Zagazig J. Agric. Res., Vol. 46 No. (6A) 2019

Plant Production Science

http:/www.journals.zu.edu.eg/journalDisplay.aspx?Journalld=1&queryType=Master

YIELD OF FABA BEAN (*Vicia faba*, L.) AS INFLUENCED BY PLANTING DENSITY, HUMIC ACID RATE AND PHOSOHORUS FERTILIZATION LEVEL UNDER DRIP IRRIGATION SYSTEM IN SANDY SOILS

Ahmed S.M. El-Kholy*, R.M.A. Aly, A.Y.A. El-Bana and M.A.T. Yasin

Agron. Dept., Fac. Agric., Zagazig Univ., Egypt

Received: 01/08/2019 ; Accepted: 25/08/2019

ABSTRACT: Two field experiments were carried out in the Agricultural Research Station, Faculty of Agriculture, Zagazig University, El-Khattara Region, Sharkia Governorate, Egypt, during the two winter seasons of 2015/2016 and 2016/2017 to find out the response of faba bean (improved Giza 3 cv.) to three planting densities (80000, 100000 and 120000 plants/fad.), three humic acid rates (zero, 2 and 4 kg humic acid/fad.) and four phosphorus levels (zero, 15.5, 31 and 46.5 kg P_2O_5/fad.). The results of the combined analysis revealed that increasing planting density significantly decreased number of pods and branches/plant, and seed weight/plant as well as protein yield/fad., while, plant height and biological yield/fad., were significantly increased by increasing plant densities up to 120000 plants/fad. The highest value of seed yield/fad., was obtained by planting faba bean on density 100000 plants/fad. Results of the combined analysis also showed that, increasing humic acid rates up to 4 kg/fad., significantly increased number of pods/plant, weight of seeds/plant and protein yield/fad., but, hundred seed weight, plant height and number of branches/plant were not affected by the application of humic acid. Meanwhile, biological and seed yields/fad., were responded to the application of humic acid rate up to 2 kg/fad. In general, application of phosphorus fertilizer up to 46.5 kg P_2O_5/fad., significantly increased all traits under study such as number of branches and pods/plant, weight of seeds/plant, seed and biological yields/fad., and protein yield/fad as compared to other rates (combined data), while, hundred seed weight significantly increased by increasing P levels up to 31 kg P_2O_5/fad. Interaction results showed that, faba bean plants received 31 kg P_2O_5/fad., and 2 kg humic acid/fad., or received 2 kg humic acid under medium density (100000 plants/fad.) produced the highest value of seed yield/fad.

Key words: Faba bean, plant density, humic acid, phosphorus fertilization, yield.

INTRODUCTION

Faba bean (*Vicia faba* L.) has potential as a source of nutrition for human feed, and as a N_2 – fixing, legume can also play an essential role in enhancing soil fertility. Increasing faba bean production and improving its quality is a major target to meet the demand of the increasing Egyptian population since faba bean constitutes major part of the diet of Egyptian people. The cultivated area of faba bean decreased in the last ten years in Egypt from 71445 to 32532/ha **FAOSTAT (2017)**. This is due to the strong competition between faba bean and other strategic winter season crops such as wheat and clover on the limited cultivated land in Nile valley and Delta as well as the infection with the broomrapes. Cultivation of faba bean in new reclaimed sandy soils under drip irrigation system may be achieved by increasing of cultivated area of faba bean.

Planting density is an important factor affecting faba bean yield and its components. In this connection, **Kubure *et al.* (2015)**, found that weight of pods/plant, number of seeds/plant and weight of seeds/plant were increased significantly as plant density was decreased from 500000 to 444444 then to 333333 plants/

***Corresponding author: Tel. :** +201114850845
E-mail address: ahmedelkholy@zu.edu.eg

ha. However the highest seeds and biological yields/ha were obtained by planting density of 444444 plants/ha. Meanwhile, number of pods/ plant was not affected by planting density. In addition, increasing faba bean planting density significantly decreased number of pods/plant and weight of seeds/plant **Bakry *et al*. (2011) and Khalil *et al.* (2015)**. However **Bakry *et al.* (2011) and Khalil *et al.* (2015)** recorded significant increase in seed yield/unit area, due to increasing planting density up to 42 and 52 plants/m^2, respectively. Meanwhile, seed index was not affected by plant densities as reported by **Khalil *et al.* (2015)**. Seed protein content of faba bean significantly decreased by increasing planting density up to 25 and 33 plants/m^2 as reported by **Abdallah (2014)**. **Edossa Kubure *et al.* (2016)** found that increasing inter-row spacing or intra-row spacing significantly increased number of branches/plant and decreased plant height. Protein yield/fad., significantly increased by decreasing row spacing **Bakry *et al.* (2011) and Kubure *et al.* (2015)**.

Humic substances are an important soil component because they constitute a stable fraction of carbon and improve water holding capacity, pH buffering, thermal insulation and availability of nutrients **El-Galad *et al.* (2013)**. Several investigations reported that increasing humic acid rates up to 4 g/l and 8 ml/l (500 l/fad., three times at 21, 45 and 60 DAS) significantly increased faba bean seed yield **(Shafeek *et al.*, 2013; Khafaga *et al.*, 2014)**, respectively. Also, **El-Ghamry *et al.* (2009)** showed that, application of humic acid with amino acids resulted in a significant increase in each of plant height, number of branches/plant, number of pods/plant and seed yield/unit area. Meantime, hundred seed weight was significantly increased by increasing humic acid rate up to 8 ml/l **Khafaga *et al*. (2014)**. Moreover, **El-Galad *et al*. (2013) and Shafeek *et al.* (2013)** showed that, increasing humic acid rate up to 15 kg/fad., and 2 g/l, respectively significantly increased seed protein content, while **El-Bassiony *et al.* (2010) and Khafaga *et al.* (2014)** cleared that seed protein content was not affected by humic acid rates. **Bayoumi and Selim (2012)** reported that application of humic acid with nitrogen fertilizers and with bio-fertilizers recorded the highest value of weight of seeds/plant compared with other treatments (nitrogen fertilizer only, humic acid only, humic acid + bio fertilizers, humic acid + N fertilizer and bio-fertilizer+N fertilizer). Results obtained by **Kaya *et al.* (2005)** showed that pre-sowing treatment with humic acid and zinc recorded the higher protein yield/fad., of common bean (*Phaseolus vulgaris* L.) as compared with control, humic acid and zinc pre sowing treatments. Biological yield/ fad., was increased significantly by spraying humic acid substances at rate of 300 mg/l (**Knany *et al*., 2009**).

Soil supply with phosphorus is very important practice for legumes, where it is considered the most important nutrient limiting pulse production. Faba bean seed and biological yields per fad., were increased due to increasing phosphorus levels as reported by **Yilmaz (2008) and Edossa Kubure *et al*. (2016).** Also, some authors reported significant increases in number of pods/ plant, weight of pods/plant and hundred seed weight by increasing phosphorus levels up to 20 and 46.5 kg P_2O_5/fad., **Tayel and Sabreen (2011) and El-Aref *et al.* (2012)** respectively. Increasing P levels significantly increased seed protein content as reported by **Yilmaz (2008) and El-Aref *et al.* (2012**). On the contrary, **El-Sobky and Yasin (2017)** recorded significant reduction in seed protein content due to raising P levels. Plant height responded to P increment while, number of branches/plant was not influenced by P levels **Hashemabadi (2013)**. By the addition of 60 kg P_2O_5/fad., to peanut plants, protein yield/fad., was significantly increased as compared with 30 kg P_2O_5/fad., **Gobarah *et al.* (2006)**.

Therefore, the present investigation aimed to determine the optimum planting density, humic acid rate and phosphorus fertilizer level which plays an important role in increasing productivity and quality of faba bean grown under drip irrigation system in sandy soil conditions.

MATERIALS AND METHODS

Experimental Site and Treatments

Two field experiments were conducted at the Agricultural Research Station, Faculty of Agriculture, Zagazig University, El-Khattara Region, Sharkia Governorate, Egypt during the two winter seasons of 2015/2016 and 2016/

2017. The study investigated three planting densities (80000, 100000 and 120000 plants/ fad.), to achieve the tested plant densities, faba bean (improved Giza 3 cv.) was manually planted on both sides of drip line with line spacing of 70 cm and hill spacings of 15, 12 and 10 cm for planting densities, respectively. Three humic acid rates (control (without application), 2 and 4 kg humic acid/fad.) humic acid was applied as potassium humate-granules (MONBAND) (67.25% humic acid, 15.73% fulvic acid, 12.60 % K_2O, 1.50 water insoluble and 14.30% moisture), by drilling between both sides of plants in three equal doses, the first one was applied after 20 days after planting (DAP) and the two remaining doses were added at intervals of 15 days time frame between each, humic acid was mixed with sand so that it was easy to distribute regularly to the experimental units, and four phosphorus levels (control, 15.5, 31 and 46.5 kg P_2O_5/fad.) were applied as calcium superphosphate fertilizer (12.5% P_2O_5), and were drilled before planting under drip lines in sandy soil conditions.

Experimental Design and Agronomic Practices

A split-split plot design with three replicates was used in each season, where the main plots were devoted to plant densities. Humic acid rates were allocated in the 1st order sub-plots, whereas the phosphorus levels were distributed in the 2nd order sub plots. Each sub-sub plot contained 6 drip lines, 3 m long and 70 cm apart.

The soil of the experimental site was sandy in texture. Soil samples were collected from the experimental sites at the depth of 0 – 30 cm before planting to determine some soil physical and chemical properties, whereas some soil mechanical and chemical properties of the experimental field in the two seasons are presented in Table 1.

The preceding summer crop was maize (*Zea mays* L.) in both seasons. Faba bean (improved Giza 3 cv.) was planted on 4th and 2nd November in the first and second seasons, respectively. Nitrogen at level of 20 kg N/fad., added at sowing in form of ammonium sulphate (20.6% N), and potassium at level of 48 kg K_2O/fad., in form of potassium sulphate (48 % K_2O), was added in two equal doses, the first one was drilled before planting under drip lines, and the second was applied through the irrigation system (fertigation) at 50 DAP. Harvesting was practiced on 10th and 15th April in the two seasons, respectively.

Recorded Data

At harvest, the following yield attributes were recorded using ten guarded plants: plant height (cm), number of branches/plant, number of pods/plant and weight of seeds/plant (g). Thereafter, a bulk sample including all plants in the three central lines (6.3 m^2) was harvest manually to determine: hundred seed weight (g), seed protein content (%), seed and biological yields (ton/ fad.). Nitrogen content (%) in seeds was determined by using micro-kjeldhl and protein percentage (%) was calculated by multiplying N content (%) by 6.25 according to **Pratt, (1978**), protein yield/fad. was calculated by multiplying protein percentage (%) by seed yield/fad.

Data of the two seasons and their combined analysis were statistically analyzed as mentioned by **Gomez and Gomez (1984)**. For comparison between means, Duncan's multiple range test was used (**Duncan, 1955**). The combined analysis was calculated for all the studied characters in both seasons. Statistical analysis was performed by using analysis of variance technique of **MSTAT-C (1989)** computer software package. In interaction Tables, capital and small letters were used to compare rows and columns means, respectively.

The combined analysis of variance was performed for the data of the two seasons after test the homogeneity of error by bartellet,^{s} test (**Steel *et al*., 1997**).

RESULTS AND DISCUSSION

Effect of Planting Densities

As shown from results presented in Tables 2, 3, 4 and 5, increasing planting density up to 120000 plants/fad., significantly increased plant height in both seasons and their combined analysis (Table 2) and biological yield during 1st season and combined analysis (Table 5).

Table 1. Soil mechanical and chemical analyses of experimental site in the two growing seasons

Soil property	2015/2016	2016/2017
Mechanical analysis		
Sand (%)	89.15	87.9
Silt (%)	0.5	1.55
Clay (%)	10.35	10.55
Organic matter (%)	0.25	0.66
Soil texture	Sandy loam	Sandy loam
Chemical analysis		
pH	7.25	7.48
EC mmhose/cm	0.8	0.77
Total N (%)	0.008	0.01
Available P (ppm)	3.64	5.55
Available K (ppm)	35.01	37.44
Soluble cations (meq./l.)		
Na^+	0.9	0.95
K^+	0.1	0.1
Ca^{++}	2	3
Mg^{++}	1	1.5
Soluble onions (meq./100 g.)		
Cl^-	1.5	2
CO_3^{--}	-	-
HCO^{-3}	0.5	0.5
SO_4^{--}	2	3.05

Source: Central Laboratory, Faculty of Agriculture, Zagazig University, Zagazig, Egypt

Table 2. Plant height and number of branches/plant of faba bean plants as affected by planting densities, humic acid rates, phosphorus fertilizer levels and their interactions during the two seasons and their combined

Main effects and interactions	Plant height (cm)			No. branches/plant		
	2015/2016	2016/2017	Combined	2015/2016	2016/2017	Combined
Planting density (D)						
80000 plants/fad.	85.09 c	178.45 b	131.63 c	3.321 a	3.831 a	3.576 a
100000 plants/fad.	88.84 b	185.28 ab	137.06 b	3.144 a	3.597 a	3.371 a
120000 plants/fad.	92.75 a	194.45 a	143.60 a	2.836 b	3.068 b	2.961 b
F-test	**	*	**	*	*	**
Humic acid rate (H)						
Control	89.08	187.79	138.44	3.032	3.433	3.233
2 kg/fad.	89.42	187.32	138.37	3.067	3.444	3.256
4 kg/fad.	88.19	182.78	135.48	3.203	3.636	3.419
F-test	NS	NS	NS	NS	NS	NS
Phosphorus level (P)						
Control	88.30	188.20	138.25	2.637 c	3.147 c	2.906 d
15.5 kg P_2O_5/fad.	87.84	188.11	136.01	3.037 b	3.344 bc	3.191 c
31 kg P_2O_5/fad.	89.01	184.17	138.56	3.298 a	3.526 b	3.412 b
46.5 kg P_2O_5/fad.	90.42	183.37	136.90	3.340 a	3.974 a	3.702 a
F-test	NS	NS	NS	**	**	**
Interactions						
D×H	**	NS	NS	NS	NS	NS
D×P	**	NS	NS	NS	NS	NS
H×P	**	NS	NS	NS	NS	NS

*,** and NS indicate significance at 0.05 and 0.01 levels and not significant of differences, in respective order.

Table 3. Number of pods/plant and seed weight/plant of faba bean plants as affected by planting densities, humic acid rates, phosphorus fertilizer levels and their interactions during the two seasons and their combined

Main effects and interactions	No. pods/plant			Seed weight/plant (g)		
	2015/2016	2016/2017	Combined	2015/2016	2016/2017	Combined
Planting density (D)						
80000 plants/fad.	13.63 a	28.62 a	21.13 a	27.32 a	61.01 a	44.20 a
100000 plants/fad.	13.42 a	22.52 b	17.97 b	23.76 b	47.27 b	35.80 b
120000 plants/fad.	9.02 b	24.33 b	16.68 c	16.56 c	53.83 b	34.92 b
F-test	**	**	**	**	*	**
Humic acid rate (H)						
Control	12.11	21.36 c	16.73 c	21.25 b	45.95 c	33.60 c
2 kg/fad.	11.75	25.67 b	18.71 b	21.92 b	55.27 b	38.59 b
4 kg/fad.	12.22	28.33 a	20.33 a	24.49 a	60.89 a	42.60 a
F-test	NS	**	**	*	**	**
Phosphorus level (P)						
Control	10.85 b	21.91 c	16.38 c	21.19 b	50.11 b	35.65 c
15.5 kg P_2O_5/fad.	11.96 ab	24.61 b	18.28 b	20.63 b	49.99 b	35.31 c
31 kg P_2O_5/fad.	12.46 a	26.48 ab	19.47 ab	22.28 b	55.91 a	39.10 b
46.5 kg P_2O_5/fad.	12.82 a	27.62 a	20.22 a	26.10 a	60.14 a	43.12 a
F-test	*	**	**	**	**	**
Interactions						
D×H	*	**	**	NS	**	*
D×P	NS	NS	NS	NS	NS	NS
H×P	**	**	**	NS	**	**

*,** and NS indicate significance at 0.05 and 0.01 levels and not significant of differences, in respective order.

Table 4. Hundred seed weight and seed yield (ton/fad.) of faba bean plants as affected by planting densities, humic acid rates, phosphorus fertilizer levels and their interactions during the two seasons and their combined

Main effects and interactions	Hundred seed weight (g)			Seed yield (ton/fad)		
	2015/2016	2016/2017	Combined	2015/2016	2016/2017	Combined
Planting density (D)						
80000 plants/fad.	76.15	81.19 a	78.67	1.345 b	1.878 a	1.612 b
100000 plants/fad.	76.79	79.58 ab	78.19	1.548 a	1.934 a	1.741 a
120000 plants/fad.	77.78	77.55 b	77.66	1.540 a	1.715 b	1.627 b
F-test	NS	*	NS	*	*	*
Humic acid rate (H)						
Control	77.46	79.56	78.51	1.268 b	1.809	1.538 b
2 kg/fad.	76.49	78.99	77.74	1.581 a	1.865	1.723 a
4 kg/fad.	76.73	79.76	78.27	1.584 a	1.852	1.718 a
F-test	NS	NS	NS	**	NS	**
Phosphorus level (P)						
Control	73.98 b	79.37	76.68 b	1.304 b	1.610 c	1.457 d
15.5 kg P_2O_5/fad.	74.32 b	80.14	77.23 b	1.347 b	1.872 b	1.609 c
31 kg P_2O_5/fad.	79.60 a	79.13	79.37 a	1.591 a	1.909 ab	1.750 b
46.5 kg P_2O_5/fad.	79.72 a	79.12	79.42 a	1.668 a	1.978 a	1.823 a
F-test	**	NS	**	**	**	**
Interactions						
D×H	NS	NS	NS	*	NS	NS
D×P	NS	**	**	*	**	**
H×P	**	*	**	**	NS	**

*,** and NS indicate significance at 0.05 and 0.01 levels and not significant of differences, in respective order.

Table 5. Biological yield (ton/fad.) and protein yield (kg/fad.) of faba bean plants as affected by planting densities, humic acid rates, phosphorus fertilizer levels and their interactions during the two seasons and their combined

Main effects and interactions	Biological yield (ton/fad.)			Protein yield (kg/fad.)		
	2015/2016	2016/2017	Combined	2015/2016	2016/2017	Combined
Planting density (D)						
80000 plants/fad.	2.306 c	5.638 b	3.972 c	400.8	562.7 a	481.8 a
100000 plants/fad.	2.408 b	6.053 a	4.231 b	437.8	560.3 a	499.1 a
120000 plants/fad.	3.010 a	5.861 ab	4.435 a	403.8	477.4 b	440.6 b
F-test	**	*	**	NS	**	*
Humic acid rate (H)						
Control	2.229 c	5.783	4.041 b	341.5 b	474.5 c	408.0 c
2 kg/fad.	2.645 b	5.843	4.244 a	428.5 a	532.2 b	480.4 b
4 kg/fad.	2.780 a	5.926	4.353 a	472.5 a	593.7 a	533.1 a
F-test	**	NS	**	**	**	**
Phosphorus level (P)						
Control	2.166 c	5.214 c	3.690 d	330.0 c	385.9 d	357.9 d
15.5 kg P_2O_5/fad.	2.609 b	5.843 b	4.226 c	346.8 c	486.5 c	416.6 c
31 kg P_2O_5/fad.	2.590 b	6.167 a	4.378 b	435.4 b	605.0 b	520.22 b
46.5 kg P_2O_5/fad.	2.935 a	6.179 a	4.557 a	544.4 a	656.5 a	600.5 a
F-test	**	**	**	**	**	**
Interactions						
D×H	**	NS	NS	*	NS	*
D×P	**	*	**	**	**	**
H×P	**	NS	NS	*	**	**

*,** and NS indicate significance at 0.05 and 0.01 levels and not significant of differences, in respective order.

Meanwhile, number of branches/plant in the two seasons and their combined (Table 2), number of pods/plant in the 1st season and combined analysis, weight of seeds/plant in the 1st (Table 3), 100-seed weight and seed yield/fad. in the 2nd season and protein yield/fad., during the 2nd season and combined analysis were significantly decreased (Tables 4 and 5). Number of pods/plant during the 2nd season, weight of seeds/plant during the 2nd season and combined analysis and seed yield/fad., in the 1st season significantly deceased with increasing planting density from 80000 to 100000 plants/fad. Furthermore, the combined analysis of the two seasons showed that planting density of 100000 plants/fad., outperformed the other densities in seed yield/fad. On the other hand, the three tried planting densities had no significant effect on hundred seed weight in the 1st season and combined analysis, these results are in agreement with those reported by **Khalil *et al.* (2015)**. Also, the obtained results are in agreement with those reported by **Abdallah (2014**) who found that increasing planting density from 25 to 33 plants/m^2 significantly decreased number of branches and pods/plant, weight of seeds/plant and seed yield/fad., but significantly increased plant height. On the other hand, **Bakry *et al.* (2011)** found that decreasing row spacing up to 20 cm (176000 plants/fad.) significantly increased biological yield, hundred seed weight and protein yield. The decrement in seed yield caused by high planting density (120000 plants/fad.) may be attributed to the competition between plants which increased shading between leaves causing insufficient carbon fixation, increasing respiration rate and intra-plant competition. On the other hand, the reduction in seed yield caused by low plant density (80000 plants/fad.) may be attributed to that the increments in yield components could not compensate the reduction occurred in plant population **(Abdallah, 2014)**.

Effect of Humic Acid Rates

Humic acid rates had no significant effect on plant height, number of branches/plant and hundred seed weight in the two seasons and the combined analysis (Tables 2 and 4). Increasing humic acid rates from zero to 2 then to 4 kg/fad., significantly increased weight of seeds/plant in both seasons and their combined, number of pods/plant, and protein yield/fad., in the 2nd season and combined analysis and biological yield/fad., in first season only (Tables 3 and 5). Seed yield/fad., in 1st season and combined results, biological yield in combined results and protein yield in 1st season only were significantly increased by increasing humic acid rates up to 2 kg/fad. On the other hand, seed and biological yields/fad., in the 2nd season were not affected by the tried humic acid rates. The obtained results are in accordance with those reported by **Shafeek *et al.* (2013) and Khafaga *et al.* (2014)**. Yield and yield components of faba bean significantly increased by application of humic acid **(El-Ghamry *et al.*, 2009; Fouda, 2017)**. This could be explained that humic acid is rich in both organic and mineral substances which are essential to plant growth and consequently increasing yield quality and quantity (**El-Bassiony *et al.*, 2010)**. Also, humic acid reduces soil pH and EC (**El-Galad *et al.*, 2013)**.

Effect of Phosphorus Fertilizer Levels

It was clearly evident from Tables 2, 3, 4 and 5 that increasing P levels up to 46.5 kg P_2O_5/ fad., significantly increased each of number of branches/ plant (the 2nd season and the combined results), weight of seeds/plant and biological yield/fad., (the 1st season and the pooled results), seed yield/fad., (combined results) and protein yield/fad., (both seasons and combined results). On the other hand, the maximum values of number of pods/plant (the 2nd season and the combined analysis), and hundred seed weight (the 1st season and the combined results) were significantly obtained when application of 31 kg P_2O_5/fad. Meanwhile, plant height in both seasons and their combined and 100 seed weight in the 2nd season were not affected by P fertilizer. Such results stated the vital role of phosphorus fertilization in improving the productivity of faba bean (**El-Gizawy and Mehasen, 2009; Edossa Kubure *et al.*, 2016)**. Also, **El-Aref *et al.* (2012)** showed that increasing P levels up to 46.5 kg P_2O_5/fad., significantly increased number of branches and pods/plant, weight of seeds/plant seed and straw yields/fad., but, hundred seed weight responded to 31 kg P_2O_5/fad. Furthermore, the obtained results concerning plant height and hundred seed weight are in accordance with those reported by **El-Sobky and Yasin (2017)** who recorded that insignificant differences in plant height and hundred seed weight of faba bean due to varying P fertilizer levels.

Interaction Effect

Interaction between planting densities and humic acid rates

Results in Table 6 show that, under low density, weight of seeds/plant and protein yield/ fad., showed positive response to increasing humic acid rates up to 2 kg/fad. Moreover, under the high planting density, the two aforementioned traits exhibited significant response to raising humic acid application up to 4 kg/fad. This finding can be explained by the fact that increasing plant density increases the nutritional requirements of plants. It could be also concluded that, the highest number of pods/ plant was obtained by sowing faba bean in density of 80000 plants/fad., and addition of 4 kg humic acid/fad., while the lowest number of pods/plant was recorded under the high planting density without humic acid application.

Interaction between planting density and phosphorus fertilizer levels

From results presented in Table 7, seed and biological yields/fad., significantly increased under low density by increasing P levels up to 31 kg P_2O_5/fad., while, under high planting density increased by increasing phosphorus fertilizer levels up to 46.5 kg P_2O_5/fad. The obtained results are in accordance with those reported by **Luikham *et al.* (2009)**. As the increase in the number of plants per unit area the competition among plants on nutrients, especially phosphorus was increased which is the most important nutrients for legumes (Table 7). The lowest value of hundred seed weight was achieved under high planting density and without phosphorus fertilizer application.

Interaction between humic acid rates and phosphorus fertilizer levels

The presented results in Table 8 clear that, the highest value for each of number of pods/ plant and weight of seeds/plant was obtained by addition of humic acid at rate of 2 kg/fad., and phosphorus fertilizer at level of 46.5 kg P_2O_5/fad.

Table 6. Number of pods/plant, seed weight/plant and protein yield/fad., as influenced by the interaction between planting densities and humic aid rates (combined analysis)

Planting density (D)	Humic acid rate (H)		
	Control	2 kg/fad.	4 kg/fad.
		Number of pods/plant	
80000 plants/fad.	C 17.83 a	B 21.22 a	A 24.33 a
100000 plants/fad.	A 17.55 a	A 18.83 b	A 17.52 b
120000 plants/fad.	B 14.82 b	B 16.08 c	A 19.13 b
		Seed weight (g)/plant	
80000 plants/fad.	B 36.22 a	A 46.92 a	A 49.36 a
100000 plants/fad.	A 34.66 a	A 35.02 b	A 37.72 b
120000 plants/fad.	B 29.92 a	B 33.84 b	A 40.99 b
		Protein yield (kg/fad.)	
80000 plants/fad.	B 419.3 a	A 505.9 a	A 520.1 a
100000 plants/fad.	B 400.5 a	A 532.5 a	A 564.2 a
120000 plants/fad.	B 404.2 a	B 402.7 b	A 515.0 a

Table 7. Hundred seed weight (g), seed and biological yields/fad., as influenced by the interaction between planting densities and phosphorous fertilizer levels (combined analysis)

Planting density (D)	Phosphorus fertilizer level (P)			
	Control	15.5 kg P_2O_5/fad.	31 kg P_2O_5/fad.	46.5 kg P_2O_5/fad.
		Hundred seed weight (g)		
80000 plants/fad.	A 80.07 a	A 77.62 ab	A 78.63 a	A 78.37 a
100000 plants/fad.	B 75.02 b	A 79.67 a	AB 78.88 a	AB 79.19 a
120000 plants/fad.	B 74.94 b	B 74.41 b	A 80.61 a	A 80.70 a
		Seed yield (ton/fad.)		
80000 plants/fad.	B 1.448 a	B 1.510 b	A 1.703 b	A 1.745 a
100000 plants/fad.	C 1.433 a	B 1.740 a	A 1.889 a	A 1.900 a
120000 plants/fad.	C 1.449 a	BC 1.578 b	B 1.658 b	A 1.824 a
		Biological yield (ton/fad.)		
80000 plants/fad.	C 3.484 b	B 3.827 b	A 4.246 a	A 4.332 b
100000 plants/fad.	B 3.667 b	A 4.357 a	A 4.413 a	A 4.485 b
120000 plants/fad.	C 3.919 a	B 4.493 a	B 4.477 a	A 4.853 a

Table 8. Number of pods /plant, seed weight/plant and seed yield/fad., as affected by humic acid rates and phosphorus fertilizer levels interaction (combined analysis)

Humic acid rate (H)	Phosphorus fertilizer level (P)			
	Control	15.5 kg P_2O_5/fad.	31 kg P_2O_5/fad.	46.5 kg P_2O_5/fad.
	Number of pods/plant			
Control	B 14.43 b	AB 16.37 b	A 18.85 a	AB 17.55 b
2 kg/fad.	BC 17.63 a	C 15.77 b	AB 19.58 a	A 21.86 a
4 kg/fad.	B 17.09 ab	A 22.72 a	AB 20.26 a	A 21.25 a
	Seed weight(g)/plant			
Control	C 28.11 b	BC 31.18 b	AB 36.45 a	A 38.65 b
2 kg/fad.	B 36.07 a	B 32.55 b	B 39.18 a	A 46.58 a
4 kg/fad.	A 42.79 a	A 42.19 a	A 41.66 a	A 44.13 ab
	Seed yield (ton/fad.)			
Control	B 1.378 a	B 1.440 b	B 1.504 b	A 1.822 a
2 kg/fad.	C 1.530 a	B 1.702 a	A 1.876 a	AB 1.785 a
4 kg/fad.	C 1.453 a	B 1.686 a	A 1.870 a	A 1.862 a

The obtained results showed that without addition of humic acid of faba bean plants responded to increments of phosphorus. However, with the addition of humic acid/fad., seed yield/fad., significantly increased by increasing P levels up to 31 kg P_2O_5/fad. From the above it is clear that the use of chemical phosphorus fertilization can be reduced by the addition of humic acid, which is characterized by its high ability to chelate anions on its surface.

Conclusion

From the obtained results it could be concluded that the highest value of seed yield/ fad., was significantly obtained by sowing faba bean plants at density of 100000 plants/fad., with application of 31 kg P_2O_5/fad., or by application of 31 kg P_2O_5/fad., with 2 kg humic/fad., under drip irrigation system in sandy soil conditions.

REFERENCES

Abdallah, A.M. (2014). Response of faba bean (*Vicia faba* L.) to different planting densities and bio-mineral fertilization systems. American-Eurasian J. Agric. and Environ. Sci., 14 (6): 541-545.

Bakry, B.A., T.A. Elewa, M.F. El-Karamany, M.S. Zeidan and M.M. Tawfik (2011). Effect of row spacing on yield and its components of some faba bean varieties under newly reclaimed sandy soil condition. World J. Agric. Sci., 7 (1): 68-72.

Bayoumi, M.A. and T.A. Selim (2012). Effect of nitrogen, humic acid and bio-fertilization on productivity and quality of faba bean under saline condition. J. Soil Sci. and Agric. Eng., Mansoura Univ., 3 (8): 829-843.

Duncan, D.B. (1955). Multiple ranges and multiple "F" test. Biometrics, 11: 1-42.

Edossa Kubure, T., C.V. Raghavaiah and H. Ibrahim (2016). Production Potential of faba bean (*Vicia faba* L.) genotypes in relation to plant densities and phosphorus nutrition on vertisols of central highlands of west showa zone, Ethiopia, East Africa. Adv. Crop Sci. Tech., 4 (2): 1-9.

El-Aref, K.A.O., A.S. Abo-El-Hamd, M.M. Ibrahim and M.A.A. El-Said (2012). Influence of phosphorus and bio-fertilizers on production and quality of some faba bean varieties (*Vicia faba* L.) Minia J. of Agric. Res. and Dev., 32(1): 83-108.

El-Bassiony, A.M., Z.F. Fawzy, M.M.H. Abd El-Baky and A.R. Mahmoud (2010). Response of snap bean plants to mineral fertilizers and humic acid application. Res. J. Agric. and Biol. Sci., 6(2): 169-175.

El-Galad, M.A., D.A. Sayed and R.M. El-Shal (2013). Effect of humic acid and compost applied alone or in combination with sulphur on soil fertility and faba bean productivity under saline soil conditions. J. Soil Sci. and Agric. Eng., Mansoura Univ., 4 (10): 1139-1157.

El-Ghamry, A.M., K.M. Abd El-Hai and K.M. Ghoneem (2009). Amino and humic acids promote growth, yield and disease resistance of faba bean cultivated in clayey soil. Aust. J. Basic and Appl. Sci., 3 (2): 731-739.

El-Gizawy, N.K.B. and S.A.S. Mehasen (2009). Response of faba bean to bio, mineral phosphorus fertilizers and foliar application with zinc. World Appl. Sci. J., 6 (10): 1359-1365.

El-Sobky, E.E.A. and M.A.T. Yasin (2017). Phosphorus and micronutrients fertilization impact on faba bean productivity (*Vicia faba* L.). Zagazig J. Agric. Res., 44 (3): 853-863.

FAOSTAT (2017). Available online: http:// www.fao.org/faostat/en/# data. QC (accessed on January 2018).

Fouda, K.F. (2017). Effect of phosphorus level and some growth regulators on productivity of faba bean (*Vicia faba* l.). Egypt. J. Soil Sci., 57 (1): 73-87.

Gobarah, M.E., M.H. Mohamed and M. Tawfik (2006). Effect of phosphorus fertilizer and foliar spraying with zinc on growth, yield and quality of groundnut under reclaimed sandy soils. J. Appl. Sci. Res., 2 (8):491-496.

Gomez, K.N. and A.A. Gomez (1984). Statistical Procedures for Agriculture Research. John Wiley and Sons, New York, 2nd Ed.

Hashemabadi, D. (2013). Phosphorus fertilizers effect on the yield and yield components of faba bean (*Vicia faba* L.). Ann. Biol. Res., 4 (2): 181-184.

Kaya, M., M. Atak, K.M. Khawar, C.Y. Ciftci and S. Ozcan (2005). Effect of pre-sowing seed treatment with zinc and foliar spray of humic acids on yield of common bean (*Phaseolus vulgaris* L.). Int. J. Agric. Biol., 7 (6): 875-878.

Khafaga, E.E.E., S.A. Hasanin and R.M. El-Shal (2014). Effect of foliar application with ascorbic, humic acids and compost tea on nutrients content and faba bean productivity under sandy soil conditions. J. Soil Sci. and Agric. Eng., Mansoura Univ., 5(6): 767-778.

Khalil, N.A., W.A. Al-Murshidy, A.M. Eman and R.A. Badawy (2015). Effect of plant density and calcium nutrition on growth and yield of some faba bean varieties under saline conditions. J. Int. Sci. Publications, 3 (1): 440-450.

Knany, R., R. Atia and A. El-Saady (2009). Response of faba bean to foliar spraying with humic substances and micronutrients. Alex. Sci. Exch. J., 30 (4): 453-460.

Kubure, T.E., R. Cherukuri, C. Arvind and I. Hamza, (2015): Effect of faba bean (*Vicia faba* L.) genotypes, plant densities and phosphorus on productivity, nutrients uptake, soil fertility changes and economics in Central high lands o Ethiopia. Int. J. Life Sci., 3 (4): 287-305.

Luikham, E., M. Phulchand and P.S. Mariam Anal, (2009): Response of broad bean (*Vicia faba* L.) to row spacing and phosphorus under late sown rainfed condition of manipur. Agric. Sci. Digest., 29(1): 54-56.

MSTAT-C. (1989). MSTAT-C Statistical program version 2.10. Crop and soil science Department, Michigan State Univ., USA.

Shafeek, M.R., Y.I. Helmy, N.M. Omer and F. A. Rizk (2013). Effect of foliar fertilizer with nutritional compound and humic acid on growth and yield of broad bean plants under sandy soil conditions. J. Appl. Sci. Res., 9 (6): 3674-3680.

Pratt, P. (1978). Methods of analysis for soil, plant and water. Univ. California, Div Agric Sci USA.

Steel, R.G.D., J.H. Torrie and D.A. Dicky (1997). Principles and Procedures of Statistics, a Biological Approach. 3rd Ed. MacGraw Hill Book Co. New York.

Tayel, M.Y. and K.P. Sabreen (2011). Effect of irrigation regimes and phosphorus level on two *Vicia faba* L. varieties: 1-growth characters. J. Appl. Sci. Res., 7 (6): 1007-1015.

Yilmaz, F. (2008). Effects of increased phosphorus rates and plant densities on yield and yield-related traits of narbon vetch lines. Turk. J. Agric., 32 (2008): 49-56.

تأثير كثافة الزراعة، معدل حمض الهيوميك ومستوى السماد الفوسفاتي على محصول الفول البلدى تحت نظام الرى بالتنقيط فى الأراضى الرملية

أحمد سليمان محمد الخولى - رجب محمد على على - عادل يوسف عبدالحميد البنا - محمد عبدالسلام طه يس

قسم المحاصيل - كلية الزراعة - جامعة الزقازيق - مصر

أجريت تجربتان حقليتان فى محطة البحوث الزراعية - كلية الزراعة - جامعة الزقازيق بمنطقة الخطارة - محافظة الشرقية – جمهورية مصر العربية خلال الموسمين الشتويين ٢٠١٦/٢٠١٥ و ٢٠١٧/٢٠١٦ لدراسة تأثير ثلاث كثافات زراعة (٨٠٠٠٠، ١٠٠٠٠٠ و١٢٠٠٠٠ نبات/فدان)، وثلاث معدلات من حمض الهيوميك (كنترول (بدون إضافة)، ٢ و٤ كجم من حمض الهيوميك/فدان) وأربعة مستويات من السماد الفوسفاتى (بدون إضافة، ١٥.٥، ٣١ و ٤٦.٥ كجم فو٢أ٥ على المحصول ومساهماته فى الفول البلدى صنف جيزة ٣ محسن، ويمكن تلخيص أهم النتائج على النحو التالى: من خلال نتائج التحليل المشترك للموسمين يتضح أنه بزيادة الكثافة النباتية عن ٨٠٠٠٠ نبات للفدان حدث نقص معنوى فى صفات عدد الأفرع للنبات، عدد القرون للنبات، وزن بذور النبات، ومحصول البروتين للفدان، بينما حدث زيادة معنوية فى ارتفاع النبات والمحصول البيولوجى للفدان بزيادة كثافة الزراعة حتى ١٢٠٠٠٠ نبات للفدان، فى حين أن الكثافة ١٠٠٠٠٠ نبات للفدان حققت أعلى محصول بذور للفدان، أدى زيادة معدلات حمض الهيوميك حتى ٤ كجم/فدان إلى زيادة متوسطات صفات عدد القرون للنبات، وزن بذور النبات، ومحصول البروتين للفدان، بينما لم تتأثر صفات ارتفاع النبات، عدد أفرع النبات، ووزن الـ ١٠٠ بذرة، فى حين أن محصول البذور والمحصول البيولوجى للفدان استجاب لزيادة معدلات حمض الهيوميك حتى ٢ كجم للفدان، بوجه عام أدى زيادة مستويات السماد الفوسفاتى حتى ٤٦.٥ كجم فو٢أ٥ إلى زيادة معنوية فى جميع الصفات تحت الدراسة، باستثناء وزن الـ ١٠٠ بذرة والذى سجل استجابة معنوية لزيادة مستويات السماد الفوسفاتى حتى ٣١ كجم فو٢أ٥ للفدان، بيانات التفاعل بين عوامل الدراسة المتحصل عليها أظهرت أن أعلى محصول بذور للفول البلدى يتحقق عند الزراعة بكثافة ١٠٠٠٠٠ نبات/فدان وإضافة حمض الهيوميك بمعدل ٢ كجم للفدان أو التسميد الفوسفاتى بمعدل ٣١ كجم فو٢أ٥ مع إضافة حمض الهيوميك بمعدل ٢ كجم/فدان تحت ظروف الاراضى الرملية والرى بالتنقيط بمنطقة الخطارة بمحافظة الشرقية.

المحكمـــــون:

١- أ.د. ماهــر عبد الله قــطب أستاذ المحاصيل – كلية الزراعة – جامعة قناة السويس.

٢- أ.د. سعد عبد المنعم غانم أستاذ المحاصيل المتفرغ – كلية الزراعة – جامعة الزقازيق.