ton/fad) in both seasons. The highest values were obtained when phosphorus was applied at the rate of 31.0 kg P_2O_5/fad in both seasons These increases might be attributed to the role of phosphorus as a constituent of all important nucleo- proteins and thus increases the efficiency of root system and consequently the physiological activities of the plant are enhanced leading to better yield. Also may be due to the effect of phosphorus fertilizer on increasing the percentage of flowering and setting which increased the number of pods and seeds / plant. These findings are in agreement with these reported by El- Kalla *et al.* (1997), Abd El-Aziz (2005), Abd- Allah and Hamed (2006) and El- Said (2008).

Also, results in Table 5 indicated that increasing phosphorus fertilizer levels up to 31.0 kg P_2O_5/fad significantly increased protein percentage. The highest values of protein percent (28.35 and 27.49) were obtained by high phosphorus rates during 2003/2004 and 2004/ 2005 seasons ,respectively. These results might be due to the beneficial effect of phosphorus fertilizer on leguminous crops due to its role in activation the microbial population in nodules to fix more N_2 that used by plant in protein synthesis (Bhadoria *et al.*, 1997). These results are in accordance with those found by Khalil *et al.* (2004), Ahmed *et al.* (2005) and El- Said (2008) they reported that protein percentage increased by increasing phosphorus rates

Applying phosphorus fertilizer at high levels also significantly increased the P content in comparison to the lowest or unfertilized treatments Table 5. The highest values (0.60 and 0.59%) were obtained when faba bean plants received the highest phosphorus level i.e. (31.0 kg P_2O_5/fad) in the first and second seasons, respectively.

The response of faba bean plans to the super phosphate application may be due to the lake increase of available (P) in soil. These results are in line with those obtained by Abd- Allah and Omran (2002), Khalil *et al.* (2004), Radwan and Mohamed (2005) and El-Said (2008) who reported that phosphorus percentage increased by increasing phosphorus rates.

3. Effect of the interaction:

Results in Tables 4 and 5 indicated that all characters under study were not significantly affected by the interaction between plant spacing and phosphorus fertilization, except number of seeds /plant in both seasons and seed yield (ardab/ fad) in the first season which were significantly influenced by plant spacing x phosphorus fertilizer. However, the highest value of number of seeds/ plant (58.80 and 60.36) was obtained by plant spacing at 25 cm (26.6 plans/ m^2) and adding 31.0 kg P_2O_5/fad in both seasons ,respectively, whereas, the lowest value (31.84 and 33.46) was obtained by plant spacing at 15 cm (44.4 plans/ m^2) and 0.0 kg P_2O_5/fad (control treatment) during 2003 / 2004 and 2004/ 2005 seasons ,respectively. On the other hand, the lowest values of seed yield (8.47 and 9.00 ardab/ fad) was obtained at 25 cm between hills (26.6 plans/ m^2) and 0.0 kg P_2O_5/fad (control treatment) in both seasons ,respectively.

Conclusions

The most important findings appear to be the following.

Plant spacing at 20 cm between hills (33.3 plans/ m^2) and application of phosphorus fertilizer at the rate of 31.0 kg P_2O_5/fad to clay loam soil cultivated with faba bean improved seeds yield and seed quality, which are important for human feeding.

REFERENCES

A.O.A.C. (1980). Official Methods of Analysis , 13th Ed. Association of Official Analytical Chemists, Washington, D.C.

Abd- Allah, A.A. and M.M. Omran (2002). Response of some faba bean varieties to irrigation intervals plant spacing in the new sandy reclaimed lands. Minufiya J. Agric. Res., 27 (3): 525- 540.

Abd- Allah, S.A. and H.H. Hamed (2006). Synergistic effect of bio- and mineral phosphorus fertilizer to improve seed yield and quality of broad bean (*Vicia faba* L.) J. Adv. Agric. Res., (Fac. Agric. Saba Basha). 11 (1): 189- 196.

Abd- El- Aziz, E.S. (2005). Effect of phosphorus in with different levels of phosphorus fertilizer on faba bean under ca/ carious soil condition. Minufiya J. Agric. Res., 30 (2): 549 563.

Abd- El- Aziz, E.S. and F.H. Shalaby (1999). Physiological studies on response of new released faba bean varieties to different plant populations. Zgazig J. Agric. Res., 26 (5): 1229- 1244.

Abd El- Aziz, M.A. (2007). Effect of plant density and phosphorus fertilization on growth and yield of variety Domani of faba bean (*Vicia faba* L.). Minia J. of Agric. Res. & Develop., 27 (1): 135- 150.

Abd El- Aziz; I.M.; S.G. Awad; M.H. Mahmoud and A.O.Osman (1987). Effect of high levels of phosphorus and zinc application of broad bean (*Vicia faba*) grown on calcareous soil. Ann. of Agric. Sci. Ain Shams Univ., 32 (2): 1149- 1160.

Abo- El- Zahab, A.A.; A.A. Al- Babawy and K.Abd El- Latif (1981). Density studies on faba bean (*Vicia faba* L.) 1. Seed yield and its components. J. Agron. & Crop Sci., 150: 291- 302.

Abo- Shetaia, A.M.A. (1990): Yield and yield components response of faba bean (*Vicia faba* L.) to plant density and NP fertilization. Ann. of Agric. Sci. Ain Shams Univ., 35 (1): 187- 204.

Ahmed, A.M.; H.A. Hassan and B.A. Hassouna (2005). Effect of nitrogen, phosphorus fertilization and inoculation with Rhizboium leguminosarum of faba bean. Minia J. of Agric. Res. Develop., 25 (3): 587- 616.

Amer, M.I.; M.A. El- Borai and M.M. Radi (1992). Response of three faba bean (*vicia faba* L) cultivars to three sowing dates under different plant densities in North Delta. J. Agirc. Res. Tanta Univ., 18 (4): 591- 599.

Bhadoria, R.B.; R.A. Tomer, H. Khan and M.K. Sharma (1997). Effect of phosphorus and sulphur on yield and quality of cluster bean (*Cyamopsis tetragonolable*) . Indian J. Agron., 42 (1): 131- 134.

Chapman, H.D. and P.F. Pratt (1961). Methods of analysis for soils, plants and waters. Edited by Homer D. Chapman and Parker F. pratt. Division of Agricultural Sciences, University of California , Berkely U.S.A. 309 p.

Coelho, J.C. and P.A. Pinto (1989). Plant density effects on the growth and development of winter faba bean. var. minoy. FABIS News letter. No. (25) 26- 30. (C.F. Field crop Abst., 35 (3): 1018, 1990).

Edris, A.S.A. (1994). Effect of plant density and distribution on yield and yield attributes of some field bean cultivars. Egypt. J. Appl. Sci., 9 (1): 166- 179.

El- Douby, K.A.; K.E. El- Habbak,., F.M. Seif El- Nasr and S.A. Basal (1996). Effect of tillage system and plant density under different phosphorus fertilization levels on the productivity of faba bean (*Vicia faba* L.). Ann. Agric. Sci. Moshtohor, 34 (3): 907-918.

El- Gazzar, M.M. (1993). Yield response of faba bean to zinc and cupper in connection with phosphorus fertilization. Egypt. J. Appl. Sci., 8 (2): 744- 755.

El- Habbak, K.E. and H.M. El- Naggar, (1991). Effect of plant density, nitrogen and phosphorus fertilizer levels on faba bean. Egypt. J. Appl Sci., 6 (8): 214- 224.

El- Kalla, S.E.; A. K. Mustafa., A.A. Leilah and A.A. Rokia (1997). Mineral and bio- phosphatic fertilization for intercropped faba bean and onion. Egypt. J. Agric. Res., 77 (1): 253 -271.

El- Said, M.A. (2008). Effect of plant density and phosphorus fertilization on some faba bean cultivars. M. Sc. Thesis Fac. of Agric. Assiut Univ., Egypt.

Freed, R.S.; S.P. Esiensmith; S.Goetez; D. Reicosky; V.W. Smail and P. Wolberge (1989). Users guide to MSTAT- C.A. Software program for the design, moorage egement and analyses of Agronomic Research Experiments Michigan State University, U.S.A.

Gomez, K.A. and A.A. Gomez (1984). Statistical Procedures for Agricultural Research 2nd ed. John Wiley and Sons, Inc. New York.

Khalil, F.A.; K.A. El-Shaikh and R.E. El- Lithy (2004). Response of two faba bean cultivars to different levels of phosphorus and sulphur applications. Assiut J. of Agric. Sci., 35 (2): 289- 309.

Khalil, S.A.; R.F. Dissouky; M.I. Amer; M.M. El- Hady and M.W. Hassan (1993). Performance of yield and yield components of two faba bean (*Vicia faba* L.) cultivars as affected by two plant densities and foliar disease control in the new reclaimed land. J. Agric. Sci., Mansoura Univ., 18 (5): 1306- 1314.

Kitiki, A.; N. Acikgez; M.Yaman; A.S. Cinsoy and T. Dizaroglu (1992). Effect of plant density and row spacing on faba bean cv. Eresen – 87. Anadolu 2 (2): 1-13 (C.F. Field Crop Abst., 47 (6): 3621, 1994)

Mwafy, S.A. (1995). Studies on faba bean (*Vicia faba* L.) M.Sc. Thesis , Faculty of Agriculture, Zagazig University, Egypt.

Parihar, S.S. and R.S. Tripathy (1989). Dry mater, nudulation and nutritent uptake in chick pea *(Cicer arietinum* L.) as influenced by irrigation and phosphorus. Exp. Agric., (25): 349- 355.

Radwan, F.I. and W.H. Mohamed (2005). Influence of plant density, biofertilizers inoculation and super phosphate application to soil on growth and yield component of faba bean plants. J. Adv. Agric. Res. (Fac. Agric. Saba Basha)10 (1): 145 -164.

Salem. S.A. and M.F. El- Massri (1986 a). Effect of cultivars, plant densities and phosphatic fertilizer levels on seed yield and other agronomic factors in faba bean (*Vicia faba* L.) Alexandria J. of Agric. Res., 31 (3): 127- 137.

Salem. S.A. and M.F. El- Massri (1986 b). Effect of rhizboium inoculation and phosphorus fertilizer levels on nodulation, seed yield and other agronomic characters of faba bean (*Vicia faba* L.). Alexandria J. of Agric. Res., 31 (3): 115- 125.

Selim, M.M. and M.A. El- Seessy (1991). Productivity of faba bean as affected by plant population, phosphorus fertilization and sowing methods. Egypt. J. Agron., 16 (1-2) : 239- 251.

Shalaby , Y. Y. and L.K. Mohamed (1978). Differences in yield of field beans due to plating date, plant density and phosphatic fertilization. Egypt. J. of Agron., 3 (1): 13- 23.

Soheir, A.M. (2001). Response of yield components of faba bean (*Vicia faba* L.) to increasing levels of nitrogen and phosphorus under two levels of plant stand density. Annals of Agric. Sci., Ain Shams Univ., (Cairo), 46 (1): 143- 154.

Stringi, I.; R.Sarno; G. Amate and L. Gristian (1988). The effect of plant density on faba beans in semiarid Mediterranean conditions *Vicia faba* L. var equine (cv. Gemini). Rivista di Agronomia. 22 (4): 293 -301 (C.F. field crop Abst., 42 (5): 3525, 1989).

Teama, E.A. (1994). Effect of skip irrigation and plant density on yield and quality of faba bean. Assiut J. Agric. Sci., 25 (5): 19- 27.

Yousrya , S.A.M. (1995). Response of faba bean to some agronomic treatments. M.Sc. Thesis, Faculty of Agric. Zagazig Univ., Egypt.

تأثير مسافات الزراعة والتسميد الفوسفاتى على نمو وانتاجية الفول البلدى

مصطفى محمد ابراهيم

قسم المحاصيل- كلية الزراعة- جامعة الازهر – فرع اسيوط

أجريت تجربتان حقليتان فى مزرعة كلية الزراعة بجامعة الازهر فرع اسيوط خلال موسمى الزراعة 2003/ 2004 و 2004/ 2005 ، لدراسة تاثير مسافات الزراعة وهى 15، 20 و 25 سم بين النباتات مع نباتين بالجورة والزراعة على الريشتين فى نفس الخط حيث تساوى (44.4 ، 33.3 و 26.6 نبات لكل متر مربع) على التريب ، وثلاث مستويات من التسميد الفوسفاتى وهى صفر، 15.5 و 31 كجم فو $_2$أ$_5$ / فدان–على النمو الخضرى والمحصول ومكوناته لنباتات الفول البلدى صنف (جيزة 40)

واوضحت النتائج ما يلى:

- أدت الزراعة على مسافة 25 سم بين الجور (26.6 نبات/ م2) إلى زيادة معنوية فى كل من عدد الافرع والاوراق / نبات والوزن الجاف للساق والاوراق / نبات فى عمر 90 يوم من الزراعة خلال الموسمين، بينما نقص ارتفاع النبات . وكذلك عند الحصاد كانت هناك زيادة معنوية فى عدد الافرع، عدد القرون ، وزن القرون ، عدد البذور ، ووزن البذور/ نبات لكلا الموسمين وايضا وزن 100 بذرة ، وزاد محصول البذرة والبيولوجى للفدان معنويا عند الزراعة على مسافة 20 و 15 سم (33.3 ، 44.4 نبات/ م2) على الترتيب فى كلا الموسمين. وأيضا زادت النسبة المئوية للبروتين والفوسفور معنويا بزيادة المسافة بين النباتات المنزرعة خلال الموسمين.
- أعطت زيادة معدل التسميد الفوسفاتى إلى 31 كجم فو $_2$أ$_5$ / فدان إلى زيادة معنوية فى ارتفاع النبات وعدد الافرع/ نبات عند عمر 90 يوم من الزراعة فى كلا الموسمين وكانت الزيادة معنوية فى الموسم الثانى فقط عند عمر 55 يوم من الزراعة، ايضا كانت الزيادة معنوية فى عدد الاوراق / نبات والوزف الجاف للساق والاوراق / نبات خلال الموسمين. وعند الحصاد أدت الزيادة فى التسميد الى زيادة معنوية لكل الصفات التى تحت الدراسة لكلا الموسمين وزات النسبة المئوية للبروتين والفوسفور فى البذرة معنويا.
- كان للتفاعل بين مسافات الزراعة ومعدلات التسميد الفوسفاتى تاثير معنوى على ارتفاع النبات عند عمر 55 يوم من الزراعة فى الموسم الأول وعلى عدد الوراق / نبات عند عمر 55 ، 90 يوم من الزراعة فى كلا الموسمين والموسم الثانى فقط على الترتيب. وكذلك فى عدد البذور / نبات ومحصول البذرة للفدان فى كلا الموسمين والموسم الأول على الترتيب. وتوصى الدراسة بزراعة نباتات الفول البلدى على مساحة 20 سم بين الجور (33.3 نبات/ م2) وإضافة السماد الفوسفاتى بمعدل 31 كيلو جرام فو $_2$أ$_5$ للتربة الطينية أدى الى تحسين فى محصول البذرة وجودته تحت ظروف منطقة الزراعة وكلاهما مهم فى للتغذية الإنسان.