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Estimation of Inter-Generation Parameters in Various Selection Schemes in Four Cowpea Crosses

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ABSTRACT

Estimates of inter-generation parameters indicated that the heritability values calculated from the regression of F_5 lines on F_4 lines using conventional and standard unit procedures were significant in PS (EF) and PS (Hy) in all the four crosses for seed yield per plant. The values of observed and predicted selection differential and response to selection were comparable in PS (EF) in cross 1 and PS (Hy) in cross 4 only. PS (EF) and PS (Hy) of cross 1 showed high estimate of realized heritability. Phenotypic correlations between F_4 and F_5 lines for seed yield per plant were significant only in PS (EF) and PS (Hy) in all the four crosses.

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INTRODUCTION

The most important function of heritability in the genetic studies of metric traits is its predictive role, expressing the reliability of the phenotypic values as a guide of its breeding value which ultimately determines its influence on the next generation. Estimates of heritability in narrow sense and genetic gain in early segregating generations provide basic information for designing an efficient and effective breeding strategy. With this view, the present study was conducted to estimate the heritability by various procedures and to compare the observed and predicted selection differential as well as response to selection.

MATERIALS AND METHODS

Five selection procedures viz., pedigree selection for early flowering [PS(EF)], pedigree selection for high yield [PS(Hy)], mass selection [MS], single seed descent [SSD] and random bulk population [RBP] were applied in F_2 (Summer, 1991), F_3 (*kharif* 1991) and F_4 (Summer 1992) generating in four cowpea crosses (Table 1). PS (EF), PS(Hy) and MS were conducted by selecting 80 superior plants from F_2 to F_4. One seed from each plant taken and bulked under SSD. Seeds from remaining plants were bulked for RBP. Plants to progenies of PS(EF) and PS (Hy) in F_3 and F_4 were evaluated in augmented design with seven parental checks, whereas, populations

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PS (EF) : Pedigree Selection for early flowering.
PS (Hy) - Pedigree Selection for high yield.

(SSD, MS and RBP) were grown in separate block with parents of cross as check. A total of 500 plants to progenies (25 plants selected in each F_4 for each of the five selection schemes) were evaluated in F_5 (*kharif*, 1992) alongwith F_2 and standard checks in Compact Family Block Design with two replications. The plot size was single row of 5.25 m length for progenies and checks and seven rows for F_2. Seeds were dibbled at 0.45 x 0.15 m spacing.

Heritability values were calculated from the regression of F_5 lines on F_4 lines using both the conventional procedure and the standard unit procedure of Frey and Horner (1957). The standard errors of the heritability estimates were obtained following the procedure described by Pesek and Baker (1971). The realized heritability and observed selectrion differential and response to selection were calculated according to the formula suggested by Falconer (1960). The predicted selection differential was calculated as the product of constant (K = 1.12 at 32 per cent selection intensity) and the phenotypic standard deviation of F_4 generation. The predicted response to selection was estimated following the procedure used by O'Brien *et al.* (1978) in which predicted respnse is the product of selection differential and the estimate of heritability from regression of progenies on parents by conventional procedure. The standard error of predicted and observed response were obtained using methods described by Pesek and Baker (1971). Simple phenotypic correlation coefficients by between different segregating generations were calculated in all the selection procedures of four crosses for seed yield per plant.

RESULTS AND DISCUSSION

There are two alternative methods open to the breeder for improving the rate of response to selecttion, one by increasing the heritability and other by reducing the proportion of selected genotypes and to increase the intensity of selection. The heritability can be increased only by reducing environmental variation. Reducing the proportion of the individual selected, seems at first sight to be straight forward means of improving the response but there are several factors to be considered which set a limit to wheat the breeder can do in this way (Falconer, 1960). In the present study, both conventional and standard unit procedures were adopted to calculate heritability values from the regression of F_5 lines on F_4 lines for seed yield per plant and were significant in PS (EF) and PS (Hy) methods in all the four crosses (Table 1). The two methods gave fairly similar values of heritability in PS (EF) of cross 2 and 3 and in PS (Hy) of cross 1, 2 and 4. This indicated that environment did not cause an expansion or contraction of the phenotypic variability present in a population (Frey and Horner, 1957). In general, the standard unit method gave the higher estimates of heritability than the conventional procedures in both the selection methods of cross 1, 2 and 4.

Differences in the ranges and variances between F_4 and F_5 generations within a cross was mainly responsible for the higher estimates of standard unit method of heritability. Similar results were also reported by Frey and Horner (1957). The standard unit method for calculating heritability is useful only when a certain type of scaling factor is operating and have two advantages over the conventional

TABLE 1

Estimates of heritability by parent-off spring regression (F_5 lines on F_4 lines) method, selection differential, response to selection and realised heritability for seed yield per plant in four cowpea crosses.

Selection procedures	Heritability		Selection differential		Response to selection		Realized heritability
	Conventional procedure	Standard procedure	Observd	Expected	Observed	Expected	
			Pusa falguni x V 269 (cross 1)				
PS (EF)	0.44** ± 0.09	0.71** ± 0.15	8.31	8.33	4.33** ± 1.07	3.66** ± 0.78	0.52
PS (HY)	0.39* ± 0.18	0.40* ± 0.19	5.08	3.65	3.01** ± 0.74	1.42* ± 0.68	0.59
			GC 1 x RC 8 (cross 2)				
PS (EF)	0.41** ± 0.12	0.57** ± 0.17	1.74	5.03	0.80 ± 0.79	2.06** ± 0.63	0.46
PS (HY)	0.53** ± 0.12	0.67** ± 0.15	8.05	6.36	1.63 ± 1.06	3.37** ± 0.79	0.20
			GC 2 x V 16 (cross 3)				
PS (EF)	0.50* ± 0.22	0.43* ± 0.19	6.27	4.95	0.01 ± 0.97	2.48* ± 1.13	0.002
PS (HY)	0.84** ± 0.28	0.52** ± 0.18	6.38	3.45	2.07 ± 1.09	2.90** ± 0.99	0.32
			GC 2 x V 240 (cross 4)				
PS (EF)	0.52** ± 0.09	0.76** ± 0.13	3.69	6.37	-1.22 ± 0.96	3.31** ± 0.91	-0.33
PS (HY)	0.40** ± 0.13	0.55** ± 0.17	6.60	6.84	2.18* ± 1.09	2.74** ± 0.92	0.21

*, ** Significant at P = 0.05 and P = 0.01 levels, respectively.

method. First, the ceiling for heritability value is 100 per cent, while in conventional method the ceillings of heritability changes with each set of data. Until the ceilling is known, it is difficult to interpret a value as high, medium or low. Secondly, the standard unit method eliminates the unrealistic values of over 100 per cent and also eliminates the environmental effects of different years which increase or decrease the range of the progenies relative to that of the parents.

The values of observed and expected selection differential were comparable in PS (EF) of cross 1 and PS (Hy) of cross 4. The expected selection differential was higher than the observed differential in PS (EF) of cross 1, 2 and 4 as well as in PS (Hy) of cross 4. This indicated that phenotypic standard deviation may be high and mean phenotypic values of the selected lines close to that of the base population. So it may give lower values of the observed selection differential.

The predicted genetic gain was lower than the realized gain in both the selection methods in cross 1. The observed and expected response to selection was comparable with each other only in PS (EF) of cross 1 and PS (Hy) of cross 4. In rest of the cases, the actual gain, however, did not agree with the estimates of the expected gain. Such lack of the relationship between expected and actual genetic gains has been attributed to heterozygosity of the selected plants at some of the loci and high genotype x environment interaction (Singh and Sharma, 1976).

TABLE 2

Phenotypic correlation coefficients between generations for seed yield per plant in different selection procedures of four cowpea crosses.

Selection procedures	*Generations*	*Pusa Falguni x V 269 (Cross 1)*	*GC 1 x RC 8 (cross 2)*	*GC 2 x V 16 (cross 3)*	*GC z x V 240 (cross 4)*
PS (EF)	F_2 and F_3	-0.12	0.09	0.15	0.15
	F_3 and F_4	-0.05	0.002	0.03	0.14
	F_4 and F_5	0.71**	0.57**	0.43*	0.76**
PS (Hy)	F_2 and F_3	0.18	0.03	0.09	-0.19
	F_3 and F_4	-0.02	0.005	0.08	-0.19
	F_4 and F_5	0.40*	0.67**	0.52**	0.55**
SSD	F_3 and F_4	0.22	0.03	-0.17	0.16
	F_4 and F_5	0.15	-0.20	0.02	-0.06
MS	F_3 and F_4	0.06	0.007	0.06	0.05
	F_4 and F_5	0.11	0.06	-0.02	-0.27
RBP	F_3 and F_4	0.06	-0.05	-0.04	0.01
	F_4 and F_5	-0.25	0.26	-0.14	-0.27

*, ** Significant at P = 0.05 and P = 0.01 levels, respectively.

The realized heritability estimates may vary from generation to generation for the same population and also with a varying magnitude of genotype x environment interaction (Bisen *et al.*, 1985). There was no consistent trend for increase of decrease in heritability estimates in different crosses from F_4 to F_5 generations. In general, both the pedigree methods of selection of cross 1 showed high estimate of realized heritability whereas, the estimate were quite inconsistent in PS (EF) of cross 3 and 4. This showed high genotype x environment interactions playing an important role in the expression of seed yield in these populations. As it is known that the yield is a complex character influenced by several factors, it is possible to get varying estimates of heritability for seed yield of the same cross in different populations created through selection. Similar findings were reported by Tee and Qualset (1975) that heritability values in wheat were changing with breeding procedures and the hybrid material.

Estimates of correlation between yields of different generations have been used as a measure of the effectiveness of selection procedures. In the present study, significant phenotypic correlation coefficients between F_4 and F_5 lines were obtained for seed yield per plant in PS (EF) and PS (Hy) procedures of all the four crosses (Table 2) thereby, indicating that selection in the F_4 generation had a greater role to play on the performance of subsequent generations. The high correlation could be due to the fact that F_4 generation had large number of near homozygous genotypes. Knott and Kumar (1975) suggested the use of later generation for yield in wheat since it attains a reasonable degree of homozygosity. However, non-significant phenotypic correlations were obtained in other generations in PS (EF) and PS (Hy) as well as in all the generation in SSD, MS and RBP of all the four crosses. The observed inconsistency in performance of different generations of cowpea crosses may have been caused by high genotype x environment interactions, as the different generations were studied in different seasons. Breaking of genetic linkages might have caused changes in performance and genetic shift in the various populations during their production cycles might have added to the inconsistency (Bejiga *et al.*, 1991). Non-significant or inconsistent correlations among different generations have also been reported by Virupakshappa (1984) in cowpea. Genotype x environment interaction tends to reduce the correlation between generations, especially when one is evaluating early generation material for seed yield (O'Brien *et al.*, 1978).

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