# 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<sub>2</sub>O<sub>5</sub>/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<sup>2</sup>) 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<sup>2</sup> 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<sup>2</sup>, 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<sup>2</sup>. Kitiki *et al.* (1992) showed that the effect of plant density on yield was linear, the most economic plant density was 29 plants/ m<sup>2</sup>. 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<sup>2</sup>.

On the other hand, seed yield was increased by increasing plant density up to 33.3 plants/ m<sup>2</sup> (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<sup>2</sup>) ,respectively and phosphorus fertilizer levels 0.0, 15.5 and 31.0 kg P<sub>2</sub>O<sub>5</sub>/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  $10.5 \text{ m}^2$  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.

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 <sup>-1</sup> )	1.15	1.16
Total CaCO₃ (%)	2.80	2.50

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

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
- 4. Dry weight of stems/ plant (g)
- 5. Dry weight of leaves / plant (g)
- 3. Number of leaves / plant

## 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)
- 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 EI- 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.

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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<sup>2</sup>) and 31.0 kg P<sub>2</sub>O<sub>5</sub>/ 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<sup>2</sup>) 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<sup>2</sup>). On the other hand, Teama (1994) found that no significant differences among plant densities of 24, 33, 48 or 67 plants/ m<sup>2</sup> 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.

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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<sub>2</sub> 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 P2O5/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<sup>2</sup>) and adding 31.0 kg P<sub>2</sub>O<sub>5</sub>/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<sup>2</sup>) and 0.0 kg P<sub>2</sub>O<sub>5</sub>/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<sup>2</sup>) 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<sup>2</sup>) and application of phosphorus fertilizer at the rate of 31.0 kg P<sub>2</sub>O<sub>5</sub>/fad to clay loam soil cultivated with faba bean improved seeds yield and seed quality, which are important for human feeding.

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تأثير مسافات الزراعة والتمسيد 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 الاز هر فرع اسيوط خلال موسمى الزراعة ٢٠٠٢ ٢٠٠٢ و ٢٠٠٤/ ٢٠٠٩ ، لدراسة تاثير مسافات الزراعة وهى ١٥، ٢٠ و ٢٥ سم بين النباتات مع نباتين بالجورة والزراعة على الريشتين فى نفس الخط حيث تساوى (٤٤.٤ ، ٣٣.٣ و ٢٦.٦ نبات لكل متر مربع) على التريب ، وثلاث مستويات من التمسيد الفوسفاتى وهى صفر، ٥،٥٠ و ٢١ كجم فو ٢٠ / فدان على النمو الخضرى والمحصول ومكوناته لنباتات الفول البلدى صنف (جيزة ٤٠)

- واوضحت النتائج ما يلى:
- أدت الزراعة على مسافة ٢٠ سم بين الجور (٢٦,٦ نبات/ ٢٦) إلى زيادة معنوية في كل من عدد الافرع والاوراق / نبات والوزن الجاف للساق والاوراق / نبات في عمر ٩٠ يوم من الزراعة خلال الموسمين، بينما نقص ارتفاع النبات . وكذلك عند الحصاد كانت هناك زيادة معنوية في عدد الافرع ، عدد القرون ، وزن القرون ، عدد البذور ، ووزن البذور / نبات لكلا الموسمين وايضا وزن اقرون ، وزن القرون ، ووزن البذور ، ووزن البذور / نبات لكلا الموسمين وايضا وزن ١٠٠ بذرة ، وزاد محصول وزن القرون ، عدد البذور ، ووزن البذور / نبات لكلا الموسمين وايضا وزن ١٠٠ بذرة ، وزاد محصول البذرة والبيولوجى للفدان معنويا عند الزراعة على مسافة ٢٠ و ١٥ سم ( ٢٣,٣ ). ٤٤,٤ نبات / م٢) البذرة والبيولوجى للفدان معنويا عند الزراعة على مسافة ٢٠ و ١٥ سم ( ٣٣,٣ ). وكذلك عند الزراعة على مسافة ٢٠ و ١٠ سم ( ٣٣,٣ ). ٢٠ بذرة المسافة على الترتيب في كلا الموسمين. وأيضا زادت النسبة المئوية للبروتين والفوسفور معنويا بزيادة المسافة بين النبات المنزرعة خلال الموسمين.
- أعطت زيادة معدل التسميد الفوسفاني إلى ٣١ كجم فو ١/٥ / فدان إلى زيادة معنوية في ارتفاع النبات وعدد الافرع/ نبات عند عمر ٩٠ يوم من الزراعة في كلا الموسمين وكانت الزيادة معنوية في الموسم الثاني فقط عند عمر ٥٥ يوم من الزراعة، ايضا كانت الزيادة معنوية في عدد الاوراق / نبات والوزف الجاف للساق والاوراق / نبات خلال الموسمين. وعند الحصاد أدت الزيادة في التسميد الى زيادة معنوية لكل الصفات التى تحت الدراسة لكلا الموسمين وزات النسبة المئوية للبروتين والفوسفور في البذرة معنويا.
- كان للتفاعل بين مسافات الزراعة ومعدلات التسميد الفوسفاتي تاثير معنوى على ارتفاع النبات عند عمر يوم من الزراعة في الموسم الأول وعلى عدد الوراق / نبات عند عمر ٥٠ ، ٩٠ يوم من الزراعة في كلا الموسمين والموسم الثاني فقط على الترتيب. وكذلك في عدد البذور / نبات ومحصول البذرة للفدان في كلا الموسمين والموسم الأول على الترتيب. وكذلك في عدد البذور / نبات ومحصول البذرة مساحة ٢٠ سم بين الجور (٣٣,٣ نبات/ ٢٢) وإضافة السماد الفوسفاتي بمعدل بمعدل بمعدل ٢٣,٣ في هذا مع من مالحة نا للتربة الطبية أدى الى تحسين في محصول البذرة وجودته تحت ظروف منطقة الزراعة وكلاهما مهم في للتغذية الإنسان.

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Plant	Fertilizer		Plant he	ight (cm	)	Numl	per of br	anches/	plant	Number of leaves/ plant				
spacing	P-levels	0	Days afte	er sowin	g	0	Days afte	er sowin	g	Days after sowing				
(cm)	P₂O₅ kg/fad	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	
	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	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	
	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	
20	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	
	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	
25	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	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	
P-levels	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	
	SxF	2.21	NS	NS	NS	NS	NS	NS	NS	1.04	1.23	NS	0.87	

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.

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Plant	Fertilizer	Dry	Dry weight of stem/ plant (g) Dry weight of leaves/ plant (g)											
spacing	P-levels P₂O₅ kg/fad		Days after sowing											
(cm)		5	5	9	0	5	5	90						
		2003/4	2004/5	2003/4	2004/5	2003/4	2004/5	2003/4	2004/5					
	0.0	1.61	1.83	9.03	9.96	1.29	1.38	4.28	4.68					
15	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					
	0.0	1.75	1.75	10.77	12.53	1.60	2.25	5.47	6.27					
25	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	0.0	1.60	1.81	9.91	11.24	1.43	1.71	4.91	5.40					
P-levels	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	spacing (S)	NS	NS	0.79	0.75	NS	0.42	0.72	0.76					
5 % level for	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					

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.

## Ibrahim, M.M.

Plant Fertilizer		Plant height (cm)		Numl	Number of		of pods/	weight	of pods/	Number of seeds/		
spacing	P-levels			branche	branches/ plant		ant	plan	it (g)	plant		
(cm)	P₂O₅ kg/fad	2003/4	2004/5	2003/4	2004/5	2003/4	2004/5	2003/4	2004/5	2003/4	2004/5	
	0.0	128.03	131.73	1.90	1.83	13.42	13.40	27.85	29.46	31.84	33.46	
15	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	
	0.0	123.97	129.23	2.10	2.15	14.40	14.63	30.91	32.80	34.65	36.10	
20	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	
	0.0	121.44	126.58	2.28	2.42	15.58	16.27	35.91	36.18	36.20	38.39	
25	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	0.0	124.48	129.18	2.09	2.13	14.46	14.76	31.55	32.81	34.23	35.98	
P-levels	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	spacing (S)	1.88	0.30	0.24	0.11	0.74	0.96	0.81	1.09	1.03	1.97	
5 % level for	Fertilizer (F)	0.76	0.48	0.23	0.17	0.58	0.83	0.89	0.80	0.63	1.00	
	SxF	NS	NS	NS	NS	NS	NS	NS	NS	1.09	1.73	

 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.

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Plant Fertilizer		Seed yield/		100-	seed	Biologi	cal yield	Seed	yield	Protein		Phosphorus		
Spacing	P-levels	plant (g)		weig	weight (g)		ton/fad		ard*/fad		%		%	
(cm)	P₂O₅ kg/fad	2003/4	2004/5	2003/4	2004/5	2003/4	2004/5	2003/4	2004/5	2003/4	2004/5	2003/4	2004/5	
	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	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	
	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	
20	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	
	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	
25	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	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	
P-levels	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	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	
5 % level for	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	
	SxF	NS	NS	NS	NS	NS	NS	0.43	NS	NS	NS	NS	NS	

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.

\*one ardab = 155 kg