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Variability, Heritability and Genetic Advance in Faba Bean, Vicia Faba L

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ABSTRACT

A field trial was conducted for two successive seasons to evaluate four genotypes of faba bean (*Vicia faba* L.). Data were gathered on the seed yield per plant and some yield related traits: number of pods per plant, the number of seeds per plant, the number of seeds per pod, the 100 seeds weight. Statistical analysis was on basis of the two seasons means. Phenotypic variance, genotypic variance, heritability and genetic advance were estimated, The medium heritability and low genetic advance reported on the seed yield indicated that selection is ineffective in improving the seed yield.

Keywords: Phenotypic Variance, genotypic variance, Heritability, genetic advance

INTRODUCTION

Faba bean, *Vicia faba* L. is the most important pulse crop in the Sudan on basis of area cultivated and farm income. The boiled beans are considered as the main dish in breakfast and dinner meals for large population in the urban areas of the Sudan (Ahmed, 1996).

Faba bean is grown as a winter crop under irrigation mainly in the Northern State in about 70% of the total cultivated area and the River Nile State in about 30% of the total cultivated area in the Sudan. It is also grown to a limited extent in Khartoum State and Jabel Marra in Western Sudan due to the suitability of the environmental conditions (Salih and Salih, 1996). Lately, it was introduced to the larger irrigated schemes of Gezeira, Rahad and New Halfa.

Selection for superior genotypes based on the yield alone is less efficient due to the complexity of the yield and its dependence on its components (Sindhu et al, 1985a and 1985b). The direct selection was also ineffective due to the large environment-genotype interaction (Johnson et al, 1955 and Yassin, 1973). For a breeding program to be successful there must be genetic differences among the individual plants of the breeder's collection of material. Then the breeder will be able to select the desirable combination of genes. Many desirable traits such as yield, protein content and quality are under the control of many genes and the environmental factors. The environment affects the expression of the character and there will be no discrete classes of phenotype and there are continuous variations of this character. Such variations need statistical techniques for their evaluation. This type of character is known as the quantitative character. The situation is different from the character considered by Mendel, the qualitative character. Observed phenotypes can be measured and assessed while the genotypes can be inferred from the phenotype data.

The Analysis of variance is used in planning the experiment and for the statistical treatment of the experimental data. The objective of the analysis of variance is to partition the variance into different sources of variation namely between samples (treatments) and within samples variances. It also provides a basis for test of significance (Dospekhov, 1984).

The variance and its square root, the standard deviation is used to measure the normal distribution around the mean value. In analysis of variance the mean square is used as an estimate of the variance.

Variability is insignificant if CV% is less than 10%, medium when CV% is 10-20% and significant when CV% is more than 20%, Dospekhov (1984).

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Heritability and genetic advance were considered as important selection parameters. The estimation of heritability together with the genetic advance is more useful to predict the gain according to selection than the estimation of heritability alone.

Heritability is defined as the share of the phenotypic variance in population attributed to the hereditary factors. It determines to which degree difference among phenotypes results from genetic causes. Heritability is used to show to which degree a trait is inherited to the offspring generation. This magnitude suggests the extent to which improvement can be achieved through selection.

In faba bean, a self pollinated crop, the analyses of variance method can be used to estimate the heritability. The observed mean square will be equated to the expected mean square and the value of phenotypic variance, $\sigma^2 p$, and genotypic variance, $\sigma^2 g$, will be obtained from the analyses of variance table. The genetic advance achieved in each breeding cycle depends on how the additive gene effect is beneficial (Hassan 1991).

Kalia and Sood, (2004) working on faba bean found high heritability and high genetic advance for pod yield per plant which indicated high additive gene action and possibility of trait improvement through selection. The same result was obtained by Mohmoud et al (1984), Dawwan and Abdel Aal (1991) and Ramgiry (1997).

High heritability and low genetic advance, which suggest dominant effect, were found in protein and ascorbic acid contents and hence these characters can be improved by hybridization, (Dawwan and Abd Aal, 1991 and Kalia and Sood, 2004).

Johnson et al (1955) showed that the estimation of heritability together with coefficient of variation is usually useful to the resulting effect of selection than heritability alone. This was mainly because heritability is a ratio of genotypic and phenotypic variances and varies greatly in accordance to the sample size, the environment and the character of the population.

Moderate heritability and low genetic advance were reported by Kalia and Sood (2004), in dry matter which were due to epistatic interaction but for harvest index both heritability and genetic advance interaction, were low, similar result were obtained by Mahmoud et al (1984).

The objective of this study was to estimate variability, heritability and genetic advance.

MATERIALS AND METHODS

This trial was conducted in the research farm of the College of Agricultural Studies, Sudan University for Science and Technology, Shambat, Khartoum North. The trial was replicated for two successive seasons.

The soil of the farm is high level dark clay soil of high similarity to the Gezeira soil in many aspects. Awadalla (1968) reported that it was poor in both organic carbon (0.6%) and nitrogen (0.05%) contents, and slightly alkaline, (pH = 8.1). The soil of the farm is continuously cultivated for teaching and research purposes.

Four cultivars of faba bean were used in this study; these were namely, Hudeiba 72, Basabeeer, Hudeiba 93 and SML. Randomized complete block design with four replications was used. All data from this experiment over the two seasons were recorded after the maturity stage of the crop.

Samples of 15 plants per plot were harvested by picking the pods from the standing crop. The number of pods per plant was counted from these samples in the laboratory. The number of seeds per plant was counted in the laboratory after shelling of the pods. The number of seeds per pod was obtained by dividing the number of seeds per plant over the number of pods per plant.

The seed yield per plant was obtained by weighing the seeds of the 15 plants and dividing the result by 15. The 100 seed weight was obtained by dividing the seeds yield per plant over the number of seeds per plant and multiplying by 100.The broad sense heritability was computed using the formula suggested by Johnson el at (1955). The genetic advance was computed using the formula suggested by Robinson et al (1949).

RESULTS

The phenotypic, genotype variances, heritability and genetic advance of seed yield, and the other yield related traits were presented in Table 1.

The phenotypic and genotypic variances were estimated for yield and the yield related traits for four genotypes using the data of the means of the two seasons. It was found that the phenotypic variances were always greater than the genotypic variances for the entire seed yield and the traits under study.

The highest phenotypic variances among yield components were observed on the number of pods and number of seeds per plant and seed weight which were 88.86, 89.01 and 66.86 respectively. The lowest phenotypic variance was observed on number of seeds per pod, 0.05.

The genotypic variance of number of seeds per pod was also lowest compared to the yield components and related traits. Generally, seed yield and yield primary components showed lower heritability values.

Table1. *Phenotypic Variance, Genotypic Variance, Heritability and Genetic Advance*

Seed yield and yield traits	Phenotypic Variance	Genotypic variance	Heritability	Genetic Advance
Seed yield per plant	10.41 M	3.63 L	0.35 M	2.31 L
No. of pods per plant	88.86 H	2.01 L	0.02 L	1.39 L
No. Seed per plant	89.01 H	17.17 M	0.19 L	15.54 H
No. of seeds per pod	0.06 L	0.01 L	0.09 L	0.04 L
100 Seeds weight (gm.)	66.86 H	38.89 H	0.58 m	9.80 M

Key: *H= high, M= moderate, L= low*

There was a wide range of variation expressed by the genetic advance. The values were 2.31, 1.39, 0.04 and 9.80 for the seed yield per plant, the number of pods per plant and the number of seed per pod and the seed weight respectively. Table1.

DISCUSSION

The moderate heritability and the low genetic advance obtained in this study for the seed yield is probably due the epistatic gene action, (Mahmoud et al 1984 and Kaila and Sood 2004) so the mass selection may be ineffective in improving the seed yield per plant in these four genotypes.

CONCLUSION

Narrow range of variability was detected in the seed yield per plant, number of pods per plant and number of seeds per pod in the four genotypes evaluated in the study.

Due to the medium heritability and low genotypic advance reported in seed yield per plant, so, the direct selection for seed yield is ineffective.

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