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Genetic variability, correlation and path coefficient analysis for yield and its component traits in chickpea (*Cicer arietinum* L.)

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Abstract
The present study was aimed to estimate the extent of genetic variability for yield & its components traits, genetic association, path coefficient analysis in forty-five genotypes of chickpea (*Cicer arietinum* L.). The experiment was conducted at Pulse research farm, Bhitti, Bihar Agricultural University, Sabour during Rabi season 2018-19. High values of phenotypic and genotypic coefficients of variation were noticed for 100 seed weight and number of pods per plant. The genotypic coefficient of variation obtained for yield and its attributing traits ranged from 0.46-26.09. Moderate genotypic coefficient of variation was observed number of pods per plant, grain yield per plot and plant height. Phenotypic coefficient of variation was recorded highest for 100 seed weight followed by number of pods per plant and grain yield per plot. High heritability was recorded for days to 50% flowering, 100 seed weight and number of pods per plant. High heritability coupled with high genetic advance was recorded by 100 seed weight, number of pods per plant and grain yield per plot. High genetic advance indicated that, additive genes govern these characters and selection will be rewarding for improvement of these traits. Correlation analysis revealed that grain yield exhibited significant and positive correlation with number of pods per plant and while it showed significant and negative association with days to maturity. Path analysis revealed that number of pods per plant, plant height and days to 50% flowering had highest direct positive effect on grain yield. The present study has clearly indicated the need for giving due weight age to 100 seed weight, number of pods per plant for improving yield in chickpea. The above mention traits should be given due emphasis for future chickpea genetic improvement because they possess high genetic variance, heritability coupled with high genetic correlation among themselves which may yield high genetic advance under proper selection pressure in a breeding programme.

Keywords: *Cicer arietinum* L., genetic variability, correlation coefficient and path analysis

Introduction
Chickpea (*Cicer arietinum* L.) is a self-pollinated crop (2n=2x=16) and genome size of 732 Mb. India is the global leader in chickpea production and produces about 15 times as much as the second largest chickpea producer in the world- Australia. As per the global production data, India produced 72.02 percent of the total global chickpea production (13.71 million tonnes). The global importance of chickpea has considerably increased during the past three decades. The number of chickpeas growing countries has increased from 36 to 52 and importing countries from 30 to 150 during 1981 to 2011. Chickpea continued to remain the most important pulse crop of India both in terms of both production and consumption.
Chickpea occupies about 36% of the pulse area and contributes to about 43% to the country's

pulse production.

The improvement in crop yield depends upon the genetic variability available in breeding material and the extent to which the yield component traits are heritable from generation to generation. Genetic variation among traits is important for breeding and in selecting desirable types. On the other hand, an analysis of the correlation between seed yield and yield components is essential in determining selection criteria; however, path coefficient analysis helps to determine the direct effect of traits and their indirect effects on other traits. The purpose of this study was to estimate the total genotypic variability, correlations, and path analysis among some important traits for selection criteria for improving yield in chickpea under normal sown condition.

Materials and methods

The experimental material comprised of forty-five genotypes of chickpea in Rabi 2018-19 at Pulse Research Farm, Bihar Agricultural University, Sabour (Bhagalpur). The experiment was laid in randomized complete block design with three replications during Rabi 2018-19 with inclusion of the recommended packages and practices needed for a healthy crop. Data for six quantitative traits were recorded viz. days to 50% flowering, days to maturity, plant height (cm), number of pods per plant, 100 seed weight (g) and grain yield per plot. The days to 50% flowering, days to maturity, and seed yield per plot were accounted on a plot basis and plant height, number of pods per plant and 100 seed weight (g) were documented from random sample of five plants in each plot. Data were subjected to statistical analysis to work out genotypic (GCV) and phenotypic (PCV) coefficients of variation, heritability and genetic advance as per cent of mean as per standard methods. Standard statistical procedure was used for the analysis of variance, genotypic and phenotypic coefficients of variation (Burton, 1952) [6], heritability (Hanson *et al.*, 1956) [9] and genetic advance (Johnson *et al.*, 1955) [11]. The genotypic and phenotypic correlation coefficients were computed using genotypic and phenotypic variances and co-variances (Al Jibouri *et al*., 1958) [2]. The path coefficient analysis was done according to the method by Dewey and Lu (1959) [7].

Results and discussion

The analysis of variance revealed significant differences among the genotypes for all the characters (Table-1). This in turn indicated that there was sufficient variability in the material studied, which could be utilized in further breeding programme. The estimation of genetic variability parameters for yield, its components traits are presented in Table-02. The phenotypic coefficient of variation was found to be higher than the genotypic coefficient of variation for all traits under study. High values of phenotypic and genotypic coefficients of variation were higher for important traits including 100 seed weight and number of pods per plant. The genotypic coefficient of variation obtained for yield and its attributing traits ranged from 0.46-26.09. Moderate genotypic coefficient of variation was observed number of pods per plant, grain yield per plot and plant height. Phenotypic coefficient of variation was high for 100 seed weight followed by number of pods per plant and grain yield per plot. Higher genotypic and phenotypic coefficient of variation was 100 seed weight and number of pods per plant indicated that, these test hybrids exhibited much variation among themselves with respect to these characters offering more scope for selection. High GCV for number of effective pods per plant and 100-seed weight were also earlier reported by Jeena *et al.* (2005) [10], Alwani *et al.* (2010) [3] and Babbar *et al*. (2012) [4]. For different characters range of heritability varied from 8.70 to 90.80 per cent (Table-2). The highest heritability was shown for days to 50% flowering, followed by 100 seed weight and number of pods per plant. Genetic advance as percent of mean ranged from 0.27 for yield per plant to 51.16. High heritability coupled with high genetic advance was recorded by 100 seed weight, number of pods per plant and grain yield per plot. High genetic advance indicated that, additive genes govern these characters and selection will be rewarding for improvement of these traits. Similar results were reported by Shreelakhsmi *et al.,* (2010) [17] and Kumar *et al*., (2017) [12] for characters showing high genotypic coefficient of variation coupled with high heritability and genetic advance as percentage of mean were taken as selection criteria in breeding programme. High heritability coupled with low genetic advance, low heritability with high genetic advance or low heritability and low genetic advance offers less scope for selection because of non-additive genetic effects. High heritability coupled with high genetic advance showed greater proportion of additive genetic variance and consequence a high genetic gain expected from selection. The characters having heritability with low genetic advance as percent of mean appeared to be controlled by non-additive gene action and selection for such characters may not be effective.

Yield is the result of the expression and association of several yield attributing traits, which contribute additively or help in some conditions in modifying the expression of other traits directly or indirectly. It is therefore desirable for plant breeder to know the extent of relationship between yield and its various components, which will inevitably facilitate selection of desirable characteristics. Phenotypic correlation analysis revealed that grain yield exhibited significant and positive correlation with number of pods per plant and while it showed significant and negative association with days to maturity and 100-seed weight (Table-3). Similar findings were reported by Telebi *et al.* (2007) [18], Hahid *et al.* (2010) [8], Ali *et al.* (2011) [1] and Kumar *et al*. (2017) [12].

Path coefficient analysis provides an effective means of partitioning correlation coefficients into unidirectional and alternative pathways thus permitting a critical examination of specific factors that produce a given correlation, which can be successfully employed in formulating an effective selection programme. Path analysis (Table-4) revealed that number of pods per plant had highest direct positive effect on grain yield followed by plant height and days to 50% flowering. The result is in close conformity with that of Talebi *et al.* (2007) [18], Babbar *et al*. (2012) [4] and Kumar *et al.* (2017) [12]. From the present study it can be inferred that the characters viz. number of pods per plant, plant height and days to 50% flowering. Therefore, these characters should be considered for selection to improve yield. The above mention traits should be given due emphasis for future chickpea genetic improvement because they possess high genetic variance, heritability coupled with high genetic correlation among themselves which may yield high genetic advance under proper selection pressure in a breeding programme.

Table 1: Analysis of variance for six different characters in forty-five chickpea genotypes

S. No.	Characters	Mean sum of squares		
		Replication (df =02)	Treatment (df =44)	Error (df =88)
1.	Days to 50% flowering	17.89	104.35**	3.41
2.	Days to maturity	3.82	4.94**	3.85
3.	Plant height (cm)	49.12	171.63**	45.36
4.	No. of pods per plant	40.86	315.93**	54.52
5.	100-seed weight (g)	6.65	118.56**	3.98
6.	Grain yield/plot	311.29	247398.67**	48391.81

**-Significant at 1% level

Table 2: Estimation of genetic parameters of variability for six characters in chickpea

Sl. no.	Characters	σ^2g	σ^2p	GCV	PCV	h^2 (%)	Genetic advance	Genetic advance as % mean
1.	Days to 50% flowering	33.64	37.06	7.20	7.56	90.80	11.38	14.14
2.	Days to maturity	0.36	4.21	0.46	1.56	08.70	0.36	0.27
3.	Plant height (cm)	42.08	87.45	11.31	16.30	48.10	9.27	16.16
4.	No. of pods per plant	87.13	141.66	18.67	23.81	61.50	15.08	30.17
5.	100-seed weight (g)	38.19	42.17	26.09	27.42	90.60	12.11	51.16
6.	Grain yield/plot	66335.62	66335.62	12.90	16.97	57.80	403.44	20.20

Table 3: Genotypic and phenotypic correlation for six characters in chickpea

Characters		Days to 50% flow.	Days to maturity	Plant height	No. of pods/plant	100-seed weight (g)	Grain yield/plot
Days to 50% flowering	G	1.000	0.3818	0.2382	0.0073	-0.1186	0.1320
	P	1.000	0.1204	0.2130	0.0109	-0.0774	0.0690
Days to maturity	G		1.000	-0.1354	-0.7501	1.0025	-0.9655
	P		1.000	-0.0478	-0.2335**	0.2910**	-0.1712*
Plant height	G			1.000	0.1040	0.1681	0.0808
	P			1.000	0.0348	0.1154	0.0576
No. of pods/ plant	G				1.000	-0.3489	0.3996
	P				1.000	-0.2247**	0.2088*
100-seed weight (g)	G					1.000	-0.3829
	P					1.000	-0.3096**

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

Table4: Direct and indirect effects of component traits on seed yield per plant in chickpea for yield and its component traits

Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of pods per plant	100-seed weight (g)	Grain yield/plot
Days to 50% flowering	0.0393	0.0047	0.0084	0.0004	-0.0030	0.0690
Days to maturity	-0.0077	-0.0643	0.0031	0.0150	-0.0187	-0.1712
Plant height (cm)	0.0154	-0.0035	0.0725	0.0025	0.0084	0.0576
No. of pods per plant	0.0014	-0.0306	0.0045	0.1309	-0.0294	0.2088
100-seed weight (g)	0.0207	-0.0777	-0.0308	0.0600	-0.2669	-0.3096

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