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Testing of Some New Genotypes of Faba Bean Grown at Different Plant Densities

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ABSTRACT

According to the Egyptian Ministry of Agriculture Statistics, faba bean shows decrease in both area and production. The reduction in cultivated area and consequently in production is due to the low and unstable yield of faba bean cultivars. Increasing productivity largely depends on growing heavy yielding cultivars and improving the cultural practices. The performance of five new faba bean genotypes under two planting densities (planting on one or two sides of ridge) were studied in two Experiments. The Experiments were carried out at the Exp. Farm of Vegetables Department, Fac. of Agric., Assiut Univ., Assiut, Egypt during the growing winter seasons 2010/2011 and 2011/2012. The new faba bean genotypes were tested namely, 'Assiut 215', 'Assiut 125', 'Assiut 159', 'Roomy 3' and 'Roomy 80'. For the two experiments, uniform and healthy seeds of the five new faba bean genotypes were sown on Oct. 20 of 2010 and Oct. 23 of 2011. The experimental design was split plot arrangement in randomized complete-block design with three replicates. Genotypes were arranged in the main plot while planting densities were distributed in the sub-plots. The results obtained showed that 'Assiut 125' genotype (equine group) showed the earliest flowering (34.2 days); highest number of dry pods per plant and highest total dry seed yield (2.1 ton fed.$^{-1}$). While, 'Roomy 3' genotype (major group) was the highest in fresh yield (10.5 ton fed.$^{-1}$). High plant density gave tallest plants, highest total fresh and total dry seed yields. According to these results, 'Roomy 3' and 'Assiut 125' could be recommended for green pod yield (fool akhdar) and dry seed yield, respectively when planted with two sides of ridges under the local environmental conditions.

Key words: *Vicia faba*, yield, cultivars, equine group, fool akhdar

INTRODUCTION

Faba bean (*Vicia faba* L.), also known as broad bean, is the most important legume in Egypt. It is grown for dry seed and fresh consumption. Its seeds are rich in protein, carbohydrate and other nutrients.

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 (Bakry *et al*., 2011). According to the Ministry of Agriculture Statistics, faba bean shows decrease in both area and production. In 2007, its area was 215858 fed. and reached 183687 fed. in 2009. The total production was 2173151 ardab and decreased to 1496713 ardab in the same respective years (31.1%). Besides 18191 fed. were grown

for fresh consumption. This reduction in cultivated area and consequently in production is due to the low and unstable yield of faba bean cultivars. Increasing productivity largely depends on growing heavy yielding cultivars and improving the factors such climatic conditions, soil fertility, water supply, varieties or genotypes and plant population density... etc.).

Considerable variation among faba bean varieties which tested in Egypt and other world countries was found by Rowland and Fowler (1977), El-Deib (1982), Waly and Abd El-Aal (1986), El-Murabba *et al.* (1987), Hanna (1995), Salem (1996), Hassan (2006) and Abdel-Rahman (2009). The effect of planting density on performance of faba bean has been studied by El-Saeed (1968), Mohammed (1972), El-Morshidy *et al.* (1978), Salih (1992), Stutzel *et al.* (1994) and Haridy (2001). Abou-Salama and Dawood (1994) observed that increasing plant density from 74 up to 111.2 thousand plant/Feddan, resulted in a significant increase in seed yield and all yield components, while 100-seed weight was not affected by plant density. Bakry *et al.* (2011) pointed that plant population density of field bean is an important factor 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. Stutzel and Aufhammer (1991), Silim and Saxena (1992), Turk and Tawaha (2002) and Thalji (2006) showed increased in seed pod yields per plant by increasing row spacing.

The present investigation was made under Assiut conditions with aim of improving the faba bean crop through testing some new and promising genotypes when planting under two different densities.

MATERIALS AND METHODS

The study area: Two Experiments carried out at the Exp. Farm of Vegetables Department, Fac. of Agric., Assiut Univ., Assiut, Egypt during the two successive growing winter seasons 2010/2011 and 2011/2012 to study the performance of five new faba bean genotypes under two planting densities. For the two experiments, uniform and healthy seeds of the five new faba bean genotypes were sown on Oct. 20 of 2010 and Oct. 23 of 2011.

Faba bean cultivars: Five new faba bean, namely, Assiut 215, Assiut 125 and Assiut 159 (medium seeded, equine) and Roomy 3 and Roomy 80 (large flat-seeded, major) was used. These five genotypes were developed by Waly and Abd El-Aal (1986).

Planting densities: Two planting densities; Hills were spaced 20 cm apart along the northern side of ridges (one side, low planting density) and along the both southern and northern sides of ridges (two sides, high planting density).

The experimental design and necessary management: The experimental design was split plot arrangement in randomized complete-block design with three replicates. Genotypes were arranged in the main plot while planting densities were distributed in the sub-plots; two planting densities were randomly allocated in the main plots. The sub-plots were designated to five new faba beans. The experimental plot area was 10.5 m^{-2} consisted of five rows, 300 cm long and 70 cm apart. All plots were planted by hand with two to three seeds per hill. Manual culture practices for faba bean production in Assiut were applied according to recommendation of Hassan (2002). The soil texture of experimental soil is clay.

Data recorded:

- Field emergence percentage, recorded at 15 days from planting
- Days to flowering recorded as number of days from planting to 50% of the plants were in bloom
- Total fresh (green pods) yield (ton fed.$^{-1}$) at maturity stage
- Plant height in cm was measured from the soil surface to the terminal bud at ripeness stage
- Number of tillers per plant, also at ripeness
- Number of dry pods per plant
- Total dry seed yield (kg fed.$^{-1}$)
- Weight of 100-dry seeds (g)

Protein content percentage in dry seeds was determined in the second season only (2011/2012) by micro-Kjeldahl method according AOAC (1984).

Statistical analysis: Data were subjected to the proper statistical analysis as the technique of Analysis of Variance (ANOVA) of split plot design as mentioned by Steel and Torrie (1982). Treatment means were compared using the Least Significant Difference (LSD) test at 0.05 as outlined by Waller and Duncan (1969).

EXPERIMENTAL RESULTS

Percentage of field emergence was significantly affected by genotype of faba bean and plant density in the two seasons of the study (Table 1). Of all tested genotypes, 'Assiut 125' recorded the highest field emergence percentage (80.5 and 86.8% in the two seasons, respectively) followed by 'Assiut 159' and 'Assiut 215', while 'Roomy 80' showed the lowest value (69.7 and 66.5%). It is clear that sowing on one side (northern side of ridges) significantly improved the field emergence percentage (83.1 and 87.6% in the two seasons, respectively), as compared with sowing on two sides (southern and northern sides of ridges) (70.1 and 72.2%). The interaction effect between genotype×density on this character was significant at the two seasons. It could be mentioned that the response of 'Assiut 125' genotype was more pronounced for growing on one side resulting in the highest values of field emergence percentage. The effect of growing on two sides was less marked with 'Roomy 80' genotype which gave the lowest values in the two seasons.

Number of days to flowering was markedly affected by studied faba bean genotype (Table 1). 'Assiut 125' showed the earliest flowering, followed by 'Assiut 215', whereas flowering was late in 'Roomy 80' and 'Roomy 3' genotypes. Insignificant difference was found between sowing on one side and two sides (39.2 and 41.3 days as an average of two seasons) in 2011/2012. With regard to the interaction effect between genotype and plant density was significant in the two seasons of the study.

Data revealed that total fresh pod yield (Table 1) differed significantly for faba bean genotypes and ranged from 3.9 to 9.9 and 4.2 to 9.9 ton fed.$^{-1}$ in 2010/2011 and 2011/2012 seasons, respectively. Yielding potential of the different genotypes showed that 'Roomy 3' gave highest fresh yield, while the lowest yield was produced by 'Assiut 159' in the two seasons. Total fresh yield was significantly increased by increasing plant density. It could be mentioned that the increases were 22.0 and 16.7 in first and second seasons, respectively. The interaction between genotypes and density on fresh yield was significant in the two seasons. The highest fresh yield was obtained from sowing 'Roomy 3' on two sides, while the lowest was resulted from sowing 'Assiut 159' in the two seasons.

Table 1: Effect of genotype and planting density on field emergence (%), days to flowering, total fresh (green) pod yield, ton fed.$^{-1}$ and plant height, cm of faba bean grown in 2010/2011 and 2011/2012 seasons

	Field emergence (%)						Days to flowering					
	2010/2011			2011/2012			2010/2011			2011/2012		
Genotype	One side	Two sides	Mean	One side	Two sides	Mean	One side	Two sides	Mean	One side	Two sides	Mean
Assiut 215	85.3	71.5	78.4	81.4	70.2	75.8	36.1	39.1	37.5	38.2	40.0	39.1
Assiut 125	87.5	73.6	80.5	95.5	78.1	86.8	33.2	35.9	34.2	34.2	36.6	35.4
Assiut 159	85.0	74.5	79.7	92.5	76.2	84.3	36.5	40.2	38.3	39.2	41.2	40.2
Roomy 80	77.2	62.3	69.7	81.4	66.5	73.9	43.7	45.7	44.7	44.8	45.8	45.3
Roomy 3	80.4	68.5	74.4	87.0	70.2	78.6	42.6	44.8	43.7	43.7	44.6	44.1
Mean	83.1	70.1		87.6	72.2		38.4	41.0		40.0	41.6	
$LSD_{0.05}$												
Genotype		3.5			2.7			2.8			1.5	
Plant density		0.9			1.2			1.2			ns	
Genotype× plant density		1.8			1.5			ns			ns	
	Total fresh (green) pod yield (ton fed.$^{-1}$)						Plant height (cm)					
Assiut 215	4.30	5.8	5.0	5.5	6.4	5.9	125.3	127.9	126.6	121.7	125.6	123.6
Assiut 125	4.70	6.3	5.5	5.8	6.8	6.3	130.5	136.7	133.6	127.3	134.1	130.7
Assiut 159	3.90	5.7	4.8	4.2	5.9	5.0	120.2	124.6	122.4	119.7	124.9	122.3
Roomy 80	7.70	8.3	8.0	7.8	9.0	8.4	113.2	117.1	115.1	115.8	117.7	116.7
Roomy 3	8.80	9.9	9.3	9.9	10.5	10.2	111.8	115.9	113.8	114.7	116.8	115.7
Mean	5.90	7.2		6.6	7.7		120.2	124.4		119.8	123.8	
$LSD_{0.05}$												
Genotype	3.70			5.0			6.5			4.4		
Plant density	1.20			0.9			1.6			2.4		
Genotype× plant density	1.26			2.4			2.8			3.9		

ns: Not significant

Faba bean genotype had a significant effect on plant height (Table 1), in the two seasons of study. The tallest plants were detected from 'Assiut 125' (133.6 and 130.7 cm in the two seasons, respectively. On the other hand, the shortest ones were obtained from 'Roomy 3' (113.8 and 115.7 cm in the two seasons, respectively). Increasing plant density from one side up to two sides caused significant increase in plant height in the two growing season. The interaction of planting density×genotype was significant. It is evident that 'Assiut 125' genotype produced tallest plats when it sowed on two sides (136.7 and 134.1 cm in the two seasons, respectively).

It is clear that number of tillers per plant was significantly differed with faba bean genotype (Table 2). 'Roomy 3' produced more tillers per plant than the other genotypes, while 'Assiut 159' gave the lowest tillers in the two seasons. Branching declined with sowing faba bean on two sides. However, this decrease was not significant. Also, there was no significant interaction between genotype×density.

Number of dry pods per plant was significantly affected by all tested genotypes (Table 2). 'Assiut 125' ranked first for number of dry pods per plant (32.7 and 32.1) and 'Roomy 3' ranked

Table 2: Effect of genotype and planting density on No. of tillers per plant, number of dry pods per plant, total yield of dry seeds, ton fed.$^{-1}$ and weight of 100-dry seeds, g of faba bean grown in 2010/2011 and 2011/2012 seasons

	No. of tillers per plant						No. of dry pods per plant					
	2010/2011			2011/2012			2010/2011			2011/2012		
Genotype	One side	Two sides	Mean	One side	Two sides	Mean	One side	Two sides	Mean	One side	Two sides	Mean
Assiut 215	6.6	6.1	6.3	5.9	5.7	5.8	26.8	23.3	25.0	28.9	25.9	27.0
Assiut 125	5.8	5.5	5.6	6.2	5.8	6.0	34.7	30.7	32.7	33.3	30.9	32.1
Assiut 159	5.5	5.2	5.3	6.0	5.5	5.7	32.1	29.4	30.7	31.6	27.7	29.6
Roomy 80	8.2	6.8	7.5	7.6	6.8	7.2	20.7	16.3	18.5	23.3	20.8	22.0
Roomy 3	8.5	7.7	8.1	8.0	7.0	7.5	18.5	17.8	18.1	19.1	16.6	17.8
Mean	6.9	6.3		6.7	6.2		26.6	23.5		27.1	24.4	
$LSD_{0.05}$												
Genotype	1.5			1.8			3.6			4.2		
Plant density	ns			ns			1.2			1.4		
Genotype× plant density	ns			ns			ns			ns		
	Total yield of dry seeds (ton fed.$^{-1}$)						Weight of 100-dry seeds (g)					
Assiut 215	1.5	2.1	1.8	1.4	1.8	1.6	88.9	87.4	88.1	85.1	82.1	83.6
Assiut 125	1.8	2.5	2.1	1.5	1.9	1.7	101.5	98.3	99.9	97.7	95.3	96.5
Assiut 159	1.7	2.1	1.9	1.4	1.8	1.6	79.8	78.8	79.3	78.2	76.7	77.4
Roomy 80	1.1	1.3	1.2	1.4	1.5	1.4	123.3	117.1	120.2	127.3	121.8	124.5
Roomy 3	0.9	1.0	0.9	1.1	1.4	1.3	108.1	102.8	105.4	111.5	108.9	110.2
Mean	1.4	1.8		1.4	1.7		100.3	96.9		100.0	97.0	
$LSD_{0.05}$												
Genotype	0.7			0.3			10.7			7.5		
Plant density	0.1			0.2			1.8			2.1		
Genotype× plant density	ns			ns			2.6			3.8		

last (18.1 and 17.8) in the two seasons, respectively. The low plant density (one side) significantly resulted in higher number of dry pods per plant. There was no significant interaction between the two studied factors.

Results showed that there are significant differences between faba bean genotypes in yield of dry seeds (Table 2). In both seasons of study, 'Assiut 125' genotype was better than all others, followed by 'Assiut 159' and 'Assiut 215'. 'Roomy 3' gave the lowest dry seed yield. Also, increasing plating density from one side of ridges up to two sides of ridges caused significant increase in total dry seed yield. The increasing percentages were 28.6 and 21.4 in 2010/2011 and 2011/2012 seasons, respectively. The highest total yield of dry seeds was obtained from planting 'Assiut 125' genotype with high density (2.1 and 1.7 ton fed.$^{-1}$ in the two seasons, respectively), while the lowest yield was recorded from planting 'Roomy 3' genotype with low plant density.

The variation in the values of 100-dry seed weight shown by the faba bean genotypes was significant, confirming the genetic variation among them (Table 2). Of all tested genotypes, 'Roomy 80' produced the heaviest 100-seeds weight, followed 'Roomy 3', while 'Assiut 159' resulted the lowest weight of 100-dry seeds. The effect of density on weight of 100-dry seeds was significant in the two seasons. The planting on one side of ridges favored 100-seeds weight as compared with

Table 3: Effect of genotype and planting density on protein content, η of faba bean grown in 2011/2012 seasons

	Protein content (η)		
	2011/2012		
Genotype	One side	Two sides	Mean
Assiut 215	27.62	27.25	27.43
Assiut 125	26.91	26.47	26.69
Assiut 159	27.81	27.15	27.48
Roomy 80	25.33	25.00	25.16
Roomy 3	26.73	26.41	26.57
Mean	26.88	26.45	-
$LSD_{0.05}$			
Genotype		1.15	
Plant density	0.26		
Genotype× plant density	1.33		

planting on two sides of ridges. Significant interaction was showed between genotype×density. The heaviest seeds were obtained from planting 'Roomy 80' on one side of ridges, while the lowest value was resulted from planting 'Assiut 159'.

Protein content in dry seeds differed significantly with faba bean genotypes (Table 3). Dry seeds of 'Assiut 159' proved best (27.48%) and 'Roomy 80' were poorest (25.16%) in protein content. The other three genotypes were ('Assiut 215', 'Assiut 125' and 'Roomy3') were intermediate. Generally, 'Roomy 80' and 'Roomy 3' genotypes (major seeded) had heavier dry seeds with lower protein percentage. On the other hand, increasing plant density was accompanied by significant decreasing in protein content in dry seeds. The interaction of genotypes×density was significant. 'Assiut 159' was superior in producing highest content of protein when planted on one side of ridges.

DISCUSSION

Results of the two seasons showed significant differences among faba bean genotypes for all measured traits. Also, El-Deib (1982), Salem (1996), El-Murabba *et al.* (1987), Waly and Abd El-Aal (1986), Hanna (1995), Salem (1996), Abdel-Rahman (2009), Hassan (2006) and others, reported considerable variation among faba bean cultivars tested. Data in this study indicated that 'Assiut 125' genotype (medium seed or equine group) showed higher field emergence percentage, earlier flowering, taller plants, also, produced the highest number of dry pods per plant and total yield of dry seeds, compared to the other tested genotypes. On the other hand, 'Roomy 3' genotype (large flat seed or major group) ranked first in number of tillers per plant and total fresh (green) yield. Generally, these results coincide with the findings of El-Murabba *et al.* (1987), Hanna (1995) and Hassan (2006). Of all tested genotypes, 'Assiut 159' proved best and 'Roomy 80' was poorest in protein content percentage. Lafiandra *et al.* (1981) reported that small seeded cultivars were richer in protein than other tested cultivars.

Plant density had significant effects on all studied characters of faba bean, except days to flowering (in the second season) and number of tillers per plant (in the two seasons). Planting on two sides of ridges (southern and northern sides of ridges) decreased field emergence percentage, compared to planting on one side of ridges (northern). Contrary to this result, Stutzel *et al.* (1994)

found that increasing plant density of faba bean caused significant increase in field emergence rates. However, the decreasing in field emergence percentage with increasing plant density in this study may be attributed to delay seed germination which sowed on southern side of ridge. Increasing plant density lead to increase plant height and decrease number of tillers per plant. Similar results were obtained by Abou-Salama and Dawood (1994) and Singh *et al.* (1992). Gurung and Katwal (1993) showed that the greatest fresh yield was obtained from increasing sowing density. High plant density gave the highest total of dry seeds and the lowest 100-seed weight. These results are in agreement with findings of Mohammed (1972) and Singh *et al.* (1992). Mohammed (1972) found that the higher population density was accompanied by higher seed yield but 100-seed weight decreased with the increase in plant density.

CONCLUSION

From the previous results, it can be concluded that heaviest fresh (green) pod yield was produced by 'Roomy 3' (major group). Therefore, this genotype may be recommended for green consumption (fool akhdar), especially, when planted with two sides of ridges. On the other hand, 'Assiut 125' genotype (equine group) may be recommended for its high dry seed yield at two sides of ridges.

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