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SOME STATISTICAL METHODS TO DETECT THE BEHAVIOUR BETWEEN YIELD AND ITS COMPONENTS UNDER DIFFERENT DENSITIES IN FABA BEAN.

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ABSTRACT

Two field trials were carried out at Sids Agricultural Research Station Bein Suef governorate during 2002 /2003 and 2003/2004 seasons to estimate the relative contributions between yield and its components for faba bean (Giza 2) as affected by different densities (27, 33, 40 plant/m²). The used statistical procedures were simple correlation, multiple regression and stepwise regression analysis . The third density (40 plant/m²) recorded the highest mean compared with 33 and 27 plant/m² for plant height. On the other hand, the first density 27 plant/m² recorded the highest means for weight of 100 seeds and weight of seeds/plant. Results for combined analysis presented significant difference between years and seed yield/plant, plant height and number of pods. The interaction between years and plant populations were significant for number of pods/plant and number of seeds/pod. On the other hand, this relation was not significant for other traits and this result indicated that some characters were more affected by environmental conditions than others. Correlation coefficient values cleared highly significant positive correlation between seed yield /plant, and No. of pods and weight of 100 seeds for first density. Also highly significant positive correlation was found between seed yield/plant and plant height , number of branches and weight of 100 seed for second density. Results also cleared highly significant positive correlation between seed yield/plant and plant height and No. of pods for third density. The relation between seed yield is changing with change plant densities. Multiple regression analysis results recorded 77.7%, 92.9% and 97.8 % for 27, 33 and 40 plant/m^2 from the total variation of seed yield/plant, respectively. Stepwise regression analysis accepted weight of 100 seeds and plant height with R^2 being 30.8% and 35.3% in 27 plant/m^2, plant height, weight of 100 seeds , No. of pods and No. of branches with relative contributions (R^2) of 65.7% ,14.8 % , 6% and 5.7 % in 33 plant/m^2 and selected plant height and No. of pods with relative contributions of 81.7 % and 10.1% in 40 plant/m^2 from the total variation of seed yield /plant , respectively . These results also indicated that the variables which having contributions were changing with change plant densities .

INTRODUCTION

Faba bean (Vicia Faba L.) is the most important legume crop in Egypt. It is used as green pods and seeds as well as dry seeds. The importance of faba bean is due to its high nutritive seed value which contains protein, carbohydrate, some vitamins and other elements. In addition faba bean plays an important role in nitrogen fixation process by Rizobia which increase fertilization in the soil especial in the newly reclaimed soils .

Stepwise multiple linear regression and multiple regression analysis are statistical techniques successfully applied to identify the relative contribution of some independent variables on a dependent variable(El-Gamal et al , 1990; and Mohamed, 1992)

The aim of this study is to investigate the variables which having the greatest effect on the yield and their relative contributions to variation in the yield under different plant densities in faba bean .

MATERIALS AND METHODS

Two field experiments were carried out at Sids Agricultural Research Station Bein Suef governorate during 2002/2003 and 2003/2004 seasons. Each experiment included three densities (27, 33 and 40 plant/m²) and designed in randomized complete block with four replications. Faba bean variety Giza 2 was used and the dependent variables was weight of seeds/plant (gm). The independent variables were presented in Table 1 .

Table 1: Independent variables that were related with seed yield /plant in faba bean .

Independent variables	
Plant height (p.h) .	X1
Number of branches (nob) .	X2
Number of pods (nop) .	X3
Number of seeds / pod (nos).	X4
Weight of 100 seeds (w100) .	X5

Statistical analysis:

Relationships among dependent and independent variables were studied using the following statistical techniques as follows:

1- Analysis of variance.
2- Simple correlation coefficient.
3- Multiple regression analysis.
4- Stepwise multiple regression analysis.

Data obtained in each season were statistically analyzed followed the produced outlined by Steel and Torrie (1980). Simple correlation coefficient were calculated as applied by Snedecor and Cochran (1989) to estimate the correlation coefficient (r) between each of dependent and independent variables. Multiple regression analysis was performed as outlined by Draper and Smith (1987) to calculate the coefficient of determination (R^2) to estimate relative contribution of independent variables for each dependent variable and to get the prediction equations. Stepwise multiple regression analysis aims to determine the variables accounting for the majority of the total variability in dependent character . This procedure develops a sequence of multiple regression equation in a stepwise manner. One variable is added to the regression equation at each step. The added variable is the variable that has the greatest contribute in the error sum of squares. Also this variable has the highest partial correlation with the dependent variable for fixed values of those variables already added, and it is the variable that has the highest F value. Stepwise regression analysis was performed as described by Draper and Smith (1987) .

RESULTS AND DISCUSSION

Data in Table 2 showed highly significant differences between population density for plant height, weight of 100 seeds and weight of seeds / plant (sw/p) in the two seasons. The third density (40 plant/m²) recorded highest mean and followed by second (33 plant/m²) and first (27 plant/m²) for plant height in the two seasons and this is due to the effect of plant competition and the growing plants search for light through elongation of internodes .Similar results were also reported by Salih (1989) . On the other hand the first density (27 plant/m²) recorded the highest mean and followed by second (33 plant/m²) and third (40 plant/m²) for weight of 100 seeds and weight of seeds / plant in the two seasons and this is due to the increase in the space between plants in the first density. For number of branches the population densities were not significant in the two seasons.

Table 2 : Average performance of all characters that were studies in the two seasons.

The averages in 2002 / 2004						
	Plant height	Number of branches	Number of pods	Number of seeds	Weight of 100 seeds	Seed yield/plant
	70.13	11.00	48.25	1.45	15.57	46.44
	72.75	10.25	55.25	1.68	14.55	43.05
	74.65	10.75	65.50	1.78	13.98	37.29
L.S.D 5%	1.79	N.S	4.75	0.197	1.122	0.562
L.S.D 1%	2.73	N.S	7.20	0.299	1.703	0.856
The averages in 2003 / 2004						
	Plant height	Number of branches	Number of pods	Number of seeds	Weight of 100 seeds	Seed yield/plant
	71.50	11.00	62.00	1.67	15.17	46.20
	73.93	10.75	60.00	1.67	15.02	47.16
	76.08	10.25	58.75	1.60	13.97	39.75
L.S.D 5%	3.02	N.S	N.S	N.S	0.991	1.598
L.S.D 1%	4.58	N.S	N.S	N.S	1.505	2.425

The number of pods/plant and seeds/pod were highly significant in the first season, but plant were not significant in the second one and this result was due to the effect of environmental conditions. The obtained results of number of branches ، pods and seed yield / plant were in harmony with those obtained by Abo El - zahab *et al (1981) ; El* - Deib (1987), Hussein et al (1994) and (1995).

Results for years, plant populations and their interactions according to combined analysis are presented in Table 3. Significant difference between years was clearly presented for seed yield/plant, plant height and number of pods. On the other hand the number of branches, number of seeds/pod and weight of 100 seeds were not significant. Results also cleared significant difference between plant populations for all traits except number of branches. This result was confirmed with that obtained by single analysis in Table 2. Table 3 also cleared that the interaction between years and plant populations were significant for number of pods/plant and number of seeds/pod.

On the other hand, this relation were not significant for other traits and this results indicated that some characters were more affected by environmental conditions than others. Generally, increasing plant density decreased most of yield components but increased plant height , number of pods and number of seeds .

Table 3: Averages of all characters according to combined analysis in the two seasons.

Seed yield gm / plant			
Densities	**First season means**	**Second season means**	**Density means**
27 plant / m^2	46.425	46.2	46.314
33 plant / m^2	43.05	47.175	45.111
40 plant / m^2	37.275	39.75	38.511
Seasons Mean	42.249	44.376	
L.S.D for seasons	5% = 0.549	1% = 0.831	
L.S.D for densities	5% = 0.755	1% = 1.059	
L.S.D densities x seasons	5% = NS	1% = NS	
Plant height			
Densities	**First season means**	**Second season means**	**Density means**
27 plant / m^2	70.125	71.500	70.813
33 plant / m^2	72.75	73.925	73.337
40 plant / m^2	74.65	76.075	75.363
Seasons Mean	72.508	73.833	
L.S.D for seasons	5% = 0.727	1% = 1.101	
L.S.D for densities	5% = 1.567	1% = 2.199	
L.S.D densities x seasons	5% = NS	1% = NS	
Number of branches/plant			
Densities	**First season means**	**Second season means**	**Density means**
27 plant / m^2	11.00	11.00	11.00
33 plant / m^2	10.25	10.750	10.50
40 plant / m^2	10.75	10.25	10.50
Seasons Mean	10.667	10.667	
L.S.D for seasons	5% = NS	1% = NS	
L.S.D for densities	5% = NS	1% = NS	
L.S.D densities x seasons	5% = NS	1% = NS	
Number of pods/plant			
Densities	**First season means**	**Second season means**	**Density means**
27 plant / m^2	48.25	62.00	55.125
33 plant / m^2	55.25	60.00	57.625
40 plant / m^2	65.50	58.75	62.125
Seasons Mean	56.33	60.25	
L.S.D for seasons	5% = 1.541	1% = 2.334	
L.S.D for densities	5% = 2.498	1% = 3.505	
L.S.D densities x seasons	5% = 3.532	1% =4.957	

Table 3 : Cont.

Number of seeds / pod			
Densities	**First season means**	**Second season means**	**Density means**
27 plant / m^2	1.45	1.675	1.563
33 plant / m^2	1.675	1.675	1.675
40 plant / m^2	1.775	1.60	1.688
Seasons Mean	1.633	1.65	
L.S.D for seasons	5% = NS	1% = NS	
L.S.D for densities	5% = 0.101	1% = 0.142	
L.S.D densities x seasons	5% = 0.143	1% = 0.201	
Weight of 100 seeds			
Densities	**First season means**	**Second season means**	**Density means**
27 plant / m^2	15.575	15.175	15.375
33 plant / m^2	14.55	15.025	14.788
40 plant / m^2	13.975	13.975	13.975
Seasons Mean	14.70	14.725	
L.S.D for seasons	5% = NS	1% = NS	
L.S.D for densities	5% = 0.668	1% = 0.937	
L.S.D densities x seasons	5% = NS	1% = NS	

1- Simple correlation.

Table 4 indicating correlation coefficients between seed yield /plant (g) and all characters that were studied in faba bean for 27, 33 and 40 plant /m^2. Results cleared that there was highly significant positive correlation between seed yield /plant and No. of pods (x3) and weight of 100 seeds (x5) with r- values were 0.537 and 0.555 for first density, respectively.

Table 4: Simple correlation coefficient between studied traits and weight of seeds /plant gm.(Y) for 27, 33 and 40 plant/m^2 of faba bean .

First density (27 plant/m^2)						
Y	Y	X1	X2	X3	X4	X5
	1.000	0.380	-.531	0.537	-.084	0.555
X1		1.000	-.459	0.315	-.287	-.328
X2			1.000	0.000	-.250	-.233
X3				1.000	-.569	0.534
X4					1.000	-.194
X5						1.000
Second density (33 plant/m^2)						
Y	Y	X1	X2	X3	X4	X5
	1.000	0.811	0.520	-.013	-.002	0.620
X1		1.000	0.334	0.327	0.358	0.316
X2			1.000	-.275	-.180	0.817
X3				1.000	0.280	-.018
X4					1.000	-.460
X5						1.000
Third density (40 plant/m^2)						
Y	Y	X1	X2	X3	X4	x5
	1.000	0.904	-.336	0.659	-.249	0.245
X1		1.000	-.505	0.407	-.367	0.321
X2			1.000	0.331	0.258	-.165
X3				1.000	-.308	-.269
X4					1.000	0.383
X5						1.000

For second density highly significant positive correlation was found between seed yield/plant and plant height(x1), number of branches and weight of 100 seed with r - values were 0.811 , 0.520 and 0.620, respectively . Also highly significant positive correlation was found between seed yield/plant and plant height (x1) and No. of pods (x3) with r- values of 0.904 and 0.659, respectively for third density. This results cleared that the relation between seed yield is changing with change plant densities.
Similar results were also reported by many investigators who studied the relationship between seed yield/plant and its components (Naidu *et al,* 1985 ;Mohamed,1992) .

2-Multiple regression analysis :

Table 5 present the prediction equation and relative contributions (R^2) for seed yield/plant as affected by all characters in faba bean for 27, 33 and 40 plant m².

Table 5: Prediction equation according to multiple regression analysis for seed yield /plant as affected by all characters in faba bean for 27, 33 and 40 plant m².

First density (27plant/ m²).	
Y=a+b1x1+b2x2+b3x3+b4x4+b5x5 Y=-61.652+0.560x1+0.498x2-.103x3+4..662x4+1.978x5	
Relative contribution (R2) for all variables according to full model regression.	77.7%
Second density (33 plant/m²).	
Y=a+b1x1+b2x2+b3x3+b4x4+b5x5 Y=-9.218+0.335x1-1.148x2-1.164x3+1.982x4+1.251x5	
Relative contribution (R2) for all variables according to full model regression.	92.9%
Third density (40 plant/m²).	
Y=a+b1x1+b2x2+b3x3+b4x4+b5x5 Y=-11.442+ 0.241x1 –0.379x2 –.0998x3 +0.877x4 +0.203x5.	
Relative contribution (R2) for all variables according to full model regression.	97.8 %

Results cleared that all variables contributed by 77.7%, 92.9% and 97.8 % from the total variation of seed yield/plant for 27, 33 and 40 plant/m^2, respectively. This result indicated that the relative contribution was affected by the density of plants and this effect is due to the competitions between plants about nutrients and light.

3-**Stepwise regression analysis** :

Table 6 cleared the predicted and removed variables with their contributions according to stepwise regression analysis between seed yield/plant and all studied characters for 27, 33 and 40 plant/m².

Data showed that 2 variables out of 5 were accepted as significantly contributing variables to variation in faba bean seed yield/plant. These accepted variables were weight of 100 seeds and plant height with R^2 being 30.8% and 35.3% in 27 plant/m^2, respectively. These results indicated that

stepwise analysis develops a sequence of multiple regression equation by removing 3 from the full model equation with relative contribution of 11.5%.

Table 6: Stepwise regression analysis for seed yield /plant as affected by all characters in faba bean for 27, 33 and 40 plant/m².

First density 27 plant/m²	
Y=a+b5x5+b1x1 Y=-19.141+1.059x5+0.258x1	
Relative contribution (R2) for each of accepted variables according to stepwise regression	
X5 weight of 100 seeds	30.8%
X1 plant height	35.3%
The total relative contribution (R2) for all accepted variables according to stepwise regression	66.27%
The relative contribution (R2) for all removed variables according to stepwise regression	11.5%
The relative contribution (R2) for residual variables according to stepwise regression	22.3%
Total effect (accepted, removed and residual)	100%
Second density 33 plant/m²	
Y=a+b1x1+b5x5+b3x3+b2x2 Y=-7.288 + 0 .356x1+ 1.009x5 –1.146x3 – 0.931x2	
Relative contribution (R2) for each of accepted variables according to stepwise regression	
X1 plant height	65.7%
X5 weight of 100 seeds	14.8%
X3 No. of pods	6%
X2 No. of branches	5.7%
The total relative contribution (R2) for all accepted variables according to stepwise regression	92.2%
The relative contribution (R2) for all removed variables according to stepwise regression	0.7%
The relative contribution (R2) for residual variables according to stepwise regression	7.1%
Total effect (accepted, removed and residual)	100%
Third density 40 plant/m²	
Y=a+ b1x1+ b3x3 Y=-20.261+ 0.399x1-.0515x3	
Relative contribution (R2) for each of accepted variables according to stepwise regression	
X1 plant height	81.7%
X3 No. of pods	10.1%
The total relative contribution (R2) for all accepted variables according to stepwise regression	91.8%
The relative contribution (R2) for all removed variables according to stepwise regression	6%
The relative contribution (R2) for residual variables according to stepwise regression	2.2%
Total effect (accepted, removed and residual)	100%

For 33 plant/m^2 the stepwise analysis also develops a sequence of full model equation by accepting four variables out of five .These variables were plant height (x1), weight of 100 seeds(x5), No. of pods(x3) and No. of branches(x2) with relative contributions (R^2) of 65.7% ,14.8 % , 6% and 5.7 % ,respectively .

Table 6 also cleared that stepwise analysis excluding 3 variables from the full model equation with R^2 of 6% and only selected plant height (x1) and No. of pods (x3) with relative contributions of 81.7 % and 10.1% in the total variation of seed yield /plant , respectively .

These results are in line with those reported by Gad EL-Karim et al (1990) .

These results indicated that the selected or removal variables and their relations were affected by plant populations which were effected on plant competitions about food and light.

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بعض الطرق الإحصائية لتحديد السلوك بين المحصول ومكوناته تحت كثافات مختلفة في الفول البلدي

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المعمل المركزي لبحوث التصميم والتحليل الإحصائي.-مركز البحوث الزراعية .

أقيمت تجربتان حقليتان في محطة بحوث سدس بمحافظة بنى سويف في موسمى٢٠٠٢ / ٢٠٠٣ و ٢٠٠٣/٢٠٠٤ لتقدير المساهمة النسبية للمحصول ومكوناته للفول البلدي (صنف جيزة ٢) تحت كثافات مختلفة (٢٧ و ٣٣ و٤٠ نبات/م٢) وأستخدم لدراسة تلك العلاقة معامل الارتباط البسيط ومعامل الانحدار .المتعدد ومعامل الانحدار المرحلى المتعدد وقد لخصت النتائج كما يلي:-

سجلت الكثافة الثالثة (٤٠ نبات/م٢) أعلى متوسط لارتفاع النبات بالمقارنة بالكثافة الأولى والثانية أما بالنسبة لوزن ١٠٠ بذرة ووزن البذور/ النبات فقد سجلت الكثافة الأولى (٢٧ نبات/م٢) أعلى متوسط . سجلت نتائج التحليل التجميعى (الضام) فرق معنوي بين السنوات ومحصول البذور/النبات وارتفاع النبات وعدد القرون وكان التفاعل بين السنوات والكثافات النباتية معنويا لكل من عدد القرون /النبات وعدد البذور/القرون وكان غير معنويا لبقية الصفات . و تشير هذه النتائج إلى أن بعض الصفات أكثر تأثرا بالعوامل البيئية عن الأخرى .

وبالنسبة لنتيجة تحليل معامل الارتباط البسيط وجد ارتباط موجب عالي المعنوية بين محصول البذور /النبات وكل من عدد القرون ووزن ١٠٠ بذرة للكثافة الأولى. كما وجد ارتباط معنوي موجب بين محصول البذور/النبات وكل من ارتفاع النبات ، وعدد الفروع ووزن ١٠٠ بذرة للكثافة الثانية .و أشارت النتائج بأن هناك ارتباط معنوي موجب بين محصول البذور/النبات وارتفاع النبات وعدد القرون للكثافة الثالثة.وقد دلت هذه النتائج على أن العلاقة بين محصول البذور تتغير بالتغير في الكثافة النباتية .كما أظهرت نتيجة تحليل الانحدار المتعدد أن المساهمة النسبية لكل الصفات كمتغيرات مستقلة مجتمعة ٧٧,٧ ، ٩٢,٩ ، ٩٧,٨ % في تباين محصول بذور النبات للكثافات (٢٧ ،٣٣ ، ٤٠ نبات/م٢)على الترتيب . كما كانت نتيجة تحليل الانحدار المتعدد المرحلي اختيار متغيرين للكثافة ٢٧ نبات/م٢ هما وزن ١٠٠ بذرة و ارتفاع النبات ويساهمان بنسبة ٣٠,٨% ، ٣٥,٣ % على الترتيب في تباين محصول البذور/النبات. و في الكثافة ٣٣ نبات /م٢ تم اختيار ارتفاع النبات، وزن ١٠٠ بذرة ،عدد القرون وعدد الفروع بنسبة مسا همة ٦٥,٧ ، ١٤,٨، ٦ ، ٥,٧ % على الترتيب في التباين الكلى لمحصول البذور/النبات .و في الكثافة ٤٠ نباتا/م٢ تم اختيار متغيرين هما ارتفاع النبات و عدد القرون /بذرة بنسبة مساهمة ٨١,٧% و ١٠,١ % على الترتيب من التباين الكلى لمحصول البذور/النبات على التوالي .

وقد دلت النتائج السابقة على أن العوامل التي تساهم في محصول البذور/النبات تتغير بتغير المسافة وتتأثر بتغيرها .