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Physiological Responses for Growth and Yield of Some Faba Bean Varieties Under Different Plant Densities

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Abstract

Two field experiments were conducted at Mallawi Agricultural Research Station, Minia Governorate during 2013/2014 and 2014/2015 seasons to study of some faba bean varieties (Giza 843, Giza 3, Giza 716, Nubarai 1and Sakha 3) under different plant densities 84.000 plants /fed. (spacing between rows 50 cm), 70.000 plants /fed.(spacing between rows 60 cm) and 60.000 plants /fed. (spacing between rows 70 cm) and plant distribution (sowing on one and two sides/row) on yield and yield components of faba bean. Results showed that faba bean cultivars varied highly significantly on plant height, weight, Number of pods/plant, 100-seed weight (g), Seed yield/plant and Seed yield (ardab/feddan), during the two growing seasons. The highest value of plant height, Number of pods/plant and Seed yield (12.93 pod and 11.18 ardab/fed.) was obtained by Giza 843 variety compared with the other varieties in both seasons. While Giza 716 produced the highest values of plant weight (62.13 and 62.5 g) in both seasons, respectively. The heaviest 100-seed weight (g) and Seed yield/plant were achieved by Nubarai 1 variety in the first and second seasons. Plant density had significant effect on plant height. In the first and second seasons 84000 plants/feddan recorded the tallest plants (101.01 and 101.25 cm, respectively). Concerning the plant distribution, planting on two sides/rows produced the heightSeed yield (9.88 and 8.43 ardab/fed.) in both seasons, respectively. Compared with the planting on one side /row.

Regarding to the first and second order interactions in both seasons the results showed that the differences in seeds yield per feddan were not significant.

Keywords: *Varieties, plant densities and plant distribution*

Introduction

One of the most important leguminous crops is faba bean it’s the fourth most important pulse crop in the world. Cultivated faba bean is used as human food in developing countries and as animal feed, mainly for pigs, horses, poultry and pigeons in industrialized countries. In Egypt faba bean (*Viciafaba* L.) is one of the most important food crop human nutritive and the straw from faba bean harvest fetches a premium is considered as a cash crop. The importance of faba bean is due to its seed which rich in protein content where its considered as a meat extender, food of high caloric and nutritive value especially in the diet of low common people and also to its role in crop rotation where it is responsible for a substantial part of the global flux of nitrogen from atmospheric N2 to fixed forms such as ammonia, nitrate and organic nitrogen. yield increases of crops planted after harvesting of legumes are often equivalent to those expected from application of 30 to 80 kg of N-fertilizer/ ha. In recent year there has been serious efforts directed at increasing faba bean production. Increasing crop production is one of the major targets of the agricultural policy and can be achieved by both increasing the cultivated area and its productivity. Therefore, efforts are always directed. To improve productivity of this crop.

It is difficult to expand the faba bean area because the total cultivated area in limited. Thereby, there are some factors playing an important role in faba bean production. One of these important factors is selecting the suitable plant density, suitable cultivars, and plant distribution.

The aim of this experiments are the increased plant density increased seed yield through improving leaf distribution, greater interception of solar radiation and better photosynthesis. Leilah and El-Deeb (1990) stated that yield of seed and straw /ha significantly increased with dense planting 33 plant as compared with 17 plant/m^2.

Materials and Methods

The field experiments were carried out at Mallawi Agricultural Research Station, Minia Governorate, Research Stations, Agricultural Research Center (ARC), Egypt; during the two winter seasons of 2012/2013 and 2013/2014, The aim of this experiments are study the best suitable cultivar under different plant densities and plant distribution on yield and yield components of faba bean.

The experimental plot size was 3×3.5 m^2 (1/400 fed.). The experiment design was split split plot design with four replicates each plot contained 5 rows, 3 meters in length and 50, 60 and 70 cm in width. Varieties were ranked the main plots, plant densities was taken sub plot and plant distribution as sub-sub plot. Nitrogen fertilizer was added as urea (46% N) according to the recommended doses20 kg/fed. Phosphorus fertilizer was added at rate of 150 kg/fed as calcium superphosphate (15.5% P_2O_5). Nitrogen and phosphorus were added at one dose after thinning. Plants were thinned after complete emergence before 2nd irrigation leaving one plant per hill on two sides/row and two plants per hill on sowing one sides/row. Other cultural practices were performed as recommended.

The applied three factors were as follow:

i. Plant densities :
   1- 50 cm between rows. (80.000 plant /fed.)
   2- 60 cm between rows. (70.000 plant /fed.)
   3- 70 cm between rows. (60.000 plant /fed.)

ii. Plant distribution:
   1- Planting on one side/row
   2- Planting on two sides/row

iii. Cultivars:
   1- Giza 843
   2- Giza 3
   3- Giza 716
   4- Nubarai 1
   5- Sakha 3

Measurements were taken on the following characters:

Plant characteristics, yield and yield components:

5 plants from each experimental unit were taken at random and the following data were recorded:

1- Plant height (cm)
2- Plant weight (g)
3- Number of pods / plant
4- 100-seed weight (g)
5- Seed yield/ plant (g)
6- Seed yield (ardab /feddan)

Results and Discussion

The results obtained could be presented and discussed under the following topics:

I- Plant characteristics:

A- Plant height (cm):

Main effects

Data reported in Table (1) revealed that average plant height tended to be reacted highly significant to varieties. The tallest plants (108.38 and 107.84 cm) were achieved by Giza 843 (A1) variety in both seasons, respectively. Followed by (104.52 and 105.45 cm) was showed by Giza 716 (A3) cultivar followed by sakha 3 (A5) cultivar (100.63 and 99.88 cm) followed by Nubaria 1 (A4) cultivar (98.98 and 98.12 cm) followed by (82.26 and 83.46 cm) were obtained by Giza 3 cultivar. This in turn resulted in the tallest plant of Giza 843 cultivar when compared with the other cultivars. These results are in harmony with the data of plant height under this system recorded during the periods of the vegetative growth. This may be due to the genotypic behavior in combination with the environmental conditions which may be suitable to Giza 843 cultivar more than cultivars.

Regarding to plant population densities, data in Table (1) showed that plant population had a significantly effect on plant height during the two growing seasons. Plant population of 50 cm between rows (84000 plants/fed.), (B1) recorded the tallest plants in both seasons (101.01 and 101.25 cm, respectively). On the other hand, plant density of (B3) 70 cm between rows (60000 plants/fed.) gave the shortage plants (97.24 and 97.72 cm, respectively) in the 1st and 2nd seasons. These results are in agreement with those of Zeidan*et al* (1990) and Singh *et al* (1992). This is logic since dense planting enhances elongation to achieve better light interception, while less dense planting allows for enough light penetration throughout the plant canopy.

Concerning the plant distribution on average plant height, data exhibited in the same Table revealed that the (C2) planting on two sides produced the tallest plants in both seasons (99.24 and 99.01 cm, respectively). Compared with the planting on one side (C1) whereas recorded the shortest plants in both seasons (98.67 and 98.88 cm) respectively. The statistical analysis proved that these differences were no significant.

Interaction effects:

Data in Table (2 and 3) indicated that the differences in plant height in the first and second order interactions were not significant (A×B, A×C, B×C and A×B×C) in both seasons.

B- Plant weight (g)

Main effects

The observed data in Table (1) showed that the varieties exerted a highly significantly effect on the plant weight. Examining means in Table (1) cleared that Giza 716 (A3) cultivar produced the heaviest plant weight (62.13 and 62.5 g) in both seasons, respectively. This could be due to the observed increase in number of leaves / plant and number of branches /plant as compared to other varieties. The lowest plant weight (47.78 and 48.00 g) was achieved by Giza 3 (A5) cultivar in both seasons, respectively. These results might be due to decrease plant height, number of leaves /plant and number of branches /plant.

Concerning the plant population densities, the results revealed that plant weight was not significant during the two growing seasons (Table 1).

Regarding to plant distribution the results revealed that plant weight was significantly affected by plant distribution in the first season only (Table 1). These results confirmed with those obtained by Zielinska *et al* (1994).

Interaction effects:

Regardless of the gradual increase of plant weight under all treatments, the statistical analysis showed no insignificant response to the first and second order interactions in both seasons (Table 2 and 3).

Table 1. The interaction effect between varieties (A), plant density (B) and plant distribution on plant characteristics at harvest in 2013/2014 and 2014/2015.

Main effects		Plant height (cm)		Plant weight (g)	
		I	II	I	II
A	A_1	108.38	107.84	59.79	62.3
	A_2	82.26	83.46	47.78	48.00
	A_3	104.52	105.45	62.13	62.50
	A_4	98.98	98.12	59.73	58.47
	A_5	100.63	99.88	60.60	58.80
F-test		**	**	**	**
LSD 5%		2.874	6.246	1.637	1.646
B	B_1	101.01	101.25	57.01	57.55
	B_2	98.61	97.88	58.15	57.90
	B_3	97.24	97.72	58.86	58.70
F-test		*	*	N.S	N.S
LSD 5%		1.979	2.429		
C	C_1	98.67	98.88	57.59	57.95
	C_2	99.24	99.01	58.42	58.126
F-test		N.S	N.S	*	N.S

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Table 2. The interaction effect between varieties (A), plant density (B) and plant distribution on plant characteristics at harvest in 2013/2014 and 2014/2015.

Interaction			Plant height (cm)		Plant weight (g)	
			I	II	I	II
A×B	A_1	B_1	110.63	111.08	58.88	62.62
		B_2	109.75	106.21	59.57	61.32
		B_3	104.76	106.22	60.93	63.07
	A_2	B_1	80.99	83.09	46.89	47.12
		B_2	82.20	84.33	47.95	47.45
		B_3	83.62	82.95	48.49	49.57
	A_3	B_1	107.23	107.47	61.46	61.81
		B_2	104.89	104.14	62.07	63.31
		B_3	101.43	104.73	62.09	62.36
	A_4	B_1	102.36	102.50	58.84	58.38
		B_2	98.16	96.75	60.33	58.46
		B_3	96.43	95.09	60.03	58.58
	A_5	B_1	103.83	102.09	58.96	57.79
		B_2	98.06	85.89	60.84	64.27
		B_3	99.99	99.60	61.99	59.96
F-test			N.S	N.S	N.S	N.S
LSD 5%						
A×C	A_1	C_1	108.09	108.41	59.34	62.47
		C_2	108.67	107.26	60.25	62.20
	A_2	C_1	81.13	83.41	47.15	48.09
		C_2	83.41	83.50	48.40	47.99
	A_3	C_1	104.41	105.59	60.74	62.04
		C_2	104.63	105.31	63.53	62.94
	A_4	C_1	98.93	96.79	60.29	58.87
		C_2	99.03	99.44	59.17	58.079
	A_5	C_1	100.81	100.23	60.47	58.27
		C_2	100.44	91.49	60.73	63.09
F-test			N.S	N.S	*	N.S
LSD 5%					1.593	
B×C	B_1	C_1	101.05	100.36	56.61	57.61
		C_2	100.96	102.13	57.40	57.479
	B_2	C_1	98.47	98.86	57.75	57.57
		C_2	98.76	92.07	58.55	60.35
	B_3	C_1	96.49	97.44	58.43	58.66
		C_2	97.99	98.00	59.29	58.76
F-test			N.S	N.S	N.S	N.S
LSD 5%						

Table 3. The interaction effect between varieties (A), plant density (B) and plant distribution on plant characteristics at harvest in 2013/2014 and 2014/2015.

Interaction				Plant height (cm)		Plant weight (g)	
				I	II	I	II
A×B×C	A_1	B_1	C_1	111.66	111.09	58.52	62.20
			C_2	109.60	111.07	59.24	63.04
		B_2	C_1	108.09	106.27	59.56	61.58
			C_2	111.41	106.15	59.58	61.06
		B_3	C_1	104.53	107.88	59.94	63.63
			C_2	105.00	104.56	61.93	62.51
	A2	B_1	C_1	81.61	91.83	46.01	46.94
			C_2	80.36	83.12	47.78	47.30
		B_2	C_1	80.16	87.97	47.03	46.76
			C_2	84.24	89.31	48.87	48.13
		B_3	C_1	81.61	89.15	48.41	50.58
			C_2	85.62	88.18	48.56	48.56
	A_3	B_1	C_1	107.79	105.82	60.53	61.74
			C_2	106.67	109.12	62.39	61.88
		B_2	C_1	105.46	106.75	60.53	62.58
			C_2	104.33	101.54	63.61	64.03
		B_3	C_1	99.97	104.18	61.18	61.79
			C_2	102.90	105.28	64.58	62.92
	A4	B_1	C_1	101.82	100.63	58.59	58.77
			C_2	102.90	104.37	59.08	57.99
		B_2	C_1	98.07	96.71	61.24	58.91
			C_2	98.27	96.80	59.42	58.01
		B_3	C_1	96.92	93.03	61.04	58.93
			C_2	95.93	97.16	59.02	58.24
	A5	B_1	C_1	102.38	101.20	59.40	58.41
			C_2	105.28	102.98	58.52	57.19
		B_2	C_1	100.60	100.30	60.40	58.04
			C_2	95.52	95.62	61.27	70.51
		B_3	C_1	99.45	99.18	61.60	58.06
			C_2	100.54	100.01	62.39	61.56
F-test				N.S	N.S	N.S	N.S
LSD 5%							

II-yield and yield components:

1-Number of pods/plant:

Main effects

Data reported in Table (4) indicated that the number of pods per plant was a highly significantly affected by varieties in both seasons. Noticed that (A5) Giza 843 cultivar produced the highest number of pods / plant compared to the other cultivars, (34.67 and 29.90), followed by (31.23 and 28.38) were achieved by Giza 716 (A3) cultivar, followed by Nubaria 1 (A4) cultivar (29.78 and 26.61) followed by (25.29 and 22.83) were obtained by sakha 3 (A5) cultivar and finally the lowest number of pods / plant was recorded by Giza 3 cultivar (22.11 and 17.34), in both seasons, respectively. Differences for this result may be attributed to genetic variations between varieties. Also the superiority of Giza 843 cultivar in number of pods / plant may be related to their growth vigorous which reflects on total dry matter accumulation, plant height, number of branches and number of leaves, consequently number of pods /plant.

Concerning the plant population densities effect on number of pods / plant, it was observed that this character was on significantly affected by plant population densities in both seasons (Table 4). These results are in accordance with Gurung Katwal (1993) and MehdiDahmardeh *et al* (2010).

Regarding to plant distribution had not significantly influence the number of pods per plant in the 1st and 2nd seasons (Table 4). Similar results were recorded by Dhingra *et al* (1990).

Interaction effects:

The results in Table (5 and 6) showed that the differences in number of pods per plant in the first and second order interactions were not significant (A×B, A×C, B×C and A×B×C) during the two growing seasons.

Table 4. The effect of varieties (A), plant density (B), and plant distribution (C), on yield components in 2013/2014 and 2014/2015.

Main effects		Number of pods/plant		100-seed weight (g)	
		I	II	I	II
A	A_1	34.67	29.90	63.45	65.56
	A_2	22.11	17.34	59.13	61.08
	A_3	31.23	28.38	77.77	82.16
	A_4	29.78	26.61	98.83	100.42
	A_5	25.29	22.83	74.34	76.62
F-test		**	**	**	**
LSD 5%		1.737	2.293	0.653	0.821
B	B_1	28.71	25.03	74.17	76.85
	B_2	28.53	25.54	75.37	77.80
	B_3	28.60	24.46	74.57	76.86
F-test		N.S	N.S	N.S	*
LSD 5%					0.827
C	C_1	28.74	24.91	74.64	77.05
	C_2	28.49	25.12	74.76	77.28
F-test		N.S	N.S	*	N.S

Table 5. The effect of varieties (A), plant density (B), and plant distribution (C), on yield components in 2013/2014 and 2014/2015.

Interaction			Number of pods/plant		100-seed weight (g)	
			I	II	I	II
A×B	A_1	B_1	34.54	30.52	62.71	65.12
		B_2	34.52	30.26	64.25	66.17
		B_3	34.96	28.92	63.40	65.39
	A_2	B_1	22.00	16.99	58.62	60.60
		B_2	22.00	17.67	59.76	61.67
		B_3	22.08	17.36	59.01	60.97
	A_3	B_1	31.72	29.21	77.15	81.80
		B_2	30.92	28.85	78.62	83.10
		B_3	31.07	27.09	77.54	81.60
	A_4	B_1	29.66	26.54	98.35	100.21
		B_2	30.37	27.63	99.47	101.04
		B_3	29.31	25.65	98.67	100.02
	A_5	B_1	25.64	21.92	74.37	76.51
		B_2	24.63	27.14	74.04	67.49
		B_3	25.61	23.28	74.26	76.35
F-test			N.S	N.S	N.S	N.S
LSD 5%						
A×C	A_1	C_1	34.52	29.60	63.39	65.62
		C_2	34.82	30.21	63.52	65.51
	A_2	C_1	22.78	16.92	59.09	60.84
		C_2	21.44	17.76	59.17	61.32
	A_3	C_1	31.57	28.74	77.67	81.90
		C_2	30.92	28.03	77.87	82.43
	A_4	C_1	30.31	26.73	98.82	100.35
		C_2	29.26	26.49	98.85	100.50
	A_5	C_1	24.51	22.55	74.27	76.57
		C_2	26.07	25.68	74.42	70.33
F-test			N.S	N.S	N.S	N.S
LSD 5%						
B×C	B_1	C_1	29.04	25.15	74.08	76.75
		C_2	28.38	24.92	74.27	76.95
	B_2	C_1	28.79	25.41	75.34	77.60
		C_2	28.29	27.21	75.40	74.19
	B_3	C_1	28.39	24.16	74.52	76.81
		C_2	28.82	24.76	74.63	76.92
F-test			N.S	N.S	N.S	N.S
LSD 5%						

Table 6. The interaction effect varieties (A), plant density (B) and plant distribution on yield components in 2013/2014 and 2014/2015.

Interaction				Number of pods/plant		100-seed weight (g)	
				I	II	I	II
A×B×C	A_1	B_1	C_1	33.58	29.66	62.67	65.02
			C_2	35.49	31.38	62.75	65.22
		B_2	C_1	35.57	30.85	64.10	66.25
			C_2	33.47	29.67	64.40	66.10
		B_3	C_1	34.41	28.28	63.40	65.57
			C_2	35.50	29.56	63.40	65.20
	A_2	B_1	C_1	22.49	17.26	58.55	60.52
			C_2	21.51	16.72	58.70	60.67
		B_2	C_1	23.28	16.79	59.82	61.25
			C_2	21.21	18.54	59.70	62.10
		B_3	C_1	22.57	16.71	58.90	60.75
			C_2	21.59	18.01	59.12	61.20
	A_3	B_1	C_1	33.59	29.69	77.07	81.42
			C_2	29.85	28.74	77.22	82.17
		B_2	C_1	29.84	28.96	78.60	82.80
			C_2	31.99	28.73	78.65	83.40
		B_3	C_1	31.27	27.57	77.35	81.47
			C_2	30.86	26.60	77.72	81.72
	A4	B_1	C_1	29.71	26.79	98.22	100.30
			C_2	29.62	26.28	98.47	100.12
		B_2	C_1	31.72	27.90	99.50	100.92
			C_2	29.02	27.37	99.45	100.15
		B_3	C_1	29.50	25.48	98.72	99.82
			C_2	29.13	25.82	98.62	100.22
	A5	B_1	C_1	25.84	22.36	73.87	76.47
			C_2	25.44	21.48	74.20	76.55
		B_2	C_1	23.52	22.53	74.67	76.80
			C_2	25.74	31.74	74.80	77.22
		B_3	C_1	24.19	22.75	74.25	76.45
			C_2	27.03	23.82	74.27	76.25
F-test				N.S	N.S	N.S	N.S
LSD 5%							

2- 100-seed weight (g)

Main effects

Data presented in Table (4) show the effect of the varieties, plant density and plant distribution, on 100-seed weight (g) in 2013/2014 and 2014/2015 seasons.

The results indicated that 100-seed weight (g) was highly significantly affected by varieties in both seasons. The heaviest weight of 100-seeds was produced from Nubaria 1 (A4) cultivar (98.83 and 100.42 g) followed by (77.77 and 82.16 g) from Giza 716 (A3) cultivar, followed by sakha 3 (74.34 and 76.62 g) followed by Giza 843 (A1) cultivar (63.45 and 65.56 g), while the lowest weight of

100-seeds recorded by Giza 3 (A2) cultivar (59.13 and 61.08 g) in both seasons, respectively. The results may be due to the genetic variation between varieties.

Regarding to plant population densities effect on 100-seed weight (g), it was observed that this character was significantly in the second season only. Seeds produced from (B2) 60 cm between rows (70.000 plants/fed.) were higher in weight. This is in harmony with the data recorded for number of pods per plant as this particular treatment had highest plant height during period of vegetative growth as compared to others treatments. Similar findings were mentioned by Shad *et al* (2011) and KeyvanShamsi, *et al* (2011).

Concerning the plant distribution, had significantly influence the100-seeds weight (g) in the first season only. Examining means in Table (4) cleared that (C2) planting on two sides produced the highest 100-seeds weight. This could be attributed partially to large plant height and weight of this particular treatments that secured enough photosynthetic assimilates to the formed pods during seed filling. These results are in accordance with El-Fieshawy and Fayed (1990).

Interaction effects:

The first and second order interactions (A×B, A×C, B×C and A×B×C) had no significantly influence on 100-seeds weight in both seasons (Tables 5 and 6).

3- Seed yield/plant (g)

Main effects

The mean values of seed yield per plant as affected by faba been varieties are exhibited in Table (7). Seed yield per plant seemed to be highly significantly differed among studied faba bean varieties. The highest mean values of seed yield per (50.48 and 47.51 g) were produced by faba bean verity Nubaria 1 (A4) when compared with the other varieties whereas variety Giza 3 (A2) recorded the lowest yield / plant (26.99 and 24.68 g) in both seasons, respectively. This trend is the resultant to the increase of yield components such as 100-seeds weight, harvest index and also this might be due to the early flowering in the 1st and 2nd seasons, which gave better opportunity to plant growth.

Reviewing Table (7) indicated that the first and second seasons showed no significant response for seed yield per plant due to plant population densities.

Mean values of seed yield / plant as affected by plant distribution are presented in Table (7). The data showed that planting on one side / row, and planting on two sides / row were reflect high significant differences in seed yield / plant in the first season only. The data showed that planting on two sides / row gave the highest seed yield/plant (38.56 g) compared with the planting on one side / row which gave (36.26 g) in the 1st season. This could be caused by both high 100-seeds weight and high harvest index. The same trend was reported by Dhingra *et al* (1990) and Mahmoud E. Mekkei (2014).

Interaction effects:

Data reported in Table (8 and 9) revealed that the first and second order interactions A×B, A×C, B×C and A×B×C) had no significantly effect on seed yield / plant.

Table 7. The effect of varieties (A), plant density (B), and plant distribution (C), on yield components in 2013/2014 and 2014/2015.

Main effects		Seed yield/plant		Seed yield (ardab/fed.)	
		I	II	I	II
A	A_1	41.91	37.74	12.93	11.18
	A_2	26.99	24.68	7.49	5.45
	A_3	38.05	30.52	10.05	9.41
	A_4	50.48	47.51	9.28	7.92
	A_5	29.62	27.77	7.92	6.72
F-test		**	**	**	**
LSD 5%		0.008	2.762	0.306	0.436
B	B_1	37.90	34.05	9.55	8.08
	B_2	37.00	32.74	9.75	8.49
	B_3	37.33	34.13	9.31	7.83
F-test		N.S	N.S	N.S	*
LSD 5%					0.527
C	C_1	36.26	33.31	9.19	7.85
	C_2	38.56	33.98	9.88	8.43
F-test		**	N.S	**	**

Table 8. The interaction effect between varieties (A), with plant density (B), and plant distribution on yield components in 2013/2014 and 2014/2015.

Interaction			Seed yield/plant		Seed yield (ardab/fed.)	
			I	II	I	II
A×B	A_1	B_1	40.13	37.98	13.01	11.25
		B_2	44.99	38.25	13.32	11.40
		B_3	41.41	36.98	12.48	10.92
	A_2	B_1	27.56	24.62	7.57	5.28
		B_2	27.07	24.85	7.63	5.66
		B_3	26.33	24.58	7.28	5.42
	A_3	B_1	37.30	29.09	10.17	9.46
		B_2	36.94	29.42	10.08	10.13
		B_3	39.92	33.06	9.92	8.66
	A_4	B_1	53.69	49.34	9.27	7.85
		B_2	48.19	44.26	9.49	8.22
		B3	49.56	48.93	9.08	7.67
	A_5	B_1	30.82	29.25	7.74	6.56
		B_2	28.64	26.35	8.23	6.14
		B_3	29.42	27.11	7.78	6.52
F-test			N.S	N.S	N.S	N.S
LSD 5%						
A×C	A_1	C_1	41.15	37.47	12.66	10.84
		C_2	42.67	38.01	13.21	11.54
	A_2	C_1	25.53	24.17	7.32	5.28
		C_2	28.45	25.19	7.66	5.63
	A_3	C_1	37.69	31.07	9.57	9.06
		C_2	38.41	29.98	10.54	9.77
	A_4	C_1	48.09	46.05	8.59	7.55
		C_2	52.87	48.98	9.97	8.28
	A_5	C_1	28.84	27.81	7.81	6.52
		C_2	30.41	27.33	8.03	6.30
F-test			N.S	N.S	N.S	N.S
LSD 5%						
B×C	B_1	C_1	36.42	33.47	9.24	7.81
		C_2	39.37	34.65	9.87	8.35
	B_2	C_1	35.33	32.53	9.38	8.18
		C_2	38.68	32.72	10.13	8.44
	B_3	C_1	37.02	33.94	8.95	7.56
		C_2	37.64	34.33	9.66	8.12
F-test			N.S	N.S	N.S	N.S
LSD 5%						

Table 9. The interaction effect varieties (A), plant density (B) and plant distribution on yield components in 2013/2014 and 2014/2015.

Interaction				Seed yield/plant I	Seed yield/plant II	Seed yield (ardab/fed.) I	Seed yield (ardab/fed.) II
A×B×C	A_1	B_1	C_1	38.46	37.15	12.85	10.96
			C_2	41.80	38.81	13.16	11.54
		B_2	C_1	42.75	38.12	13.01	10.92
			C_2	45.62	38.39	13.62	11.88
		B_3	C_1	42.25	37.13	12.10	10.63
			C_2	40.57	36.83	12.85	11.19
	A_2	B_1	C_1	27.25	24.23	7.38	5.18
			C_2	27.87	25.01	7.77	5.37
		B_2	C_1	24.67	24.36	7.32	5.39
			C_2	29.47	25.34	7.94	5.93
		B_3	C_1	24.67	23.93	7.28	5.26
			C_2	27.99	25.24	7.28	5.58
	A_3	B_1	C_1	36.35	29.09	9.69	9.04
			C_2	38.25	29.11	10.64	9.87
		B_2	C_1	36.51	30.00	9.49	9.61
			C_2	37.37	28.83	10.67	10.64
		B_3	C_1	40.22	34.13	9.54	8.52
			C_2	39.62	31.99	10.31	8.80
	A_4	B_1	C_1	51.03	47.87	8.61	7.34
			C_2	56.35	50.81	9.94	8.37
		B_2	C_1	44.52	43.27	8.98	8.05
			C_2	51.87	45.26	10.01	8.39
		B_3	C_1	48.72	47.00	8.19	7.27
			C_2	50.40	50.86	9.96	8.07
	A_5	B_1	C_1	29.05	28.98	7.67	6.53
			C_2	32.60	29.51	7.82	6.59
		B_2	C_1	28.22	26.92	8.09	6.92
			C_2	29.05	25.78	8.38	5.37
		B_3	C_1	29.25	27.51	7.66	6.11
			C_2	29.59	26.71	7.91	6.94
F-test				N.S	N.S	N.S	N.S
LSD 5%							

4- Seed yield (ardab /fed.)

Main effects

Varieties had highly significantly influence on seeds yield in both seasons. The results in Table (7) showed that Giza 843 cultivar produced the highest seeds yield (12.93 and 11.18ardab/fed.) when compared with the other varieties, While, the lowest values were (7.49 and 5.45 ardab/fed.) obtained by Giza 3cultivar in both seasons respectively. The superiority of Giza 843 cultivar in seed yield in both seasons may be due to the considerable increase in plant height, total dry weight, leaf area /plant, number of branches and pods which directly in turn on seed yield.

Similar results were reported by Hussein, *et al* (1999) and Abd El-Hafez, *et al* (2012).

Reviewing in the same table indicated that the second season showed significant response for seeds yield per feddan. The greatest seeds yield in the second season (8.49 ardab per feddan) was observed under planting (60 cm between rows) 70000 plants/fed. These results might be due to increase in number of pods; 100-seeds weight and harvest index which directly in turn on seed yield. Similar findings are in agreement with reported by Ahmed (1993), Hussein *et al* (1994) and Naser Al-Suhaibani *et al* (2013).

As with the case of varieties, plant distribution highly significantly influenced seeds yield in both seasons (Table 7). The data showed that planting on two sides / row gave the highest seed yield/plant (9.88 and 8.43 ardab per feddan) in both seasons respectively. This could be attributed mainly to increase 100-seeds weight, high harvest index and seed yield / plant. These results are in harmony with those concluded by Chatterjee and Som (1991), and Abd-rabou (1992).

Interaction effects:

The results in Table (8 and 9) showed that the differences in seeds yield per feddan in the first and second order interactions (A×B, A×C, B×C and A×B×C) were not significant in both seasons.

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الاستجابات الفسيولوجيه للنمو والمحصول لبعض أصناف الفول البلدى تحت كثافات نباتيه مختلفه

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الملخص

اقيمت تجربتان حقليتان فى محطة بحوث ملوى بمحافظة المنيا خلال موسمى الزراعه ٢٠١٣/٢٠١٤و٢٠١٤/٢٠١٥ وذلك لدراسة تاثير بعض اصناف الفول البلدى على المحصول ومكوناته (جيزه ٨٤٣ ، جيزه ٣، جيزه ٧١٦، نوباريه ١ ، سخا ٣) تحت كثافات نباتيه مختلفه وهى ٨٤٠٠٠ نبات/فدان(٥٠ سم بين النباتات) و ٧٠٠٠٠ الف نبات/فدان (٦٠ سم بين النباتات) و ٦٠٠٠٠ نبات/فدان (٧٠ سم بين النباتات) وتوزيع فراغى للنباتات (الزراعه على ريشه واحده وريشتين للخط) وقد اشارت النتائج الى:

١- الاصناف كان لها تأثير معنوى جدا فى الموسمين على كلا من: طول ووزن النبات - عدد القرون / نبات - وزن ال١٠٠ بذره - وزن البذور/ نبات واخيرا محصول البذور/فدان. وقد وجد ان الصنف جيزه ٨٤٣ كان اطول النباتات مقارنة بالاصناف الاخرى كما انه سجل اعلى قيمه بالنسبه لكل من عدد القرون / نبات و محصول البذور/فدان (١٢,٩٣ و ١١,١٨ اردب/فدان). وقد سجل الصنف جيزه ٧١٦ اعلى قيمه لوزن النبات (٦٢,١٣ و٦١,٥ جم) فى الموسمين على التوالى. كما وجد ان اعلى قيمه لوزن ال١٠٠ بذره (جم) ووزن البذور/ نبات من الصنف نوباريه ١ فى الموسم الاول والثانى.

٢- الكثافه النباتيه كان لها تأثير معنوى على طول النبات وكانت اطول النباتات تحت الكثافه ٨٤,٠٠٠ نبات فى الفدان(١٠و٠١٠ ، ١٠و٢٥٠ سم) فى الموسمين على التوالى.

٣- بالنسبه لتوزيع النباتات فقد وجد ان الزراعه على ريشتين/خط اعطت اعلى محصول للبذور(٩,٨٨ و ٨,٤٣ اردب/فدان) بالمقارنه بالزراعه على ريشه واحده/خط.

٤- بالنسبه للتفاعلات من الدرجه الاولى والثانيه فان النتائج اوضحت ان الاختلافات فى محصول البذور/ فدان غير معنويه.