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THE RELATIVE CONTRIBUTION OF SOME CHARACTERS TO SEED YIELD IN SOME FABA BEAN VARIETIES GROWN UNDER THREE POPULATION DENSITIES

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ABSTRACT

Two field experiments were conducted at the Research and Experiments Center, Faculty of Agriculture, Moshtohor, during the two successive seasons of 1995/96 and 1996/97. Three varieties of faba bean, *i.e*, Giza 3, Giza 461 and Giza 716 were evaluated at plant densities adjusted to 17, 33 and 50 plants/m^2 producing 70000, 140000 and 210000 plants/fed, respectively. Simple correlation and factor analysis procedures were performed to study the relationship between yield and its components in faba bean.

Increasing plant density decreased seed yield/plant, number of branches/plant, number of pods/plant and 100-seed weight. Number of seeds/pod was not affected either by varieties or plant densities. However, increasing plant density resulted in taller plants. Giza 716 variety outyielded the other two tested varieties, Giza 3 and Giza 461, regarding seed yield/fed. The results indicate the possibility of increasing the productivity of faba bean yield by planting under a population density between 140000 and 210000 plants/fed.

Highly significant and positive correlations were found between seed yield/plant and each of number of pods/plant, number of

branches/plant and weight of 100 seeds. On the other hand, plant height was negatively correlated with seed yield/plant.

Factor analysis grouped five yield contributing characters in two factors which altogether were responsible for 77.5% of the total variability in the dependence structure. Factor I accounted for 49.42% of the total variance and included plant height, number of branches/plant and weight of 100 seeds. Factor II included number of pods/plant and number of seeds/pod and it accounted for 28.09% of the total variance.

***Key words**: faba bean varieties , factor analysis.*

1. INTRODUCTION

Faba bean (*Vicia faba L.*) is the most important food legume crop grown for seeds in Egypt. Therefore, the agricultural policy of faba bean seed production in Egypt aims to cover 132000 ha with an average productivity of 2.86 t/ha.

Plant density plays a major role in yield improvement of faba bean. Increasing plant density reduced number of branches, pods and seed yield/plant whereas seed yield/fed., increased by increasing plant population density (Abo El-Zahab *et al.*, 1981; Pandey, 1981; El-Deib, 1982; Nassib *et al.*, 1982; Salih, 1985; Hussein *et al.*, 1994 and 1995). Increasing number of plants/hill from one to two or three plants/hill led to increase in seed yield/fed .,(Salih, 1987 and 1989).

Yield is the final product of several characters. The determination of the most important characters influencing yield may be useful in the breeding programmes. Path coefficient, stepwise multiple linear regression and multiple regression analysis are statistical techniques applied successfully to identify the relative contribution of some independent variables on a dependent variable (Mahmoud *et al.*, 1978; El-Gamal *et al.*, 1990; El-Sergany, 1992 and Mohamed, 1992). Walton (1972) reported that biologists must seek right assistance from statistical methodology and suggested factor analysis as a new technique to identify growth and plant characters related to yield in spring wheat. Denis and Adams (1978) used factor

analysis to search for and identify patterns of morphological characteristics in a set of dry bean cultivars which could relate to yield. Factor analysis is a type of multivariate analysis that reduces a large number of correlated variables to a small number of main factors. El-Kalla and El-Rayes (1984), Gad El-Karim *et al.*, (1990), Nasr and Geweifel (1991) and Mohamed and Sedhom (1993) used factor analysis in corn, faba bean, peanut and corn experiments, respectively.

The objectives of this study were to evaluate three faba bean varieties under different plant densities to determine the optimal plant density and use of factor analysis technique to determine the dependence relationships between yield components in faba bean.

2.MATERIALS AND METHODS

The present investigation was conducted at the Research and Experiments Center, Faculty of Agriculture, Moshtohor during the two successive seasons of 1995/96 and 1996/97. Three faba bean varieties i.e, Giza 3, Giza 461 and Giza 716 were grown under plant densities of 17, 33 and 50 plants/m^2 which are equivalent to 70,140 and 210 thuosand plants/fed. This was conducted by planting 4-5 seeds/hill and plants were thinned to one, two and three plants/hill. Hills were on both sides of the ridge at 20 cm distance.

Treatments were arranged in a split-plot design with three replications. Varieties were assigned to the main plots and plant population densities were assigned to the sub-plots. Each sub-plot consisted of 7 ridges of 4 m long and 0.6 m apart. Agricultural practices were applied as recommendations.

At harvest, ten plants were selected randomly from the central five ridges after excluding the first and last rows from each plot to collect data on the following characters:

1- Plant height, cm.
2- Number of branches/plant.
3- Number of pods/plant.
4- Number of seeds/pod.
5- Seed yield/plant, gm.
6- Weight of 100 seeds, gm.
7- Seed yield in kg/fed was determined from yield of five rows from the plot (12 m^2).

Data were statistically analyzed according to Snedecor and Coch-

ran (1981) and least significant difference test (LSD) at 5 % level of significance was calculated to detect significant differences.

Factor analysis method was discussed by Cattell (1965). The method consists of the reduction of a large number of correlated variables to a much smaller number of clusters or patterns of variables called factors. When the contribution of a factor to the total percentage of the trace was less than 10 %, the process stopped. After extraction, the matrix of factor loadings was submitted to a varimax orthogonal rotation, as applied by Kaiser (1958). The effect of rotation is to accentuate the larger loading in each factor and to suppress the minor loading coefficient and in this way to improve the opportunity of achieving a meaningful biological interpretation of each factor. A communality (h^2) is the amount of the variance of a variable accounted for the common factors together. Since the purpose was to determine the way in which yield components are related to each other, yield was not included in this structure.

3.RESULTS AND DISCUSSION

3.1.Effect of varieties.

Results in Table 1 show yield and related characters of the three tested faba bean varieties during the 1995/96 and 1996/97 seasons. The results indicated clearly that the tested varieties differed significantly in plant height in both seasons. Giza 461 variety gave the tallest plants followed by Giza 3 and Giza 716.

Significant differences were found among the tested varieties in number of branches/plant. Giza 716 and Giza 461 varieties developed more branches per plant than Giza 3 variety in both seasons. The tested faba bean varieties only significantly differed in the 1996/97 season for number of pods/plant. Varieties could be arranged in a descending order as follows: Giza 461, Giza 3 and Giza 716. Number of seeds/pod was not significantly affected by varieties in both seasons. The results in Table 1 show that the effect of tested varieties was significant on seed yield/plant in both seasons. Giza 461 gave the highest seed - yield/plant followed by Giza 3 and Giza 716, respectively. Differences in seed index due to varieties were found to be significant in both

Table(1):Effect of varieties on yield and its component characters in faba bean during seasons of 1995/96 and 1996/97.

Characters	Varieties			Mean	L.S.D 5%
	Giza 3	Giza 461	Giza 716		
1995/96 season					
1- Plant height (cm)	137.6	146.4	122.7	135.6	7.8
2- Number of branches/plant	2.5	3.4	3.5	3.1	0.4
3- Number of pods/plant	18.6	19.6	16.3	18.2	N.S
4- Number of seeds/pod	3.6	3.6	3.4	3.5	N.S
5- Seed yield/plant (gm)	50.1	56.2	50.5	52.3	4.2
6- Weight of 100 seeds (gm)	56.4	64.3	76.3	65.7	3.6
7- Seed yield/fed. (Kg)	905.9	1033.3	1136.7	1025.3	70.1
1996/97 season					
1- Plant height (cm)	122.4	134.7	107.4	121.5	7.3
2- Number of branches/plant	3.3	4.3	4.7	4.1	0.6
3- Number of pods/plant	23.7	27.6	19.8	23.7	7.3
4- Number of seeds/pod	3.0	3.3	2.8	3.0	N.S
5- Seed yield/plant (gm)	45.9	50.2	39.3	45.1	6.8
6- Weight of 100 seeds (gm)	54.2	60.1	73.1	62.5	5.5
7-Seed yield/fed. (Kg)	849.1	959.3	1054.0	954.1	71.8

seasons. Giza 716 variety had the heaviest seeds followed by Giza 461 and Giza 3 in both seasons. Giza 716 exceeded Giza 461 and Giza 3 by 18.7% and 35.3% in the first season and 21.6% and 34.9% in the second season, respectively .

Data in Table 1 indicate clearly that seed yield/fed was significantly affected by the tested varieties in both seasons. Giza 716 variety surpassed both Giza 3 and Giza 461 by 25.5 % and 10.0 % in the 1995/96 season and 24.1 % and 9.9 % in the 1996/97 season, respectively.

3.2.Effect of plant population

Data of yield and related characters as affected by plant densities during 1995/96 and 1996/97 seasons are presented in Table 2. Results show that plant densities significantly affected all the studied traits in both seasons, except number of seeds/pod.

Results indicated that increasing plant density from 17 plants/m^2 to 33 and 50 plants/m^2 increased seed yield/fed by 23.4% and 25.4%, respectively, in the first season. The increases were 15.1% and 16.4%, for 33 plants/m^2 and 50 plants/m^2 respectively, in the second season. These findings are in agreement with those obtained by Salih (1987).

Similarly, plant height significantly increased by increasing plant density from 17 to 33 and 50 plants/m^2 in both seasons. Such effect may be attributed to the fact that the denser the plant density, the more competiton exists among the plants for light. The growing plants sereach for light through elongation of internodes. Similar results were also reported by Salih (1985).

On the other hand, increasing plant density significantly decreased number of branches/plant, number of pods/plant, seed yield/plant and 100-seed weight in both seasons of the study. The results indicated that increasing plant density from 17 to 33 and 50 plants/m^2 decreased number of branches/plant by 21.8% and 62.5% in 1995/96 season and by 19% and 56.2% in the 1996/97 season, respectively.

Number of pods/plant was decreased by 25.3% and 70.1% as a result of increasing plant population density in the first season. The corresponding reductions in the second season were 30.8% and 52.6%,

respectively. Increasing plant density led to significant reductions in seed yield/plant in both seasons. The reductions were 22.3% and 78.1% in the 1995/96 season being 25.6% and 72.7% in 1996/97 season, respectively. Similarly, seed index was significantly affected by plant population, where it was reduced as a result of increasing plant density from 17 to 33 and 50 plants/m^2 by 8.9%, 16.8% and by 8.1%, 19.2% in the first and second seasons, respectively.

The obtained results of branches, pods and seed yield/plant and seed index were in harmony with those obtained by Abo El-Zahab *et al.*, (1981); El-Deib (1982), and Hussein *et al.*, (1994 and 1995).

Number of seeds/pod was not affected by plant population density in both seasons (Table 2).

3.3.Interaction efffect

Results of effect of the interaction between varieties and plant density on yield and related characters are presented in Table 3. The results indicated that plant height was only significantly affected by varieties x plant density interaction in the1995/96 season. Results in Table 3 show that plant height was gradually increased by increasing plant density for all tested varieties. Number of branches/plant was not affected by the interaction of varieties x plant density in both seasons. Number of pods/plant was sinificantly affected by this interaction only in the 1996/97 seasons. Giza 461 variety gave the highest value by planting 17 plants/m^2, while the lowest value was produced by planting Giza 716 variety at the density of 50 plants/m^2. The interaction between varieties and plant density significantly affected seed yield/plant in both seasons. Yield of seeds/plant decreased by increasing plant density for all varieties. Giza 416 variety produced the highest seed yield/plant when it was grown at the density of 17 plants/m^2 recording 70.1 gm and 62.0 gm in the first and second seasons, respectively. On the other hand, Giza 3 variety gave the lowest value by growing 50 plants/m^2 (Table 3). Seed index was significantly affected by varieties x plant density interaction in the second season only. The heaviest seed index was produced by planting Giza 716 variety at the density of 17 plants/m^2 recording 78.0 gm, while Giza 3 gave the lightest seed index at the density of 50 plants/m^2. Variety x

Table (2) : Effect of plant density on yield and its component characters in faba bean during seasons of 1995/96 and 1996/97.

Characters	Plant Populations			Mean	L.S.D 5%
	17 pl/m^2	33 pl/m^2	50 pl/m^2		
1995/96 season					
1- Plant height (cm)	117.3	140.8	148.6	135.6	5.9
2-Number of branches/plant	3.9	3.2	2.4	3.2	0.5
3- Number of pods/plant	22.8	18.2	13.4	18.1	1.5
4- Number of seeds/pod.	3.5	3.4	3.4	3.4	N.S
5- Seed yield/plant (gm)	65.9	53.9	37.0	52.3	3.9
6-Weight of 100 seeds (gm)	71.0	65.2	60.8	65.7	4.2
7- Seed yield/fed. (Kg)	881.8	1088.4	1105.7	1025.3	50.7
1996/97 season					
1- Plant height (cm)	104.9	120.7	139.0	121.5	5.8
2- Number of branches/plant	5.0	4.2	3.2	4.1	0.7
3- Number of pods /plant	29.3	22.4	19.2	23.6	3.1
4- Number of seeds/pod.	3.0	3.0	3.1	3.0	N.S
5- Seed yield/plant (gm)	57.0	45.4	33.0	45.1	4.2
6- Weight of 100 seeds (gm)	67.8	62.7	56.9	62.5	1.8
7- Seed yield/fed. (Kg)	819.8	943.8	1098.8	954.1	78.5

Table (3): Effect of interaction between varieties and plant densities on yield and its components in faba bean during seasons of 1995/96 and 1996/97.

Characters	Plant height (cm)		Number of branches/pl.		Number of pods/pl.		Number of seeds/pod		Seed yield /pl. (gm)		100-seed weight (gm)		Seed yield (Kg/fed)	
Treatments	95/96	96/97	95/96	96/97	95/96	96/97	95/96	96/97	95/96	96/97	95/96	96/97	95/96	96/97
Giza 3														
17plants/m^2	115.3	102.7	2.9	4.0	22.1	28.7	3.5	3.0	65.3	58.0	61.2	58.8	769.8	713.0
33 plants/m^2	142.3	123.3	2.7	3.3	19.0	22.3	3.5	2.9	48.7	47.7	54.6	53.3	971.3	826.7
50 plants/m^2	155.0	141.3	2.0	2.7	14.6	20.0	3.6	3.1	36.3	32.0	53.3	50.3	976.5	1007.5
Giza 461														
17 plants/m^2	127.3	121.0	4.4	5.2	25.4	33.7	3.6	3.3	70.1	62.0	68.5	66.5	914.5	842.2
33 plants/m^2	152.3	132.3	3.3	4.5	20.5	26.7	3.6	3.3	60.2	51.3	65.9	61.8	1090.2	950.7
50 plants/m^2	159.7	150.7	2.5	3.0	12.9	22.3	3.5	3.3	38.2	37.3	58.5	51.9	1095.3	1085.0
Giza 716														
17 plants/m^2	109.3	91.0	4.5	5.7	21.0	25.7	3.4	2.8	62.3	51.0	83.1	78.0	961.0	904.2
33 plants/m^2	127.7	106.3	3.5	4.7	15.2	18.3	3.3	2.8	52.7	37.3	75.1	73.0	1203.8	1054.0
50 plants/m^2	131.0	125.0	2.7	3.8	12.8	15.3	3.4	2.7	36.6	29.7	70.7	68.4	1245.2	1203.8
LSD at 0.05 Level														
C x PD*	10.2	N.S	N.S	N.S	N.S	5.4	N.S	N.S	4.8	7.2	N.S	3.0	N.S	N.S

*C x PD = cultivars x plant densities interaction

plant density interaction did not affect seed yield/fed in the two seasons. Giza 716 produced the highest yield of seeds/fed by planting 140000 to 210000 plants/fed. However, Giza 3 produced the lowest yield at the density of 70000 plants/fed.

Generally, increasing plant density decreased most of yield components but increased seed yield/fed.

3.4.Simple correlation analysis

The matrix of simple correlation coefficients (n = 54) among seed yield/plant and its components: plant height, number of branches/plant, number of pods/plant, number of seeds/pod and weight of 100 seeds is shown in Table 4.

The results indicate that the number of pods/plant was highly significant and positively correlated with seed yield/plant with r value being 0.54. High association with number of pods is of interest to plant breeder, because it is relatively an easily indentifable character in the field. Plant height was found to be highly significant and negatively correlated with seed yield/plant (r = -0.348). However, the number of branches/plant was highly significant and positively correlated with seed yield/plant with r value being 0.396. Obviously, seed producing advantage of more branches results from giving more pods/plant. This association was a result of the tillering plants with leaf surface were capable of greater photosynthetic activity, hence more photosynthetates were directed into seed formation. Significant and positive association was found between seed yield/plant and weight of 100 seeds with r value of 0.336.

Similar results were reported by many investigators who studied the relationship between seed yield/ plant and its components (Hung *et al.*, 1983; Naidu *et al.*, 1985; Sindhu *et al.*, 1985 and Mohamed, 1992).

3.5.Factor analysis

The results of factor analysis are recorded in Tables 5 and 6. Factor analysis grouped the five variables namely, plant height, number of branches/plant, number of pods/plant, number of seeds/pod and weight of 100 seeds into two main factors which accounted for 77.51%

Table(4): Simple correlation coefficients among seed yield/plant of faba bean and its components over both 1995/96 and 1996/97 seasons,(n=54).

	Plant height	Branches /plant	Pods /plant	Seeds /pods	Seed index
Branches /pl	0.673**				
Pods /plant	- 0.374**	0.532**			
Seeds /Pod	0.142	- 0.211	- 0.369**		
Seed index	- 0.574**	0.579**	0.004	0.214	
Yield/plant	- 0.348**	0.396**	0.540**	0.041	0.336*

* significant at 5% level of significance.

** significanct at 1% level of significance.

Table (5): Principal factor matrix after orthogonal rotation for five characters of faba bean.

Variables	Factors		Communality (h2)
	Factor I	Factor II	
Plant height	- 0.8424	0.2269	0.7611
Number of branches/plant	0.8383	- 0.3694	0.8392
Number of pods/plant	0.3260	- 0.7734	0.7044
Number of seeds/pod	0.0866	0.8410	0.7148
Weight of 100 seeds	0.8701	0.3146	0.8560
Latent roots	2.4711	1.4044	3.8755
Factor variance ratio %	49.42	28.09	77.51

Table (6): Summary of factor loading for five variables of faba bean.

Variables	Loading	% Total communality
Factor I:		49.42
1-Plant height.	- 0.8424	
2-Number of branches/plant.	0.8383	
3-Weight of 100 seeds.	0.8701	
Factor II:		28.09
1-Number of pods/plant.	- 0.7734	
2-Number of seeds/pod.	0.8410	
Commulative variance.		77.51

of the total variability in the dependence structure.

Factor I included three variables which accounted for 49.42% of the total variance. These variables were plant height, number of branches/plant and weight of 100 seeds. Factor II included two variables which accounted for 28.09% of the total variance. These two variables were number of pods/plant and number of seeds/pod

Generally, plant height, number of branches/plant and 100-seed weight were the most important variables in Factor I, which had a large communality value (h^2 = 49.42%). Number of pods/plant and number of seeds/pod were the most important variables in factor II. (h^2 = 28.09%) Table 6). These results are in the line with those reported by Gad El-Karim *et al* (1990).

From the previous results, it could be concluded that factor analysis indicates both grouping and percentage contribution to total variation in the dependence structure. Factor analysis procedure can be used succcessfully for analysis of large amounts of multivariate data, and should be applied more frequently in field of faba bean research. Use of factor analysis technique by plant breeders may be helpful in determining the nature and sequence of characters to be selected in breeding programmes

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المساهمة النسبية لمكونات المحصول فى بعض أصناف الفول البلدى المزروعة تحت كثافات مختلفة

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ملخص

أجريت هذه الدراسة لبيان تأثير ثلاثة كثافات نباتية مختلفة على المحصول ومكوناته لثلاثة أصناف من الفول البلدى (جيزة3،جيزة461،جيزة716) وكذلك التدخل بين هذه الأصناف والكثافة النباتية وأثر ذلك على إنتاجية الفول البلدى . وقد نفذت تجارب هذه الدراسة بكلية الزراعة بمشتهر جامعة الزقازيق- فرع بنها - فى موسم 1995/96،1996 /97. وقد تم توزيع المعاملات فى تصميم قطع منشقة حيث وزعت الأصناف فى القطع الرئيسية و معاملات الكثافة النباتية فى القطع المنشقة. وتمت الزراعة بكثافة عالية فى جور على مسافة 20سم بين الجورة والأخرى والزراعة على الريشتين وبعد الإنبات تم الخف على نبات ونباتين وثلاث نباتات فى الجورة لتعطى 17،33،50 نبات فى المتر المربع ، وهى تناظر كثافة نباتية 70،140،210 الف نبات للفدان على التوالى . ويمكن تلخيص النتائج فيما يلى :

- أدت زيادة الكثافة النباتية الى إنخفاض معنوى فى كل من محصول النبات وعدد أفرع النبات وعدد القرون وكذلك وزن ال100 بذرة بالجرام بينما زاد طول النبات ومحصول البذور للفدان بزيادة الكثافة النباتية .
- لم تتأثر صفة عدد بذور القرن بالإختلافات بين الأصناف أو الكثافة النباتية أو التفاعل بينهما .
- أدت زيادة الكثافة النباتية الى زيادة محصول بذور الفدان لكل الأصناف المختبرة وأعطى الصنف جيزة716 أعلى محصول من البذور عند الكثافة النباتية ما بين 140000 - 210000 ألف نبات/فدان ويليه الصنف جيزة 461 .
- توضح النتائج أيضا إمكانية زيادة إنتاجية أصناف الفول البلدى عند زراعتها بكثافة نباتية تتراوح ما بين 140-210 ألف نبات/فدان

- وجد تلازم معنوى موجب بين محصول البذور/النبات و كل من عدد قـــرون النبات و عدد فروع النبات ووزن 100 بذرة بينما تلازمت صفة ارتفاع النبات تلازما سالبا مع محصول بذور النبات.
- اظهرت نتائج تحليل العامل أن الصفات تحت الدراسة تجمعت فى عاملين هما العامل الأول ويضم إرتفاع النبات وعدد أفرع النبات ووزن100 بذرة ويســـهم هذا العامل بحوالى 49.42% من التباين الكلى وضم العامل الثانى عدد قـــرون النبات وعدد بذور القرن وأسهم هذا العامل بحوالى 28.09% من التباين الكلى.
- أوضحت نتائج تحليل العامل أن التحليل يتسع لدراسة مزيد مـــن الصفـــات حيث أن الصفات تحت الدراسة فسرت 77.5% فقط من التباين .

المجلة العلمية لكلية الزراعة - جامعة القاهرة - المجلد (49) العدد لرابع (أكتوبر 1998):517-532 .