PERFORMANCE OF SOME FABA BEAN GENOTYPES AND THEIR DIALLEL CROSSES FOR EARLINES, YIELD AND ITS COMPONENTS

BY

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ABSTRACT

The present investigation was carried out under the insect free cage at Giza Research Station during 2008/09 and 2009/10 growing seasons. A diallel cross including reciprocals among five faba bean genotypes (Giza 40, Giza 843, Nubaria 1, Triple White and ICARUS) was utilized to estimate different sources of genetic variability and other derived parameters for earliness, seed yield and its components i.e.,. pods, seeds and 100-seed weight.

The analysis of variance for earliness showed highly significant differences among genotypes, pointing to a wide genetic variability for flowering and maturity. The parental genotype Giza 843 had the earliest and tallest plants and exhibited significantly the highest seed yield/plant. Nubaria 1 had significantly the highest number of pods/plant and 100-seed weight. All crosses had highly significant heterosis and heterobeltiosis for seed yield/plant except the three crosses: Nubaria 1 x ICARUS, ICARUS x Nubaria 1 and ICARUS x Triple White.

The ratio of GCA/SCA exceeded the unity except for days to flowering, days to maturity, branches/plant and 100-seed weight. Low GCA/SCA ratios revealed the predominance of non-additive gene action in this cases.

Most of the genetic variation among the investigated genotypes appeared to be additive. Thus, selection could be favored for improving these traits. The additive genetic variance (D) was highly significant for days to flowering; pods/plant and 100-seed weight indicating that additive effect is important in the inheritance of these traits. Therefore, selection would be expected to be effective. The component of variation due to dominance effects (H1) was highly significant for all traits indicating the presence of dominance with asymmetrical gene distribution in the parental genotypes. All traits had high values of H1 and H2 than "D" except days to flowering and 100-seed weight (g) indicating the important role of dominance genetic variance.

Heritability estimates in broad sense were found to be high for all traits and ranged from 72% (days to maturity) to 98% (number of seeds/plant). Heritability in narrow sense was lower than in broad sense and ranged from 19% for seed yield/plant to 77% for days to flowering. This is indicator for the importance of both additive and non-additive genetic variance in the inheritance of these traits.

Key words: *Faba bean, Earliness, Heterosis, Combining ability, Heritability*

CONTENTS

INTRODUCTION

Faba bean (Vicia faba L.) is the most important food legume that has potential to provide the Egyptian, increasing demand for food. It is a primary source of protein in the diet of mass. It is an important food crop being consumed both in the green succulent state and as dry edible seeds. The crop in generally included in the crop rotation and has succeeded to keep the soil fertile and productive through biological N2- fixation. The average cultivated area of faba bean is about 184.000 feddan with an average seed yield of 8.15ardab/feddan during 2009-2010 seasons. Improvement of earliness, pest resistance and high yield potential are the primary objectives of faba bean breeding programs. An understanding of the fundamental nature of the actions and interactions of genes involved in the inheritance of quantitative traits is very helpful to plant breeders in their evaluation of various selection and breeding procedures. The breeding system need to be fitted to the types of gene action to maximize the result of improvement.

Heterosis, expressed as deviation of F1 hybrid from the mid-parent or the better parent result from the combined action and interaction of allelic or interallelic genes.

Diallel cross technique have been used to obtain considerable information on the genetical bases and understanding of the nature of gene action involved in controlling quantitative traits

Early flowering and early maturing genotypes are very useful in breeding early varieties. Such varieties will not only escape environmental hazards and climatic changes during flowering and pod setting; but also will contribute to use of less water irrigation. Also early maturing varieties of faba bean will allow cultivation of early summer crops without delay. Therefore it is important to know the nature of gene action and combining ability of diverse potential faba bean genotypes that may contribute to early genotypes coupled with high yield.

REVIEW OF LITERATURE

1- Heterosis

Abdalla (1977) studied the hybrids among *Paucijuga*, *Equina* and *Major* types. Heterosis was very pronounced in F_1 particularly among divergent material (more than 100% in pods and seeds). Less heterotic response occurred in hybrids between local varieties (± 15%).

Kittlitz (1981) studied the heterotic effects on yield in the F_1 to F_3 generations of single crosses among three inbred lines of *Vicia faba* under the bee-proof cages and open conditions. Heterotic effects on yield were detected in F_1 to F_3 crosses under the bee-proof cages. However, these heterotic effects were observed only in F_1's under field conditions. He suggested that heterosis results from differences in self fertility among inbreds, a factor which may be unimportant under the condition of open field occurring in synthetic varieties.

Nassib (1982) evaluated eight faba bean genotypes, i.e., (Giza 2, F. 204, Aquadulce, NA112, NEB114, NEB133, NA62 and NA77) in a diallel cross including reciprocals under insect free cage. The heterosis and inbreeding depression emphasized that average true heterosis was significant and consistent over years for pods and seed yield per plant.

Abdalla and Fischbeck (1983) studied the crosses among 12 faba bean sorts belonging to *paucijuga* subspecies and *Minor*, *Equina* and *Major* types of *Eu-faba* subspecies. Materials were grown under insect proof cage and in environmentally controlled growth chambers.

The results of hybrids showed that certain types nicked better than others, i.e. (*Equina* x *Major*, were the best combinations in all traits when compared to other type combinations, *Minor* x *Minor, Minor* x *Equina* and *Minor* x *Major*). Reciprocal cross differences were occurred among reciprocal hybrids growing under cage and in growth chamber. Heterosis was high in certain combinations and reached 80% but the traits were reacted differently.

De Pace and Filippetti (1983) studied mean heterotic values of seed yield and its components for parents and their F_1's between *Vicia faba* var. *minor* and *V. faba* var. *major*. The results showed that the F_1 plants had intermediate pod and seed size, while pods/plant, seeds/plant, seeds/pod and pods/podding node showed positive heterosis over the mean parental values and over the *Major* parent.

El-Hosary (1985) studied heterosis in the F_1 diallel among seven parental faba bean genotypes. He found significant heterosis for F_1 in seed yield per plant.

Mahmuod and Al-Ayobi (1987) evaluated four faba bean parents and their all possible F_1 crosses excluding reciprocals under cage house. Negative heterosis was detected for earliness in four crosses as well as for plant height in two crosses (Giza 2 x Giza 4 and Giza 4 x Roumi) while pod length showed positive hybrid vigor.

Abdel-Hafez *et al.* (1988) studied heterosis in the F_1 of faba bean under wire cage. They detecated negative heterotic values for the traits related to earliness such as pre- anthesis, but positive ones for seed yield and its components were obtained as a deviation from mid parents. They reported the possibility of breeding for earlier ripening without reduction in seed yield.

El-Hady (1988) studied 8 x 8 diallel mating design with reciprocals in F_1 and F_2 generations of faba bean under insect free cage. Significant heterotic effects were detected for seed yield, number of pods and seeds per plant.

El-Keredy *et al.* (1988) made 5 x 5 factorial crosses of faba bean. They showed that heterosis and heterobeltiosis were significant for number of pods, seeds per plant and 100-seed weight.

El-Hosary (1988) used three introductions and two local stocks of faba bean in diallel cross without reciprocals to study heterotic effect for number of branches, pods per plant and seed yield per plant as well as 100-seed weight. He found that mean squares for heterosis reached the significant level for F_1 generation in all studied traits.

Bargale and Billore (1990) studied the parental diversity and heterosis among a set of diallel cross involving seven faba bean parental genotypes and their F_1 hybrids under irrigated and rainfed conditions at Jabour, India during rabi season. Heterosis was observed for seed yield and a number of yield components.

El-Hady *et al.* (1991-a) estimated heterotic effects, genetic components and combining ability in five parent and their 10 F_1 hybrids in faba bean under the screen house. The heterosis was on average highest for pods per plant (44.5%) followed by seeds per plant (33.5%) and seed yield per plant (24.8%).

El-Hady *et al.* (1991-b) crossed seven faba bean pure lines with two high yielding disease resistant testers. They found hybrid vigor as compared to the better and best parent for seed yield per plant. Two crosses outyieded the better parent and eight crosses were over the better parent (useful heterosis).Heterosis ranged from 47% for the cross Triple White x 461/837A/83 to 165% for the cross Triple White x 461/845/83 with an average of 106%.

Omar *et al.* (1992) evaluated seventeen F_1 hybrids of faba bean in the green house to estimate the heterotic effects for seed yield and its components (number of seed per plant, number of pods per plant and plant height). They found heterotic effects as percentage over the mid and better parents for the four studied. traits The range of useful heterosis over the best parent was 0.33 to 7.02 % for plant height, 5.6 to 63.16% for number of seed per plant, 18.36 to 80.35% for number of pods per plant and 22.36 to 105.72% for seed yield. The increased seed yield seemed to be associated with the increased pods and seeds number per plant.

Bargale and Billore (1992) studied the heterosis effects in the F_1 crosses among seven diverse strains of faba bean for thirteen quantitative traits. They showed that nine hybrids expressed significant better parent heterosis for seed yield per plant. The results indicated that high magnitude in seed yield per plant was mostly due to heterosis in number of pods per plant.

Abo El-Zahab *et al*. (1994) estimated the significance of the relationship and differences among eight faba bean parental varieties. They showed that five crosses, (Giza 3 x BPL266, Giza 402 x ILB938, Giza 402 x 249/804/80, Giza 402 x BPL 261 and Giza 402 x BPL 266) had true heterosis for the two yield components; pods perplant and seeds per plant. Besides three crosses (Giza 402 x ILB938, Giza 402 x 249/804/80, and Giza 402 x BPL 1814) were significantly outyielded the highest yielding parent Giza 402. Heterosis for yield was primarily due to the heterotic effect of the two yield components, number of pods and seeds per plant.

El-Lithy (1996) studied the morpho-physiological and components of yield traits in 6x6 diallel cross. He showed that the crosses which have Reina Blanca or N.A. 112 as common parent were later in days to first flower than other ones, while those which have Rebaya 40 Giza 674 or Giza 2 as common parent bloomed earlier than other crosses. Heterosis was present for all traits except first podded node per main stem and number of productive nodes on main stem.

El-Hady *et al*. (1997) evaluated three faba bean crosses using six populations in each cross, (P_1, P_2, F_1, F_2, BC_1 and BC_2.) Highly significant negative heterosis over mid parents were detected for flowering date. Also highly significant positive heterosis over mid parents and higher parents were found for number of seeds per plant and seed yield per plant in three crosses. On the other hand, significant negative heterosis were observed over higher parent with highest seed index in all studied cases and over mid parents in one cross.

Attia (1998) investigated the performance of faba bean hybrids resulting from 8 x 8 diallel cross under insect free cage and open field conditions. All studied traits under insect free cage exhibited highly significant superiority of the F_1 means over the mean of all parental genotypes except plant height. Pronounced heterosis were observed in the crosses of “distant” parents particularly when using exotic ones, in hybridization with local genotypes.

El-Hady *et al.* (1998-b) crossed five commercial varieties and two promising genotypes of faba bean in 7 x 7 diallel cross excluding reciprocals under insect free cage. Negative insignificant heterosis over better parent was found over all crosses for days to maturity. Heterosis effects relative to better parent was significantly positive in several crosses for number of pods per plant, seeds per plant, 100-seed weight and seed yield per plant.

Abdalla *et al.* (2001) studied the parental diversity and heterosis among F_1's of diallel cross involving five parents of faba bean. Significant differences were observed among genotypes for all studied traits. F_1 crosses were superior over means of all parents and recorded 55% higher seed yield per plant. Significant negative heterosis was detected for position of first podded node and days to flowering.

Attia *et al.* (2001) used a diallel cross of five faba bean genotypes including reciprocals. They estimated heterosis effects for seed yield and its components (pods per plant, seeds per plant and 100-

seed weight). Significant differences among genotypes and some crosses were detected for all studied traits. Heterosis over the better parents was significantly positive in 5 crosses for number of pods per plant, whereas heterosis over mid-s was significantly positive in five, one, two, and four crosses for pods per plant, seeds per plant, seed yield and 100-seed weight, respectively.

Attia *et al.* (2002) estimated heterosis effects using diallel mating design between six faba bean genotypes. Significant heterosis was detected either over mid or better parents for seed yield. Such heterosis was pronounced for number of pods and seeds per plant particularly over mid-parents.

Attia *et al.* (2006) studied heterosis using the six population model. The heterosis over mid parents showed that the three crosses (Giza 429 x Giza 716, Giza 843 x Giza 716 and Giza 716 x Giza 429) exhibited significant or highly significant heterosis for number of pods/plant, number of seeds/plant and 100-seed weight except number of pods per plant in the first cross (Giza 429 x Giza 716).

Attia and Salem (2006) used a diallel mating design among five faba bean genotypes. The results showed that heterosis over mid and better parents was highly significant for number of pods, seeds and seed yield per plant. Also highly significant heterosis for number of branches per plant. On the other hand, heterosis over better parents ranged from 5.22% for plant height, to 87.63% for number of pods per plant. Heterosis over mid parents was on average 19.95% for number of branches per plant and 61.24% for number of pods per plant.