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Effect of Row Spacing on Yield and its Components of Some Faba Bean Varieties under Newly Reclaimed Sandy Soil Condition

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Abstract: Two field experiments were carried out at the Researches and Production Station of the National Research Centre (NRC) at Al Nubaria district, El-Behaira Governorate, Egypt during 2008/09 and 2009/10 winter seasons. Five faba bean varieties (Cairo -4, Cairo -5, Cairo -25, Nubaria -1 and Giza -843) were seeded at (20, 40 and 60 cm between rows) which were 42, 25, 16 plants/m^2 in newly reclaimed sandy soils. Results indicated that faba bean varieties varied significantly in all studied characters. Nubaria-1 and Cairo-25 varieties produced high seed and protein yields per feddan and significantly out yielded the other varieties. Increasing plant density significantly increased seed and protein yields per feddan as well as plant height, 100-seed weight and biological yield per feddan. On the other hand, increasing plant density decreased number of branches and number of pods per plant, pods and seed yields per plant, number of seeds per pod and harvest index. Results also indicated that the interaction between varieties and plant density had significant effect in all studied characters. Nubaria-1 variety produced the highest seed and protein yields per feddan when it seeded at 20 cm between rows and significantly out yielded the other all varieties. However, Cairo-25 and Nubaria-1 varieties produced high biological yield per feddan when they seeded at the highest plant density.

Key words: Faba bean (*Vicia faba* L.) · Varieties · Plant density · Seed yield · Protein percentage

INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the most important winter legume crops for human consumption in Egypt as a protein source and has potential N_2-fixing legume can also play an essential role in enhancing soil fertility. Also, production of faba bean in Egypt is still limited and falls to face the increasing local consumption of the crop, this is related to the cultivated area by faba bean in Egypt is relatively small and decreased dramatically in last decade. This is due to the strong competition between faba bean and other strategic winter season crops such as wheat and clover on the limited arable land in Nile valley and Delta. Faba bean production is affected by different factors such climatic conditions, soil fertility, water supply, varieties or genotypes and plant population density. For that this investigation aimed to study the performance of some local faba bean varieties under different row spacing at the newly reclaimed sandy soils using sprinkler irrigation system. Many investigators, Osman *et al*. [1], Ragab *et al*. [2], Al Ghamdi [3], Stutzel *et al.* [4], Singh *et al.* [5], Silim and Saxena [6], Pilbeam *et al.* [7] and Stutzel and Aufhamer [8] reported significant differences among faba bean varieties concerning seed, biological and protein yields and there components.

Plant population density of field bean is an important factor in the new reclaimed lands which depends on stand establishment. However, plant competition for environmental resources is affected by the spatial arrangement of those plants, this may be affected by the plant density (number of plants per unit area) by the distance between rows. Concerning the effect of row spacing or plant population densities reveled that increasing seed yield as row spacing decreased. On the other hand, other studies, Bonari and Macchis [9], Bianchi [10], Caballero [11], El-Deeb [12], Salem [13], Mc Ewen *et al*. [14], Darwish and Hassanin [15], Amer *et al*. [16], Khalil *et al*. [17], Farag and El-Shama [18], Salwau [19], Al-Rifaee [20], Turk and Tawaha [21] and Thalji [22] pointed that seed, pods and straw yields per plant were increased by increasing row spacing. Previous studies, Stutzel *et al.* [4], Silim and Saxana [6], Pilbeam *et al*. [7], Stutzel and Aufhammer [8] and Darwish

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and Hassanin [15] reported that the response of faba bean varieties or genotypes to plant density or row spacing was different.

Therefore, the present study aims to evaluate yield and quality traits of five faba bean varieties grown in the Researches and Production Station of the National Research Centre (NRC) at Al Nubaria district, El-Behaira Governorate, Egypt.

MATERIALS AND METHODS

Two field trials were carried out during winter seasons of 2008/09 and 2009/10 in order to evaluate the yield and quality traits of five faba bean varieties grown in the Researches and Production Station of the National Research Centre (NRC) at Al Nubaria district, El-Behaira Governorate, Egypt. The mechanical and chemical soil analysis are presented in Table 1.

The experiments were laid out in split plot design with four replications where faba bean varieties (Cairo -4, Cairo -5, Cairo -25, Nubaria -1 and Giza -843) were randomly assigned in main plots, while rows spacing (20, 40 and 60 cm between rows) were distributed randomly in sub-plots. The experimental unit area was 10.5 m^2= (1/400 fed., one feddan =4200 m^2) 3 m long and 3.5 m width which formed of 14 rows from 20 (cm) between rows, 7 rows from 40 (cm) between rows and 5 rows from 60 (cm) between rows. Seeds of faba bean varieties were planted in 15th November in both growing seasons. Irrigation was carried out using the sprinklers according zoon system. During seed bed preparation P_2O_5 and K_2O fertilizers were added at the rate of 31.0 and 24.0 (kg/fed), respectively, while nitrogen fertilizer as ammonium nitrate (33.5%) was added at the rate of 33.5 kg N/fed. Plants of 1 m^2 were counted in each plot at 60 days after sowing (DAS) recorded 42 plants from 20 cm between rows - 25 plants from 40 cm between rows - 16 plants from 60 cm between rows.

At harvest the following characters were recorded on a random sample of ten guarded plants from each plot:

- Plant height (cm).
- Number of branches /plant.
- Number of pods /plant.
- Pods yield /plant (g).
- Number of seeds /pod.
- Seed yield /plant (g).
- 100 seeds weight (g).

The whole plot was harvested to determine seed and biological yields/feddan then calculated harvest index by divided seed yield/biological yield. Total N content in seeds was determined by using micro-kjeldhl and protein% was calculated by multiplying N content by 6.25 according to Chapman and Pratt [23], protein yield/fed was also calculated by multiply protein% x seed yield/fed.

Data were statistically analyzed separately for each season. The combined analysis was conducted for the data of the two seasons after tested the variances homogeneity of both seasons according to Snedecor and Cochran [24]. The least significant difference (LSD) was used to compare between different means.

RESULTS AND DISCUSSION

Varietal Differences: Combined data presented in Table 2 indicated that faba bean varieties were differed significantly in all studied characters. Nubaria-1 variety

Table 1: Mechanical and chemical analysis of experimental soil

Sand %	Silt %	Clay %	pH	Organic matter %	$CaCO_3$ %	EC dS/m	Soluble N ppm	Available P ppm	Exchangeable K ppm
91.2	3.7	5.1	7.3	0.3	1.4	0.3	8.1	3.2	20

Table 2: Effect of faba bean varieties on seed yield and its components (combined analysis of 2008/09 and 2009/10 seasons)

Varieties	Plant height (cm)	No. of branches /plant	No. of pods / plant	Pods yield / plant(g)	No. of seeds / pod	Seed yield / plant (g)	100 seeds weight g	Seed yield kg/fed*	Biological yield (ton/fed)	Harvest index %	Nitrogen %	Protein %	Protein yield (kg/fed)
Cairo-4	78.78	2.00	4.56	12.96	3.00	9.60	79.00	388.08	2.067	18.78	3.75	23.46	91.04
Cairo-5	74.44	1.33	3.11	8.09	2.89	9.18	81.00	357.47	1.539	23.23	3.70	23.15	82.75
Cairo-25	78.44	1.33	2.67	13.44	2.44	10.97	77.00	451.87	2.135	21.16	3.41	22.10	99.86
Nubaria-1	80.67	3.22	5.89	14.13	3.56	12.67	106.70	479.55	2.643	18.14	3.54	21.96	105.31
Giza-843	75.67	2.67	4.00	14.11	3.00	10.87	87.70	396.20	2.004	19.77	3.51	21.33	84.51
LSD 0.05	1.51	0.16	0.94	0.05	0.39	0.77	0.66	0.28	0.031	0.29	0.03	0.16	0.79

*fed. = One feddan= 4200 m^2

Table 3: Effect of row spacing on seed yield and its components (combined analysis of 2008/09 and2009/10 seasons)

Row spacing (cm)	Plant height (cm)	No. of branches /plant	No. of pods /plant	Pods yield/ plant (g)	No. of seeds /pod	Seed yield/ plant (g)	100 seeds weight g	Seed yield (kg/fed)	Biological yield (ton/fed)	Harvest index %	Nitrogen %	Protein %	Protein yield (kg/fed)
20	82.67	1.60	2.60	9.47	3.13	7.76	94.00	469.70	2.666	17.62	3.64	22.56	105.96
40	76.13	2.00	4.33	13.03	3.07	10.81	86.00	427.62	2.175	19.66	3.61	22.73	97.20
60	74.00	2.73	5.02	15.14	2.73	13.40	78.80	346.58	1.392	24.90	3.51	21.91	75.94
LSD 0.05	0.90	0.11	0.50	0.03	0.20	0.50	0.52	0.05	0.020	0.21	0.02	0.11	0.57

Table 4: Effect of interaction between faba bean varieties and row spacing on seed yield and its components (combined analysis of 2008/09 and 2009/10 seasons)

Varieties	Row spacing (cm)	Plant height (cm)	No. of branches /plant	No. of pods /plant	Pods yield/ plant (g)	No. of seeds /pod	Seed yield/ plant (g)	100 seeds weight g	Seed yield kg/fed	Biological yield (ton/fed)	Harvest index %	Nitrogen %	Protein %	Protein yield (kg/fed)
Cairo-4	20	83.33	1.00	2.00	6.37	3.00	4.80	83.00	497.70	2.600	19.14	3.90	24.38	121.34
	40	78.00	2.00	5.67	15.67	3.00	10.20	80.00	358.26	2.060	17.39	3.75	23.44	83.98
	60	75.00	3.00	6.00	16.83	3.00	13.80	74.00	308.28	1.540	20.02	3.61	22.56	69.55
Cairo-5	20	77.00	1.00	2.33	6.77	3.00	5.80	84.00	379.40	1.691	22.44	3.90	24.38	92.50
	40	74.00	1.00	3.33	7.43	3.00	8.73	83.00	357.00	1.677	21.29	3.75	23.44	83.68
	60	72.33	2.00	3.67	10.07	2.67	13.00	76.00	336.00	1.250	26.88	3.46	21.63	72.68
Cairo-25	20	86.33	1.00	2.00	11.67	2.67	8.40	87.00	472.22	3.441	13.72	3.46	21.63	102.14
	40	76.00	1.00	3.00	12.40	2.67	11.10	74.00	448.70	1.860	24.12	3.46	21.63	97.05
	60	73.00	2.00	3.00	16.27	2.00	13.40	70.00	434.70	1.105	39.34	3.32	20.57	89.42
Nubaria-1	20	88.67	3.00	4.33	13.00	4.00	12.00	117.00	580.58	3.226	18.00	3.61	22.56	130.98
	40	77.67	3.00	5.67	13.33	3.67	12.50	103.00	561.12	3.107	18.06	3.54	22.13	124.18
	60	75.67	3.67	7.67	16.07	3.00	13.50	100.00	296.94	1.596	18.61	3.46	21.63	64.23
Giza-843	20	78.00	2.00	2.33	9.57	3.00	7.80	99.00	418.60	2.370	17.66	3.54	22.13	92.64
	40	75.00	3.00	4.00	16.30	3.00	11.50	90.00	413.00	2.173	19.01	3.54	22.13	91.40
	60	74.00	3.00	5.67	16.47	3.00	13.30	74.00	357.00	1.470	24.29	3.46	21.63	77.22
LSD 0.05		2.23	0.28	1.24	0.09	0.49	1.23	1.29	0.13	0.157	0.51	0.02	0.27	1.42

produced significant high seed and protein yields (479.55 and 105.31 kg/fed, respectively) compared with the other varieties. This was due to high seed index value, number of pods per plant, pods and seed yields per plant and number of seeds per pod. However, the highest protein yield of Nubaria-1 variety due its high seed yield. Also, Cairo-4 variety recorded the highest seed nitrogen and protein contents with significant difference in comparison to the other varieties (Table 2). Data also illustrated that the highest biological yield (2.643 ton /fed.) was obtained with Nubaria-1 variety. This was due to its high plant height (80.67 cm), the highest number of branches per plant and seed yield may be due to the different genetical make up which affects on growth habit. Similar results are in agreement with those obtained by Osman *et al*. [1], Ragab *et al*. [2], Al Ghamdi [3], Stutzel *et al.* [4], Singh *et al.* [5], Silim and Saxena [6], Pilbeam *et al.* [7] and Stutzel and Aufhamer [8], they reported significant differences among faba bean varieties concerning seed, biological and protein yields and there components.

Effect of Row Spacing: Data presented in Table 3 showed that there were significant differences between row spacing in all studied characters. Results indicated that seed, biological and protein yields were increased at high plant population density (42 plants/m^2). Such increases in these traits may be attributed to the increase in plant growth and other yield components such as number of seeds per pod and seed index under high plant density (Table 3). On the other hand, Number of pods / plant, pods and seed yields per plant were gradually increased by increasing raw spacing from 20 to 40 and/or 60 cm. The increase in these traits may be attributed to the decrease number of plants / m^2 which in turn counter balance the increase in metabolites synthezed due to less competition between plants in the same unit area. These results are in accordance with that obtained by Darwish and Hassanin [15], Amer *et al*. [16], Khalil *et al*. [17], Farag and El-Shama [18], Salwau [19], Al-Rifaee [20], Turk and Tawaha [21] and Thalji [22].

Effect of Interaction Between Varieties and Row Spacing: Combined data presented in Table 4 showed that the interaction between faba bean varieties and row spacing had significant effect on all studied characters. Results in Table 4 showed that number of branches, number of pods per plant, pods yield per plant and seed yield per plant were gradually reduced by increasing plant

population density in all tested varieties. On contrary, in all varieties 100-seed weight, nitrogen % and protein % were decreased gradually by increasing raw spacing from 20 up to 60 cm.

Data in Table 4 demonstrated that seed and pods yield per plant of all varieties were significantly decreased as plant density increased. However, seed yield (kg/fed) was increased as plant density was increased for all varieties due to the increase in number of plants per unit area. The highest seed yield (580.58 kg) was recorded with Nubaria-1 x high plant density (42 plant /m^2) and the lowest (296.74 kg) was obtained by low plant density (16 plants / m^2). On the other hand, the greatest biological yield was obtained with Cairo-25 variety when it seeded at narrow raw spacing (20 cm), whereas, the highest protein yield (130.98 kg) was obtained by Nubaria-1 and the same narrow raw spacing. The increase in protein yield mainly attributed to the increase in seed yield (kg/fed) and also the protein % under the same condition. These results were similar of findings reported by Stutzel *et al*. [4] and Silim and Saxana [6].

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