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# PERFORMANCE OF SEVERAL NEWLY BRED FABA BEAN LINES

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## ABSTRACT

***Two field trials were conducted during 2001/2002 and 2002/2003 growing seasons at Deirab Agricultural and Experimental Research Station, College of Food and Agriculture Sciences, Riyadh, King Saud University, Saudi Arabia to evaluate eighteen promising breeding lines compared with Giza 3 cultivar.***

***Data revealed highly significant differences among tested genotypes for all traits, which indicated wide genetic variability. Mean squares of genotypes x season interaction were significant for studied traits except 100-seed weight and seed yield (t/ha).***

***Data revealed that line 1 followed by lines 4, 5 and 6 showed the highest mean values for seed yield and recorded 3.7, 3.55, 3.46 and 3.29 (t/ha), in the same order. The phenotypic and genotypic variances and coefficients of variability and heritability and genetic advance from selection were estimated for yield and associated traits. Results indicated that seed yield (t/ha) was significantly positively correlated with each of plant height, 100-seed weight, seed weight/plant and biological yield (t/ha), but negatively correlated with maturity date. Moreover, the relationship between seed yield (t/ha) and its components would be considerable value to breeders for screening breeding materials and selecting donor parents for breeding programs.***

Key words: ***Faba bean, Breeding lines, Evaluation, Yield performance, Variances, Correlation.***

## INTRODUCTION

Faba bean (*Vicia faba* L.) is an important legume crop due to its high nutrient value. The crop in Saudi Arabia is consisting a daily dish in the diet of most of the population, and large quantities of seeds are imported every year. The production of faba bean is severely limited by several constraints, which include the total lack of research emphasis on the crop, drought stress and salinity problems (large areas of cultivatable land use tube-well irrigation). The way to expansion in faba bean production in Saudi Arabia lies in placing considerably more emphasis upon research in these critical problem areas. However, College of Food and Agriculture Sciences University, Riyadh, Saudi Arabia has initiated breeding programs on faba

bean in early nineties, the research efforts are being focused on the identification of high-yielding genotypes that have a good adaptation to the production conditions.

Heritability estimates provide a measure of relative importance of genetic components to the phenotypic variation. Heritability estimates in faba bean varied according to materials and methods (Bond 1966, Poulsen 1977, El-Hosary and Sedhom 1990, El-Hady *et al* 1997 & 1998, El-Hifny *et al* 2001 and Attia 2002).

Seed yield is a complex trait and is quantitatively inherited with low heritability value (Bond 1966). The low heritability and consequent limited genetic advance for yield in response to selection has lead many scientists to search for characters which are associated with yield but which are more highly heritable (de Pace 1979 and Alghamdi 2003).Therefore, yield itself may not be the best criterion for selection, so breeding for high yielding ability is associated with yield and its component *viz*, number of pods, seeds/plant and seed size (Rowlans 1955). The phenotypic correlation of each component to seed yield was previously reported by several investigators Huang *et al* (1983), Sindhu *et al* (1985), Bakheit and Mahdy (1988) and El-Hady *et al* (1991).

The current study aimed to study the extent genetic variability, heritability and expected genetic advance for seed yield and its attributing traits among several faba bean genotypes under Saudi Arabia conditions..

## MATERIALS AND METHODS

Two field trials were conducted during 2001/2002 and 2002/2003 growing seasons in sandy clay soil at Deirab Agricultural and Experimental Research Station, College of Food and Agriculture Sciences, Riyadh, King Saud University, Saudi Arabia (24° 42 N Latitude and 46° 44 E Longitude) to evaluate eighteen promising breeding lines compared with Giza 3 cultivar. A randomized complete block design with three replications was used. The materials were sown in mid October in both seasons. Each plot consisted of 5 ridges, each three meters long and 50 cm apart (plot size = 7.5 $m^2$). The seeds were hand planted in hills spaced 20 cm apart at both sides of ridge. Calcium superphosphate (15.5 % $P_2O_5$) was added before sowing at a rate of 30 kg/acre. Nitrogen fertilizer was applied at 20 kg N per acre. The other cultural practices were done according to the recommended methods in Central area in Saudi Arabia. The data of 95 % maturity dates, 100- seed weight (g), biological yield (t/ha) and seed yield (t/ha) were recorded on plot

basis. However, individual characters were determined from a sample of 10 guarded plants randomly picked from each experimental plot.

**Statistical procedures:**

The statistical analysis was estimated according to the method of Snedecor and Cochran (1967) and treatment means were compared against least significant differences test (L.S.D.) at 5 % level of probability.

## RESULTS AND DISCUSSION

The combined analysis of variance over two seasons for all studied traits is presented in (Table 1). The combined analysis showed that seasons were highly significant source of variation in performance of days to maturity, plant height and biological yield (t/ha). Insignificant effects of seasons were recorded for the other characters. Therefore, it could be concluded that environmental effects significantly affected the performance of the present faba bean genotypes. The sensitivity of faba bean to environmental effects is well known (Darwish and Abdalla 1994 and Abdalla and Darwish 1996). Data revealed highly significant differences among tested genotypes for all traits, which indicated wide genetic variability. Mean squares of genotypes x season interaction were significant for studied traits except 100-seed weight and seed yield (t/ha). This finding indicated that certain genotypes carried alleles with different additive and additive x additive gene effects which were constant from season to another. These results are in agreement with those reported by El-Hosary and Sedhom (1990).

**Table 1. Significance of mean squares due to sources of variation of faba bean characters (combined data of 2001/2002 and 2002/2003).**

| Characters | Season | Genotype | Genotype x season |
|---|---|---|---|
| df | 1 | 18 | 18 |
| Days to maturity | 768.561 ** | 205.974 ** | 13.098 ** |
| Plant height (cm) | 690.67 ** | 182.091 ** | 132.615 ** |
| No. of pods/plant | 40.8 ns | 63.901 ** | 20.395 ** |
| No. of seeds/plant | 5.704 ns | 539.625 ** | 133.063 * |
| 100-seed weight (g) | 84.59 ns | 633.461 ** | 8.897 ns |
| Seed weight/plant (g) | 305.435 ns | 370.802 ** | 98.038 * |
| Biological yield (t/ha) | 88.599 ** | 5.231 ** | 2.213 ** |
| Seed yield (t/ha) | 0.526 ns | 1.485 ** | 0.153ns |

*, ** and ns indicate significant at 5% &1 % levels and not significant, respectively.

The mean performance of the tested genotypes is presented in Table (2). The mean values showed differences between genotypes with a range of 65.88-86.60, 140.17-163.67, 18.32-29.59, 39.74-72.79, 51.63-102-85, 31.12-58.32, 5.767-8.983 and 1.950-3.704 for plant height, days to maturity, number of pods/plant, number of seeds/plant, 100-seed weight, seed weight/plant, biological yield and seed yield (t/ha), respectively. Such wide range suggests the presence of significant genetic variability. Three genotypes L.6, L. 5 and L. 1 possessed tallest plants and recorded 86.60, 85.93 and 80.90 cm, respectively. Meanwhile, line 3 followed by line 2 had the shortest plants with a mean of 65.88 and 69.27 cm in the same order. In addition, line 5 and line 1 were earlier for days to maturity and recorded 140.17 and 143.67 days, respectively. On the other hand, line 4 followed by line 13 were the latest genotypes and recorded 163.67 and 162.00 days in the same order. Furthermore, high mean values of number of pods/plant were detected among lines 6, 1 and check variety (G.3) which recorded 29.59, 29.39 and 29.19 pods/plant, respectively. However, line 14 and line 10 possessed the lowest number of pods/plant and recorded 18.32 and 19.49 pods/plant, respectively. Regarding number of seeds/plant, three genotypes, line 5, check cultivar (Giza 3) and 6 exhibited higher number of seeds/plant and recorded 72.79, 70.39 and 69.35 seeds/plant, in the same order. Moreover, lines 10, 14 and 16 recorded the lowest number of seeds/plant with mean values of 39.74, 43.22 and 44.75 seeds/plant, respectively. With respect to 100-seed weight, line 4 followed by lines 8 and 13 had the heaviest values of 100-seed weight and recorded 102.85, 86.97 and 86.50 (g), respectively. The lowest 100-seed weight was observed among the check cultivar (Giza 3), lines2 and 1 with mean values of 51.63, 66.45 and 67.42 (g), respectively. For seed weight/plant (g), results indicated that line 4 followed by lines 6 and 5 exhibited the highest seed yield/plant with a mean values of 58.32, 54.09 and 50.40 g/plant, respectively. However, three genotypes: line 11, 15 and 9 had the lowest values of seed weight/plant and recorded 31.12, 31.67 and 33.24 (g) /plant, in the same order. The mean values of biological yield (t/ha) indicated that three lines (6, 16 and 4) exhibited the highest biological yield per hectare and recorded 8.983, 8.967 and 8.733 (t/ha), respectively. In contrast, check variety (G.3) and line 2 recorded the lowest biological yield with mean values of 5.767 and 5.950 (t/ha), respectively. For seed yield (t/ha), data revealed that line 1 followed by lines 4, 5 and 6 showed the highest mean values and recorded 3.704, 3.552, 3.459 and 3.292 (t/ha), respectively, in the same order. On the other hand, check cultivar (Giza 3) followed by lines 3 and 2 possessed the lowest estimates with a mean values of 1.950, 2.175 and 2.184 (t/ha), respectively.

**Table 2: Range and mean performance for yield and yield components characters of several faba bean genotypes (combined data of 2001/2002 and 2002/2003 seasons).**

| Genotype | Days to maturity | | Plant height (cm) | | Number of pods/plant | | Number of seeds/plant | | 100-seed weight (g) | | Seed weight/plant (g) | | Biological yield (t/ha) | | Seed yield (t/ha) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Line 1 | 143.67 | f | 80.90 | b | 29.39 | a | 57.95 | c-f | 67.42 | f | 36.18 | d-g | 7.950 | a-e | 3.704 | a |
| Line 2 | 156.83 | d | 69.27 | gh | 22.44 | de | 58.90 | cde | 66.45 | f | 37.10 | d-g | 5.950 | gh | 2.184 | fgh |
| Line 3 | 159.33 | cd | 65.88 | h | 23.57 | d | 61.93 | bcd | 71.00 | f | 43.45 | bcd | 7.017 | d-g | 2.175 | gh |
| Line 4 | 163.67 | a | 80.30 | bc | 22.62 | de | 64.82 | abc | 102.85 | a | 58.32 | a | 8.733 | a | 3.552 | a |
| Line 5 | 140.17 | g | 85.93 | a | 28.02 | ab | 72.79 | a | 80.52 | b-e | 50.40 | ab | 8.300 | f | 3.459 | ab |
| Line 6 | 151.33 | e | 86.60 | a | 29.59 | a | 69.35 | ab | 79.85 | cde | 54.09 | ab | 8.983 | d | 3.292 | abc |
| Line 7 | 157.00 | d | 70.62 | fgh | 21.97 | def | 47.94 | f-i | 77.50 | e | 40.42 | d-g | 7.733 | bc | 2.734 | de |
| Line 8 | 160.17 | bc | 76.77 | b-e | 22.80 | de | 48.82 | e-i | 86.97 | b | 34.85 | efg | 6.950 | a | 2.607 | d-g |
| Line 9 | 158.50 | cd | 71.82 | efg | 23.65 | d | 53.90 | d-g | 82.92 | b-e | 33.24 | c-f | 6.850 | bc | 2.302 | e-h |
| Line 10 | 158.50 | cd | 70.23 | fgh | 19.49 | ef | 39.74 | i | 85.85 | bcd | 38.10 | g | 8.183 | bc | 2.324 | e-h |
| Line 11 | 159.17 | cd | 72.48 | d-g | 23.58 | d | 56.12 | c-f | 79.90 | cde | 31.12 | d-g | 6.717 | bc | 2.665 | def |
| Line 12 | 159.33 | cd | 72.57 | d-g | 21.87 | def | 47.28 | f-i | 80.02 | cde | 34.20 | efg | 7.067 | bc | 2.624 | d-g |
| Line 13 | 162.00 | ab | 77.85 | bcd | 27.70 | abc | 62.90 | a-d | 86.50 | bc | 37.25 | bc | 7.933 | ab | 2.939 | cd |
| Line 14 | 159.00 | cd | 75.48 | b-f | 18.32 | f | 43.22 | hi | 79.12 | de | 45.80 | fg | 6.517 | bc | 2.297 | e-h |
| Line 15 | 157.00 | d | 75.20 | c-f | 22.92 | de | 56.82 | c-f | 82.67 | b-e | 31.67 | bcd | 7.217 | c | 3.040 | bcd |
| Line 16 | 153.33 | cd | 78.97 | bc | 24.17 | cd | 44.75 | ghi | 80.42 | b-e | 38.92 | d-g | 8.967 | bc | 2.712 | de |
| Line 17 | 156.67 | d | 77.45 | bcd | 21.60 | def | 50.94 | e-h | 83.72 | b-e | 40.14 | cde | 7.333 | bc | 2.853 | cd |
| Line 18 | 157.33 | cd | 79.63 | bc | 24.57 | bcd | 54.84 | c-g | 80.07 | cde | 38.25 | def | 7.717 | bc | 2.978 | cd |
| Giza 3 (Check) | 151.67 | e | 72.42 | d-g | 29.19 | a | 70.39 | ab | 51.63 | g | 35.29 | d-g | 5.767 | d | 1.950 | h |
| Range | 140.17-163.67 | | 65.88-86.60 | | 18.32-29.59 | | 39.74-72.79 | | 51.63-102.85 | | 31.12-58.32 | | 5.767-8.983 | | 1.950-3.704 | |

**Mean design by the same letters are bot significantly different from 0.05 level of probability.**

From the previously reported results, it could be concluded that the following genotypes: lines 1, 4, 5, 6, 15, 18, 13 and 17 would prospect in faba bean breeding for improving seed yield (t/ha) and its important components.

The phenotypic ($\delta^2_{ph}$), genotypic ($\delta^2_g$), environmental ($\delta^2_e$) variances, phenotypic (PCV) and genotypic coefficient of variability (GCV), broad-sense heritability ($h^2_B$) and expected genetic advance (Gs %) for yield and its traits are presented in (Table 3). The results illustrated that the magnitude of genotypic variance was greater than that of environmental variances for all the studied characters. Moreover, high estimates of phenotypic ($\delta^2_{ph}$) and genotypic ($\delta^2_g$) variances were observed for 100-seed weight followed by number of seeds/plant and seed weight/plant, indicating better scope for the genetic improvement in these characters. The broad-sense heritability estimates ranged from 16.63 to 96.25 %. In addition, high estimates of heritability were detected for 100-seed weight followed by days to maturity, seed yield (t/ha), 100-seed weight and number of seeds/plant were recorded 96.25, 88.62, 69.25 and 66.67 %, respectively. On the other hand, plant height and biological yield (t/h) exhibited the lowest magnitude of heritability (16.63 and 45.92 %) in the same order. The expected genetic advance (Gs %) exhibited considerable range (2.72 to 28.28 %). Seed yield (t/ha) followed by seed weight/plant (g) and 100-seed weight (g) expressed the highest estimates of genetic advance and recorded 28.28, 24.13 and 22.24 in the same order. On the other hand, the estimates of GCV coupled with high broad-sense heritability and high genetic advance were exhibited for seed yield (t/ha), seed weight/plant (g) and number of seeds/plant. These findings detected that these characters showing to be highly heritable and can be taken as criterion for effective selection. A greater chance of success in indirect selection for yield may come from selecting for various morphological attributes such as, number of pods/plant, number of seeds/plant and seed which could be used in the construction of selection indices for the improvement of yield. Johanson *et al* (1955) reported that heritability estimates along with genetic advance are usually more useful than the heritability values alone in predicting the results of selecting the best individuals. On the other hand, heritability is not always associated with high genetic advance, but to make effective selection, high heritability should be associated with high genetic advance. In the present study relatively high genetic advance was found to be associated with rather moderate or high heritability estimates for seed weight/plant (g) and number of seeds/plant.

Table 3. Phenotypic ($\delta^2_{ph}$), genetic ($\delta^2_g$), environmental ($\delta^2_e$) variances, phenotypic and genotypic coefficient of variability, broad-sense heritability ($h^2_B$) and expected genetic advance (Gs %) for several faba bean characters.

| Character | Mean | $\delta^2_e$ | $\delta^2_{ph}$ | $\delta^2_g$ | PCV | GCV | ($h^2_B$) | Gs | Gs % |
|---|---|---|---|---|---|---|---|---|---|
| Days to maturity (days) | 156.3 | 1.11 | 53.66 | 48.22 | 4.69 | 4.44 | 89.86 | 11.59 | 7.41 |
| Plant height (cm) | 75.81 | 4.30 | 74.38 | 12.37 | 11.38 | 4.64 | 16.63 | 2.52 | 3.33 |
| No. of pods/plant | 24.07 | 2.25 | 18.82 | 10.88 | 18.02 | 13.70 | 57.79 | 4.41 | 18.33 |
| No. of seeds/plant | 55.97 | 35.07 | 152.44 | 101.64 | 22.06 | 18.01 | 66.67 | 14.49 | 25.89 |
| 100-seed weight (g) | 79.23 | 6.08 | 162.22 | 156.14 | 16.08 | 15.77 | 69.25 | 21.58 | 27.23 |
| Seed weight/plant (g) | 39.69 | 12.55 | 104.66 | 68.19 | 25.78 | 20.81 | 65.15 | 11.73 | 29.56 |
| Biological yield (t/ha) | 7.47 | 0.22 | 1.64 | 0.75 | 17.16 | 11.63 | 45.92 | 1.01 | 13.87 |
| Seed yield (t/ha) | 2.76 | 0.03 | 0.38 | 0.33 | 22.21 | 20.91 | 88.62 | 0.96 | 34.64 |

Therefore, selection for these traits would be effective and satisfactory for successful breeding purposes. These results are in conformity with those of Abdalla (1976), Abul-Naas *et al* (1991), EL-Hosary and Sedhom (1990), El-Hady *et al* (1997 &1998) and El-Hifny *et al* (2001).

The phenotypic correlation coefficients among all possible pairs of important traits are presented in Table (4). Results suggesting that seed yield (t/ha) was significantly positively correlated with each of plant height, 100-seed weight, seed weight/plant and biological yield (t/ha) and negatively correlated with maturity date, respectively. Moreover, biological yield (t/ha) was significantly positively correlated with each of plant height and seed weight/plant. Furthermore, seed weight/plant was significantly positively correlated with plant height, number of pods and seeds/plant. Meanwhile, number of seeds/plant was significantly positively correlated with number of pods/plant. However, number of pods/plant was significantly negatively correlated with maturity date. Finally, days to maturity was significantly negatively correlated with plant height. These results are in harmony with those reported by Bond (1966), Rowlands (1955), Huang *et al* (1983), Sindhu *et al* (1985), Bakheit and Mahdy (1988) and El-Hady *et al* (1991). Other studies reported differing correlations (see Abdalla 1976 and Abdalla *et al* 2001). Moreover, the relationship between seed yield and its components would be of considerable value to breeders for screening breeding materials and selecting donor parents for breeding programs.

**Table 4. Estimates of phenotypic correlation coefficient among all possible pairs of several faba bean characters (combined data of 2001/2002 and 2002/2003 seasons #).**

| Characters | Maturity date | Plant height (cm) | No. Pods/plant | No. Seeds/plant | 100-Seed weight (g) | Seed weight / plant (g) | Biological yield (t/ha) |
|---|---|---|---|---|---|---|---|
| Plant height (cm) | -0.441** | | | | | | |
| No. Pods/plant | -0.449** | 0.221 | | | | | |
| No. Seeds/plant | -0.392* | 0.212 | 0.714** | | | | |
| 100-Seed weight (g) | 0.440** | 0.230 | -0.333* | -0.228 | | | |
| Seed weight/plant (g) | -0.182 | 0.342* | 0.376* | 0.758** | 0.305 | | |
| Biological yield (t/ha) | -0.309 | 0.545** | -0.045 | 0.023 | 0.313 | 0.414* | |
| Seed yield (t/ha) | -0.385* | 0.545** | 0.311 | 0.277 | 0.387* | 0.527** | 0.577** |

# df = 36

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# أداء بعض سلالات حديثة التربية من الفول البلدى للمحصول

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ص.ب: ٢٤٦٠ الرياض ١١٤٥١ المملكة العربية السعودية

أقيمت تجربتان حقليتان بمحطة الأبحاث والتجارب الزراعية بديراب-كلية علوم الأغذية والزراعة جامعة الملك سعود-الرياض-المملكة العربية السعودية وذلك خلال الموسمين الزراعيين ٢٠٠١/٢٠٠٢، ٢٠٠٢/٢٠٠٣م لتقييم ثمان عشرة سلالة مقارنة بالصنف جيزة ٣. أظهرت النتائج المتحصل عليها اختلافات معنوية بين السلالات المختبرة لكل الصفات المدروسة. كانت قيم تفاعل التراكيب الوراثية X السنوات معنوية لكل الصفات فيما عدا وزن ١٠٠ بذرة ومحصول البذرة (طن/هكتار). كما أظهرت النتائج ان السلالة ١ تليها السلالات رقم ٤، ٥، ٦ كانت الأعلى فى محصول البذرة حيث سجلت ٣,٧٠، ٣,٥٥، ٣,٤٦، ٣,٢٩ (طن/هكتار) على الترتيب. تم تقدير التباين المظهرى والوراثى والبيئى وكذلك معامل الاختلاف المظهرى والوراثى ودرجة التوريث والتحسين المتوقع من الانتخاب للمحصول وبعض الصفات المتعلقة به.

أوضحت النتائج وجود ارتباط معنوى وبقيم موجبة بين المحصول البذرة للهكتار وارتفاع النبات ووزن الـ ١٠٠ بذرة ومحصول البذور للنبات والمحصول البيولوجى للهكتار بينما كان الارتباط معنوى سالب مع تاريخ ميعاد النضج. وعلاوة على ذلك كان الارتباط بين صفة محصول البذور ومكوناته ذو قيم معقولة للمربى للبحث عن تراكيب وراثية مرغوبة يمكن استغلالها كآباء وإدخالها فى برامج التربية والتهجين.

*المجلة المصرية لتربية النبات ٨: ١٨٩-٢٠٠ (٢٠٠٤)*