Study the performance of different genotypes in chickpea (*Cicer arietinum* L.)

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Abstract— Thirty genotypes of chickpea germplasm along with three checks were evaluated in partially reclaimed soil under late sown and irrigated conditions. The characters studied were days to 50% flowering, days to maturity, number of primary branches per plant, number of secondary branches per plant, plant height, number of seeds/pods, 100-seed weight, harvest index, biological yield and Seed yield per plant. The variance due to plots was non-significant for most the characters except plant height and seed yield, which show highly significant at 1% probability level. However, the variation due to check was found highly significant at 1% probability level for days to 50% flowering, days to maturity, number of seeds per plant, plant height, 100-seed weight, biological yield and number of pods per plant. While rest of the characters (Viz., primary branches per plant and secondary branches per plant were found non-significant and in check significant character under investigation indicating the presence adequate variability. Among the thirty chickpea genotypes Bidhan Chola 1, GCP 105, GNG 2207, GNG 38, GNG 312, GNG 0703, GNG 0820, GNG 1001 and GNG 1013 and GNG 1969 also possessed high mean performance for most of the quantitative traits. The genotypes mentioned above and some other genotypes having high mean performance for characters may be used as donor parents in hybridization programme for improving the characters for which they showed high mean performance.

Keywords: Harvest Index, Heritability, GCV, PCV and Genetic Advance, etc.

I. INTRODUCTION

Pulse crops play an important role and occupy a unique position in Indian agriculture by virtue of their inherent capacity to grow on marginal lands and provide protein rich diet to vegetarian mass of the country. Pulses are used as food for human and other animals. Pulses are an important food crop due to their high protein and essential amino acids (methionine, cysteine and tryptophan) required for the proper growth and development of human body. On an average pulses contain 20-25 percent protein in dry seed.

Chickpea (*Cicer arietinum* L.) is the most important *Rabi* season self-pollinated, diploid pulse crop. It belongs to the family *Fabaceae* and sub family *Papilionaceae*. Mostly, two types of chickpea are with domain, *Kabuli* is grown in temperate regions while the *Desi* type is in the semi-arid tropics**,** having extensive geographical distribution. Chickpea is the 3rd pulse crop, 5th food legume and 15th grain crop of the world among various grain legumes. Chickpea is known by different names in various countries such as gram, chana, bengal gram, garbanzo bean, Indian pea, cerci bean, etc. Besides its main use as dal, the tender green seeds are used as a vegetable, crushed dry seed as animal feed, green leaves as green leafy vegetable and also as fodder etc. Chickpea is grown in India, Bangladesh, Iran, Nepal, Pakistan, Syria, and Turkey.

In India, total chickpea had the area of 9.99 million ha with production of 11.91 million tonnes and productivity 1192 Kg/ha 2020-2021 **(ICAR-IIPR Kanpur, website: www.iipr.icar.gov.in)**. It is grown in Madhya Pradesh, Rajasthan, Uttar Pradesh, Jharkhand, Maharashtra, Bihar, Punjab, Haryana, Andhra Pradesh and Chhattisgarh. However, six major states *viz*., Madhya Pradesh, Rajasthan, Maharashtra, Uttar Pradesh, Karnataka and Andhra Pradesh altogether contribute 91 per cent of the production and 90 per cent of the area. In U P chickpea production was 759.47 thousand tonnes with average yield of 1243 kg/ha from an area of 611 thousand hectare in year 2020-2021 **(ICAR-IIPR Kanpur, website: www.iipr.icar.gov.in).**

The study of association among various traits is useful to breeders in selecting genotypes possessing groups of desired traits. The success of any breeding programme depends on the quantum of genetic variability present in the material for exploitation and it also offers better scope for selection. Information of the genetic variability, heritability and association of various characters provides a basis to the plant breeders to breed the chickpea genotypes possessing higher yield potential. Plant breeders are continuously engaged to improve the genetic yield potential of this crop to meet the demands of ever increasing population. The information on nature and magnitude of genetic variation in quantitative characters and their interrelationship in population comprising diverse genotypes is an important prerequisite for systematic breeding program.

II. REVIEW OF LITERATURE

The prime of objective of breeder is to breed varieties better than the best exiting ones. This requires sufficient genetic variability on which direct and indirect selection can be applied effectively. Knowledge of genetic architecture of different traits and direct and indirect selection parameters, help the formulating of effective breeding strategies for the plant improvement through manipulation on of genetic variability. Work done by different research workers on chickpea (*cicer arietinum* L.) on various aspects under the present study in reviewed here as under.

II.I. GERMPLASM EVALUATION AND GENETIC VARIABILITY

II.II. HERITABILITY AND GENETIC ADVANCE

II.III. GERMPLASM EVALUATION AND GENETIC VARIABILITY

Possibility of achieving improvement in any crop plants depends heavily on the magnitude of genetic variability. The phenotypic variability expressed by a genotype or a group of genotypes in any species can be partitioned into genotypic and phenotypic components. The genotypic component being the heritable part of the total variability, its magnitude on yield and its contributing characters influences the selection strategies to be adopted by the breeders.

A thorough understanding of the genetic extent of variation, genetic architecture of the plant and heritability of characters among the genotypes would help in developing sound plant improvement programme. A comprehensive review on variability is presented below:

Chavan *et al.* (1995) found greatest genetic variability for pods per plant, pod weight per plant and branches per plant. Low genetic variability was noted for remaining characters of chickpea.

Jahagirdar *et al.* (1995) reported that high genotypic and phenotypic coefficient of variations for number of pods per plant in chickpea.

Tripathi (1998) observed that high genotypic coefficient of variation for pods per plant, seeds per plant, biological yield and seed yield per plant indicating the pre-dominance of genetic variance in the expression of these traits. It is suggested that selection criteria based on plant height, biological yield and pods per plant will improve seed yield.

Suryawanshi *et al.* (1999) evaluated two genotypes of chickpea foe seed color 100-seed weight and germination traits. These two cultivars were also superior in terms of germination and emergence.

Rao (2000) evaluated twenty one vascular wilt resistant chickpea genotypes for plant type characteristics. The highest genetic variation was observed for seed yield, biological yield and plant spread**.**

Kumar *et al.* (2001) reported that pods per plant exhibited highest amount of genetic variability followed by secondary branches per plant, seed yield per plant, 100 seed weight, seeds per pod, plant height and biological yield per plant in chickpea.

Ali *et al.* (2002) evaluated 20 elite lines of chickpea and estimate the genetic variability for different quantitative traits *viz.*, days to flower initiation, days to maturity, plant height, primary branches per plant, secondary branches per plant, total weight of plant, pods per plant and seed yield per plant. Genotypic differences were found to be significant for all the traits studied.

Yadav *et al.* (2003) studied 33 diverse genotypes of chickpea **(***Cicerarietinum* L.). Maximum variability was observed for harvest index, biological yield, grain yield per plant and 100 seed weight.

Khan *et al.* (2006) studied analysis of variance in gram and found that all the characters examined indicated high genetic variability. The phenotypic coefficient of variation ranged from 2.23 (number of days to flowering) to 15.47 (number of seeds per plant). The genotypic coefficient of variation was relatively low for days to flowering, days to maturity and plant height while it was high for pods per plant, 100 seed weight and seed yield per hectare indicating low environmental impact for these characters.

Lokere *et al.* (2007) studied kabuli chickpea and observed that PCV for all characters was slightly greater than GCV, indicating the variability existing due to genetic factors and there was influence of environmental factors in their expression. The magnitude of genotypic coefficient of variation was highest for number of pods per plant followed by 100 seed weight.

Dwevedi and Lal (2009) found that harvest Index, 100 seed weight and number of pods per plant contributed maximum manifestation of genetic diversity in chickpea. Number of pods per plant had maximum phenotypic and genotypic coefficient of variation (PCV and GCV) followed by biological yield per plant and 100 seed weight. A moderate to high degree of heritability and genetic advance was observed for number of pods per pant, harvest index and biological yield.

Vaghela *et al.* (2009) studied kabuli chickpea and found that broad sense heritability was higher for all the traits except plant height. High genetic advance expressed as a percentage of mean was exhibited by seed yield per plant and number of pods per plant.

Sreelakshmi *et al.* (2010) high heritability with high genetic advance observed for seed yield, number of pods per plant and number of fruiting branches per plant indicated additive gene action for these traits in Bengal gram.

Yadav *et al.* (2010) studied chickpea genotype and found that all the characters showed significant differences among the genotypes except plant height and number of seeds per plant, indicating the presence of ample amount of variability. In most of the character phenotypic coefficient of variation was higher than the genotypic coefficient of variation indicating the present variability among the genotypes is due to the genetic differences.

Ojha *et al.* (2010) reported that coefficient of variation (%) was higher for 100 seed weight fallowed by pods per plant and minimum coefficient of variation was found for days to maturity and days to 50 per cent flowering in chickpea.

Kumar *et al.* (2012) reported maximum coefficient of variation was found in seed yield per plant followed by pods per plant, harvest index and minimum was found in days to maturity followed by days to 50 per cent flowering.

Kumar *et al.* (2015) studied black gram and recorded the highest PCV for branches per plant followed by seed yield, total biomass, seeds per plant, fodder biomass. The highest GCV recorded for seed yield followed by clusters per plant, fodder biomass, seeds per plant, pod weight, total biomass and branches per plant indicating that sufficient phenotypic and genotypic variability was present in the material.

Johnson *et al.* (2018) noted that the phenotypic coefficient of variation (PCV) was higher in magnitude than its corresponding genotypic coefficient of variation GCV for all the characters under study in chickpea. This indicated the influence of the environment on the expression of these characters. The high values of phenotypic coefficients of variation were recorded for secondary branches$plant^{-1}$, pod$plant^{-1}$, hydration index, seed yield$plant^{-1}$, hydration capacity$seed^{-1}$, biological yield, primary branches plant.

Kumar *et al.*(2019) observed maximum phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were noticed for 100-seed weight, biological yield per plant, grain yield per plant and number of primary branches per plant.

Kumar *et al*. (2019) noted that the values of PCV were found greater than GCV for all the traits studies indicating environmental factors influencing the characters. High PCV and GCV were observed for effective pods per plant (36.41% and 34.38%) followed by total number of pods per plant (34.85% and 32.70%) and seed index (29.98% and 29.78%) indicated large extent of genetic variability for these traits in the material.

Vijay Kumar *et al.* (2019) found that high variability was observed for majority of the traits of chickpea in both the seasons. In late sown condition high GCV and PCV was recorded for days to fifty per cent podding, number of pods, yield per plant, hundred seed weight, pollen viability and per cent membrane leakage at 50 days. Ample variability available for these traits can be exploited by direct selection. In general the late sown crop matured early due to restricted reproductive period and hastened maturity.

II.IV. HERITABILITY AND GENETIC ADVANCE

Genetic variability is a basic feature of crop improvement programme, and effectiveness of selection depends upon its nature and magnitude on available genetic materials. In other words, genetic variability is basis of selection and to a great extent in adopting suitable breeding methodology as such. The genetic variability is highly heritable and hence important in any selection programme.

Muthuraj *et al.* (2001) studied heritability of seed quality characters namely 100-seed weight, germination percent and electrical conductivity of seed leachate in a field experiment conducted at Delhi, India during the *kharif* season of 1998 using twenty seven soyabean cultivars. The broad sense heritability of germination percentage and electrical conductivity of seed leachate were 41.2 and 44.0%, respectively, indicating that these seed quality characters are greatly influenced by environmental factors; the genetic component is quite low. The broad sense heritability for 100- seed weight was high (70.5%) indicating that the character is mainly controlled by additive gene effects.

Pratap *et al.* (2004) evaluated 38 genotypes of chickpea to assess the extent of variability in 4 different environments. High genetic variation in all individual environments was observed. High heritability coupled with high genetic advance were observed for 100 seed weight and reproductive phase in the entire individual as well as combined over the environments. On the other hand, high estimate of all the variability parameters in individual environments and moderate to low in the pooled over environments for seed yield, pods per plant, effective pods per plant, biological yield and harvest index indicated that simple selection could be highly effective for these traits in the individual environments. Moderate to low estimates of variability parameters for rest of traits suggested that direct selection will not be effective for these, though environmental influence was also low as revealed by low G x E coefficient of variation.

Biradar *et al*. (2007) reported high heritability for plant height, pod length, number of seeds per pod, 100-seed weight and seed yield per plant in green gram. Genetic advance expressed as per cent of mean was highest for 100-seed weight followed by seed yield. Vigour parameters shoot length, root length and vigour index, expressed moderate levels of GCV and PCV coupled with high heritability estimate except for root length. Among the seedling parameters, vigour index recorded high heritability coupled with high genetic advance.

Lokere *et al.*(2007) revealed that high heritability coupled with high genetic advance was observed for seed yield per plant, 100 seed weight and pods per plant in chickpea

Dar *et al.* (2012) reported that sufficient variability was present in the chickpea germplasm for almost all the characters. High heritability with moderate to high genetic advance was recorded for 100 seed weight, seeds per plant and seed yield per plant.

Mushtaq *et al.* (2013) revealed that heritability estimates were maximum for days taken to flowering, days taken to maturity, pods per plant, total weight of plant, 100-grains weight, primary branches, and plant height. These are important parameters for selecting maximum yielding genotypes in chickpea.

Kumar *et al.* (2015) evaluated that highest heritability and genetic advance were recorded for days to 50% flowering and clusters per plant respectively in black gram. High genetic advance as percent of mean coupled with moderate to high heritability was observed for number of clusters per plant, pods per plant, seeds per plant, pod weight, seed yield per plant and fodder biomass. The present findings could be useful for establishing selection for improvement of seed yield in black gram breeding program.

Kumar *et al.* (2019) revealed that high heritability were recorded for 100 seed weight, biological yield per plant, primary branches per plant, grain yield per plant, effective pods per plant, total number of pods per plant, secondary branches per plant, plant height, days to 50% flowering and days to maturity. High heritability coupled with high genetic advance as percent of mean was observed for 100 seed weight, biological yield per plant, primary branches per plant, grain yield per plant, effective pods per plant, total number of pods per plant, secondary branches per plant and plant height in chickpea.

Kumar *et al.* (2019) reported that high heritability were recorded by seed index (98.61%) followed by harvest index (90.81%), effective pods per plant (89.14%), total number of pods per plant (88.01%), secondary branches per plant (84.42%), primary branches per plant (84.31%) and plant height (81.03%).High heritability along with high genetic advance was observed for the traits, viz., effective pods per plant, total number of pods per plant, seed index, primary branches per plant and secondary branches per plant indicated that the characters were mostly governed by additive gene effects.

Vijay Kumar *et al.* (2019) estimated that higher estimates of heritability and genetic advance as per cent of mean were noticed for plant height (cm), first pod height (cm), number of pods per plant, yield per plant (g/plant) and hundred seed weight (g). Occurrence of high estimates of heritability coupled with genetic advance as per cent of mean for these traits suggest that these traits can be considered as favorable attributes for improvement through selection.

III. MATERIALS AND METHODS

The field experiment under present investigation was conducted during *Rabi* 2019-20 at the Agriculture Research Farm of Shri Durga Ji Post Graduate College Chandeshwar, Azamgarh (U.P.). Geographically, Chandeshwar is situated between 83.19^{0}E longitude, 26.01^{0}N latitude and at an altitude of 81 meters above the mean sea level. The climate of district Azamgarh is semi-arid with hot summer and cold winter. Nearly, 80 *per cent* of total rainfall is received during the monsoon with a few showers in the winter. The soil type of experimental site was clay loam, low in organic carbon, nitrogen, phosphorus and rich in potash. The present investigation consisted of 30 lines of chickpea along with three check varieties (Pant G-186, Udai and BG-372) of chickpea. These lines were procured from genetic stock available in Pulse Section, Department of Genetics and Plant Breeding, A. N. D. University of Agriculture and Technology, Kumarganj, Ayodhya (UP). Experimental materials exhibited wide spectrum of variation for various agronomical and morphological characters. The check varieties used in experiment are well adopted varieties of the region. The details of these lines are presented in **Table 3.2.**

III.I. METEOROLOGICAL DATA

The meteorological data pertaining to annual rainfall, temperature, relative humidity and sunshine hours during investigation are presented in **Table 3.1.**

Table 3.1 Meteorology data (weekly–average) during investigation (*Rabi* 2019-20)

Months		Mean temperature (^{0}C)			Sunshine

	Week	Min.	Max.	Relative Humidity (%)	Total Rainfall (mm)	(hrs/day)
October	01-07	21.6	32.8	77.0	3.6	3.8
	08-14	19.7	30.5	80.3	3.1	3.6
	15-21	17.7	29.9	82.3	0.0	4.2
	22-28	17.4	30.6	69.4	0.0	6.7
	29-04	14.9	29.9	73.9	0.0	4.6
November	05-11	13.7	30.0	71.2	0.0	5.8
	12-18	10.0	28.0	67.0	0.0	5.7
	19-25	8.2	27.2	66.4	0.0	6.0
	26-02	8.6	27.5	70.5	0.0	5.4
December	03-09	7.9	23.2	66.2	0.0	6.5
	10-16	8.0	19.2	68.7	0.0	4.1
	17-23	9.1	22.4	72.8	0.0	0.8
	24-31	7.6	21.7	71.8	0.4	3.6
January	01-07	6.2	14.3	75.6	2.1	4.4
	08-14	5.9	15.5	87.9	6.1	0.4
	15-21	8.2	17.1	83.1	56.2	2.0
	22-28	9.5	20.7	7.5	0.0	3.1
	29-04	8.8	18.2	84.5	0.0	2.5
February	05-11	10.2	25.8	66.9	0.0	7.1
	12-18	8.6	20.6	70.8	7.4	4.3
	19-25	10.3	23.4	72.1	17.7	5.0
	26-04	13.0	24.0	73.9	15.3	5.2
March	05-11	11.2	20.3	62.3	0.0	7.0
	12-18	11.5	30.2	58.2	0.0	7.6
	19-25	13.6	31.8	54.7	0.0	6.4
	26-01	15.7	34.8	50.0	0.0	8.0
April	02-08	16.7	32.5	61.3	0.0	4.6
	09-15	18.8	33.7	59.7	9.6	5.2
	16-22	21.8	36.8	53.6	0.0	8.1
	23-29	21.7	34.5	58.8	37.0	4.0
May	30-06	22.5	37.1	56.5	0.0	8.4
	07-13	25.1	38.3	54.6	0.0	5.6
	14-20	25.6	38.6	53.2	26.0	6.1
	21-27	27.0	39.7	48.9	0.0	8.4
	28-03	26.1	41.6	46.7	0.0	7.4

Source: Agro-meteorology Section, Azamgarh.

III.II. EXPERIMENTAL DETAILS

The experiment was conducted in Randomized Block Design with three replications. Each plot consisted of four rows of 4 m length with inter and the intra row spacing of 30 cm and 10 cm, respectively. To avoid the border effect experimental plot was surrounded on all side by non-experimental rows. Recommended cultural practices were followed to raise the crop. Five plants from each treatment were selected randomly for data recording. Observations on the following characteristics were recorded on the basis of five plants randomly selected and tagged from each row except for days to 50% flowering and days to maturity, which were recorded on the plot basis.

Table 3.2 30 Genotypes of chickpea along with three check varieties (Pant G-186, Udai and BG-372)

S. No.	Genotypes	S. No.	Genotypes	S. No.	Genotypes
1	**Pant G-186 (Check)**	**12**	GNG 1926	**23**	GNG 2216
2	**Udai (Check)**	**13**	GNG 1929	**24**	GNG 2217
3	**BG-372 (Check)**	**14**	GNG 1947	**25**	GNG 2219

4	GNG 2207	**15**	GNG 1958	**26**	GNG 2257
5	GNG 38	**16**	GNG 1969	**27**	DBGC 2
6	GNG 312	**17**	GNG 1999	**28**	DC 17-1111
7	GNG 0703	**18**	GNG 2018	**29**	DC 17 -1115
8	GNG 0820	**19**	GNG 2124	**30**	BDNG 2017-1
9	GNG 1001	**20**	GNG 2127	**31**	NDG 18-4
10	GNG 1013	**21**	GNG 2177	**32**	Bidhan Chola 1
11	GNG 1854	**22**	GNG 2215	**33**	GCP 105

1. Days to 50% flowering

Days to 50% flowering was recorded as number of days taken from the date of sowing to the emergence of flowering in 50% of the plants on line basis.

2. Days to maturity

It was recorded as number of days taken to the maturity from the date of sowing to the appearance of brown yellow leaves and pods.

3. Number of primary branches per plant

The total number of primary branches per plant on five randomly selected plants from each line were counted and averaged out at the time of maturity.

4. Number of secondary branches per plant

The total number of secondary branches per plant from the five randomly selected plants in each plot were counted at maturity and averaged out at the time of maturity.

5. Plant height (cm)

The height of five plants from ground level to the tip was measured in centimeters (cm) at maturity.

6. Number of pods per plant

Total number of mature pods were counted separately from sampled five plants in each row, and averaged out for single plant.

7. Number of seeds per pod

Five pods from total pods of five randomly selected plants from each germplasm were taken. Total number of seeds of these pods was counted and their mean value was expressed as the number of seeds per pod.

8. Biological yield per plant (g)

Each randomly selected plant (biomass excluding root) sun-dried and dry matter was weighed in gm to estimate the biological yield per plant.

9. 100 seed weight (g)

One hundred seeds were taken from the bulk seed of five selected plants and these were weighed in grams on the electronic pa

10. Seed yield per plant (g)

The total seeds produced from five individual plants after threshing and cleaning were weighed with the help of electronic pan balance and seed yield per plant (g) was recorded.

11. Harvest index

The ratio of grain yield (g) to biological yield (g) of a plant was considered as harvest-index and expressed in percentage. The value was calculated as:

$$\text{Harvest index (\%)} = \frac{\text{Grain yield per plant (g)}}{\text{Biological yield per plant (g)}} \text{ x } 100$$

III.III. STATISTICAL ANALYSIS

The data recorded on the above characters were statistically analyzed for various parameters.

III.III.I MEAN

It was calculated by using following formula:

$$\text{Mean}(\bar{x}) = \frac{\sum X}{N}$$

Where,

$\sum X$ = Summation of N variables

N = Number of observations

III.III.II. RANGE

It was taken at the lowest and highest value for each character:

$$\text{Range}(R) = X_1 - X_n$$

Where,

X_1 = Lower limit

X_n = Upper limit

III.III.III. ANALYSIS OF VARIANCE

The analysis of variance for Randomized Complete Block Design was carried out by **Panse and Sukhatme (1978).**

ANOVA TABLE

Sources of Variation	D.F.	S.S.	M.S.S.	F(Variance Ratio)
Replications	(r-1)	SSR	MSR	MSR/MSE
Treatments	(t-1)	SST	MST	MST/MSE
Error	(r-1) (t-1)	SSE	MSE	-
Total	(rt-1)	TSS	-	-

Test of Significance

The calculated variance ratio (F value) was compared with the Table value. The calculated value of F is greater than the table value of F at 0.05 probability levels indicated the significant differences among the treatments. Greater the calculated value of F than the table value of F at 0.01 probability level indicated that differences were highly significant.

Critical Difference (CD)

It was calculated as standard error of Differences of two means ×t value.

CD = S.E.$_{(Diff.)}$ ×t

Where, S.E.$_{(Diff.)} = \sqrt{\frac{2 \times MSE}{\text{Number of replications}}}$

t = t value at error degree of freedom at 0.05 or 0.01 probability level.

III.III.IV. ESTIMATION OF VARIABILITY

Variability for different characters was estimated as suggested **by Burton and de Vane (1953)**. The formula used in the estimation of coefficients of variability at genotypic (GCV) and phenotypic (PCV) levels are as follows:

Error variance (σ_e^2) = MS Error

Genotypic Variance (σ_g^2) = $\frac{\text{MS Treatment} - \text{MS Error}}{\text{Number of Replication}}$

Phenotypic Variance (σ_p^2) = (σ_g^2) + (σ_e^2)

$$GCV = \frac{\text{Genotypic standard deviation}}{\text{Mean}} \text{x}100$$

$$PCV = \frac{\text{Phenotypic standard deviation}}{\text{Mean}} \text{x}100$$

III.III.V. ESTIMATION OF HERITABILITY

Heritability in broad sense (h^2) was calculated using the formula suggested by **Hanson *et al.* (1956)**.

Heritability $h^2 = \frac{\sigma_g^2}{\sigma_g^2 + \sigma_e^2}$

Where,

σ_g^2 = genotypic variance

σ_e^2 = environmental variance

III.III.VI. GENETIC ADVANCE AS PER CENT OF MEAN ($\overline{Ga}$)

Expected genetic advance ($\overline{Ga}$) was estimated by the method suggested **by Johnson *et al.* (1955).**

Genetic advance (Ga) $= \frac{\sigma_g^2}{\sigma_p^2} \times K \times \sigma_p$

Ga = $\frac{\sigma_g^2}{\sigma_p} \times K$

Where,

K = Selection differential at 5% Selection intensity, i.e., 2.06

Genetic advance in per cent of Mean

$$(\overline{Ga})\% = \frac{\text{Genetic advance}}{\bar{x}} \times 100$$

Where, $\overline{X}$ = General mean of the character

IV. EXPERIMENTAL FINDINGS

The present investigation was carried out with 30 genotypes of chickpea (*Cicer arietinum* L.) along with 3 checks were during *Rabi* Season 2019-20. The data recorded on 11 characters including seed yield were subjected to various statistical analysis. The experimental findings in respect of various aspects of the experiments have been described as under the following sections.

IV.I Analysis of variance

IV.II. Mean performance of genotypes

IV.I. ANALYSIS OF VARIANCE

The analysis of variance for the Randomized Block Design (RBD) accommodating 30 chickpea accessions and 3 checks was done for each of the 11 characters. The Analysis of variance is presented in **Table 4.1**.

IV.II. MEAN PERFORMANCE OF GENOTYPES

The adjusted mean of 30 genotypes along with three checks and range for eleven characters are presented in **Table 4.2.**

4.1 Analysis of variance for eleven characters in chickpea (*Cicer arietinum* L.)

S. No.	Characters	Source of variation		
		Replications	Treatments	Error
	D.F.	2	32	64
1	Days to 50% flowering	28.798**	61.732**	2.725
2	Days to maturity	7.394	48.797**	3.154
3	Plant height	13.721*	94.853**	2.810
4	Primary branch	0.059	0.064**	0.013
5	Secondary branch	0.195	14.326**	0.096
6	Pods/plant	17.496**	396.685**	10.747
7	Seeds/pod	0.051	0.213	0.039
8	Biological yield /plant	26.139**	176.269**	8.881
9	Harvest index	26.151**	98.949**	8.584
10	100 seed wt	3.300	59.728**	1.718
11	Yield/plant	8.891*	37.215**	1.358
* Significant at 5% level of significance			** Significant at 1% level of significance	

IV.II.I. DAYS TO 50% FLOWERING

The days to 50% flowering ranged from 56 to 71.67 days. Six out of thirty and three check entries were presented top significant group for early flowering, because of being statistically closed with earliest flowering genotype, variety NDG 18-4.

IV.II.II. DAYS TO MATURITY

The number of days to maturity ranges from 113.67 to 131.67 days to attain maturity. The four entries, GCP 105, GNG 2207, GNG 38 and GNG 312 required.

IV.II.III. PLANT HEIGHT

The mean performance of plant height ranges from 29.73 to 54.57. On the other hand, general mean for this trait was 39.71 cm.

IV.II.IV. PRIMARY BRANCH

The minimum number of primary branches per plant ranges from 1.27 to 1.87. The general mean performance for this character was 1.55.

IV.II.V. SECONDARY BRANCH

The general mean calculated for secondary branches per plant of entire population ranges from 3.43 to 14.60 was observed for this character.

IV.II.VI. PODS PER PLANT

The highest numbers of pods per plant ranges from14.27 to 56.73. The general mean performance was 35.17.

IV.II.VII. SEEDS PER POD

The maximum number of seeds per pod (1.07) and minimum number of seeds per pod (2.07) were recorded in several genotypes, *i.e.*, GNG 1969, GNG 1999, GNG 2018, GNG 2124, GNG 2127, GNG 2177, Bidhan Chola 1, GCP 105, GNG 2207, GNG 38, GNG 312 and GNG 2215 were shows significant group for this trait. The general mean of above-mentioned characters was 1.45.

IV.II.VIII. BIOLOGICAL YIELD PER PLANT

The highest biological yield per plant was 44.50, while the lowest seed yield per plant 12.15. The general mean calculated for this character was 26.57.

IV.II.IX. HARVEST INDEX

The highest harvest index (48.52), while the lowest harvest index (17.95). The general mean calculated for this character was 32.72.

IV.II.X. HUNDRED SEED WEIGHT (G)

The hundred seed weight ranged from 12.10 g to 26.49 g with a general mean of 17.88 g.

IV.II.XI. YIELD PER PLANT

The highest seed yield per plant (18.38 g), while the lowest seed yield per plant (3.30g). The general mean calculated for this character was 8.81 g.

4.2 Mean performance for eleven characters in chickpea (*Cicer arietinum* L.)

S. No.	Characters / Genotypes	Days to 50% flowering	Days to maturity	Plant height	Primary branch	Secondary branch	Pods/plant	Seeds/pod	Biological yield /plant	Harvest index	100 seed wt.	Yield/plant

1	**Pant G-186 (Check)**	56.00	113.67	40.57	1.47	4.17	34.77	1.33	29.73	33.28	21.33	9.93
2	**Udai (Check)**	68.33	128.00	34.80	1.67	14.60	16.71	1.27	12.39	35.35	20.83	4.38
3	**BG-372 (Check)**	66.33	125.33	37.90	1.67	5.40	42.77	1.87	34.79	38.36	16.53	13.16
4	**GNG 2207**	62.00	119.00	38.70	1.53	4.07	29.11	1.73	27.18	24.86	13.39	6.74
5	**GNG 38**	58.33	120.67	38.07	1.53	5.60	26.93	1.47	26.11	33.26	22.02	8.65
6	**GNG 312**	58.67	119.67	36.33	1.53	6.00	47.55	1.40	28.97	34.18	14.99	9.95
7	**GNG 0703**	58.33	121.33	37.00	1.27	4.50	25.47	1.67	18.81	32.62	14.33	6.06
8	**GNG 0820**	59.00	125.67	40.43	1.40	5.67	29.82	1.20	20.23	30.37	17.31	6.14
9	**GNG 1001**	68.33	127.33	49.23	1.60	6.93	37.10	1.40	33.03	37.18	23.70	12.27
10	**GNG 1013**	60.67	125.00	39.73	1.73	5.90	44.00	1.73	40.03	40.41	21.21	16.17
11	**GNG 1854**	71.00	130.33	43.77	1.53	7.87	46.98	1.27	32.42	48.52	26.49	15.70
12	**GNG 1926**	71.33	132.67	39.87	1.60	8.20	56.27	1.27	31.37	30.63	13.82	9.67
13	**GNG 1929**	68.67	129.00	41.70	1.67	8.67	44.40	1.80	30.48	32.51	12.48	9.92
14	**GNG 1947**	71.67	130.67	50.73	1.47	7.80	42.78	1.87	29.41	32.95	12.10	9.66
15	**GNG 1958**	69.67	130.67	45.30	1.87	7.53	45.80	1.53	28.38	31.82	13.04	9.02
16	**GNG 1969**	61.33	126.00	40.50	1.67	8.80	49.27	1.20	25.11	28.92	12.43	7.29
17	**GNG 1999**	64.00	124.00	33.20	1.33	6.10	43.11	1.40	28.25	32.27	15.22	9.09
18	**GNG 2018**	61.67	123.33	29.73	1.67	8.27	44.67	1.20	28.70	25.94	14.04	7.47

19	**GNG 2124**	71.00	127.67	35.13	1.73	3.43	21.17	1.40	14.37	32.18	15.89	4.62
20	**GNG 2127**	67.00	124.00	37.80	1.80	3.60	14.27	1.07	12.60	26.34	21.79	3.30
21	**GNG 2177**	66.67	127.33	45.37	1.27	3.53	14.78	1.80	12.15	33.47	15.50	4.07
22	**GNG 2215**	69.67	130.67	31.67	1.53	4.60	23.78	1.07	18.15	33.29	23.88	6.02
23	**GNG 2216**	64.67	124.33	36.90	1.27	5.53	30.47	1.13	24.26	32.22	22.85	7.84
24	**GNG 2217**	60.67	127.00	40.43	1.53	6.23	34.55	1.67	29.14	32.56	16.51	9.47
25	**GNG 2219**	68.67	129.00	43.73	1.40	6.07	34.00	1.73	28.40	36.90	17.68	10.40
26	**GNG 2257**	66.33	126.00	40.37	1.40	5.17	27.91	1.33	23.92	22.69	14.51	5.40
27	**DBGC 2**	69.67	131.00	30.53	1.60	3.63	15.71	1.20	16.20	26.83	23.44	4.36
28	**DC 17-1111**	60.33	124.00	35.43	1.53	7.53	34.46	1.27	29.96	31.91	22.27	9.59
29	**DC 17 -1115**	63.00	125.33	47.03	1.53	6.27	34.51	1.20	28.24	35.13	24.25	9.92
30	**BDNG 2017-1**	59.67	122.00	40.77	1.73	4.53	30.20	1.47	26.83	40.32	24.43	10.84
31	**NDG 18-4**	64.00	122.67	34.33	1.67	5.57	39.80	1.67	26.74	33.19	13.47	8.87
32	**Bidhan Chola 1**	66.33	125.00	38.73	1.53	4.53	40.78	1.27	36.06	17.95	12.75	6.49
33	**GCP 105**	66.67	125.67	54.57	1.47	5.30	56.73	2.07	44.50	41.38	15.72	18.38
34	**Mean**	**64.84**	**125.58**	**39.71**	**1.55**	**6.11**	**35.17**	**1.45**	**26.57**	**32.72**	**17.88**	**8.81**
35	**Range Min.**	56.00	113.67	29.73	1.27	3.43	14.27	1.07	12.15	17.95	12.10	3.30
36	**Range Max.**	71.67	132.67	54.57	1.87	14.60	56.73	2.07	44.50	48.52	26.49	18.38

37	**C.D (at 5%)**	**2.771**	**2.981**	**2.814**	**0.191**	**0.519**	**5.503**	**0.330**	**5.002**	**2.200**	**2.2006**	**2.771**

V. DISCUSSION

The adjusted mean of 30 genotypes along with three checks and range for eleven characters are discussed as under:

V.I. DAYS TO 50% FLOWERING

Six out of thirty and three check entries were presented top significant group for early flowering, because of being statistically closed with earliest flowering genotype, variety NDG 18-4. The five lines presented in the significant group for early flowering were GNG 38, GNG 0703, GNG 312, GNG 0820 and BDNG 2017-1. The general mean calculated for days to 50% flowering of entire genotypes was 97.40 days.

V.II. DAYS TO MATURITY

The significant group for early maturity was Bidhan Chola 1, GCP 105, GNG 2207, GNG 38, GNG 312, GNG 0703, GNG 0820, GNG 1001 & GNG 1013 and left was non-significant. The general mean calculated for all character was 125.58 days.

V.III. PLANT HEIGHT

The mean performance of plant height ranges from 29.73 to 54.57. On the other hand, general mean for this trait was 39.71 cm. six entries namely, GNG 2216, GNG 2217, GNG 2219, GNG 2257, DBGC 2 and DC 17-1111 constituted the significant group for tall stature along with the tallest genotypes, GNC 1926.

V.IV. PRIMARY BRANCH

Ten entries present in the significant group for primary branches per plant were GNG 1854, GNG 1926, GNG 1929, GNG 1947, GNG 1969, GNG 1999, GNG 2018, GNG 2124, GNG 2127 and GNG 1958.

V.V. SECONDARY BRANCH

Out of 33 genotypes, 19 entries exhibited significantly better secondary branches per plant than the general mean. The best eleven lines among them were namely, Bidhan Chola 1, GCP 105, GNG 2207, GNG 38, GNG 312, GNG 0703, GNG 0820, GNG 1001, DC 17-1111, DC 17-1115 and GNG 1013.

V.VI. PODS PER PLANT

The significant group for maximum pods per plant comprised of seventeen lines which were GNG 2216, GNG 2217, GNG 2219, GNG 2257, DBGC 2, DC 17-1111, DC 17 -1115, Bidhan Chola 1, GCP 105, GNG 2207, GNG 38, GNG 312, GNG 0703, GNG 0820, GNG 1001, GNG 1999 and GNG 2018.

V.VII. SEEDS PER POD

The maximum and minimum number of seed per pod were recorded in several genotypes, *i.e*, GNG 1969, GNG 1999, GNG 2018, GNG 2124, GNG 2127, GNG 2177, Bidhan Chola 1, GCP 105, GNG 2207, GNG 38, GNG 312 and GNG 2215 were shows significant group for this trait.

V.VIII. BIOLOGICAL YIELD PER PLANT

Eight genotypes namely, Bidhan Chola 1, GCP 105, GNG 2207, GNG 38, GNG 312, GNG 0703, GNG 0820 and GNG 1013 were significantly produced biological yield per plant.

V.IX. HARVEST INDEX

Nine genotypes namely, Bidhan Chola 1, GCP 105, GNG 2207, GNG 38, GNG 312, GNG 0703, GNG 0820, NDG 18-4 and GNG 1013 were significantly produced harvest index.

V.X. HUNDRED SEED WEIGHT (g)

Twenty three genotypes possessed significant higher mean value than general mean. The best nine entries were observed for Bidhan Chola 1, GCP 105, GNG 2207, GNG 38, GNG 312, GNG 0703, GNG 0820, GNG 1001 and GNG 1013.

V.XI. YIELD PER PLANT

Ten genotypes namely, Bidhan Chola 1, GCP 105, GNG 2207, GNG 38, GNG 312, GNG 0703, GNG 0820, GNG 1001, NDG 18-4 and GNG 1013 were significantly produced seed yield per plant.

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