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Exploring variability in chickpea (*Cicer arietinum* L.) accessions in the Prayagraj region of India

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Abstract
One type of legume crop that is a member of the Leguminosae (Fabaceae) family is the chickpea (*Cicer arietinum* L.). Therefore, increasing the yield of chickpeas may benefit from a deeper understanding of the relationship between yield and its constituent features. Evaluating genetic diversity facilitates the identification of stronger genotypes, enabling the production of high-yielding crops with climate resilience and facilitating effective agricultural modification. The present study aimed to assesses the genetic variability 20 chickpea [*Cicer arietinum* (L.)] genotypes on 13 characteristics. The experiment utilized Randomized complete block design with three replications conducted at field experimentation centre of Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U.P. ANOVA revealed significant variation existed for most of the trait. High GCV and PCV was recorded for Seed yield per plant, Biological yield per plant followed by Number of pods per plant.

Keywords: Chickpea, variability, environmental conditions, yield, *cicer arietinum*

1. Introduction
The chickpea or Bengal gram (*Cicer arietinum* L.) is a legume crop of the Fabaceae family. The origin of the chickpea is thought to be somewhere between southeast Turkey and neighbouring Syria. There are four hubs of diversity which are the Mediterranean, Central Asia, Near East, and India. The Cicer arietinum L is annual, with a 738 Mb haploid genome, 2n = 2x =16 chromosomes" **[1]**. "It is a legume crop grown during the winter that does well at temperatures between 20 and 25 °C during the day and 15-20 °C at night effectively in dry weather. Chickpeas can be widely divided into two categories based on the shape of their seeds: desi, which has little seeds with a brown coat colour, and kabuli, which has large seeds with a cream or beige-colored coat" [2, 3]. It is a major cold season pulse crop in India, during 2022-23, a domestic produce of 13.75 million tonnes in 10.91 million ha. With a productivity of 12.6 q./ha [4]. Understanding the genetic variability is important for the development of improved cultivars. Genetic variability allows breeders to select parents with desirable traits and to create new hybrid varieties that combine desirable traits from different parental lines. By analysing the genetic variability of different chickpea varieties, breeders can also identify unique genes and alleles that are important for crop improvement, such as genes that confer resistance to pests or diseases or genes that improve yield or quality [5]. This information can be used to develop new breeding strategies and to guide the development of new chickpea varieties that are adapted to specific agro-climatic conditions. Genetic variability among the parents of chickpea is essential for establishing selection strategies and identifying diverse parents that lead to a wide spectrum of gene combinations. The parental selection for breeding programs is of utmost importance, and genetic variability and divergence among the parents play a crucial role in crop improvement. Plant breeders generally select parents based on phenotypic divergence, but knowledge about genetic variability amongst parents is necessary for effective breeding, particularly with respect to traits needing improvement [6]. This present study involves above mentioned components to the study the variability among the entries which helps in selection of genotypes for utilization in future breeding agendas.

2. Materials and Methods

The present investigation was carried out at the field experimentation center, Department of Genetics and Plant Breeding, SHUATS, Prayagraj, during the Rabi season 2022-2023. The experimental material is comprised of 20 genotypes. Three replications of a randomized complete block design were used for the experiment. In three replications with 45 × 20 cm inter and intra- row spacing in 1 × 1 m plots. For this chickpea crop, recommended agronomical and plant protection practice were followed. In order to select the best yield giving genotype in the agro climatic conditions of Prayagraj region observation were recorded for various quantitative traits like Days to 50% flowering, Days to 50% pods setting, Plant height (cm), Number of primary branches, Number of secondary branches, Days to maturity, Number of pods per plant, Number of seeds per pod, Biological yield per plant (g), Number of seeds per plant, Seed index (g), Harvest index (%), Seed yield per plant (g). During the study, used genotype were:

1. 200, 2. 166, 3.170, 4. 272, 5. 245, 6.120, 7.112, 8.192, 9. 177, 10. 63, 11. 299, 12. 66, 13. 78, 14. 162, 15. 114, 16.169, 17. 186, 18. 51, 19. 79, 20. 278.

2.1 Statistical Analysis

2.1.1 Genetic variability

Genotypic (GCV and phenotypic coefficient of variation (PCV) was calculated as per formula prearranged by Burton [7], heritability in the broad sense (h^2) as suggested by Burton and De [8] and genetic advance as per the method described by Johnson *et al*. [9].

3. Results and Discussion

3.1 Variability Studies

The Two-way ANOVA implies (Table 1) that the mean sums of squares due to genotypes were significant for all the traits under study *viz*., Days to 50% flowering, Days to 50% pods setting, Plant height (cm), Number of primary branches, Number of secondary branches, Days to maturity, Number of pods per plant, Number of seeds per pod, Biological yield per plant (g), Number of seeds per plant, Seed index (g), Harvest index (%), Seed yield per plant (g). This substantial variability provides a good prospect for improving traits of interest in chickpea breeding programmes. These results agreed with the finding of Katkani *et al.* [10] and Sharma *et al.* [11].

Genetic parameters of yield and their components are given in Table 2. Results showed that phenotypic coefficient of variation (PCV) was found higher than their corresponding genotypic coefficient of variation (GCV) indicating the influence of environment on the expression of these characters. High GCV and PCV (20% and above) was recorded for Seed yield per plant, Biological yield per plant followed by Number of pods per plant. Moderate GCV (10-20%) was observed for Primary branches per plant, Seed Index, No. of seeds per plant and Plant height. Low GCV and PCV (<10%) was recorded for Days to 50% flowering, Number of secondary branches per plant, Days to 50% pod setting, Harvest Index and Days to maturity. These results agreed with the finding of [12] under similar conditions.

In the present investigation, the estimates of heritability (%) in broad sense for 13 characters studied, ranged from 96.776% (Number of pods per plant) to 28.455% (Harvest Index). High heritability (broad sense) (>60%) was recorded for Number of pods per plant, Plant height, Days to 50% flowering, Number of primary branches per plant, Number of seeds per pod, Number of seeds per plant, Seed Index, Biological yield per plant, Days to 50% pod setting and Seed yield per plant. Moderate heritability (broad sense) (30-60%) was observed for Days to maturity and Number of secondary branches per plant. Low heritability (broad sense) (<30%) was observed in Harvest Index. These results agreed with the finding of **[13]** under similar conditions.

The genetic advance furnishes an idea of the amount of progress that can be achieved by selection for the concerned trait. The Genetic advance ranged from (18.578) Number of seeds per plant to (0.568) Number of secondary branches per plant. High genetic advance (20 and above) was not recorded for any character. While all other characters had low estimates of genetic advance.

Genetic advance as% of mean varied from 48.682% (Number of seeds per pod) to 1.833% (Days to maturity). High genetic advance as% of mean (>20%) was recorded for Number of seeds per pod, Seed yield per plant, Number of pods per plant, Biological yield per plant, Number of primary branches per plant, Seed index, Number of seeds per plant and Plant height. Moderate Genetic advance as% of mean (10-20%) was recorded for Days to 50% flowering. Low Genetic advance as% of mean (<10%) was recorded for Number of secondary branches per plant, Days to 50% pod setting, Harvest index and Days to maturity. showed similarity with Solanki *et al.* [2] under similar conditions.

Table 1: Analysis of Variance for 20 genotypes of Chickpea during rabi 2022-23

Sl. No.	Genotypes	Days to 50% flowering	Days to 50% pod setting	Plant height (cm)	Primary branches per plant	Secondary branches per plant	Days to Maturity	Number of pods per plant	Number of seeds per pod	Biological yield per plant (g)	Number of seeds per plant	Seed Index	Harvest Index	Seed yield per plant (g)
1	G200	82.67	97.67	57.01	4.00	4.33	125.67	36.13	1.66	26.47	60.07	21.99	44.95	13.47
2	G166	81.33	96.67	54.52	4.33	5.00	124.33	32.80	1.90	24.20	62.27	25.03	40.08	14.53
3	G170	80.33	99.33	55.91	4.27	5.33	125.67	30.80	1.71	21.00	52.67	25.13	43.09	14.13
4	G272	81.33	99.67	48.25	2.67	4.67	128.00	32.80	1.53	25.07	50.27	24.00	43.54	10.00
5	G245	81.00	101.00	52.86	3.13	5.67	125.67	27.33	1.38	24.40	37.60	26.69	42.27	10.20
6	G120	64.33	97.33	49.48	2.67	6.00	129.00	33.60	1.79	17.00	60.07	15.13	39.77	7.07
7	G112	62.33	98.33	58.11	3.33	6.00	128.00	51.93	1.20	29.60	62.27	16.87	38.80	12.20
8	G192	68.33	89.33	56.67	2.67	5.67	130.00	33.60	1.57	17.40	52.67	16.93	41.11	7.07
9	G177	67.00	89.67	61.25	2.67	5.67	131.00	45.73	1.10	26.93	50.27	17.00	42.82	11.47
10	G63	66.00	101.00	50.61	2.73	6.00	128.00	33.40	1.13	25.07	37.60	19.33	41.30	10.93
11	G299	67.00	98.67	42.39	2.73	5.67	128.67	28.87	1.94	16.27	56.13	16.67	40.95	6.67
12	G66	66.00	95.33	42.68	2.73	5.33	129.33	26.47	2.62	17.07	69.33	16.07	41.06	7.53
13	G78	67.00	104.33	41.31	2.67	6.00	128.67	29.60	1.79	21.60	52.87	15.87	40.74	8.73
14	G162	67.67	88.00	58.30	2.80	5.33	130.33	43.77	1.20	31.53	52.33	15.93	37.23	11.67
15	G114	65.67	97.00	43.81	2.67	5.00	129.00	44.73	1.09	28.80	49.00	21.13	42.59	12.20

16	G169	67.67	93.67	52.57	2.80	5.67	128.33	44.67	1.49	19.30	66.60	17.93	40.40	7.93
17	G186	66.00	96.67	53.69	2.93	6.00	129.33	32.73	1.31	20.20	42.73	16.93	38.05	7.67
18	G51	67.33	99.00	58.35	2.67	5.67	129.67	30.60	1.30	28.67	39.73	18.33	42.33	11.40
19	G79	65.33	98.33	55.91	2.60	5.33	129.00	46.40	1.37	16.73	63.60	18.53	42.66	8.53
20	G278	65.33	101.00	50.77	2.80	4.33	129.33	34.20	1.27	17.47	43.40	19.20	40.47	7.00
Mean		69.98	97.10	52.22	2.99	5.43	128.35	36.01	1.52	22.74	53.07	19.24	41.21	10.02
CV		2.15	1.92	2.16	4.67	9.74	1.10	3.72	6.26	8.81	5.17	6.31	5.39	14.41
SEm		0.87	1.08	0.65	0.08	0.31	0.81	0.77	0.05	1.16	1.58	0.70	1.28	0.83
CD at 5%		2.48	3.09	1.86	0.23	0.87	2.33	2.21	0.16	3.31	4.54	2.01	3.67	2.39
CD at 1%		3.32	4.14	2.50	0.31	1.17	3.11	2.97	0.21	4.44	6.08	2.69	4.92	3.20
Minimum		62.33	88.00	41.31	2.60	4.33	124.33	26.47	1.09	16.27	37.60	15.13	37.23	6.67
Maximum		82.67	104.33	61.25	4.33	6.00	131.00	51.93	2.62	31.53	69.33	26.69	44.95	14.53

Table 2: Parameters of genetic variability for grain yield and its attributing traits

Genetic Parameters													
	Days to 50% flowering	**Days to 50% pod setting**	**Plant height (cm)**	**Primary branches per plant**	**Secondary branches per plant**	**Days to Maturity**	**Number of pods per plant**	**Number of seeds per pod**	**Biological yield per plant (g)**	**Number of seeds per plant**	**Seed Index**	**Harvest Index**	**Seed yield per plant (g)**
GCV	9.72	4.16	11.34	18.24	7.99	1.20	20.39	24.40	21.17	17.70	18.03	3.40	24.10
PCV	9.96	4.59	11.54	18.83	12.60	1.63	20.72	25.19	22.93	18.44	19.10	6.37	28.08
h2 (Broad Sense)	95.36	82.41	96.50	93.85	40.26	54.67	96.78	93.83	85.23	92.14	89.08	28.46	73.68
Genetic Advancement 5%	13.69	7.56	11.98	1.09	0.57	2.35	14.88	0.74	9.15	18.58	6.74	1.54	4.27
Gen. Adv as% of Mean 5%	19.56	7.79	22.95	36.39	10.45	1.83	41.31	48.68	40.25	35.01	35.05	3.73	42.62

4. Conclusion

From the present investigation it is concluded that among 20 hybrids of Chickpea (*Cicer arietinum* L.) G166 (14.53 g/plant) exhibited substantially higher seed yield per plant and performed better for other desirable traits. The analysis of variance for all characters of Chickpea hybrids revealed presence of good extant of significant differences among the hybrids for all traits. Henceforth, the data for all characters that showed sufficient amount of significant differences were subjected to further statistical analysis. High GCV and PCV (20% and above) was recorded for Seed yield per plant, Biological yield per plant followed by Number of pods per plant.

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