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ORIGINAL ARTICLE

Analysis of gene action in diallel crosses among some Faba bean (*Vicia faba* L.) genotypes under Maryout conditions

H.I.A. Farag *, S.A. Afiah

Plant Genetic Resources Dept., Desert Research Center, El-Mataria, Cairo, Egypt

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Abstract Seven genotypes of faba bean (*Vicia faba* L.) were used in carrying out half diallel cross, 21 F_1 hybrids and 21 F_2 progenies evaluated under well watered and rainfed conditions at the Maryout Agriculture Experimental Station of Desert Research Center. Mean squares of genotypes in F_1 and F_2 generations showed that the differences due to genotypes were significant for all characters studied under well watered and rainfed conditions. The four parental genotypes; P_2, P_4, P_5 and P_6 were the earliest in days to 50% flowering and recorded values raging from 30.88 to 47.98 days under well watered and rainfed conditions and the two crosses; $P_1 \times P_3$ and $P_2 \times P_7$ in both generations under the two treatments. The parental genotype P_2 recorded the highest number of branches per plant (7.85 and 6.94 branches) under well watered and rainfed treatments, respectively. While, the two crosses; $P_2 \times P_4$ and $P_2 \times P_6$ recorded the highest number of pods per plant in both generations under well watered and rainfed treatments. For 100-seed weight the parent Aquadulce (P_4) recorded the highest values under well watered and rainfed conditions (95.62 and 71.72 g, respectively). As well as the two crosses; $P_2 \times P_5$ and $P_2 \times P_6$ recorded the highest values for seed yield per plant. Significant positive heterosis and heterobeltiosis were detected for different traits; With respect to seed yield per plant, the seven crosses; $P_1 \times P_7$, $P_2 \times P_5$, $P_2 \times P_6$, $P_4 \times P_6$, $P_5 \times P_6$, $P_5 \times P_7$ and $P_6 \times P_7$ had significant positive heterotic effects relative to mid and better parents under the two irrigation treatments. Mean squares of both GCA and SCA estimates were highly significant or significant in both generations for all the studied traits under well watered and rainfed

* Corresponding author. Tel.: +20 2 4444 14 54.
E-mail address: hossam_frg@yahoo.com (H.I.A. Farag).

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conditions. Variances due to GCA were larger than those for SCA and exceeded the unity were detected for days to 50% flowering in F_1 generation under rainfed conditions, No. of branches per plant, No. of pods per plant in both treatments and generations except for F_1 generation under rainfed condition, 100-seed weight in both treatments and generations except for the F_1 generation under well watered conditions and seed yield per plant in both treatments and generations except for the F_2 generation under well watered and rainfed conditions, revealing that the largest part of the total genetic variance associated with different traits being the result of additives types on gene action. General combining ability results showed that the three parental genotypes (P_1 (G.461), (P_2 (NBL2) and P_4 (Aquadulce)) were good combiners for improving most studied traits. Such combinations might have desirable transgressive segregations, provided that the additive genetic system is present in different crosses for increasing plant yield and its components under targeted well watered and rainfed conditions. For SCA, the desirable inter-and intra-allelic interactions were presented in the cross $P_6 \times P_7$ in the two generations under both treatments along with $P_1 \times P_2$ in the F_2 generation under both treatments, $P_1 \times P_5$ in F_1 and F_2 generations under well watered and rainfed conditions respectively, $P_1 \times P_6$, $P_2 \times P_5$ and $P_4 \times P_6$ in F_1 under both treatments and the three crosses; $P_1 \times P_7$, $P_3 \times P_4$ and $P_3 \times P_5$ in F_1 generation under well watered conditions showed significant positive effects for 100-seed weight. Moreover, seven F_1' $P_1 \times P_7$ in both generations and under the two treatments, $P_1 \times P_4$ in the F_1 generation under well watered conditions, $P_2 \times P_5$, $P_2 \times P_6$, $P_4 \times P_6$ and $P_5 \times P_7$ under F_1 generation under both treatments and $P_6 \times P_7$ in the F_2 generation under rainfed conditions possessed significant positive effects for seed yield per plant. These crosses might be of interest in breeding programs to produce pure lines while most of them involve at least one good combiner for the trait in view.

Introduction

Faba bean (*Vicia faba* L.) is one of the most important grain legumes in prone regions of North and East Africa, especially in Egypt. It plays an important role in world agriculture, owing to its high protein content, ability to fix atmospheric nitrogen, capacity to grow and yield well on marginal lands. The production of faba bean is severely limited by several constraints, which include drought and salinity stresses (Alghamdi, 2007).

Breeders use two strategies to improve drought tolerance; the first which is rather unspecific is based on the exploitation of heterosis. Heterosis for the yield of faba bean tends to increase under drought stress (Abdelmula et al., 1999). The second strategy is direct selection for drought tolerance and its components (Loss and Siddique, 1997).

Hybrids breeding has been suggested as a solution for improving seed yield and yield stability in the faba bean. Superiority of hybrids over the mid and/or better parents for seed yield is associated with the manifestation of heterotic effects in important yield components, i.e., number of branches per plant, number of pods per plant and seed index. These heterotic effects may range from significantly positive to significantly negative for different traits depending on genetic makeup of parents (Duc, 1997; Abdalla et al., 1999; El-Keredy et al., 1999; Darwish et al., 2005; El-Hady et al., 2006). Bond et al. (1994) and Abdelmula et al. (1999) reported that faba bean hybrids showed better adaptation to a wide range of abiotic conditions as compared to open pollinated or inbred cultivars and better tolerance to drought stress. While, Omar et al. (1998) suggested that the economic feasibility would be considerably improved if sufficient heterosis were retained in the F_2 generation to make its production of value particularly under stress conditions.

In addition several researchers have stated the significance of both general and specific combing ability effects for yield and other important traits of faba beans (Abdalla et al., 2001; Attia et al., 2002; Attia and Salem, 2006; Hossam, 2010).

The present investigation aimed to understand the nature of gene action and the relative magnitude of heterosis and the combining ability of seven faba bean diverse genotypes in addition to their respective F_1 and F_2 generations using diallel cross mating design for some agronomic traits under well watered and rainfed conditions.

Materials and methods

Two field adjacent experiments were conducted at the Maryout Agriculture Experiment Station of Desert Research Center (D.R.C.) under two irrigation treatments, rainfed amount only and rainfed + 2 supplemental irrigations given at sowing and flowering stage to study the response of seven genotypes of faba bean (*V. faba* L.) and their respective F_1 and F_2 generations. Names, source and pedigree of faba bean varieties or lines are presented in Table 1. In 2006/07 season different genotypes were crossed in a half-diallel mating design under wire cages at the Maryout experimental site and 21 F_1 hybrids were obtained. The F_2 seeds of these crosses were produced by bagging F_1 plants during the flowering period in 2007/08 season and F_1 crosses were made to obtai additional F_1' seeds. The soil of the site is loamy clay in texture, E.C. 4.53 ds/m, calcareous (34.19% $CaCO_3$) and 0.76% organic matter.

In the 2008/09 season the parental genotypes along with their 21 F_1 and 21 F_2 progenies were sawn in a randomized complete block design with three replications. Each experimental plot consisted of 3, 1 and 5 rows for parents, F_1 and 21 F_2, respectively in each replication under both experiments. The