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# GENERATION MEAN ANALYSIS OF YIELD AND SOME OF ITS COMPONENTS IN FABA BEAN (*Vicia faba* L.)

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## ABSTRACT

The genetic parameters controlling the expression of seed yield and some of its components have been studied using generation mean analysis in three faba bean crosses namely; C. 6/1148/94 x Giza 3/6/25,C. 8/1156/94 x Giza 3/6/25 and C. 9/1172/94 x Giza 3/6/25. Six populations of in each cross; $P_1$, $P_2$, $F_1$, $F_2$, $BC_1$ and $BC_2$ were used in this concern, to estimate additive (a), dominance (d) and (aa), (ad) and (dd) types of epistasis according to Gamble's method (1962).

Significant additive gene effects were found for plant height (cm) in all crosses, seed yield/plant in the second and third cross and 100-seed weight (g) in the third cross, indicting that selection after each generation of selfing would be effective with such traits. On the other hand, the dominance effects were significant and higher in magnitude than additive ones for plant height (cm) in the first and second cross, number of branches/plant and 100-seed weight (g) in the third cross and number of pods and seeds/plant in the second cross, indicating the possibility to increasing yield performance via breeding procedure which emphasizes the dominance gene effects. Significant (aa) and (dd) types of epistasis were found to be accompanied by the significance of either $F_2$ deviation ($E_1$) or backcross deviations ($E_2$) for plant height (cm), number of branches/plant and 100-seed weight (g) in the third cross.

Significant positive mid and better parental heterosis were found for plant height (cm) in first and second cross, number of pods/plant and 100-seed weight (g) in all crosses, and seed yield/plant (g) in the second and third cross, due to overdominance. Inbreeding depression values were significant for plant height (cm) in first and second cross, and number of pods and seeds/plant and seed yield/plant (g) in the second and third cross. Relatively high genetic gain upon selection was found to be associated with moderate narrow-sense heritability ($h^2$) values and relatively high estimates of GCV% for number of pods and seeds and seed yield/plant (g) of the third cross plants, indicating the effective of selection for these traits of the cross.

## INTRODUCTION

Faba bean crop has attracted the attention of most plant breeders to improve its yield because of the importance of the crop for both human and animal nutrition. Most of breeding programs are planed assuming the absence or decrease of epistatic gene effects. Gamble (1962) reported that epistatic gene effects are present in sufficient magnitude in quantitative traits which may be alter the breeders account for the breeding method which must be followed. For example, if the additive genetic variance is of major importance, the intra-population selection will be considered as the most effective procedure for gathering the favorable genetic constitutions. If dominant variance especially overdominance is predominant, then the hybrids program for commercial purpose may be the appropriate choice. On the other hand, if the epistatic variance is relatively high, more reliance should be placed on selection between families.

Therefore, the estimation of gene action and the inheritance of the traits especially seed yield/plant (g) is an interesting procedure for the breeders in order to formulate the most efficient breeding methods to bring about the maximum improvement of the attribute in question.

The aim of the present study is to elucidate the relative magnitudes of the different types of gene action for yield and some of its components of faba bean. Heterosis, inbreeding depression and genetic advance were the another objective discussed in this study.

## MATERIALS AND METHODS

The present investigation was carried out during the successive seasons of 1999/2000, 2000/2001 and 20001/2002. four faba bean (*Vicia faba* L.). Stocks namely; Giza 3/6/25, C. 6/1148/94, C. 8/1156/94 and C. 9/1182/94 were used to generate the experimental materials for this study. The three initial crosses; C. 6/1148/94 x Giza 3/6/25, C. 8/1156/94 x Giza 3/6/25 and C. 9/1172/94 x Giza 3/6/25 are designated in the text as first, second and third cross, respectively.

The original crosses were developed in 1999/2000 season under the isolation wirecages of Sakha Agriculture Research Station, Kafr El-Sheikh. In 2000/2001 season $F_1$ plants were selfed and backcrossed to each parent under the same wirecages to obtain the $F_2$, $BC_1$ and $BC_2$ for each cross. The resultant six populations; $P_1$, $P_2$, $F_1$, $F_2$, $BC_1$ and $BC_2$ were sown in an experiment for each cross at the Experimental Farm, Sakha Agriculture Research Station during 2001/2002 season.

Each experiment consisted of two ridges for each parent and $F_1$'s three ridges for $BC_1$ and $BC_2$ and ten ridges for $F_2$ plants. Sowing took place on one side of 3 m long ridge, 60 cm wide with double seeded hills of 20 cm. apart. All cultural practices were maintained at optimum levels for maximum faba bean productivity.

With respect to data, seed yield/plant (g) and its components were recorded on individual guarded plants for plant height (cm) number of branches/plant, number of pods/plant, number of seeds/plant, seed yield/plant (g) number of seeds/pod and 100-seed weight (g).

**Statistical analysis:**

A one-tail F ratio was calculated to test the significance of the $F_2$ variance ($VF_2$) from the environmental variance (Ve) as follows:

$$F = VF_2/Ve$$

The environmental variance (Ve) was estimated according to Mansur *et al.* (1993) as follows:

$$Ve = n^{-1}_e (n_{P1} V_{P1} + n_{P2} V_{P2} + n_{F1} V_{F1}),\ Vg = V_{F2} - Ve,$$

**where:** $Ne = n_{P1} + n_{P2} + n_{F1}$ and $n_{P1}$, $n_{P2}$ and $n_{F1}$ are the number of plants in the $P_1$, $P_2$ and $F_1$ generation in each cross, respectively.

If the F-ratio was significant, Mahter's procedure (1949) was used to calculated the components of the genetic variance.

The six generation means in each cross were used to estimate six parameters for gene effects, using the relationships given by Gamble (1962) namely; main effects (m), additive (a), dominance (d) and the three digenic types of epistasis; (aa), (ad) and (dd).

The significant of the three effects were tested by t-test:

t = effect/variance of effect,

where the variance of an effect is a linear function of the variance of its mean.

To determine the relative contribution of epistatic gene effects in the performance of the trait (s) in the question, $F_2$-deviation ($E_1$) and backcross deviation ($E_2$) were measured as suggested by Mather and Jinks (1971), where:

$$E_1 = \bar{F}_2 - 1/2\ \bar{F}_1 - 1/4\ \bar{P}_1 - 1/4\ \bar{P}_2$$

$$S.E\ (E_1) = [V_2\bar{F} + 1/4\ V\bar{F}_1 + 1/16\ V\bar{P}_1 + 1/16\ V\bar{P}_2]^{1/2}$$

$$E_2 = BC_1 + BC_2 - \bar{F}_1 - 1/2\ \bar{P}_1 - 1/2\ \bar{P}_2$$

$$S.E\ (E_2) = [VBC_1 + VBC_2 + V\bar{F}_1 + 1/4\ V\bar{P}_1 + 1/4\ V\bar{P}_2]^{1/2}$$

Heterosis and inbreeding depression were determined according to Mather and Jinks (1971).

Potence ratio was calculated according to Wigan (1944) and Mather and Jinks (1971).

The genotypic coefficient of variation (GCV%) was estimated as the formulae developed by Burton (1952). Broad-sense heritability ($H^2$) for $F_2$ *generation* was estimated according to Mansur *et al.* (1993). Narrow-sense heritability ($h^2$) for $F_2$ generation was calculated as proposed by Warner (1952).

The expected genetic advance from selection ($G_a$) was calculated as *the formulae proposed by Johnson et al. (1955), using the selection* differential (K) equal 2.06 for 5% selection intensity and heritability in narrow-sense.

Genetic advance as percentage of $F_2$ mean ($G_a$%) was calculated following Miller *et al.* (1958).

## RESULTS AND DISCUSSION

The data shown in Table (1) revealed that the differences between each two parents were found to be, at least, significant for all studied traits in the three crosses, except number of pods, seeds/plant and seeds/pod in the first and second cross *where the differences were not significant. On the* other hand, the genetic variance within $F_2$ population was also found to be significant for all traits in all crosses. Consequently, the genetic parameters needed in this concern were calculated.

The estimated mean effect parameter (m), which reflects the contribution due to overall mean plus the locus effect and interaction of the fixed loci, was found to be highly significant for all traits in the three crosses (Table 2). Additive gene effects were found to be significant for plant height (cm) in all crosses, seed yield/plant (g) in the second and third cross and 100-

seed weight (g) in the third cross, the relative of some these effects to the mean effects were higher in magnitude than for the dominance one, especially for seed yield/plant (g) in second and third cross. This would indicate that the additive gene effects were more important in the inheritance of these traits. However, Saleh and Gitton (1994) reported that maximum utilization of additive effects could be obtained by selection after each generation of selfing.

**Table (1): Number of plants, population mean and mean variance of cross I, cross II and cross III for the studied faba bean traits.**

| Traits | Statistics | Cross I population | | | | | |
|---|---|---|---|---|---|---|---|
| | | $P_1$ | $P_2$ | $F_1$ | $F_2$ | $BC_1$ | $BC_2$ |
| Plant height (cm) | n | 30 0 | 30.0 | 30.0 | 150.0 | 40.0 | 40.0 |
| | $\bar{X}$ | 121.33 | 105.00 | 128.17 | 119.50 | 122.75 | 116.75 |
| | $S^2_x$ | 1.793 | 2.084 | 2.008 | 1.040 | 2.386 | 3.141 |
| No. of branches/ plant | n | 30.0 | 30.0 | 30.0 | 150.0 | 40.0 | 40.0 |
| | $\bar{X}$ | 3.87 | 2.73 | 4.20 | 4.00 | 3 98 | 3.45 |
| | $S^2_x$ | 0.035 | 0.034 | 0.036 | 0.021 | 0.051 | 0.067 |
| No. of pods/ plant | n | 30.0 | 30.0 | 30.0 | 150.0 | 40.0 | 40.0 |
| | $\bar{X}$ | 20.57 | 19.50 | 24.95 | 22.77 | 21.08 | 20.77 |
| | $S^2_x$ | 1.650 | 1.606 | 1.843 | 0.964 | 2.990 | 2.496 |
| No. of seeds/ plant | n | 30.0 | 30.0 | 30.0 | 150.0 | 40.0 | 40.0 |
| | $\bar{X}$ | 61.30 | 55.50 | 70.25 | 61.30 | 66.74 | 58.50 |
| | $S^2_x$ | 11.090 | 16.480 | 23.455 | 7.134 | 18.123 | 23.390 |
| Seed yield (g)/plant | n | 30.0 | 30.0 | 30.0 | 150.0 | 40.0 | 40.0 |
| | $\bar{X}$ | 52.44 | 41.84 | 59.99 | 55.92 | 60.21 | 52.05 |
| | $S^2_x$ | 12.924 | 12.445 | 16.149 | 7.335 | 19.11 | 22.795 |
| No. of seeds/ pods | n | 30.0 | 30.0 | 30.0 | 150.0 | 40.0 | 40.0 |
| | $\bar{X}$ | 2.98 | 2.85 | 3.02 | 2.69 | 3.12 | 2.88 |
| | $S^2_x$ | 0.007 | 0.006 | 0.011 | 0.005 | 0.012 | 0.014 |
| 100 seed weight (g) | n | 30.0 | 30.0 | 30.0 | 150.0 | 40.0 | 40 0 |
| | $\bar{X}$ | 85.55 | 75.39 | 95.40 | 91.22 | 90.22 | 88.97 |
| | $S^2_x$ | 1.82 | 2.401 | 3.984 | 1.994 | 4.761 | 5.621 |
| | | Cross II population | | | | | |
| Plant height (cm) | n | 30.0 | 30.0 | 30.0 | 150.0 | 40.0 | 40.0 |
| | $\bar{X}$ | 122.83 | 110.00 | 126.50 | 116.63 | 124.88 | 115.88 |
| | $S^2_x$ | 1.763 | 1.851 | 1.871 | 1.186 | 2.958 | 3.245 |
| No. of branches/ plant | n | 30.0 | 30.0 | 30.0 | 150.0 | 40.0 | 40.00 |
| | $\bar{X}$ | 3.23 | 2.80 | 3.37 | 3.19 | 3 13 | 3.00 |
| | $S^2_x$ | 0.034 | 0.030 | 0.041 | 0.014 | 0 046 | 0.041 |
| No. of pods/ plant | n | 30.0 | 30.0 | 30.0 | 150.0 | 40.0 | 40.0 |
| | $\bar{X}$ | 20.07 | 19.38 | 25.70 | 20.80 | 23.60 | 21.78 |
| | $S^2_x$ | 1.855 | 1.605 | 1.754 | 1.080 | 2.973 | 2.710 |
| No. of seeds/ plant | n | 30.0 | 30.0 | 30.0 | 150.0 | 40.0 | 40.0 |
| | $\bar{X}$ | 56.97 | 54.50 | 71.40 | 58.69 | 68.45 | 59 88 |
| | $S^2_x$ | 7.845 | 9.805 | 9.338 | 4.801 | 13.716 | 13.554 |
| Seed yield (g)/plant | n | 30.0 | 30.0 | 30.0 | 150.0 | 40.0 | 40.0 |
| | $\bar{X}$ | 56.02 | 40.84 | 68.16 | 60.85 | 61.89 | 51.90 |
| | $S^2_x$ | 5.033 | 5.778 | 4.790 | 4.028 | 12.071 | 11.477 |
| No. of seeds/ pods | n | 30.0 | 30.0 | 30.0 | 150.0 | 40.0 | 40.0 |
| | $\bar{X}$ | 2.83 | 2.81 | 2.78 | 2.87 | 2.82 | 2.75 |
| | $S^2_x$ | 0.003 | 0.002 | 0.003 | 0.002 | 0.005 | 0.006 |
| 100 seed weight (g) | n | 30.0 | 30.0 | 30.0 | 150.0 | 40.0 | 40.0 |
| | $\bar{X}$ | 98.40 | 74.93 | 94.35 | 96.29 | 91.50 | 96.03 |
| | $S^2_x$ | 1.843 | 1.934 | 1.942 | 1.734 | 4.890 | 3.762 |

**Table (1) cont.**

| | | Cross III population | | | | | |
|---|---|---|---|---|---|---|---|
| | | $P_1$ | $P_2$ | $F_1$ | $F_2$ | $BC_1$ | $BC_2$ |
| Plant height (cm) | n | 30.0 | 30.0 | 30.0 | 150.0 | 40.0 | 40.0 |
| | X | 119.83 | 108.56 | 121.50 | 118.83 | 120.88 | 109.63 |
| | $S^2_x$ | 2.120 | 2.184 | 1.905 | 0.909 | 2.945 | 0.923 |
| No. of branches/ plant | n | 30.0 | 30.0 | 30.0 | 150.0 | 40.0 | 40.0 |
| | X | 4.03 | 2.70 | 3.33 | 3.56 | 3.23 | 2.82 |
| | $S^2_x$ | 0.018 | 0.019 | 0 020 | 0.013 | 0.036 | 0.020 |
| No. of pods/ plant | n | 30.0 | 30.0 | 30.0 | 150.0 | 40.0 | 40.0 |
| | X | 26.97 | 20.45 | 29.43 | 23.44 | 25.23 | 22.30 |
| | $S^2_x$ | 0.695 | 0.706 | 0.741 | 0.591 | 1.512 | 1.178 |
| No. of seeds/ plant | n | 30.0 | 30.0 | 30.0 | 150.0 | 40 0 | 40.0 |
| | X | 66.90 | 59.75 | 71.53 | 65.29 | 68.88 | 52.99 |
| | $S^2_x$ | 3.977 | 4.480 | 4.782 | 4.437 | 14.158 | 8.113 |
| Seed yield (g)/plant | n | 30.0 | 30.0 | 30.0 | 150.0 | 40.0 | 40.0 |
| | X | 61.30 | 45.84 | 68.89 | 61.91 | 65.67 | 52.99 |
| | $S^2_x$ | 5.756 | 6.533 | 6.475 | 5.266 | 13.788 | 8.374 |
| No. of seeds/ pods | n | 30.0 | 30.0 | 30.0 | 150.0 | 40.0 | 40.0 |
| | X | 2.48 | 2.92 | 2.43 | 2.79 | 2.73 | 2.89 |
| | $S^2_x$ | 0.004 | 0.006 | 0.003 | 0.014 | 0.036 | 0.002 |
| 100 seed weight (g) | n | 30.0 | 30.0 | 30.0 | 150.0 | 40.0 | 40.0 |
| | X | 91.22 | 76.71 | 96.31 | 95.82 | 95.33 | 82.22 |
| | $S^2_x$ | 2.085 | 1.734 | 2.395 | 1.505 | 4.567 | 0.779 |

On the other hand, the dominance gene effects were found to be significant for plant height (cm) of the first and second cross, number of branches/plant of the third cross plants, number of pods and seeds/plant in the second cross, number of seeds/pod in the first cross and 100-seed weight (g) in the third cross. The contribution of these effects to the mean effects were higher in magnitude than for the additive one, indicating that the dominance played an important role in the inheritance of these traits. Similar results were detected in faba bean by Elliot and Whihington (1979), El-Hosary (1981 and 1983), El-Refaey (1987), Henaway (1994a) and b) and El-Refaey (1998 and 1999).

The $F_2$ mean value would be expected to be intermediate between mid-parent and $F_1$ value. If epistasis is present, it could be cause of $F_2$ deviation from the expected value which expressed as ($E_1$). Also, when no epistasis is assumed, backcross performance would be expected to be near the average of $F_1$ and recurrent parent performance. Appreciable deviation from this expected value ($E_2$) will be observed if epistasis is found (Table 2).

However, the digenic types of epistasis, i.e., (aa) and (dd) were found to be significant for plant height (cm), number of branches/plant and 100-seed weight (g) in the third cross. In most cases, the presence of these two types of epistasis were accompanied by the significance of either $F_2$ deviation ($E_1$) or backcross deviations ($E_2$). This would indicate that the epistatic gene effects are important in the basis genetic mechanisms of these traits in the cross refered.

It could be, also, observed that dominance x dominance (dd) type of gene actions were relatively more important than the dominance effects, moreover, the (dd) gene effects are mostly positive indicating an enhancing effects on performance of the trait (s) in question, while the (aa) gene effects

**Tabls (2): Estimates of $F_2$-deviation ($E_1$), backcross deviation ($E_2$), types of gene action using generation mean analysis of three faba bean crosses for the studied traits.**

| Traits | Cross | $E_1$ | $E_2$ | Gene action six parameters (Gamble procedure) | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | m | a | d | aa | ad | dd |
| Plant height (cm) | I | -1.17 | -1.83 | 119.50** | 6.00* | 16.00* | 1.00 | -2.17 | 2.66 |
| | II | -4.83* | -2.16 | 116.63** | 9.00** | 25.08** | 15.00* | 2.58 | -10.69 |
| | III | 0.98 | -5.19* | 118.83** | 11.25** | -7.00 | -14.30** | 5.61* | 24.67** |
| No. of branches/ plant | I | 0.25 | -0.07 | 4.00** | 0.53 | -0.24 | -1.14 | -0.04 | 1.28 |
| | II | -0.01 | -0.26 | 3.19** | 0.13 | -0.15 | -0.50 | -0.09 | 1.01 |
| | III | 0.21 | -0.65* | 3.56** | 0.40 | -2.18** | -2.15** | -0.26 | 3.46** |
| No. of pods/plant | I | 0.28 | -3.14 | 22.77** | 0.31 | -2.49 | -7.40 | -0.23 | 13.68 |
| | II | -1.91 | -0.04 | 20.80** | 1.82 | 13.54* | 7.56 | 1.48 | -7.47 |
| | III | -3.13** | -5.61** | 23.44** | 2.93 | 7.02 | 1.30 | -0.33 | 9.92 |
| No. of seeds/plant | I | -303 | -3.41 | 61.30** | 8.24 | 17.13 | 5.28 | 5.34 | 1.54 |
| | II | -4.88 | 1.020 | 58.69** | 8.57 | 37.57** | 21.00 | 7.34 | -24.29 |
| | III | -2.14 | -1.53 | 65.29** | 4.43 | 13.71 | 5.50 | 0.86 | -2.45 |
| Seed yield (g)/plant | I | 2.36 | 5.13 | 55.92** | 8.16 | 13.69 | 0.84 | 2.86 | -11.10 |
| | II | 2.58 | -2.74 | 60.85** | 9.999* | 3.87 | -15.8 | 2.40 | 21.28 |
| | III | 0.75 | -3.66 | 61.91** | 12.68** | 5.14 | -10.32 | 5 08 | 17.65 |
| No. of Seeds/pod | I | 3.29** | 3.32** | 91.22** | 1.25 | 8.43** | -6.50** | -3.83 | -0.14 |
| | II | 5.78** | 6.51** | 96.29** | -4.53 | -2.42 | -10.11 | -16.27 | -2.91 |
| | III | 5.68** | -2.72** | 95.82** | 13.11 | -15.84 | -28.18 | 5.86 | 33.63 |
| 100-seed weight (g) | I | -0.28 | 0.06 | 2.69** | 0.24 | 1.34 | 1.23 | 0.17 | -1.36 |
| | II | 0.07 | -0.03 | 2.87** | 0.07 | -0.38 | -0.34 | 0.06** | 0.40 |
| | III | 0.23 | 0.49 | 2.79** | -0.16** | -0.19* | 0.08** | 0.06* | -1.06** |

are mostly negative giving a diminishing effect which apparently are an undesirable form of epistasis.

However, the additive x dominance (ad) type of epistasis seems to be less contributor in the inheritance of the studied traits, except plant height (cm) in the third cross and 100-seed weight (g) in the second and their cross. These results are in agreement with those reported in faba bean by Bond (1966), El-Hosary (1981 and 1983), Mahmoud *et al.* (1984), Hendawy (1994a and b) and El-Refaey (1998 and 1999).

Significant and/or highly significant positive heterosis over mid and better parent were found for plant height (cm) in the first and second cross, number of pods/plant in all crosses, number of seeds/plant in the second cross, seed yield/plant (g) in the second and third cross, number of seeds/pod in the third cross and 100-seed weight (g) in all studied crosses. In all cases the heterotic effects were due to overdominance ($P > +1$), except one case, i.e., 100-seed weight (g) in the second cross, where the heterotic effect was due to partial dominance as pointed out in Table (3). However, the results illustrated the important of epistasis as well as dominance gene effects in the expression of the heterosis found in the present materials. Generally. Jinko and Jones (1958) considered that dominance and epistatic gene effects as a major source of heterosis.

The results shown in Table (3) indicating that the inbreeding depression values were significant for plant height (cm) in the first and second cross, number of pods and seeds/plant and seed yield/plant (g) in the second and third cross, and number of seeds/pod in the first cross. The results of heterosis and inbreeding depression were supported by similar findings reported by Abdalla (1977), El-Hosary (1983), Bargale and Billore (1990), El-Refaey and Radi (1991b), Hendawy (1994 a and b), Melchinger *et al.* (1994), El-Galaly (1997) and El-Refaey (1998 and 1999).

However, both heterosis and inbreeding depression share a similar phenomenon .Therefore, its logical to predict that heterosis in the $F_1$ will be followed by an appreciable reduction in $F_2$ performance. In most cases, the obtained results were in good agreement with this prediction.

Estimates of coefficient of genetic variation (GCV%) were relatively low for plant height (cm) and 100-seed weight (g) in all crosses and number of seeds/pod in the first and second cross, while moderate estimates were obtained for number of branches/plant. However, high values of (GCV%) were found for both numbers of pods and seeds/plant and seed yield/plant (g). Heritability values in broad-sense ($H^2$) were relatively high for number of branches/plant, number of pods and seeds/plant in the third cross, seed yield/plant (g) and number of seeds/pod in the first and second cross and 100-seed weight (g) in all crosses. Moreover, the values of heritability in broad-sense ($H^2$) were in general higher than the corresponding values in narrow-sense ($h^2$) in all crosses for all studied traits, and the crosses differed from one to another in their estimated values of $H^2$ and $h^2$. El-Hosary (1983), El-Refaey (1987), Ramging (1997) and El-Refaey (1998 and 1999).

Swarup and Changale (1962) reported that it is impossible to estimate the magnitude of heritable variation, when GCV% is used alone. The heritable portion of the variation could be figured out with help of other

**Table (3):** Estimates of mid ($\overline{MP}$) and better ($\overline{BP}$) parental heterosis, potence ratio (P), inbreeding depration (ID%), heretability in broad sense ($H^2$) and narrow sense ($h^2$), expected ($\Delta g$) and predicted ($\Delta g\%$) genetic advance and genotypic coefficient of variation (GCV%) of three faba bean crosses for the studied traits.

| Traits | Cross | Heterosiss (%) | | P | ID (%) | Heretability (%) | | Genetic advance | | G.C.V. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $\overline{MP}$ | $\overline{BP}$ | | | $H^2$ | $h^2$ | $\Delta g$ | $\Delta g$ % | % |
| Plant height | I | 13.26** | 5.63** | 1.84 | 6.76** | 62.27 | 58.26 | 14.9 | 12.54 | 87.25 |
| | II | 8.66** | 2.99* | 1.57 | 7.80** | 69.18 | 60.58 | 16.65 | 14.27 | 9.51 |
| | III | 6.40** | 1.39 | 1.30 | 2.20 | 54.48 | 34.49 | 8.30 | 6.98 | 7.25 |
| No. of branches/ plant | I | 27.21** | 8.53 | 1.58 | 4.76 | 66.02 | 47.25 | 1.71 | 42.77 | 35.71 |
| | II | 11.60 | 4.12 | 1.62 | 5.35 | 51.16 | 37.41 | 1.13 | 35.46 | 32.91 |
| | III | -1.04 | -17.36** | -0.05 | -6.80 | 70.90 | 57.87 | 1.67 | 47.00 | 33.20 |
| No. of pods/plant | I | 4.54** | 21.31** | 9.22 | 8.72 | 64.76 | 48.31 | 11.97 | 52.56 | 42.50 |
| | II | 30.30** | 28.07** | 17.41 | 19.07** | 67.81 | 59.70 | 15.65 | 75.26 | 50.39 |
| | III | 24.13** | 9.13* | 1.76 | 20.35** | 75.81 | 55.92 | 10.84 | 46.25 | 34.96 |
| No. of seeds/plant | I | 20.29* | 14.60 | 4.09 | 12.74 | 52.32 | 44.83 | 30.21 | 49.28 | 38.60 |
| | II | 28.11** | 25.34** | 12.70 | 17.80** | 62.52 | 48.54 | 26.83 | 45.72 | 36.16 |
| | III | 12.96** | 6.92 | 2.30 | 8.72* | 80.17 | 45.11 | 23.98 | 36.72 | 35.38 |
| Seed yield (g)/plant | I | 27.26** | 14.39 | 2.42 | 6.78 | 62.27 | 47.33 | 32.34 | 57.84 | 46.81 |
| | II | 40.62** | 21.57** | 2.59 | 10.65* | 74.18 | 44.11 | 22.33 | 36.70 | 34.79 |
| | III | 28.92** | 12.88* | 2.03 | 10.13* | 76.24 | 57.41 | 33.24 | 53.69 | 39.64 |
| No. of seeds/pod | I | 3.60 | 1.34 | 1.62 | 10.93** | 66.67 | 54.29 | 0.94 | 34.78 | 25.40 |
| | II | -1.42 | -1.77 | 4.00 | -3.24 | 72.22 | 56.67 | 0.64 | 22.28 | 16.22 |
| | III | -10.00** | -16.78** | -1.23 | -14.81** | 93.90 | 52.38 | 1.6 | 56.05 | 50.33 |
| 100-seed weight (g) | I | 18.55** | 11.51** | 2.94 | 4.38 | 72.57 | 61.15 | 21.79 | 23.88 | 16.15 |
| | II | 8.87** | -4.12* | 0.65 | -2.05 | 78.01 | 66.94 | 22.24 | 23.10 | 14.79 |
| | III | 14.740** | 5.58** | 1.70 | 0.51 | 72.48 | 52.15 | 16.14 | 16.85 | 13.35 |

heritability and the genetic advance Moreover, Dixit *et al.* (1970) pointed out that high heritability is not always associated with high genetic advance, but in order to make effective selection, high heritability should be associated with *high genetic gain.*

From the above points of view, high genetic gain (Δg%) upon selecting the highest 5% of the $F_2$ population was found to be associated with relatively high narrow-sense heritability values and relatively high estimates of GCV% for number of branches/plant in the first and third cross, number of pods/plant in the second and third cross, seed yield/plant (g) and number of seeds/pod in the third cross. This might indicate that selection for these traits would be successful. Similar results were obtained by El-Refaey (1987), Dawwam and Abdel Aal (1991), El-Refaey and Radi (1991a), El-Refaey (1992), El-Refaey and El-Keredy (1992), Ramging (1997) and El-Refaey (1998 and 1999).

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## تحليل متوسطات الأجيال للمحصول وبعض مكوناته فى الفول البلدى

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**قسم بحوث المحاصيل البقولية – معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية**

أجريت هذه الدراسة خلال المواسم ١٩٩٩/٢٠٠٠ ، ٢٠٠٠/٢٠٠١ ، ٢٠٠١/٢٠٠٢م لتقدير طبيعة التأثير الجينى باستخدام كل من متوسطات الأجيال والتباين الوراثى وذلك لصفة المحصول وبعض مكوناته وقد استخدم لذلك أربعة أباء من الفول البلدى حيث تم عمل التهجينات بين الأباء أو التهجينات الرجعية بالصوبة السلكية بمزرعة محطة البحوث الزراعية بسخا – كفر الشيخ للحصول على ثلاثة هجن هى:

- الهجين الأول (C.6/1148/94 x Giza 3/6/25).
- الهجين الثانى (C.8/1156/94 x Giza 3/6/25).
- الهجين الثالث (C.9/1172/94 x Giza 3/6/25).

وتمت زراعة الأجيال المختلفة لكل هجين وهى الأبوين $P_1$, $P_2$ والجيل الأول $F_1$ ، والجيل الثانى $F_2$ والهجن الرجعية $BC_1$, $BC_2$ بمعدل خطين لكل من الأباء والجيل الأول ، ثلاثة خطوط لكل من الهجن الرجعية وعشرة خطوط للجيل الثاني حيث تمت الزراعة على ريشة واحدة بكل منها ١٥ جوره على مسافة ٢٠سم بين الجور مع وضع بذرتين بالجوره ويمكن تلخيص النتائج المتحصل عليها فيما يلي:

١- باستخدام طريقة (Gamble, 1962) لتقدير كل من التأثيرات الجينية المختلفة وجد أن كل من التأثيرين الوراثيين المضيف والسيادى لهما معنوية عالية لصفات طول النبات فى جمع الهجن ، محصول البذره للنبات فى الهجينين الثانى والثالث ووزن الـ ١٠٠ بذره فى الهجين الثالث مشيرا إلى أن الأنتخاب بعد كل جيل من أجيال التلقيح الذاتى سوف يكون فعالا لمثل هذه الصفات. وعلى الجانب الأخر ، كانت تأثيرات السيادة معنوية لصفة طول النبات فى الهجينين الأول والثانى . عدد الأفرع ووزن الـ ١٠٠ بذره فى الهجين الثالث وعدد القروق والبذور للنبات فى الهجين الثانى مما يدل على إمكانية زيادة المحصول باتباع أسلوب للتربية يعتمد على التأثيرات الجينية السيادية. هذا إلى جانب وجود معنوية لطرازين على الأقل من طرز التأثير الراجع للتفوق Epistatic effect وخاصة التأثير التفوقى المضيف × المضيف ، والتأثير التفوقى السيادى × السيادى واللذان يرتبطان بأحد الإنحرافين إما إنحراف الجيل الثانى ($E_1$) أو إنحرافات الهجن الرجعية ($E_2$) لصفات طول النبات وعدد الأفرع للنبات ووزن الـ ١٠٠ بذره فى الهجين الثالث.

٢- كانت قوة الهجين على اساس متوسط الأبوين أو الأب الأفضل معنوية وموجبة لصفة طول النبات فى الهجينين الأول والثانى ، عدد الفروع بالنبات ووزن الـ ١٠٠ بذره فى جميع الهجن ، محصول بذور النبات فى الهجينين الثانى والثالث وترجع قوة الهجن هذه إلى السيادة المتفوقة تجاه الأب الأعلى.

٣- وجد أن قيم التدهور الراجع إلى التربية الداخلية معنوية لصفة طول النبات فى الهجينين الأول والثاني ، وعدد القرون والبذور ومحصول البذره بالنبات فى الهجينين الثاني والثالث.

٤- تشير النتائج إلي الارتفاع النسبى للتحسين الوراثي المتوقع فى الجيل الثاني والذى يرتبط بالقيم المعتدلة للمكافئ الوراثى فى معناه المحدود والقيم العالية نسبيا لمعامل الاختلاف الوراثى وذلك لصفات عدد القرون والبذور ومحصول البذره بالنبات فى الهجين الثالث بما يشير إلى فاعلية الأنتخاب لهذه الصفات داخل نباتات هذا الهجن.