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Studies on Genetic Variability, Correlation and Path Coefficient Analysis for Yield and Yield attributes in Chickpea (*Cicer arietinum* L.)

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ABSTRACT

The present investigation was carried out to study genetic variability, correlation, and path coefficient analysis in thirty-six chickpea genotypes (Cicer arietinum L.). The success of the breeding program is largely dependent on the genetic variability available in the existing germplasm and its efficient utilization in the breeding program. GCV and PCV, heritability, and genetic advance expressed as a percentage of the mean were estimated. Correlation and path coefficient analysis was carried out to identify yield contributing traits. Phenotypic coefficients of variation (PCV) were higher than genotypic coefficients of variation (GCV) for all the traits. The number of primary branches per plant and seed yield per plant exhibited moderate PCV & GCV. Maximum heritability and genetic advance over mean were recorded for 100-seed weight followed by seed yield per plant among all the characters studied. The traits 100-seed weight and number of pods per plant have a favorable and highly significant correlation with seed yield. 100 seed weight had the most positive direct effect on seed yield per plant, followed by the number of pods per plant. Correlation and path coefficient analysis indicated selection based on numbers of pods per plant and 100-seed weight are important to achieve higher seed yield in chickpea crop improvement.

Keywords: *Chickpea, Correlation, GCV, Path coefficient, Variability, PCV, heritability*

Introduction

Chickpea (*Cicer arietinum* L.) is an important legume crop grown during the Rabi season on residual soil moisture. Madhya Pradesh, Rajasthan, Telangana, Maharashtra, Karnataka, Uttar Pradesh, and Andhra Pradesh are among the states where chickpea is mostly cultivated. During 2019-20, chickpea was grown on 97 lakh hectares in India, with production and productivity of 11.08 MT and 1142 kg/ha, respectively. (Source: Directorate of Economics and Statistics, DAC&FW 2019-20). The crop produces a significant amount of residual nitrogen for future crops; increasing soil quality, long-term stability, and sustainability. Yield enhancement has been the major focus in chickpea crop improvement and is possible through the selection and utilization of superior genotypes in breeding programs. Yield is a complex character that is affected by a number of factors, including the environment. Yield and yield contributing variables are the most often targeted traits in chickpea improvement projects.

Since the success of the breeding program is dependent on the existence of genetic diversity in the population, the first step would be to assess the genetic variability of the base population. Correlation analysis identifies the component traits on which selection may be based for genetic yield enhancement by measuring the mutual relationship between various factors. The correlation coefficient is a statistical metric used to determine the strength (or direction) of a relationship between two or more variables. Plant breeders can utilize path analysis to estimate yield contributing characteristics, which can help them choose elite genotypes from a heterogeneous population. The association of one or more characters influenced by a large number of genes is elaborated statistically by correlation coefficients. The genotypic correlation coefficient provides a measure of genotype conjugation between characters. Partitioning of correlation into direct and indirect effects using path coefficients analysis was proposed by earlier researchers [1]. It offers helpful information on the relative advantages of the selection criterion. The selection of parents is based on phenotypic divergence, but knowledge of existing genetic variability with regard to trait improvement is critical for effective breeding. Correlation and path analysis are important in designing breeding strategies in applied plant breeding because they give information on the genetic association of yield and yield contributing characteristics.

Material and methods

Thirty-six chickpea genotypes from Agricultural Research Station, Adilabad were sown in randomized block design at the PJTSAU college farm during Rabi 2020-21. The crop was grown in 4m row plots with 30 cm between the rows and 10 cm spacing

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between the plants. The required agronomic procedures were followed to raise a good crop. Five plants were chosen at random for the data collection on days to 50% flowering, days to maturity, plant height (cm), number of primary branches per plant, number of pods per plant, 100 seed weight (g), and seed yield/plant (g). The data were statistically analyzed to determine GCV and PCV, heritability, and genetic advance expressed as a percentage of the mean. The phenotypic coefficient of correlation was computed [2]. The phenotypic connection was divided into direct and indirect effects [3]. The statistical program WINDOSTAT Version 9.2 was used to analyze the data.

Results and discussion

Analysis of variance revealed significant differences among the chick genotypes for all the traits studied. Mean, range, and standard error are presented in Table 1. The range of variation was highest for seed yield per plant and lowest for the number of pods per plant. The genetic parameters such as genotypic and phenotypic variability, genotypic and phenotypic coefficient of variation, heritability, and genetic advance as a percent of the mean are given in Table 1.

A relatively higher phenotypic coefficient of variation was observed compared to the genotypic coefficient of variation for all the traits which indicates the influence of environment on trait expression. The range of PCV observed was 7.03 to 20.45% for the characters which indicates the extent of phenotypic variability in the population. Moderate PCV was observed for the number of primary branches per plant (20.45%) followed by seed yield per plant (19.28%), while the number of pods per plant (8.24%), plant height (7.20%) and days to maturity (7.03%) had low PCV. The extent of genetic variability revealed by the genotypic coefficient of variation ranged from 3.55% to 13.32%. Moderate GCV was recorded for seed yield per plant (13.32%), followed by the number of primary branches per plant (12.95%) and 100 seed weight (12.30%). Low GCV was observed for days to 50% flowering (8.40%), number of pods per plant (4.37%), plant height (4.36%), and days to maturity (3.55%). The efficiency of selection is dependent on both GCV and heritability (Burton, 1952). The heritability (broad sense) ranged from 25 to 85%. The character's 100-seed weight and seed yield per plant exhibited relatively higher heritability and moderate GCV. Earlier studies reported high heritability for seed yield and yield contributing traits in chickpeas such as 100 seed weight [4-8]. Genetic advance over mean (GAM) expressed as a percentage of mean was highest for the trait 100-seed weight (23.47%) followed by seed yield per plant (18.97%). A higher magnitude of genetic advance for yield and component traits was observed in chickpeas by several researchers [9, 8]. Seed yield per plant, 100-seed weight, number of pods per plant, and harvest index had a high genotypic coefficient of variation, high heritability, and genetic advance as a percent of the mean, indicating that response to selection will be very high for these traits [10]. In the current study, the trait 100-seed weight had high heritability and moderate genetic advance as a percentage of the mean in comparison to other traits. This trait can be reliable selection criterion for chickpea crop improvement. While characters including primary branches per plant and days to 50% flowering had moderate heritability, they had low estimates of genetic advance over mean, which may be due to the low variability in the experimental material.

Correlation coefficients were calculated to determine the relationship between seed yield per plant and its components at the genotypic (rg) and phenotypic (rp) levels. The data showed that the genotypic correlation coefficients were generally higher than the phenotypic correlations. Seed yield per plant exhibited a highly significant and positive correlation with pods per plant (0.6020**) and 100-seed weight (0.9471**) at the genotypic level (Table 3). Days to maturity were positively correlated with seed yield per plant both genotypically and phenotypically. 100-seed weight (0.8697**) and number of pods per plant (0.6334**) showed a highly significant positive phenotypic correlation with seed yield per plant. The data indicated that the number of pods per plant and 100 seed weight are the most important selection criteria for chickpea crop improvement. Similar results were reported earlier by several researchers. A significant and positive correlation was observed for pods per plant and 100-seed weight with seed yield per plant both genotypically and phenotypically. These traits serve as valuable selection indices for the production of high-yielding genotypes in chickpeas [11, 7].

Path coefficient analysis revealed that 100 seed weight (0.7783) exerted a maximum positive direct effect on seed yield per plant followed by the number of pods per plant (0.4915) indicating that yield improvement is directly influenced by these traits. The direct effect of 100 seed weight on seed yield per plant was mainly due to indirect effects via the number of pods/plant (0.1405) while the direct effect of the number of pods/plant on seed yield per plant was mainly due to indirect effects via 100 seed weight (0.0888) and days to 50% flowering (0.0145). The trait 100 seed weight and number of pods per plant exhibited a higher positive direct effect among all the traits and hence can be considered as the major yield-contributing trait (Table 4). Path coefficients at both the genotypic and phenotypic levels indicated that the number of pods per plant, number of seeds per plant and 100-seed weight had maximum direct contribution towards seed yield per plant. Because of their significant and high positive correlation with seed yield, the number of pods per plant and 100-seed weight has been identified as the key traits for selection in chickpea breeding program [12]. The number of pods per plant and 100 seed weight had the most beneficial direct impact on single plant yield [13], while biological yield per plant, the number of pods per plant, and the 100 seed weight showed maximum direct positive effect for seed yield [10].

Future scope of the study

For all of the traits studied, the GCV values were lower than the corresponding PCV indicating environmental influence. Seed yield per plant was significantly and positively correlated with the number of pods per plant and 100 seed weight. Selection based on these traits will improve seed yield. Path analysis indicated that pods per plant and 100 seed weight exerted the greatest direct effect. Hence selection based on these traits will improve seed yield in chickpea varietal development programs.

Conflict of interest

All authors declare that they have no conflicts of interest.

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Table 1. Estimates of GCV, PCV, h_b^2, Genetic advance of seven characters in chickpea

Characters	Mean	Range	SE	PCV (%)	GCV (%)	h^2 (bs) (%)	GA	GAM (%)
Days to 50% flowering	46.02	37.66 - 55.33	1.59	10.32	8.40	0.66	6.49	14.10
Plant height (cm)	58.12	50 - 63.83	1.92	7.20	4.36	0.36	3.16	5.44
Primary branches per plant	6.25	4.33 – 7.67	0.57	20.45	12.95	0.40	1.05	16.89
Number of pods per plant	39.68	35 - 45.67	1.6	8.24	4.37	0.28	1.89	4.77
Days to maturity	98.62	86.66 - 106.33	3.45	7.03	3.55	0.25	3.64	3.69
100-seed weight (gm)	27.27	20 - 34.16	0.79	13.31	12.3	0.85	6.40	23.47
Seed yield per plant (gm)	10.78	7.86 - 14.50	0.53	19.28	13.32	0.47	767.65	18.97

Table 2. Estimates of genotypic and phenotypic correlation coefficients for yield related traits of chickpea genotypes

Characters	R	Days to 50% flowering	Plant height (cm)	Primary branches per plant	Number of pods per plant	Days to maturity	100-seed weight(g)	Seed yield per plant (g)
Days to 50% flowering	G	**1.0000**	0.427	0.0378	-0.2279	0.2818**	-0.0132**	-0.0769*
	P	**1.0000**	0.2547*	-0.0614	0.0295	0.1448	-0.0192**	0.0061
Plant height (cm)	G		**1.0000**	-0.1512	-0.3719	0.0549	-0.0161	-0.1473
	P		**1.0000**	-0.0660	-0.2252*	0.0886	0.0167	-0.1005
Primary branches per plant	G			**1.0000**	0.0589	0.1052**	-0.1972	-0.1588
	P			**1.0000**	-0.0044	-0.0779	-0.1549	-0.1423
Number of pods per plant	G				**1.0000**	0.0539	0.3138	0.6020**
	P				**1.0000**	0.0220	0.1806	0.6334**
Days to maturity	G					**1.0000**	0.1479	0.1250
	P					**1.0000**	0.0186	0.0190
100-seed weight (g)	G						**1.0000**	0.9471**
	P						**1.0000**	0.8697**
Seed yield per plant (g)	G							**1.0000**
	P							**1.0000**

*, **Significant at 5% and 1% level, respectively.

Table 3. Phenotypic path coefficient showing direct and indirect effect of characters on seed yield in chickpea

Characters	Days to 50% flowering	Plant height(cm)	Primary branches per plant	Number of pods per plant	Days to maturity	100 seed weight(g)	Correlation with seed yield per plant
Days to 50% flowering	**0.0080**	0.0020	-0.0005	0.0002	0.0012	-0.0002	0.0061
Plant height (cm)	-0.0014	**-0.0054**	0.0004	0.0012	-0.0005	-0.0001	-0.1005
Primary branches per plant	0.0012	0.0013	**-0.0201**	0.0001	0.0016	0.0031	-0.1423
Pods per plant	0.0145	-0.1107	-0.0022	**0.4915**	0.0108	0.0888	0.6334
Days to maturity	-0.0012	-0.0008	0.0007	-0.0002	**-0.0085**	-0.0002	0.0190
100 seed weight (gm)	-0.0150	0.0130	-0.1205	0.1405	0.0145	**0.7783**	0.8697

Residual effect = 0.0922

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