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Full Length Research

Genetic variability, heritability and correlation in some faba bean genotypes (*Vicia faba* L.) grown in Northwestern Ethiopia

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A study was conducted at Dabat, Northwestern Ethiopia, during 2010 cropping season. Genotypic and phenotypic coefficient of variation, heritability and correlation coefficients were performed for yield and its contributing parameters in 10 faba bean genotypes. Analysis of variance for traits studied showed significant (P<0.01) differences among the genotypes. Phenotypic coefficient of variation values for most characters was closer than the corresponding genotypic coefficient of variation values showing little environment effect on the expression of these characters. The estimated values of broad-sense heritability were found to be between 27 (stand count at emergence) and 81% (grain yield). Heritability values determined were 72, 67, 65, 46, 44, 53, 58 and 45% for 100 seed weight, biological yield, number of pods per plant, number of pods per node, disease status, days to flowering, days to maturity and plant height, respectively. High heritability indicated that selection based on mean would be successful in improving these traits. Positive and significant correlation coefficients were also obtained between number of pods per node and each of plant height (r = 0.676), number of pods/plant (r = 0.636**) and number of nodes per plant (r = 0.421*). Pods per plant had a significant positive correlation with plant height (p<0.01) in this study.**

Key words: Correlation, faba bean, grain yield, genetic variability, heritability.

INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the main pulse crops grown for seed in Ethiopia. It is widely considered as a good source of protein, starch, cellulose and minerals for humans in developing countries and for animals in industrialized countries (Haciseferogullari et al., 2003). In addition, faba bean is one of the most efficient fixers of the atmospheric nitrogen and, hence, can contribute to sustainability or enhancement of total soil nitrogen fertility through biological N_2-fixation (Lindemann and Glover, 2003).

Successful breeding program depends on the magnitude of genetic variation in the population. Moreover, reliable estimates of genetic and environmental variations will be helpful in estimating the heritability ratio and consequently predicted genetic advance from selection. These estimates are useful to initiate such breeding program in order to improve productivity and quality of the crop. The fraction of the phenotypic variation in a trait that is due to genetic differences can be measured as the heritability of the trait. The simplest model for variation in a quantitative trait splits phenotypic variation into variation due to genetic differences between individuals, and variation due to environmental differences. El-Kady and Khalil (1979) estimated the heritability values for some yield components in three faba bean crosses. Bora et al. (1998) stated that a high heritability was followed by high genetic advance for fruiting branches/plant, pods/

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plant and seed yield/plant indicating the scope for their improvement through selection. The relationship between seed yield and its components would be of considerable value to breeders for screening breeding materials and selecting donor parents for breeding programs. Some traits of faba bean have a positive as well as a negative correlation. For example, Bond (1966), Lawes (1974) and Shalaby and Katta (1976) reported that yield was highly correlated with number of pods/plant, number of seeds and seed weight/plant in field bean. Poulsen and Knudsen (1980) determined the phenotypic correlation coefficient among weight, number of seeds/pod and seed weight. Positive relationships were obtained between weight of seeds/pod and both seed weight and number of seeds/pod. However, no correlation was found between seed weight and number of seed/pod. Ulukan et al. (2003) found the direct and indirect effects of plant height, pod number/plant and seed number/pod upon biological yield. The total determination coefficient was found to be 0.636 in the model used. A significant and positive correlation was reported between seed yield and plant height, 100-seed weight, seed weight/plant and biological yield, but a negative correlation was determined with maturity date (Alghamdi and Ali, 2004).

The present investigation aimed to determine the variability of traits, provide information on interrelationships of yield with some important yield components and to partition the observed genotypic correlations into their direct and indirect effects. This means that yield has direct and indirect relations with other agronomic traits.

MATERIALS AND METHODS

Experimental procedures

The field experiment was conducted at Dabat in 2010 main cropping season. Dabat is located 12° 59' 3" North latitude and 37° 45' 54" East longitude. It is found in the Amhara National Regional State, North Gondar zone. The area receives average annual rainfall of about 1100 mm, which is sufficient for crop production. The major soil type of the study area is vertisol. The average annual maximum and minimum temperatures are 19.9 and 8.58°C, respectively. Nine faba bean genotypes which are inbreds obtained from Holleta Agricultural Research Center (Degaga, Moti, Gebelcho, Dosha, Wolki, Wayu, Selale, EH99051-3 and Holetta-2 one local check that is, CS20DK) were included in this study. The trial was laid down in randomized complete block design with three replications. Each genotype was planted in four rows of 4 m length by 0.4 m spacing between rows. The distance between replications and plots was 1.5 and 0.6 m, respectively. Diammonium phosphate (DAP) fertilizer was applied at the recommended rate of 100 kg/ha at sowing. Sowing was done by hand drilling at a seed rate of 40 seeds/row or 160 seeds/plot.

Data collection

Data on different agronomic traits were collected on plot and plant basis. Hundred seed weight (g), plant height (cm), number of nodes per plant, number of pods per node and number of pods per plant, were recorded on plant basis; whereas biological yield per plot (g), grain yield per plot (g), biomass (g), days to flowering, days to maturity, disease resistance and stand count at emergency were estimated on plot basis.

Data analysis

The mean values of the recorded data were subjected to analysis of variance (Gomez and Gomez, 1984). The mean squares were used to estimate genotypic and phenotypic variance according to Sharma (1998). Phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were estimated according to the method suggested by Burton and De Vane (1953). Broad sense heritability was calculated as the ratio of genotypic variance to the phenotypic variance according to Falconer and Mackay (1996).

Phenotypic and genotypic correlations between yield and yield related traits were estimated using the method described by Miller et al. (1958). The coefficients of correlations at phenotypic level were tested for their significance by comparing the value of correlation coefficient with tabulated r-value at g-2 degree of freedom. However, the coefficients of correlations at genotypic level were tested for their significance using the formula described by Robertson (1959).

RESULTS AND DISCUSSION

Genetic variability and heritability

In the present study, high phenotypic coefficient of variation (PCV) was observed for 100 seed weight (22.08%), disease resistance (23.98), number of pods per node (33.54%), number of pods per plant (60%), grain yield (67.39%) and biological yield (98.49%). Medium PCV were observed for plant height (16%), stand count at emergency (12.21%) and number of nodes per plant (20%), but the remaining traits showed low PCV (Table 1). The result more or less agreed with that reported by Swarup and Changle (1962).

As reported previously by other investigators like Bond (1966), Omar et al. (1970), Mahmoud et al. (1986) and Abul-Naas et al. (1989), the genetic variance components in traits such as seed yield, number of pods per plant, 100 seed weight and plant height, played an important role in the total variation (Table 1).

High genotypic coefficients of variation (GCV) were observed for biomass yield (80.95%), grain yield (60.85%), number of pods per plant (48.73%) and number of pods per node (22.78%). Moderate genotypic coefficients of variation were estimated for plant height, number of nodes per plant and 100 seed weight. These results were also reported by several authors such as Abul-Naas et al. (1989), El-Hosary and Nawar (1984) and Mahmoud et al. (1986). Low GCV was observed for days to flowering (3.33%), days to maturity (0.85%) and stand count at emergency (6.35%) (Table 1). High GCV value of characters suggested the possibility of improving these traits through selection. Similarly, El-Hosary and Nawar (1984) estimated different levels of GCV in faba bean. Moreover, the differences between PCV and GCV were

Table 1. Variances, coefficient of variations and heritability.

Trait	$\delta^2{}_p$	$\delta^2{}_g$	H%	PCV	GCV
Days to flowering	7.12	3.81	53.51	4.54	3.33
Days to maturity	2.47	1.44	58.29	1.12	0.85
Stand count at emergency	108.06	29.25	27.06	12.21	6.35
Plant height	193.68	88.77	45.83	16.0	10.83
Pods per plant	33.28	21.84	65.62	60.0	48.73
Pods per node	0.52	0.24	46.15	33.54	22.78
Nodes per plant	11.96	3.32	27.76	20.06	10.56
100 seed weight	213.59	154.28	72.23	22.08	18.76
Checolate spot	39.35	17.41	44.25	23.98	15.95
Biomass yield	496.94	335.72	67.56	98.49	80.95
Seed yield	56.47	46.04	81.53	67.39	60.85

$\delta^2{}_p$, Phenotypic variance; $\delta^2{}_g$, genotypic variance; H, heritability; PCV, phenotypic coefficient of variation; GCV, genotypic coefficient of variation.

very narrow which indicated the importance of genetic variance in the inheritance of the studied characters.

Heritability (H) in broad sense estimates were generally high for most studied traits which ranged from 27.06% for stand count at emergency to 81.53% for grain yield. The highest estimate of broad sense heritability (H) was recorded by grain yield, 100 seed weight, biological yield, number of pods per plant, number of pods per node, disease status, days to flowering, days to maturity and plant height, with heritability of 81.53, 72.23, 67.56, 65.62, 46.15, 44.25, 53.51, 58.29 and 45.83%, respectively (Table 1). Hence, these traits can be assumed as mainly determined by their genetic constitution. Stand count at harvest (27.06%) showed medium heritability including number of pods per plant (27.76%) which makes selection for these traits difficult because environmental effect is more evident than genetic effect. However, Dixit et al. (1970) reported that high heritability and GCV were not always associated with high genetic advance. Meanwhile, Swarup and Changle (1962) reported that both heritability ratio and GCV% gave the best picture for the expected genetic advance. Those traits that showed high and moderate heritability are found to have high GCV value than traits that showed low heritability. Selection for these traits is relatively easy because most of the variation is genetic rather than environmental. On the other hand, traits with high PCV have less heritability which means variation for these traits is more of environmental than genetic and it is not advisable to select for these traits. Dabholkar (1992) explained that whenever values are stated for heritability of a character, it refers to a particular population under particular environmental conditions. He classified heritability estimates as low (5 to 10%), medium (10 to 30%) and high (>30%). Accordingly, all the agronomic characters considered for analysis showed high heritability, constituting high breeding value which has more additive genetic effects which is important for crop improvement.

Correlation coefficients

Positive and significant correlation coefficients were obtained between number of pods per node and each of plant height (r = 0.676**), number of pods/plant (r = 0.636**) and number of nodes per plant (r = 0.421*). In the present study, pods per plant had a significant positive correlation with plant height ($p<0.01$) but, according to Alan and Geren (2007) and Ulukan et al. (2003), such pair of characters showed a low level of significance ($p<0.05$) and non-significance, respectively for faba bean as correlation. Seed yield was strongly correlated with number of nodes per plant, number of pods per node, number of pods per plant and plant height with the value of 0.484**, 0.56**, 0.634** and 0.649**, respectively (Table 2). This result shows the yield of plant is determined by these traits. There was a significant correlation between biological yield and plant height as it was also reported by Ulukan et al. (2003). Negative and significant correlations were observed between 100-seed weight and number of pods per plant (r = -0.530**) as well as number of pods per node (r = -0.418*). These results are in disagreement with those obtained by Bond (1966), Lawes (1974), Shalaby and Katta (1976), Poulsen and Kundesn (1980), Ulukan et al. (2003) and Alghamdi and Ali (2004).

Bianco et al. (1979) found positive relationships between yield and plant height, number of branches and pods/plant, number of seeds/pod and 1000-seed weight, whereas, seed yield was negatively correlated with flowering date and the lowest node bearing pods. These findings indicate that selection for each or both of number of pods, nodes and biomass would be accompanied by high yielding ability under such conditions.

Table 2. Correlation coefficients of the main traits of faba bean genotypes.

	DF	DM	NPP	PPN	PPP	PH	HSW
DF							
DM	0.719**						
NPP	0.011	0.1009					
PPN	0.427*	0.382*	0.432*				
PPP	0.1064	0.195	0.410*	0.477**			
PH	0.2619	0.1971	0.421*	0.676**	0.636**		
HSW	0.0694	-0.268	-0.223	-0.418*	-0.530**	-0.305	

DF, Days to flowering; DM, days to maturity; NPP, nodes per plant; PPN, pods per node; PPP, pod per plant; PH, plant height; HSW, hundred seed weight; * and ** significant at 0.05 and 0.01 level of probability, respectively.

Conclusion

The present study illustrated the existence of wide ranges of variations for most of the traits among faba bean genotypes and opportunities of the genetic gain through selection or hybridization. Phenotypic and genotypic correlation analysis showed the positive correlation of grain yield with important agro-morphological characters. Hence, improving one or more of the traits could result in high grain yield for faba bean. Presence of genetic variability and heritability estimates would be helpful to the breeder to estimate genetic advance and to predict percentage of genetic advance in the population(s) under study. Success of genetic improvement is attributed to the magnitude and nature of variability present for a specific character. Accordingly, all the agronomic characters considered for analysis showed high heritability, constituting high breeding value which has more additive genetic effects which is important for crop improvement.

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REFERENCES

Abul-Naas AA, Abdel-Barry AA, Rady, S, El-Shawaf IS, El-Hosary AA (1989). Breeding studies in yield and its components in faba bean (*Vicia faba* L.). Egypt Agron. 14(1-2):117-149.

Alghamdi SS, Ali Kh A (2004). Performance of several newly bred faba bean lines. Egypt. J. Plant Breed. 8:189-200.

Bianco VV, Damato G, Miccolis V, Polignano G, Poerceddu E, Scipa G (1979). Variation in a collection of Vicia faba L. and correlations among agronomically important characters. In: Some current research on *Vicia faba* in Western Europe. Ed. D.A. Bond, G.T. Scarascia-Mugnozza and M.K. Poulsen. Pub. EEC, EUR 6244:125-143.

Bond DA (1966). Yield and components of yield in diallel crosses between inbred lines of winter beans (*Vicia faba* L.). J. Agric. Sci. Camb. 57:352-336.

Bora GC, Gupta SN, Tomer YS, Singh S (1998). Genetic variability, correlation and path analysis in faba bean (*Vicia faba*). Indian J. Agric. Sci. 68(4):212-214.

Burton GW, de Vane EW (1953). Estimating heritability in tall Fescue (*Festuca arundinacea*) from replicated clonal material. Agron. J. 45:478-481.

Dabholkar AR (1992). Elements of biometrical genetics. Concept Publishing Company, (Eds.), New Dehli. p. 431.

El-Hosary AA, Nawar AA (1984). Gene effects in field beans (vicia faba L.) earliness and maturity. Egypt J. Genet. Cytol. 13:109-119.

El-Kady MAK, Khalil SA, (1979). Behaviour of seed yield components in cross between broad bean cultivars and selection for superior yield. Egypt. J. Agron. 4:159-170.

Falconer DS, Mackay TFC (1996). Introduction to quantitative genetics. 4th Ed. Longman, New York. p. 580.

Gomez KA, Gomez AA (1984). Statistical procedures for agricultural research. 2nd Ed. John Willey and Sons, New York.

Haciseferogullari H, Gezer I, Bahtiyarca Y, Menges HO (2003). Determination of some chemical and physical properties of Sakiz faba bean (vicia faba L. Var. major).J. Food Eng. 60:475-479

Lawes DA (1974). Field beans: improving yield and reliability. Span 17:21-23.

Lindemann C, Glover R (2003). Nitrogen fixation by legumes. New Mexico State University, Mexico. http://www.cahe.nmsu.edu/pubs/_a/a-129.pdf.

Mahmoud SA, Al-Ayobi D (1986). Combining ability for yield and its components in broad bean (*Vicia faba* L.) Ann. Agri. Sci. 24(4):1923-1936.

Miller PA, Williams C, Robinson HF, Comstock RE, (1958). Estimates of genotypic and Environmental variances and co-variances in upland cotton and their implications in selection. Agric. J. 50:126-131.

Omar Abdel-Aziz, Selim AKA, Hassanein SH, Abdel-Hafiz SM (1970). Mode of inheritance of protein content and seed weight in broad bean (*Vicia faba* L.) Ain Shams Univ. Res. Bull. 626:1-10

Poulsen MH, Knudsen JN (1980). Breeding for many small seeds/pod in *Vicia faba* L. FABIS Newsletter 2:26-28.

Robertson A (1959). The sampling variance of the genetic correlation coefficient. Biometrics 15:469-485.

Shalaby TA, Katta YS (1976). Path coefficient analysis of seed yield and some agronomic characters in field beans (*Vicia faba* L.). J. Agric. Res. Tanta Univ. 2(2):70-79.

Sharma JR (1998). Statistical and biometrical techniques in plant breeding. New Age International Publication, New Delhi. p. 432.
Swarup V, Changle DS (1962). Studies on genetic variability in Sorghum phenotypic variation and its inheritable component in some important quantitative characters contributing towards yield. Ind. J. Genet. 22:31-36
Ulukan H, Culer M, Keskin S (2003). A path coefficient analysis of some yield and yield components in faba bean (*Vicia faba* L.) genotypes. Pak. J. Biol. Sci. 6(23):1951-1955.