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INVESTIGATION OF GENETIC PARAMETERS FOR QUANTITATIVE TRAITS IN CHICKPEA (*CICER ARIETINUM* L.)

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ABSTRACT

The 34 chickpea genotypes were investigated at the Field Experimentation Centre of the Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, U.P., during *Rabi* 2017-2018. The experiment was conducted in a Randomized Block Design with three replications. Observations were recorded on five randomly selected plants for all nine quantitative traits from each replication. The mean sum of squares due to genotypes showed significant differences for all traits. The genotype CSJ-1085 (15.91) exhibited maximum seed yield per plant (g), whereas the low value of seed yield per plant (g) was exhibited by genotype CSJ-1101 (5.70). High magnitudes of GCV and PCV were recorded for pods per plant. Heritability estimates were found to be high (more than 60%) for harvest index (%), followed by seed yield per plant (g), seed index (g), biological yield per plant (g), number of pods per plant, plant height (cm), and days to maturity. High genetic advance was recorded for the number of pods per plant and plant height (cm). Whereas high genetic advance as a percentage of mean was recorded for a number of pods per plant, seed yield per plant (g), plant height (cm), seed index (g), biological yield per plant (g), and harvest index (%).
***Keywords*:** Variability, Chickpea, Genetic advance, Heritability, GCV and PCV.

Introduction

Chickpea (*Cicer arietinum* L.), an important *Rabi* season legume crop, is cultivated extensively across the globe. The genus *Cicer* is derived from the Greek word *kiros*, associated with the Roman family name Cicero, while the species name *arietinum* originates from the Latin word *arise*, meaning "ram," referencing the ram-head shape of the seed (Singh *et al.,* 1999). Chickpea is a diploid species (2n = 2x = 16), self-pollinated, and belongs to the subfamily *Papilionoideae*, tribe *Cicereae* of the family *Leguminosae*. It is widely known by various names such as Bengal gram, chana, and kadle in different regions.

Globally, chickpea ranks as the third most important pulse crop after beans and peas, occupying around 12 million hectares with an annual production of approximately 8.9 million tons. It significantly contributes to sustainable agriculture by fixing atmospheric nitrogen up to 141 kg/ha through root nodules in symbiosis with *Rhizobium* spp., thereby enhancing soil fertility and structure (Khan *et al.,* 2006). Chickpea is rich in protein (19–29%), carbohydrates (61.5%), fat (4.5%), and essential minerals like phosphorus, calcium, and iron, making it nutritionally valuable (Saxena, 1990).

The estimation of genetic parameters such as genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability, and genetic advance is crucial for understanding the extent of

variability and the potential for improvement in chickpea. GCV and PCV indicate the range of variability at the genotypic and phenotypic levels, respectively, while heritability reflects the proportion of observed variation that is heritable. When considered alongside genetic advance, heritability offers insight into the expected gain from selection. High heritability coupled with high genetic advance suggests that additive gene effects are predominant, and selection for such traits can be highly effective (Gowda *et al.,* 2011; Kumar *et al.,* 2014; Raval and Dobariya, 2017). Therefore, these genetic parameters are vital tools in identifying superior genotypes and guiding effective selection strategies in chickpea improvement programs.

The success of crop improvement programs depends on the availability of genetic variability within germplasm collections. Evaluation and utilization of such variability are essential for identifying superior genotypes for yield and its contributing traits. Therefore, assessment of genetic variability, correlation, and path coefficient analysis provides insights into trait relationships and helps in formulating effective breeding strategies (Singh *et al.,* 2016; Yadav *et al.,* 2018). The present study aims to estimate genetic variability parameters and analyze interrelationships among yield-contributing traits in chickpea to facilitate selection in breeding programs.

Materials and Methods

The present investigation was carried out during the *Rabi* season of 2017–2018 at the Field Experimentation Centre of the Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad (U.P). A total of 34 chickpea (*Cicer arietinum* L.) genotypes, including indigenous and exotic lines along with one check variety, were evaluated. The experimental material, received from the Rajasthan Agricultural Research Institute, Durgapura, Rajasthan, was sown on 8th November 2017 following a Randomized Block Design with three replications. Each genotype was grown in plots consisting of three rows of 1 meter length, maintaining a spacing of 30 cm between rows and 10 cm between plants. The list of chickpea genotypes along with their origin is presented in Table 1. The recommended dose of fertilizers (N:P:K :: 20:40:20) was applied, and all standard agronomic practices were followed to raise a good crop. The gross experimental area was 221 m², with a net plot area of 102 m², and border rows were planted to minimize border effects. The crop was harvested on 27th March 2018. Observations were recorded on five randomly selected plants in each replication for 9 quantitative traits, namely days to 50% flowering, plant height (cm), days to maturity, number of pods per plant, number of seeds per pod, seed index (g), biological yield per plant (g), harvest index (%), and seed yield per plant (g). The data recorded were subjected to statistical analysis. Analysis of variance was conducted following Fisher (1936). The mean performance for all the studied traits was calculated to assess the variability among the chickpea genotypes. Genetic variability parameters such as phenotypic and genotypic coefficients of variation (Burton, 1952), heritability in broad sense (Burton and Devane, 1953), and genetic advance (Johnson *et al.* 1955) were estimated to assess the scope for genetic improvement through selection.

Results and Discussion

The findings of the present study and their interpretation are discussed under the following sections:

Analysis of Variance

The ANOVA for different characters across 34 genotypes is presented in Table 2. The mean sum of squares due to genotypic differences revealed significant variation for all the characters studied, namely days to 50% flowering, plant height (cm), days to maturity, number of pods per plant, number of seeds per pod, seed index (g), biological yield per plant (g), harvest index (%), and seed yield per plant (g). Among these, the highest magnitude of mean sum of squares was observed for number of pods per plant (492.40**), indicating substantial genetic variability. The significant differences among genotypes for all traits suggest ample scope for genetic improvement and selection for enhancing seed yield in chickpea. Similar results have been reported by Yadav *et al.* (2016) and Singh *et al.* (2017), highlighting the existence of considerable genetic variability for yield and its component traits in chickpea.

Mean Performance of Genotypes

The mean values of the 34 genotypes with respect to nine traits of chickpea are presented in Table 3. Considerable variation was observed among the genotypes for traits such as plant height, number of pods per plant, biological yield per plant, seed yield per plant, and seed index (Raval *et al.* 2017). The genotype showing superior mean performance for seed yield can be considered a potential candidate for future breeding programs (Kumar *et al.* 2014).

The observed variability in mean performance among genotypes indicates the presence of sufficient genetic diversity, which can be effectively utilized for

the improvement of seed yield and its related traits through selection (Yadav *et al.* 2018).

Estimates of Genetic Parameters

A detailed study of genetic variability is crucial for any crop improvement program. Genetic variability was assessed through genotypic and phenotypic coefficients of variation (GCV and PCV), heritability (broad sense), and genetic advance for nine traits, presented in Table 4.

Coefficient of Variation

The PCV was generally higher than the corresponding GCV for all traits, indicating the influence of the environment. High GCV and PCV were recorded for number of pods per plant (26.88% and 28.39%, respectively), followed by seed yield per plant (24.55% and 25.50%) and plant height (20.51% and 22.43%). Moderate estimates were observed for biological yield per plant, seed index, and harvest index, while low estimates were recorded for days to 50% flowering and days to maturity. Similar results were reported by Sharma *et al.* (1990) and Tiwari *et al.* (2016).

Heritability

Heritability estimates (broad sense) were high for harvest index (98%), seed yield per plant (93%), seed index (93%), biological yield per plant (90%), pods per plant (90%), and plant height (84%). Moderate heritability was observed for days to 50% flowering (59%). High heritability coupled with high GCV suggests that selection would be effective for these traits. These findings corroborate with reports by Jeena and Arora (2001) and Sidramappa *et al.* (2008).

Genetic Advance

High genetic advance was observed for pods per plant (24.52) and plant height (21.13), indicating the effectiveness of selection. Moderate genetic advance was recorded for harvest index, while lower values were found for days to 50% flowering, days to maturity, biological yield per plant, seed index, seed yield per plant, and seeds per pod. Similar findings were reported by Patel and Babbar (2004) and Tiwari *et al.* (2016).

Genetic Advance as Percent of Mean

High genetic advance as a percent of mean was recorded for pods per plant (52.42%), seed yield per plant (48.69%), plant height (38.61%), and biological yield per plant (36.36%). Low estimates were recorded for days to 50% flowering, days to maturity, and seeds per pod. The expected genetic advance as percent of mean provides an indication of the type of gene action and helps in selecting appropriate breeding methods. Similar results were reported by Sharma *et al.* (2012), Waseem *et al.* (2014), and Meena *et al.* (2018), indicating the potential for effective selection based on these traits.

Conclusions

The study on 34 chickpea genotypes revealed significant genetic variability for seed yield and its components. Genotypes CSJ-1085, CSJ-1088, CSJ-1090, and CSJ-1079 exhibited superior seed yield per plant. High GCV and PCV values indicated the environmental influence on seed yield. Heritability estimates were high for harvest index (98%), signifying strong genetic control. Positive correlations were observed between seed yield and traits like plant height, pods per plant, biological yield, and seed index, both phenotypically and genotypically. These traits had a direct positive effect on seed yield. The considerable variability in mean performance highlights the potential for selection of superior genotypes for seed yield improvement in chickpea. Therefore, the selection of genotypes based on these traits will be crucial for improving chickpea yield, and breeding strategies should focus on traits with high heritability and genetic advance, particularly pods per plant, plant height, and seed index. This summary highlights the importance of these genetic parameters in shaping effective breeding programs for chickpea improvement.

Table 1 : List of chickpea genotypes along with their origin

S. No.	Name of Genotypes	Origin
1	CSJ – 1075	RARI, Durgapura
2	CSJ – 1076	RARI, Durgapura
3	CSJ – 1077	RARI, Durgapura
4	CSJ – 1078	RARI, Durgapura
5	CSJ – 1079	RARI, Durgapura
6	CSJ – 1080	RARI, Durgapura
7	CSJ – 1081	RARI, Durgapura
8	CSJ – 1082	RARI, Durgapura
9	CSJ – 1083	RARI, Durgapura
10	CSJ – 1084	RARI, Durgapura
11	CSJ – 1085	RARI, Durgapura
12	CSJ – 1086	RARI, Durgapura
13	CSJ – 1087	RARI, Durgapura
14	CSJ – 1088	RARI, Durgapura
15	CSJ – 1089	RARI, Durgapura
16	CSJ – 1090	RARI, Durgapura
17	CSJ – 1091	RARI, Durgapura
18	CSJ – 1092	RARI, Durgapura
19	CSJ – 1093	RARI, Durgapura
20	CSJ – 1094	RARI, Durgapura
21	CSJ – 1095	RARI, Durgapura
22	CSJ – 1096	RARI, Durgapura

23	CSJ – 1097	RARI, Durgapura
24	CSJ – 1098	RARI, Durgapura
25	CSJ – 1099	RARI, Durgapura
26	CSJ – 1100	RARI, Durgapura
27	CSJ – 1101	RARI, Durgapura
28	CSJ – 1102	RARI, Durgapura

29	CSJ – 1103	RARI, Durgapura
30	CSJ – 1104	RARI, Durgapura
31	CSJ – 1105	RARI, Durgapura
32	CSJ – 1106	RARI, Durgapura
33	CSJ – 1107	RARI, Durgapura
34	UDAY (Check)	RARI, Durgapura

Table 2 : Analysis of variance for different quantitative traits in 34 chickpea genotypes

S. No.	Traits	Mean Sum of Squares		
		Replication (d.f = 2)	Treatments (d.f = 33)	Error (d.f = 66)
1.	Days to 50% Flowering	3.09	68.37**	12.78
2.	Plant height (cm)	0.75	402.74**	24.80
3.	Days to maturity	4.77	20.32**	3.15
4.	Number of pods per plant	34.72	492.40**	18.28
5.	Number of seeds per pod	0.02	0.16**	0.17
6.	Seed index (g)	0.71	38.17**	0.93
7.	Biological yield per plant (g)	0.53	31.35**	1.14
8.	Harvest index (%)	1.78	175.34**	1.17
9.	Seed yield per plant (g)	0.23	18.08**	0.46

*Significant at 5%, ** Significant at 1% level of significance

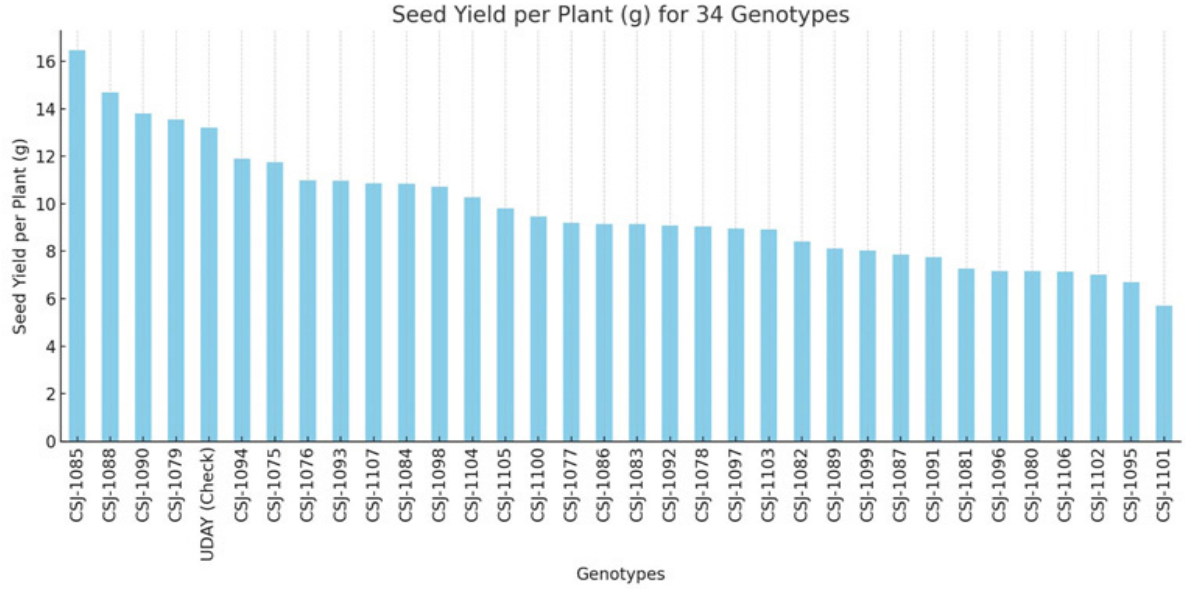

Fig. 1 : Mean performance of 34 chickpea genotypes for seed yield per plant (g) during *Rabi* 2017-18

Table 3 : Mean performance of 34 chickpea genotypes for nine quantitative traits during *Rabi* 2017-18

S. No.	Genotypes	Days to 50% Flowering	Plant Height (cm)	Days to Maturity	Pods Per Plant	Seeds Per Pod	Seed Index (g)	Biological Yield Per Plant (g)	Harvest Index (%)	Seed Yield Per Plant (g)
1	CSJ – 1075	94.00	64.60	134.67	47.53	1.33	14.62	15.73	43.16	11.74
2	CSJ – 1076	87.33	53.47	133.33	54.13	1.67	22.92	18.60	41.50	10.99
3	CSJ – 1077	89.00	44.93	133.67	55.67	1.33	24.41	17.30	52.06	9.20
4	CSJ – 1078	88.67	58.40	133.33	54.67	1.67	16.56	18.00	58.99	9.04
5	CSJ – 1079	80.33	73.73	129.33	63.47	1.67	25.92	20.94	63.66	13.54
6	CSJ – 1080	90.67	59.53	134.67	48.00	1.33	18.67	16.55	40.77	7.16
7	CSJ – 1081	88.33	49.67	134.67	39.93	1.33	19.33	16.61	53.87	7.28
8	CSJ – 1082	87.00	67.00	134.67	47.27	1.67	21.43	19.81	53.57	7.13
9	CSJ – 1083	86.67	57.13	133.33	47.87	1.67	16.98	16.08	56.15	9.15
10	CSJ – 1084	88.00	59.80	133.67	54.80	1.00	17.20	18.36	47.44	10.84
11	CSJ – 1085	72.33	78.60	123.67	68.53	2.00	27.58	23.81	69.16	15.92

12	CSJ – 1086	87.67	51.80	133.33	40.93	1.00	17.23	17.64	54.60	9.15
13	CSJ – 1087	87.33	68.93	134.67	51.33	1.33	18.85	18.43	42.58	8.16
14	CSJ – 1088	74.33	77.07	127.00	67.40	1.67	27.01	23.11	64.95	14.69
15	CSJ – 1089	90.00	55.47	134.33	58.07	1.33	17.58	20.05	38.18	8.11
16	CSJ – 1090	79.33	75.87	127.33	65.33	1.67	25.89	22.24	64.67	13.79
17	CSJ – 1091	92.33	53.87	135.67	45.40	1.67	13.67	18.61	59.01	7.76
18	CSJ – 1092	91.33	54.07	134.33	48.27	1.33	19.28	17.97	43.99	9.08
19	CSJ – 1093	90.67	53.80	133.33	39.53	1.67	17.38	19.04	56.30	10.97
20	CSJ – 1094	89.00	50.00	134.33	33.80	1.67	23.90	13.88	50.76	11.89
21	CSJ – 1095	91.67	52.80	133.67	22.40	1.33	22.11	14.08	46.90	6.71
22	CSJ – 1096	88.67	39.53	134.67	24.87	1.33	22.79	12.00	57.56	7.16
23	CSJ – 1097	88.67	38.93	132.67	25.67	1.33	17.41	13.34	57.30	8.96
24	CSJ – 1098	88.00	39.07	134.00	26.07	1.67	23.12	15.93	59.30	10.72
25	CSJ – 1099	89.00	41.87	135.33	32.87	1.33	23.03	11.12	45.14	8.03
26	CSJ – 1100	89.00	41.07	132.67	40.53	1.33	20.36	15.10	55.98	9.64
27	CSJ – 1101	89.67	42.07	133.67	32.80	1.67	20.42	13.32	51.42	5.70
28	CSJ – 1102	86.33	47.27	133.33	50.47	1.67	20.90	17.29	58.82	7.01
29	CSJ – 1103	90.00	49.87	134.67	52.20	1.33	21.04	15.40	49.29	11.94
30	CSJ – 1104	89.67	41.73	133.67	31.67	1.67	23.79	18.99	58.50	10.27
31	CSJ – 1105	90.67	43.47	134.33	40.40	1.67	23.90	13.76	55.78	9.81
32	CSJ – 1106	92.33	49.53	134.67	57.27	1.00	21.46	11.01	57.15	10.05
33	CSJ – 1107	89.33	56.07	133.00	59.07	1.33	23.95	14.34	57.10	10.87
34	UDAY(Check)	81.33	70.00	130.00	61.86	1.33	25.14	20.60	60.93	13.20
Mean		**87.61**	**54.74**	**133.05**	**46.77**	**1.47**	**21.05**	**17.03**	**53.72**	**9.87**
Range	**Min.**	**72.33**	**38.93**	**123.67**	**22.40**	**1.00**	**13.67**	**11.01**	**38.18**	**5.70**
	Max.	**94.00**	**78.60**	**135.67**	**68.53**	**2.00**	**27.58**	**23.81**	**69.16**	**15.92**
C.V.		**4.08**	**9.10**	**1.34**	**9.14**	**28.33**	**4.59**	**6.29**	**2.02**	**6.89**
S.E.		**2.06**	**2.88**	**1.03**	**2.47**	**0.24**	**0.56**	**0.62**	**0.63**	**0.39**
C.D. (5%)		**5.83**	**8.12**	**2.90**	**6.97**	**0.68**	**1.57**	**1.75**	**1.77**	**1.11**

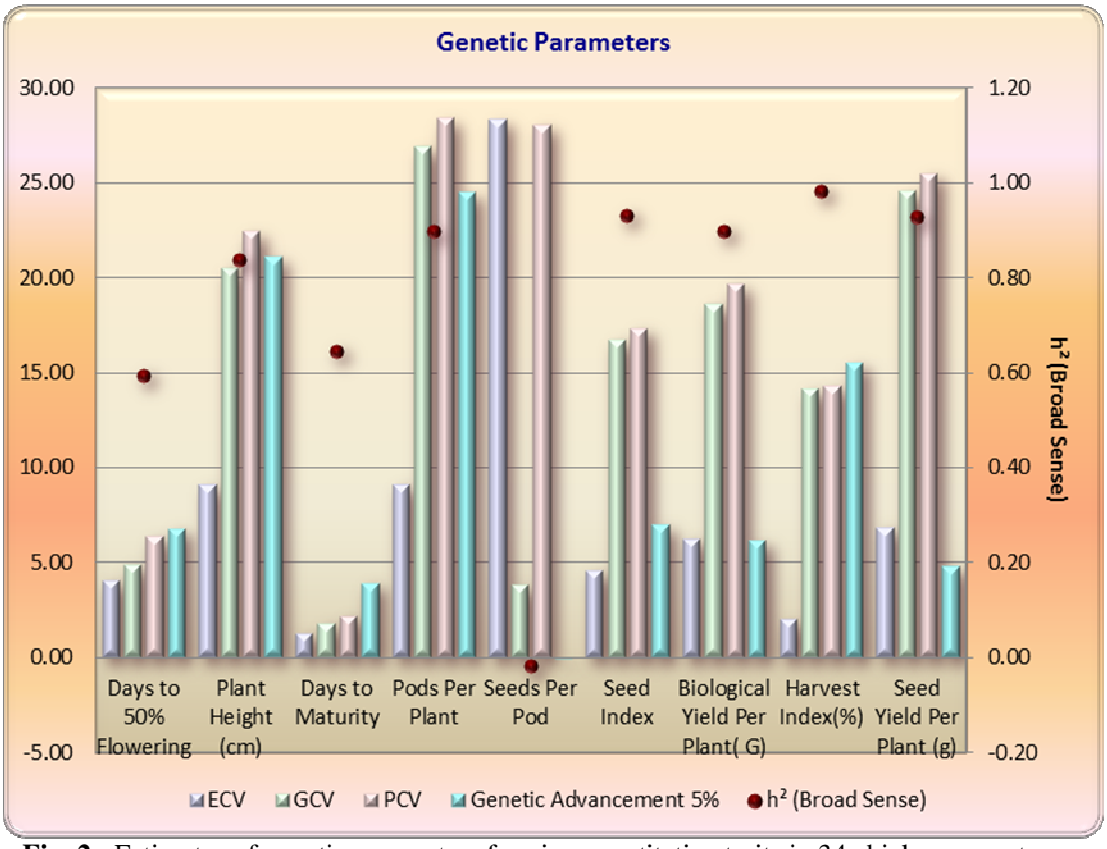

Fig. 2 : Estimates of genetic parameters for nine quantitative traits in 34 chickpea genotypes

Table 4 : Estimates of genetic parameters for nine quantitative traits in 34 chickpea genotypes

S. No.	Traits	σ^2g	σ^2p	Coefficient of variation (%)		h^2 (bs) %	GA	GA as % of mean
				GCV	PCV			
1.	Days to 50% flowering	18.53	31.31	4.91	6.39	59.00	6.82	7.79
2.	Plant height (cm)	125.98	150.78	20.51	22.43	84.00	21.13	38.61
3.	Days to maturity	5.72	8.88	1.80	2.24	64.00	3.96	2.97
4.	Number of pods per plant	158.04	176.33	26.88	28.39	90.00	24.52	52.42
5.	Number of seeds per pod	0.00	0.17	3.84	28.07	2.00	0.02	1.08
6.	Seed index (g)	12.08	13.25	16.74	17.35	93.00	7.00	33.25
7.	Biological yield per plant (g)	10.07	11.22	18.63	19.67	90.0	6.19	36.36
8.	Harvest index (%)	58.05	59.23	14.18	14.33	98.00	15.54	28.92
9.	Seed yield per plant (g)	5.87	6.34	24.55	25.50	93.00	4.81	48.69

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