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Estimation of Inter-Generation Parameters in Various Selection Procedures in Desi Chickpea (*Cicer arietinum* L.) Crosses

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ABSTRACT

Estimates of inter-generation parameters indicated that the heritability values calculated from the regression of F_4 lines using conventional and standard unit procedures were significant in PS (HY) and PS (EF) in all the four crosses for seed yield per plant. The expected selection differential was higher than observed values in case of PS (EF) in all the four crosses, while it was lower in case of PS (HY) in all the four crosses of chickpea studied. The predicted genetic gain was lower than the realized gain in both the selection methods in all the four crosses except PS (EF) in cross 1. The highest estimate of realized heritability was observed in PS (HY) in cross 4, which was followed by PS (EF) in cross 4 and PS (HY) in cross 3. The PS (HY) in cross 1 and cross 2; and PS (EF) in cross 2 and cross 3 showed moderate estimate of realized heritability. Significant phenotypic correlation coefficients between F_2 and F_3 lines were obtained for seed yield per plant and number of pods per plant in PS (HY) procedures of all the four crosses except for number pods per plant in cross 4; in PS (EF) procedures of all the four crosses except for cross 2 and number of pods per plant in cross 3.

Key words: *Inter-generation parameters, Breeding methods, Correlation*

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 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

Four selection procedures viz., pedigree selection for high yield [PS (HY)], early flowering [PS(EF)], single seed descent (SSD) and random bulk population (RBP) were applied in F_2 (*Rabi* 2012-13) F_3 (*Rabi* 2013-14) generating in four chickpea crosses (Table1).

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PS (HY), PS (EF) were conducted by selecting 80 superior plants from F_2 to F_3. One seed from each plant taken and bulked under SSD. Seeds from remaining plants were bulked for RBP. Plants to progenies of PS (HY) and PS (EF) in F_3 was evaluated in augmented design with eight parental checks, whereas, populations (SSD and RBP) were grown in separate block with parents of cross as check. A total of 400 plants to progenies (25 plants selected in each F_3 for each of the four selection schemes) were evaluated in F_4 (*Rabi* 2014-15) alongwith F_2 and standard checks in Compact Family Block Design with three replications. The plot size was single row of 3.0 m length for progenies and checks and two rows for F_2. Seeds were grown at 0.45 x 0.15 m spacing.

Heritability values were calculated from the regression of F_4 lines on F_3 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[7]. The realized heritability and observed selection differential and response to selection were calculated according to the formula suggested by Falconer[3]. 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*.[6] in which predicted response is the product of the selection differential and the estimate of heritability from regression of progenies on parents by conventional procedure. The standard errors of predicted and observed response were obtained using methods described by Pesek and Baker[7]. Phenotypic correlation coefficients 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 selection, 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 what the breeder can do in this way[3]. The heritability estimated by parent-offspring regression methods, observed and expected selection differential as well as response to selection and realized heritability for seed yield per plant in F_4/F_3 generation of four chickpea crosses are presented in Table 1. In present study, the heritability values calculated from the regression of F_4 lines on F_3 lines, using conventional procedure and standard unit procedure were significant in both the selection procedures *viz.*, PS (HY) and PS (EF) in all the four crosses. The standard unit method gave the higher estimate of heritability than the conventional procedure in both the selection methods of cross 2; in PS (EF) in crosses 1, 3 and 4. Difference in the ranges and variance between F_3 and F_4 generations within a cross was responsible for the higher estimates of standard unit method of heritability[4]. The standard unit method of calculating heritability is useful only when a certain type of scaling factor is operating and have two advantages over the conventional method. First, the ceiling for heritability changes with each set of data. Until the ceiling is known it is difficult to interpret a value as high, medium or low. Secondly, the standard unit method eliminates the environmental effects of different years which increase or decrease the range of the progenies relative to that of the parents. The reverse was true for PS (HY) in crosses 1, 3 and 4. The two methods of heritability estimated were close to each other in cross 2 for both the methods.

The expected selection differential was higher than observed values in case of PS (EF) in all the four crosses. This indicated that phenotypic values of the selected lines close to that of the base population so it may give lower values of the observed selection differential. While it was lower in case of PS (HY) in all the four crosses of chickpea studied.

The predicted genetic gain was lower than the realized gain in both the selection methods in all the four crosses except PS (EF) in cross 1. In this case relationship between expected and actual gains has been attributed to homozygosity of the selected plants at this loci and low genotype x environment interaction[5,8].

The realized heritability estimates may vary from generation to generation for the same population and also with a varying magnitude of genotype x environment interactions[2]. There was no consistent trend for increase or decrease in heritability estimates in different crosses from F_3 to F_4 generations. The highest estimate of realized heritability was observed in PS (HY) in cross 4 (2.70) which was followed by PS (EF) in cross 4 (2.57) and PS (HY) in cross 3 (2.16). The PS (HY) in cross 1 and cross 2; and PS (EF) in cross 2 and cross 3 showed moderate estimate of realized heritability. The value of realized heritability in PS (EF) of cross 1 was quite low. 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. Tee and Qualset[9] observed that heritability value in wheat were changing with breeding procedures and the hybrid material.

Phenotypic correlation coefficients between different segregating generations for seed yield per plant and number of pods per plant in different selection procedures for four chickpea crosses are presented in Table 2. In the present study, significant phenotypic correlation coefficients between F_2 and F_3 lines were obtained for seed yield per plant and number of pods per plant in PS (HY) procedures of all the four crosses except for number pods per plant in cross 4; in PS (EF) procedures of all the four crosses except for cross 2 and number of pods per plant in cross 3. The significant correlation coefficients between F_3 and F_4 lines for seed yield per plant in PS (HY) of cross 4 (-0.247); in RBP of crosses 3 and 4 (0.610 and -0.317); in SSD of cross 2 (-0.369).

Number pods per plant had significant and negative relationship with F_3 and F_4 lines in PS (EF) of cross 4 (-0.317); in RBP of cross 4 (-0.575); and in SSD of cross 2 (-0.258). Thereby indicating that selection in the generation had a greater role to play on the performance of subsequent generations. The high correlation could be due to the fact that F_3 generation had more number of heterozygous genotypes. The observed inconsistency in performance of different generations of chickpea 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[1]. Non-significant or inconsistent correlations among different generations have also been reported by some workers[5,10,11]. Genotype x environment interaction tends to reduce the correlation between generations, especially when one is evaluating early generation material for seed yield[6].

Table 1: Estimate of heritability by parent-offspring regression (F_4 lines on F_3 lines) method, selection differential, response to selection and realized heritability for seed yield per plant in four chickpea crosses

Selection procedures	Heritability		Selection differential		Response to selection		Realized heritability
	Conventional procedure	Standard unit procedure	Observed	Expected	Observed	Expected	
GJG 0315 x ICCV 96029 (cross 1)							
PS(HY)	1.85** ± 0.16	0.92**± 0.08	4.03	1.92	6.72**± 0.21	3.55 ± 1.89	1.89
PS(EF)	0.33** ± 0.03	0.94**± 0.07	4.77	5.90	0.59 ± 0.35	1.92**± 0.15	0.30
GAG 0419 x JCP 245 (cross 2)							
PS(HY)	0.70** ± 0.07	0.90**± 0.09	4.24	2.71	3.65**± 0.25	1.89**± 0.20	1.93
PS(EF)	0.83**± 0.07	0.92**± 0.08	1.90	3.56	4.46**± 0.22	2.94**± 0.26	1.52
GJG 0107 x GCP 105 (cross 3)							
PS(HY)	1.85** ± 0.26	0.82**± 0.12	4.16	2.06	8.19**± 0.17	3.80**± 0.55	2.16
PS(EF)	0.31** ± 0.03	0.93**± 0.08	4.03	5.10	2.53**± 0.39	1.77**± 0.14	1.43
GJG 0719 x SAKI 9516 (cross 4)							
PS(HY)	2.11**± 0.21	0.90** ± 0.09	3.33	1.79	10.22**± 0.16	3.78**± 0.38	2.70
PS(EF)	0.47**± 0.04	0.92** ± 0.08	3.77	4.95	5.97**± 0.35	2.32**± 0.20	2.57

*,** Significant at 5% and 1% levels, respectively

Table 2: Phenotypic correlation coefficients between generations for seed yield per plant and number of pods per plant in different selection procedures of four chickpea crosses

Selection procedures	Generations	GJG 0315 x ICCV 96029 (cross 1)		GAG 0419 x JCP 245 (cross 2)		GJG 0107 x GCP 105 (cross 3)		GJG 0719 x SAKI 9516 (cross 4)	
		Seed yield per plant (g)	Number of pods per plant	Seed yield per plant (g)	Number of pods per plant	Seed yield per plant (g)	Number of pods per plant	Seed yield per plant (g)	Number of pods per plant
PS(HY)	F_2 and F_3	0.904**	0.663**	0.925**	0.407**	0.926**	0.493**	0.854**	0.205
	F_3 and F_4	-0.016	-0.216	-0.169	0.138	-0.197	-0.069	-0.247*	-0.059
PS(EF)	F_2 and F_3	0.958**	0.785**	0.121	0.031	0.232*	0.160	-0.317**	-0.361**
	F_3 and F_4	0.140	0.103	-0.002	-0.188	0.027	0.080	-0.129	-0.317**
RBP	F_3 and F_4	0.170	0.244*	0.067	0.023	0.610**	0.463**	-0.317**	-0.575**
SSD	F_3 and F_4	-0.201	-0.306	-0.369**	-0.258*	-0.024	0.076	0.008	0.170

*,** Significant at 5% and 1% levels, respectively

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