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# Diallel Analysis of Some Characters Among Five New Faba Bean Lines

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**Abstract:**

The genetic studies were carried out using diallel cross analysis among some new genotypes of faba bean. All characters studied showed the existence of significant genetic variation. Significant G.C.A. and S.C.A. effects for all characters were detected. Assiut 11/8 is a good general combiner for time to flowering, plant height, number of tillers per plant and number of dry pods per plant. Parent 2 (Assiut 12/1) is good general combiner for number of seeds per pod and weight of dry seeds per plant. On other hand parent 2 (Assiut 12/1), and both hybrids $P_1xP_4$ (Assiut 11/8 x Assiut 14/9) and $P_4xP_5$ (Assiut 14/9 x Assiut 15/4)produced dead plants.All $F_1$ hybrids showed 100% podded plants with invisible *Orobanche*, except three crosses ($P_1xP_4$, $P_1xP_5$ and $P_4xP_5$).

**Introduction:**

Faba bean (*Vicia faba* L.), is an annual and winter crop that belongs to the *Fabaceae* family. It is an important for human diet, which provides Egyptian consumers with cheap and high quality protein. During the past several years, faba bean showed considerable decrease in both area and production. While in 2004, its area was 252558 feddan and it became 215858 feddan in 2007 (14.5%).The total production was 2173151 ardab and decreased to 1946924 ardab in the same respective years (10.4%). The major problem of faba bean crop is low and unstable yield from season to season and farm to farm. This problem may be attributed to: a) the number of cultivated cultivars is very limited and characterized with low yield, b) cultivation in infested soils with *orobanche*, which cause extensive damage by reducing the yield of faba bean, between 5 and 100% (Sauerborn and Saxena, 1986).Over 30 years, the general breeding research program in Department of Horticulture, Faculty of Agriculture, Assiut University produced many new and promising faba bean lines. Several studies were carried out using diallel cross technique, combining ability, gene action and evaluation of traits in these new lines. [(Waly (1982), Abdel-Aal and Waly (1982) , Waly and Abdel-Aal (1986) ,

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Zayed (1995), Nassef (2000), Ahmed et al. (2001), Badawy (2003), Nassef (2005) and Zayed (2005).These studies confirmed that usage the diallel crosses technique and estimation of combining ability give the breeder an effective procedure to evaluate the breeding material and identify the most suitable parents that produce better hybrids and produce new cultivars which characterized with high yield (quantity and quality) and resistance to broomrape attack. Using the diallel crossing system in five parents of faba bean, Waly (1982) studied flowering time, tiller number, plant height, pod length, pod width, number of dry seeds per pod and weight of 100 seeds. Existence of very highly significant additive genetic variation and dominance were demonstrated in all characters. Zayed (2005) showed that resistance of vicia faba L. (var. major) to *orobanche crenata* infestation was conditioned by a complementary interaction of two dominant pairs of gene, while susceptibility was determined by a duplicate interaction of two recessive pairs of these genes. The present investigation was done in order to study the genetic systems controlling variation in growth, yield and quality characteristics of new breeding lines of faba bean using diallel crossing system.

**Materials and Methods**

The present work was conducted in a clay soil naturally infested with *Orobanche crenata* at the Experimental Farm of Faculty of Agriculture, Assiut during the winter seasons of 2005/2006 and 2006/2007. All faba bean breeding lines, which used in this study, were produced in research program Dept. of Horticulture, Assiut University (waly, E. A. and Abdel-Aal S.A. 1976- 2011).

**Experiment A.**

In 2005/2006 season, five faba bean breeding lines (parents) and the ten hybrids derived from them (5x5 diallel cross) were used in this experiment to study their genetic performance and to produce seeds of $F_2$ generation. The general characteristics of the five breeding lines used in the investigation were as follow:

| Lines | Plant height | Number of tillers | Time to flowering | Seed size |
|---|---|---|---|---|
| Assiut 11/8 ($P_1$) | Tall | Large | Early | Equine |
| Assiut 12/1 ($P_2$) | Medium | Medium | Medium | Equine |
| Assiut 13/6 ($P_3$) | Medium | Small | Medium | Equine |
| Assiut 14/9 ($P_4$) | Medium | Small | Late | Equine |
| Assiut 15/4 ($P_5$) | Short | Medium | Medium | Equine |

These materials were laid out in three replicates, each represented 10 plots of $F_1$ hybrids and 5 plots of parents. Each plot consisted of one row of 10 plants spaced 30 cm within 60 cm wide rows. Cultures practices for faba bean production in Assiut were applied (cultivation, irrigation, fertilization and pest and weed control) according to recommendations of Waly and Abdel-Aal (1992). Harvesting took place in April 2006.The following characters were recorded per plant :

1- Time to flowering, recorded as number of days from sowing to 50% of the plants bloom.
2- Plant height, in cm, was measured from the soil surface to the terminal bud of the main stem at ripeness stage (time of dry seed harvest).
3- Number of tillers per plant, counted also at time of dry seed harvest.
4- Number of dry pods per plant, at dry seed harvest, as total harvested pods per plant.
5- Weight of dry seeds per plant, in g, at dry seed harvest stage.
6- Distribution percentage of parents and $F_1$ plants under the infestation of *orobanche*. The ifeeted plants were classified as follows:-

a)Number of dead plants.

b)Number of survival podless plants.

c)Number of survival podded plants with visible spikes of *orobanche*.

d) Number of survival podded plants with invisible spikes of *orobanche*.

Experiment B.

$F_2$ generation of a 5x5 half diallel cross (2006/2007 season).The seeds of the ten $F_1$ hybrids were taken from experiment A and planted on October 19, 2006 in ten blocks with all plants spaced 30x60 cm. The following characters were recorded on 50-80 plants of each $F_2$ population:-

1- Plant height, in cm
2- Number of tillers per plant.
3- Number of dry pods per plant.
4- Weight of dry seeds per plant, g.
5- Distribution of infested $F_2$ plants of faba bean with *orobanche* at dry seed harvest. The infeeted host plants in the field were classified to:

a)Number of dead plants.

b)Number of survival podless plants.

c) Number of survival podded plants with visible spikes of *orobanche*.

d) Number of survival podded plants with invisible spikes of *orobanche*.

The data of each class were calculated as percentages.

Statistical analysis:

The genetic analyses were based on the method proposed by Griffing (1956b), method 2 model 1. Variance/Covariance (Vr/Wr) graphs were also prepared according to Jinks (1954).

**Results:**

**Experiment A (2005/2006 season)**The results of the studied characters in this experiment are presented in Tables (1, 2, 3, 4 and 5) and illustrated in Figure1.

**1-Time to flowering**

The mean of five parents values was 42 days with a range of individual value from 39 days to 46 days. Their 10 $F_1$ hybrids ranged from 39 days to 49 days, with a mean of 44.8 days (Table 1).The partitioning of the variance into additive (G.C.A.) and non-additive (S.C.A.) components, revealed the existence of additive and non-additive effects. However, the former was quite large in comparison with the latter indicating the predominant role of additive type of the genetic variance in the expression of this character. Also, the ranking of general combining ability effects (gi) and parental performance is similar indicating the predominant of additive genetic variance.The graphical analysis of the data is shown in Figure (1).

The regression line has the slope (b=0.698±0.241), which is significantly different from zero but not from unity indicating the expression of additive inheritance pattern. Also, the regression line cuts the Wr axis below its origin, indicating the presence of over-dominance for this character (Fig.1a).The estimated effects of G.C.A. of five parents and S.C.A. of their $F_1$ hybrids are given in Table (3 and 4). G.C.A. effects were significant in all parents. Parent 2 (Assiut 12/1), Parent 5 (Assiut 15/4) and Parent 4 (Assiut 14/9) showed significant positive G.C.A. effects for late flowering, while Parent 1(Assiut 11/8) and Parent 3 (Assiut 13/6) showed significant negative G.C.A. effects for early flowering.The S.C.A. effects were significant in seven hybrids. The crosses $P_1xP_4$ (Assiut 11/8 x Assiut 14/9), $P_2xP_4$ (Assiut 12/1 x Assiut 14/9), $P_2xP_5$ (Assiut 12/1 x Assiut 15/4 ), $P_3xP_4$ (Assiut 13/6 x Assiut 14/9) and $P_3xP_5$ (Assiut 13/6 x Assiut 15/4 ) showed significant positive S.C.A. effects for late flowering, while the crosses $P_1xP_5$ (Assiut 11/8 x Assiut 15/4) and $P_4xP_5$ (Assiut 14/9 x Assiut 15/4 ) showed significant negative S.C.A. effects for early flowering.

**2- Plant height**

In the 5x5 diallel, the mean of five parents was 85.2 cm with a range from 72.2 cm to 96.1 cm the mean of the $F_1$ hybrids was 91.6 cm, with a range from 56.6 cm to 113.3 cm Table (1).There are highly significant differences among the studied genotypes with respect to this character. Both G.C.A. and S.C.A. are significant, showing the existence of both additive and dominance effects. The mean square for G.C.A. is greater than that of S.C.A., indicating the predominance of additive type of genetic variance in the expression of plant height. In addition, the S.C.A. demonstrates that dominance of factors is also very important in the expression of plant

height (Table 2).The presentation of Vr/Wr graph is illustrated in Figure (1 b). The regression line (b=0.456±0.111) is significantly different from zero but not from unity, and the line cuts the Wr axis above the origin indicating partial dominance. G.C.A. effects are significant in three parents. One of these parents Parent 1(Assiut 11/8) showed significant positive G.C.A. effects. While, Parent 4 (Assiut 14/9) and Parent 5 (Assiut 15/4) showed significant negative G.C.A. effects for this trait. the S.C.A. effects are non-significant in all hybrids(Table 3 and 4).

**3-Number of tillers per plant**

The five parents ranged from 2.8 to 4.9 with a mean of 3.42. The $F_1$ hybrids ranged from 2.6 to 4.8 with a mean of 3.40 (Table1). There are highly significant differences among the studied genotypes with respect to this character. In the 5x5 diallel cross, both G.C.A. and S.C.A. are significant, showing the existence of both additive and dominance effects on the number of tillers (Table2).The regression line has a slope (b=0.720±0.247), which is not significantly different from zero. Also, the line cuts the Wr axis above the origin, indicating the presence of partial dominance in this character (Fig.1c).The G.C.A. effects are highly significant in four parents. Parent 1 (Assiut 11/8) showed significant positive G.C.A. effects for large number of tillers. While $P_2$ (Assiut 12/1), $P_3$ (Assiut 13/6) and $P_4$ (Assiut 14/9) showed significant negative G.C.A. effects for small number of tillers. The S.C.A. effects are significant and positive in two hybrids: $P_1xP_3$ (Assiut11/8 x Assiut 13/6) and $P_1xP_5$ (Assiut 11/8 x Assiut 15/4), but S.C.A. effects are significant and negative in three hybrids: $P_1xP_2$ (Assiut 11/8 x Assiut 12/1), $P_1xP_4$ (Assiut 11/8 x Assiut 14/9) and $P_2xP_3$ (Assiut 12/1 x Assiut 13/6).

**4-Number of dry pods per plant:**. The mean of five parents was 23.6 pods with a range from 20.4 pods to 27.1 pods. Their ten $F_1$ hybrids ranged from 7.3 pods to 47.8 pods with a mean value of 28.8 pods per plant (Table 1). Both the G.C.A. and S.C.A. are highly significant, showing the existence of both additive and dominance effects on number of dry pods per plant (Table 2). The regression slope (b=0.042±0.104) is not significant different from zero (Figure 1d).The scattering pattern of the different points of the parents for this trait revealed the presence of non-allelic gene interaction and is likely to be revealed by relatively large S.C.A. item. Parent 1 (Assiut 11/8), Parent 2 (Assiut 12/1), and Parent 3 (Assiut 13/6) showed significant positive G.C.A. effects for number of pods, while both Parent 4 (Assiut 14/9) and Parent 5 (Assiut 15/4) showed significant negative effect. The S.C.A. effects are significant in eight hybrids, four hybrids showed significant positive S.C.A. effects for this character. The cross $P_1xP_3$ (Assiut 11/8 x Assiut 13/6)

had maximum S.C.A. effects and the cross $P_2xP_5$ (Assiut 12/1 x Assiut 15/4) had minimum effects for number of dry pods per plant. $P_4xP_5$ (Assiut 14/9 x Assiut 15/4) showed high significant negative S.C.A. effect for this character (Table 3 and 4).

**5-Weight of dry seeds per plant**

The mean parental value is 40.1 g, with a range from 26.8 to 54.4 g. The corresponding set of $F_1$ hybrids had a mean value of 48.4, and ranged from 16.4 g to 73.6 g indicating the existence of hybrid vigor (Table 1). Both

G.C.A. and S.C.A. are highly significant showing the existence of both additive and dominance effects. Because of the magnitude of the G.C.A. item it may be concluded, that additive effect is very important in the expression of this character (Table 2).

The graphical analysis of the data is shown in Figure (1e). The regression not from unity indicating the expression of additive inheritance pattern. Also the line cuts the Wr axis below its origin, indicating some expression of overdominance of factors for this character.The estimated effects G.C.A., of the parental lines and S.C.A., S.C.A. of hybrids are given in Table (3 and 4). Only Parent 2 (Assiut 12/1) showed high significant positive, While Parent 4 (Assiut 14/9) and

Parent 5(Assiut 15/4) showed significant negative G.C.A. effects for this character.The S.C.A. effects are high significant positive in one hybrid $P_1xP_3$ (Assiut 11/8 x Assiut 13/6) and significant positive in another one hybrid $P_2xP_5$ (Assiut 12/1 x Assiut 15/4). All other hybrids showed non significant effects.

**6- Distribution of faba bean plants under the infestation conditions of *Orobanche***

The percentages for the distribution of faba bean plants of the five parents and 10 $F_1$ hybrids under the natural infestation of *Orobanche* are presented in Table (5). The dead plants percentage appeared only in parent Assiut 12/1 (10%) and two crosses Assiut 11/8xAssiut 14/9 (11%) and Assiut 14/9xAssiut 15/4 (10%). All others parents and crosses did not showed any dead plants.On the other hand, the podded plants with invisible *Orobanche* of parent3,Parent 4and parent 5 showed the (100%) followed by parent 2 (80%) and parent 1 (60%).

All $F_1$ hybrids showed 100% podded plants with invisible *Orobanche*, except, crosses $P_1xP_4$ (66%), $P_1xP_5$ (60%) and $P_4xP_5$ (90%).

**Experiment B(2006/2007 season).** The data of characters of the ten studied F2 families was presented in Table (6).

**1- Plant height**.

The data indicated that plants of family (2x3) gave highest mean value of plant height (142.9cm) and plants of family 4x5 gave the lowest mean value (98.2cm). On the other hand, the best segregation (in height) was obtained from family 1x3 and 2x3 (180cm).

**2- Number of tillers per plant.** The plants of family 1x5 recorded the highest mean value of tillers (4.7 tillers). While, plants of family 3x4 recorded the lowest number of tillers per plant (3.2 tillers). Three best segregation plants (8 tillers) were obtained from three families (1x5, 2x5 and 3x5).

**3- Number of dry pods per plant**

The highest mean value of number of dry pods per plant (35 pods) and the better segregation plant (67 pods) were obtained from the plants of family 2x3.

**4- Weight of dry seeds per plant** Data of this character showed, that plants of family 2x3 and family 3x4 gave the highest and the lowest mean values of weight of dry seeds per plant, 72.2 gm and 25.5 gm, respectively. The best segregation plant was obtained from plants of 1x5 family (157.1 gm).

**5- Distribution percentage $F_2$ plants of faba bean plants under the infestation of *Orobanche* (2006/2007).**

The data for the distribution percentage of faba bean plants of the studied $F_2$ families is presented in Table (7). Results showed that, there is no dead plants appeared in all $F_2$ families.The survival percentage of podless plants were higher (51.3%) in 1x4 $F_2$ family, while, 1x2 and 3x5 $F_2$ families did not gave any podless plants. The survival percentage of podless plants were higher (51.3%) in 1x4 $F_2$ family, while, 1x2 and 3x5 $F_2$ families did not gave any podless plants. For the podded plants 1x2 $F_2$ family showed the highest percentage (95.7%) with invisible *Orobanche* followed by 2x3 and 3x5 $F_2$ families, while the $F_2$ family (4x5) showed the lowest percentage (29.6%).

**Table (1): Mean performance of parents and $F_1$ hybrids:**

| Item | Time of flowering | Plant height, cm | No. of tillers/ plant | No. of dry pods / plant | Weight of dry seeds/ plant, g |
|---|---|---|---|---|---|
| Parents | | | | | |
| Assiut11/8 (P1) | 39 | 96.1 | 4.9 | 23.4 | 26.8 |
| Assiut12/1 (P2) | 43 | 88.8 | 3.3 | 24.7 | 54.4 |
| Assiut13/6 (P3) | 41 | 90.1 | 2.8 | 27.1 | 43.8 |
| Assiut14/9 (P4) | 46 | 78.8 | 2.9 | 20.4 | 42.3 |
| Assiut15/4 (P5) | 41 | 72.2 | 3.2 | 22.5 | 33.4 |
| Hybrids | | | | | |
| P1 x P2 | 43 | 109.4 | 3.8 | 42.1 | 68.4 |
| P1 x P3 | 45 | 113.3 | 4.6 | 47.8 | 73.6 |
| P1 x P4 | 48 | 103.5 | 3.3 | 38.8 | 53.6 |
| P1 x P5 | 49 | 99.7 | 4.8 | 27.9 | 37.9 |
| P2 x P3 | 39 | 99.7 | 2.7 | 26.7 | 51.4 |
| P2 x P4 | 46 | 85.8 | 3.0 | 21.3 | 40.4 |
| P2 x P5 | 47 | 95.2 | 3.3 | 28.0 | 68.6 |
| P3 x P4 | 42 | 82.0 | 2.6 | 25.8 | 41.4 |
| P3 x P5 | 44 | 71.0 | 3.0 | 22.3 | 32.4 |
| P4 x P5 | 45 | 56.6 | 2.9 | 7.3 | 16.4 |

**Table (2): Analysis of variance of combining ability in 5x5 diallel cross of faba bean.**

| | d.f. | M.S. | F.R. |
|---|---|---|---|
| (1)Time of flowering | | | |
| GCA | 4 | 13.74 | 42.42** |
| SCA | 10 | 7.88 | 24.31** |
| (2)Plant height | | | |
| GCA | 4 | 541.413 | 45.54** |
| SCA | 10 | 118.605 | 9.98** |
| (3) Number of tillers / plant | | | |
| GCA | 4 | 1.66 | 28.006** |
| SCA | 10 | 0.14 | 2.35* |
| (4) Number of dry pods /plant | | | |
| GCA | 4 | 131.09 | 241.187** |
| SCA | 10 | 76.55 | 140.843** |
| (5) Weight of dry pods / plant | | | |
| GCA | 4 | 302.44 | 4.87** |
| SCA | 10 | 244.65 | 3.94** |

*, ** significant at p =0.05 and p = 0.01, respectively.

**Table (3): GCA estimates for the five characters in a diallel cross of five parents of faba bean**.

| Parents | Time of flowering (days) | Plant height, cm | No. of tillers / plant | No. of dry pods /plant | Weight of dry seeds / plant |
|---|---|---|---|---|---|
| P1 | -2.029** | 11.599** | 0.83** | 5.694** | 1.889 |
| P2 | 1.114** | 4.404 | -0.15** | 0.818** | 9.089** |
| P3 | - 0.885** | 1.328 | -0.29** | 2.120** | 1.783 |
| P4 | 0.686** | -7.339** | -0.396** | -4.132** | -5.369* |
| P5 | 1.114** | -9.992** | 0.005 | -4.500** | -7.392* |
| S.E. (gi-gj) | ±0.0925 | ±2.2372 | ±0.0169 | ±0.1790 | ±3.535 |

*, ** significant at p =0.05 and p = 0.01, respectively.

**Table (4): SCA estimates for 10 single crosses for the five charac ters under study.**

| $F_1$ Hybrids | Time of flowering (days) | Plant height, cm | No. of tillers / plant | No. of dry pods /plant | Weight of dry seeds / plant |
|---|---|---|---|---|---|
| 1x2 | -0.048 | 3.946 | -0.27** | 8.475** | 11.81 |
| 1x3 | 0.048 | 10.889 | 0.60** | 12.866** | 24.281** |
| 1x4 | 3.476** | 9.722 | -0.56** | 9.341** | 11.433 |
| 1x5 | -1.952** | 8.608 | 0.58** | -0.431 | -2.210 |
| 2x3 | 0.905 | 4.451 | -0.25* | -2.592* | -5.152 |
| 2x4 | 2.333** | -0.749 | 0.13 | -2.450* | -8.967 |
| 2x5 | 2.905** | 11.337 | 0.025 | 4.698** | 21.224* |
| 3x4 | 2.333** | -1.440 | -0.11 | 0.691 | -0.662 |
| 3x5 | 2.905** | -9.821 | -0.14 | -2.384* | -7.638 |
| 4x5 | -1.667** | -15.587 | -0.066 | -10.689** | -16.519 |
| S.E. (Sij-Sik) | ±0.555 | ±1.342 | ±0.1015 | ±1.074 | ±8.685 |
| S.E. (Sij-Skl) | ±0.4625 | ±1.1186 | ±0.0846 | ±0.895 | ±7.904 |

*, ** significant at p =0.05 and p = 0.01, respectively.

**Table (5): Distribution percentage of parentel and $F_1$ hybrid plants under the infestation of *Orobanche* (2005/2006 season).**

| Parents and their $F_1$ hybrids | Dead plants | Survival plants | | |
|---|---|---|---|---|
| | | Podless plants | Podded plants with : | |
| | | | Visible *Orobanche* | **invisible *Orobanche*** |
| $P_1$ | 0.0 | 0.0 | **40.0** | **60.0** |
| $P_2$ | **10.0** | 0.0 | **10.0** | **80.0** |
| $P_3$ | 0.0 | 0.0 | 0.0 | **100.0** |
| $P_4$ | 0.0 | 0.0 | 0.0 | **100.0** |
| $P_5$ | 0.0 | 0.0 | 0.0 | **100.0** |
| $P_1xP_2$ | 0.0 | 0.0 | 0.0 | **100.0** |
| $P_1xP_3$ | 0.0 | 0.0 | 0.0 | **100.0** |
| $P_1xP_4$ | 11.0 | 0.0 | 22.3 | **66.6** |
| $P_1xP_5$ | 0.0 | 0.0 | 40.0 | **60.0** |
| $P_2xP_3$ | 0.0 | 0.0 | 0.0 | **100.0** |
| $P_2xP_4$ | 0.0 | 0.0 | 0.0 | **100.0** |
| $P_2xP_5$ | 0.0 | 0.0 | 0.0 | **100.0** |
| $P_3xP_4$ | 0.0 | 0.0 | 0.0 | **100.0** |
| $P_3xP_5$ | 0.0 | 0.0 | 0.0 | **100.0** |
| **$P_4xP_5$** | **10.0** | **0.0** | **0.0** | **90.0** |

**Table (6) Mean values for some characters studied in the $F_2$ generation, 2006/2007.**

| Family | Plant height, cm. | | Number of tillers per plant | | Number of dry pods per plant | | Weight of dry seeds per plant, gm. | |
|---|---|---|---|---|---|---|---|---|
| | Mean | Value of best segregation | Mean | Value of best segregation | Mean | Value of best segregation | Mean | Value of best segregation |
| **1.2** | 123.3 | 160 | 3.7 | 6 | 22.2 | 55 | 54.6 | 117 |
| **1.3** | 121.8 | 180 | 4.3 | 6 | 17.5 | 65 | 38.9 | 129 |
| **1.4** | 101.6 | 150 | 4.4 | 7 | 15.8 | 33 | 36.5 | 70.7 |
| **1.5** | 121.6 | 165 | 4.7 | 8 | 23.7 | 64 | 49.2 | 157.1 |
| **2.3** | 142.9 | 180 | 3.5 | 6 | 35 | 67 | 72.2 | 147 |
| **2.4** | 106.7 | 150 | 3.4 | 6 | 12.7 | 35 | 28.3 | 80.2 |
| **2.5** | 105.8 | 135 | 4.1 | 8 | 16.6 | 45 | 40.1 | 126 |
| **3.4** | 106.8 | 135 | 3.2 | 5 | 11.9 | 29 | 25.5 | 64.4 |
| **3.5** | 113 | 135 | 4.1 | 8 | 24 | 60 | 53.5 | 109 |
| **4.5** | 98.2 | 135 | 3.9 | 7 | 16.4 | 49 | 31.5 | 81.3 |

**Table (7): Distribution percentage of $F_2$ plants faba bean under the infestation of *Orobanche* (2006/2007 season).**

| Families | Dead plants | Survival plants | | |
|---|---|---|---|---|
| | | Podless plants | Podded plants with : visible *Orobanche* | Invisible *Orobanche* |
| **($P_1$x$P_2$)** | 0.0 | 0.0 | 4.3 | 95.7 |
| **($P_1$x$P_3$)** | 0.0 | 30.2 | 27.0 | 42.8 |
| **($P_1$x$P_4$)** | 0.0 | 51.3 | 12.8 | 35.9 |
| **($P_1$x$P_5$)** | 0.0 | 12.7 | 25.4 | 61.9 |
| **($P_2$x$P_3$)** | 0.0 | 1.4 | 4.2 | 94.4 |
| **($P_2$x$P_4$)** | 0.0 | 44.6 | 21.5 | 33.9 |
| **($P_2$x$P_5$)** | 0.0 | 14.3 | 17.8 | 67.9 |

| | | | | |
|---|---|---|---|---|
| **($P_3$x$P_4$)** | 0.0 | 17.2 | 42.2 | 40.6 |
| **($P_3$x$P_5$)** | 0.0 | 0.0 | 19.7 | 80.3 |
| **($P_4$x$P_5$)** | 0.0 | 40.8 | 29.6 | 29.6 |

**General Discussion and Conclusion**

Results of this study revealed that there is a wide range of genetic variation faba bean this used. In the diallel studies, the results showed that GCA component of variation is highly significant in all characters studied. This indicates that a considerable amount of readily fixable variation is present and available for the plant breeder to manipulate. The results, also, showed the significance of S.C.A. item in all characters, indication of the presence of dominance effect. The magnitude of G.C.A. is higher as compared to S.C.A. in all characters, indicating a high magnitude of additive gene effects. Also, in such characters the ranking of the parents for general combining ability effects ($g_i$) is the same as their ranking based on parental performance suggests that additive genetic variance is the predominant component. On the other hand, in situation with a significant S.C.A. value with large hybrid vigour as shown by the absolute differences between parents and $F_1$, it is likely that the production of $F_1$ hybrid varieties would be the best means of obtaining fullest expression of the character. The obtained results are in according with the conclusion of Mahmoud (1977), Poulsen (1977), Waly (1982), Waly and Abdel-Aal (1982, 1986 and 1987), El-Hosary *et al*. (1984), Waly *et al*. (1987), Hendawy *et al*. (1988), Zayed (1995), Yamani (1998), Badawy (2003), Haridy (2005), Nassef (2005), Hamed (2008), Alghamdi (2009). All, reported that most faba bean characters were under the control of both additive and non-additive gene action.

Variance/Covariance analysis of diallel data illustrates some genetic information, i.e. dominance levels and relative proportion of dominant to recessive in the corresponding parents. For example, the graph of 5x5 diallel showed that the over-dominance was manifested within the time to flowering, and weight of dry seeds per plant, while the partial dominance was operating for plant height and number of tillers per plant.

With respect to GCA and SCA for parents and individual cross combination, it appear that parent 1 (Assiut 11/8) is good general combiner for early flowering, plant height, number of tillers per plant and number of dry pods per plant. Parent 2 (Assiut 12/1) is good general combiner for number of seeds per pod and weight of dry seeds per plant. Therefore, these parents could be used in breeding pro-

grams in different ways. For individual cross combinations, the cross parent 1 x parent 3 (Assiut 11/8 x Assiut 13/6) showed high performance for number of tillers per plant, number of dry pods per plant and weight of dry seeds per plant and could be used in practical plant breeding.

This cross (1X3) was derived from high X low general combiner parents for number of tillers per plant and number of dry seeds per pod and from high X high general combiner parents for number of pods per plant and exhibited the highest mean yield, highest heterosis, highest S.C.A. effect for weight of dry seeds per plant. These results reveal that this cross can be considered the best combination among the 10 crosses evaluated in this work. In the cross showing high A.C.A. involving only one good combiner, such combination would show with desirable transgressive segregates, providing that the additive genetic system present in the good combiner as well as the complementary and epistatic effect present in cross, act in the same direction to reduce undesirable plant characters and maximize the character in view. Kumar et al (2003) found that, the majority of the crosses showing high S.C.A. effects for grain yield involved low X low or low X average general combinations. Therefore, the previous cross (Assiut11/8 X Assiut 13/6) might be of prime importance in breeding program for traditional breeding procedures. The obtained results of the distribution percentage of five parents and $F_1$ hybrid plants of faba bean under the infestation of *Orobanche* in 2005/2006 season showed that only parent 2 (Assiut 12/1), and

both hybrids $P_1xP_4$ (Assiut 11/8 x Assiut 14/9) and $P_4xP_5$ (Assiut 14/9 x Assiut 15/4) produced dead plants, compared to all other parents and crosses which did not showed any dead plants. On the other hand, all $F_1$ hybrids showed 100% podded plants with invisible *Orobanche*, except three crosses ($P_1xP_4$, $P_1xP_5$ and $P_4xP_5$). Ahmed *et al*. (2001) and Zayed (2005) reported that the only suitable forecast method for losses in faba bean under the effect of broomrape is the actual values of percentage of dead and podless plants. Hassan (2006) and Hamed (2008) reported that there is a wide range of variations among the new breeding lines of faba bean with respect for tolerance to broomrape.

With respect to evaluation of $F_2$ generation plants, it appear that family 2x3 showed the highest mean values for, plant height, number of dry pods per plant and weight of dry seeds per plant. The best segregation of plant for weight of dry seeds was obtained from family 1x5 (157.1 gm). The families $P_1xP_2$, $P_2xP_3$ and $P_3xP_5$ produced the highest survival podded plants with invisible *Orobanche*. From these results, it can be concluded that there are real useful variations among the

breeding lines involved. Also, from the genetic investigation, it may be useful to use line Assiut 11/8 and Assiut 12/1 in advanced breeding programs.

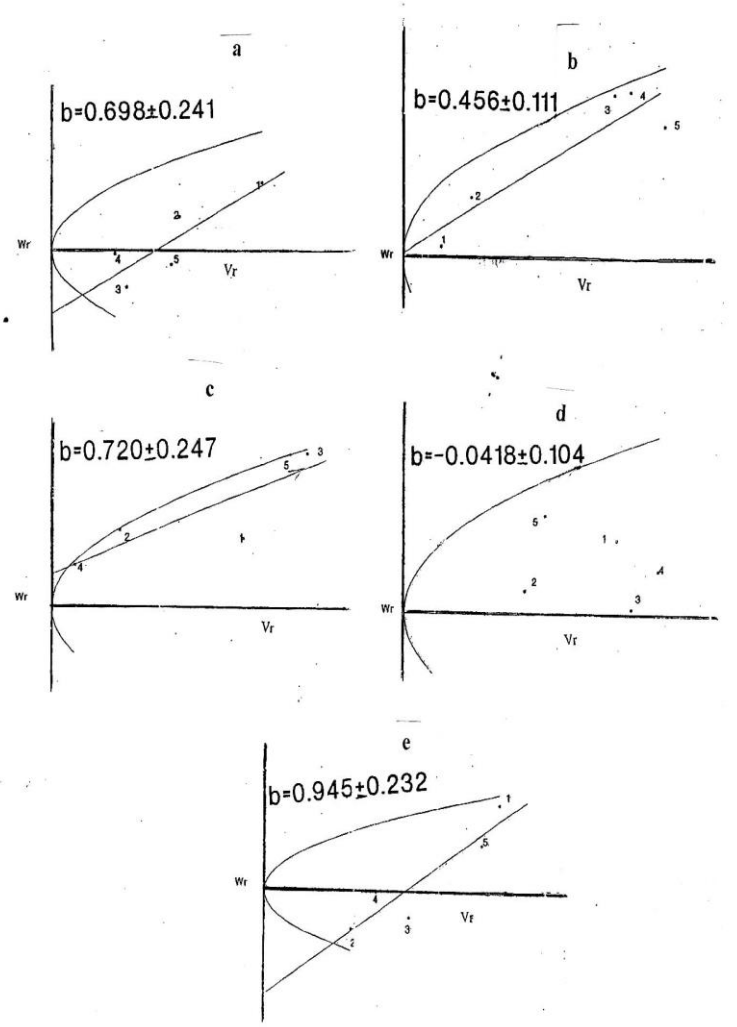


Figure (1): Vr/Wr graphs for five characters in a diallel cross of five lines of faba bean. a) Time to flowering b) Plant height
c) Number of tillers per plant
d) Number of dry pods per plant
e) Weight of dry seeds per plant

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# تحليل دايلل لبعض الصفات فى خمسة سلالات جديدة من الفول

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أجريت هذه الدراسة بمزرعة كلية الزراعة - جامعة أسيوط - خلال المواسم الزراعية ٢٠٠٥/٢٠٠٦ و ٢٠٠٦/٢٠٠٧ و وذلك لدراسة:-الاختلافات الوراثية لبعض صفات النمو والمحصول والجودة فى خمسة سلالات جديدة من الفول والتى تم استنباطها بقسم البساتين - كلية الزراعة - جامعة أسيوط ( والى و عباس ١٩٧٦-٢٠١١)و اشتملت الدراسة على التجارب التالية :

التجربة الأولى ( موسم ٢٠٠٥/٢٠٠٦ )

تم زراعة بذور خمسة سلالات من الفول و كذلك الجيل الأول لهم (الناتج من التهجين الأليلي المزدوج 5x5) و ذلك لتقييمهم من حيث صفات النمو والمحصول وكانت الآباء المستخدمة هى : أسيوط ٨/١١ وأسيوط ١/١٢

وأسيوط ٦/١٣ وأسيوط ٩/١٤ وأسيوط ٤/١٥

التجربة الثانية (موسم ٢٠٠٦/٢٠٠٧)

تم زراعة بذور عشرة عشائر من الجيل الثانى والناتجة من الموسم السابق (٢٠٠٥/٢٠٠٦) فى موسم ٢٠٠٦/٢٠٠٧.

و فيما يلى النتائج المتحصل عليها :

١-إختلفت جميع السلالات التى درست فى هذه التجارب اختلافا معنويا فيما بينها وذلك لجميع الصفات المدروسة

٢-أظهرت كل الصفات معنوية عالية للقدرة العامة على التآلف

٣- أظهرت كل الصفات معنوية للقدرة الخاصة على التآلف

٤- من هذه النتائج ومن مناقشة القدرة العامة على التآلف للآباء والقدرة الخاصة على التآلف للهجن لكل الصفات المدروسة تظهر أهمية كلا من الفعل الإضافى للجين بالإضافة إلى أهمية الفعل الغير إضافى للجين فى وراثة هذه الصفات.

٥-أظهرت السلالة أسيوط ٨/١١ تفوقها فى الإزهار المبكر وإرتفاع النبات وعدد الفروع للنبات وعدد القرون الجافة للنبات

٦- أظهر التحليل البيانى لجينكز تواجد الفعل الإضافى و الغير إضافى للجينات فى الصفات المدروسة و أكدت المعلومات الوراثية التى أعطيت بالطريقة الحسابية

٧- بالنسبة للآباء فإن السلالة أسيوط ١/١٢ هى السلالة الوحيدة التى ظهرت فيها النباتات الميتة وبالنسبة للهجن فإن الهجين أسيوط ٨/١١ × أسيوط ٩/١٤ والهجين أسيوط ٩/١٤ × أسيوط ٤/١٥ قد ظهرت فيها نسبة النباتات الميتة .

٨-النباتات التى عليها قرون وليست مصابة بالهالوك ظهرت فى الأب ٣ والأب ٤ والأب ٥ ويتبعه الأب ٢ والأب ١ أما الهجن كلها أظهرت نباتات عليها قرون وليست مصابة بالهالوك ما عدا الهجين الأب ١x الأب ٤ و الأب ١ x الأب ٥ و الأب ٤ x الأب ٥.

٩- فى عشائر الـ $F_2$ لا توجد أى نباتات ميتة

١٠- سجلت عشيرة $F_2$ 1x4 أعلى نسبة نباتات حية وليس عليها قرون بينما 1x2 و 3x5 لم يسجل أى نباتات حية ليس عليها قرون

١١-العشيرة 1x2 سجلت أعلى نسبة نباتات حية عليها قرون و غير مصابة بالهالوك ويتبعها 2x3 و 3x5 أما 4x5 فقد سجل أقل نسبة نباتات حية عليها قرون ومصابة بالهالوك