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Genetic Variability, Heritability and Genetic Advance in Chickpea (*Cicer arietinum* L.) Genotypes

Manmohan Singh[1], P.B. Singh[1], Vijaypal Singh[1], Sandeep Kumar Bangarwa and S.P. Singh[2]
[1]*Department of Genetics and Plant Breeding, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan*
[2]*CSAUAT-Agriculture Research Station, Kalai, Aligarh, U.P.*

Abstract

The present investigation entitled "Genetic variability, heritability and genetic advance in chickpea (*Cicer arietinum* L.) Genotypes" was conducted during *rabi,* 2019-20. In the experiment twenty five diverse genotypes including three checks *viz*., PC-1, JG-16 and JG-315 of chickpea, were grown at the instructional farm, CTAE, MPUAT, Udaipur. This experiment was conducted in RBD with three replications. All Observations recorded for twelve characters viz., Days to 50 per cent flowering, Days to maturity, Plant height (cm), Number of primary branches per plant, Number of secondary branches per plant, Number of pods per plant, Number of seedsper pod, 100-seed weight (g), Biological yield per plant (g), Harvest index (%), Protein content (%) and Seed yield per plant (g). The data so obtained were subjected to analysis of variance, estimation of different variability parameters for all twelve characters. Analysis of variance revealed that genotypes were highly significant for all the twelve characters, indicated the presence of ample genetic variability available in the experimental material under study that can be further exploited for chickpea improvement. High GCV coupled with high heritability and expected genetic gain were recorded for 100-Seed weight, seed yield per plant, number of primary branches per plant, plant height, number of secondary branches per plant, biological yield per plant and harvest index in the experiment.An ideal plant of chickpea is one which should have higher value of harvest index, number of seeds per pod, number of primary branches per plant, number of secondary branches per plant, biological yield per plant, number of pods per plant and 100-seed weight.

Key words : *Genetic variability, heritability, genetic advance, chickpea*

Introduction

Chickpea (*Cicer arietinum* L.), belonging to the family Fabaceae, sub-family Fabiodea. It is a self pollinated leguminous crop with chromosome no. 2n=14. It is native crop of India. Chickpea is also known as Gram, Bengal gram, Garbanzo, Garbanzo bean and Egyptian pea.

Chickpea have tap root system and roots are with root nodules. Root system is robust, upto 2m deep, but major portion upto 60cm. The stem is mostly herbaceous and erect. Chickpea stems are branched, erect or spreading, sometimes shrub by much branched, 0.2-1m tall, glandular pubescent, olive, dark green or bluish green in color. Leaves are stipulate, alternate, imparipinnate, glandular, pubescent with 3-8 pairs of leaflets and a top leaflet (rachis ending in a leaflet) pinnately compound and have pulvinate leaf base; leaflets ovate to elliptic. The flower of chickpea is complete, bisexual, zygomorphic, hypogynous, pentamerous solitary, axillary and polypetalous standard aestivation. Calyx is gamosepalous, lanceolate and densely covered with hairs. Corolla is polypetalous, papillionacious having five petals, odd petal posterior, consisting of a posterior standard two lateral wings, two anterior ones forming a keel (enclosing stamens and pistil), vexillary aestivation. Stamens are ten in number in diadelphous (9 anthers are fused + 1 anther is free), condition of ovary is superior, sessile, inflated and pubescent. Majority of buds commence opening between 8.00 a.m. to 11.00 a.m. After fertilization, pod formation starts in 5-6 days. Fruits (pods) known as Legume. Pods are rhomboid ellipsoid, containing one/two or rarely three seeds and inflated, glandular-pubescent. Seed colour cream, yellow, brown, black, or green, rounded to angular, seed coat smooth or wrinkled. Chickpea is largely grown as rainfed but can also be grown as irrigated crop.

Chickpea is one of the major pulses cultivated and consumed in India. Chickpea is an important food legume providing protein in human diet. Chickpea is also a major and cheap source of protein compared to animal protein. Chickpea contains 21-24 per cent protein, 2.2 per cent fat, 62 per cent carbohydrates. It also contains 190 mg/100g calcium, 280 mg/100g phosphorous and 90.5 mg/100g iron and high percentage of other mineral nutrients and unsaturated oleic and linoleic acid. Among pulses, chickpea has relatively lower protein content but of higher biological value and protein digestibility. The granular hair of leaves and pods secretes two acids in liquid forms Malic acid (90-96%) and Oxalic acid (4-10%).

The trend of production of top 5 states of india is Madhya Pradesh followed by Rajasthan followed by

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Maharashtra followed by Karnataka followed by Uttar Pradesh while Telangana have highest productivity i.e., 1.54 tha^{-1}. The total area, production and yield are 2463029 ha, 2660934 tonnes and 1080 $kgha^{-1}$ respectively in Rajasthan. Large variation is seen in terms of area (ha), production (tonnes), yield/productivity ($kgha^{-1}$) in rajasthan. Top 5 districts in terms of area(ha) for chickpea production are Churu followed by Hanumangarh, Bikaner, Ajmeramd Jaisalmer while production trend is different Ajmer followed by Bikaner, Jaipur, Tonk, Hanumangarh and the trend of productivity so much different from this *i.e.,* Chittorgarh followed by Sawaimadhopur, Baran, Rajsamand and Bundi (1).

Seed yield in chickpea is a complex character and is depend on its component traits. For genetic manipulation of seed yield, quality and other characters in chickpea, there is a need to examine the nature of genetic variability for the yield related attributes and quality traits. Estimation of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) helps to choose the potential genotype and heritability along with genetic advance would be more useful tool in predicting the resultant effect for selection of best genotypes for yield. Keeping these things in the view, the present investigation was made to assess genotypes with the objectives, to estimate the variability, heritability and genetic advance for yield and yield components traits in chickpea.

Materials and Methods

The present investigation was carried out to elicit the information on "Genetic Variability, Heritability and Genetic Advance in Chickpea (*Cicer arietinum* L.) Genotypes" during *Rabi* 2019-2020 at the instructional farm CTAE, MPUAT, Udaipur. The 25 genotypes along with 3 checks of chickpea were evaluated for genetic variability, correlation and path analysis for 12 economically important traits during *Rabi 2019*-2020.

CTAE, Maharana Pratap University of Agriculture and Technology, Udaipur is situated at an elevation of 579.5 meters above mean sea level, latitude of 24º35' North and longitude of 73°42' East.

The experimental material used in the present investigation was consisted of the 25 diverse genotypes along with 3 checks chickpea genotypes representing diversity in adaptability and variability in characters and geographical origin. The experimental material was evaluated for genetic variability, correlation analysis and path analysis for 12 economically important traits during *Rabi 2019*-2020.

The experimental materials consisting of twenty five diverse genotypes of chickpea were sown in randomized block design in three replications. Each entry was planted in a plot size of 4 x 1.50 m^2 accommodating 5 rows of 4 m length, keeping row to row and plant to plant distance of 30 cm and 10 cm, respectively. All the recommended package of practices was followed to raise a good and healthy crop.

Five competitive plants for each entry were randomly selected for recording observations for all the quantitative characters in each replication except days to 50 per cent flowering and days to maturity, where observations were recorded on plot basis.

Statistical analysis : To test the difference among the genotypes, the analysis of variance was worked out separately for each character as per method suggested by (2) and using standard statistical procedure given by (3). Genotypic coefficient of variation (GCV) and Phenotypic coefficient of variation (PCV) were calculated as per the standard formula suggested by (4).

$$\text{Genotypic variance } ({}^2_g) = \frac{MSg - MSe}{r}$$

$$\text{Phenotypic variance } ({}^2_p) = {}^2_g + {}^2_e$$

Heritability (h^2) was calculated in broad sense by using the following formula given by (5).

$$h^2 = \frac{{}^2_g}{{}^2_p} \quad 100$$

Genetic gain (GG) is the genetic advance expressed as per cent of mean. It was estimated by using the formula of (5,6).

$$GA = k \times {}_p \times h^2$$

Where,

K = Selection differential (value of k at 5% selection intensity = 2.06)

${}_p$ = Phenotypic standard deviation

h^2 = Heritability in broad sense

$$\text{Genetic advance (as percentage of mean)} = \frac{GA}{\bar{X}} \quad 100$$

Where,

GA = Expected genetic advance under selection

$\bar{X}$ = General mean of a character

Results and Discussion

Analysis of variance revealed that mean sum of squares due to genotypes were highly significant for days to 50 per cent flowering, days to maturity, plant height (cm), number of primary branches per plant, number of secondary branches per plant, number of pods per plant, number of seeds per pod, 100-seed weight (g), biological yield per plant (g), harvest index (%), seed yield per plant (g) and

Table-1 : Mean square for RBD in individual environment.

S. No.	Characters	Replication [2]	Genotype [24]	Error [48]
1.	Days to 50% flowering	0.09	24.22**	1.61
2.	Days to maturity	1.21	28.72**	2.60
3.	Plant height (cm)	11.62	222.69**	6.72
4.	No. of primary branches per plant	0.03	0.99**	0.04
5.	No. of secondary branches per plant	0.16	6.86**	0.06
6.	No. of pods per plant	32.16	105.28**	14.84
7.	No. of seeds per pod	0.01	0.06**	0.02
8.	100 Seed weight(g)	0.06	48.40**	0.40
9.	Seed yield per plant (g)	1.20	17.06**	0.90
10.	Biological yield per plant (g)	0.39	32.84**	1.38
11.	Harvest index (%)	61.62	223.89**	30.67
12.	Protein content (%)	0.01	2.01**	0.14

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

Table-2 : Genetic variability parameters for yield and its contributing traits in chickpea.

S. No.	Characters	Mean	Range		GCV (%)	PCV (%)	h^2 (bs) (%)	Genetic Advance	Genetic Gain
			Min.	Max.					
1.	Days to 50% flowering	68.33	63	75	4.02	4.43	82.43	5.13	7.51
2.	Days to maturity	129.13	122	135	2.29	2.60	76.99	5.33	4.13
3.	Plant height (cm)	45.92	31.57	61.80	18.48	19.32	91.46	16.72	36.40
4.	Number of primary branches per plant	2.77	1.80	3.73	20.29	21.46	89.37	1.09	39.51
5.	Number of secondary branches per plant	8.72	5.63	12.20	17.26	17.48	97.48	3.06	35.10
6.	Number of pods per plant	60.36	52.33	68.67	9.10	11.11	67.01	9.26	15.34
7.	Number of seeds per pod	1.57	1.33	1.87	7.24	11.08	42.64	0.15	9.73
8.	100-seed weight (g)	15.52	10.07	23.30	25.78	26.10	97.55	8.14	52.45
9.	Seed yield per plant (g)	9.57	5.60	14.00	24.25	26.20	85.71	4.43	46.25
10.	Biological yield per plant (g)	19.20	13.72	25.23	16.86	17.94	88.35	6.27	32.65
11.	Harvest index (%)	50.35	32.84	63.79	15.94	19.37	67.74	13.61	27.02
12.	Protein content (%)	21.64	20.20	23.50	3.65	4.04	81.52	1.47	6.78

protein content (%). Whereas mean sum of squares due to replication were found to be non-significant for all the characters, Table-1. The overall analysis of ANOVA indicated the presence of ample genetic variability available in the experimental material under study that can be further exploited for chickpea improvement. The similar finding for all yield related traits have been reported by (7,8,9).

Genotypic coefficient of variation (GCV) was recorded highest for 100-seed weight (25.78%) followed by seed yield per plant (24.25%), number of primary branches per plant (20.29%), plant height (18.48%) and number of secondary branches per plant (17.26%). Days to maturity (2.29%) and protein content (3.65%) exhibited low genotypic coefficient of variation.

The phenotypic coefficient of variation (PCV) was higher in magnitude than that of genotypic coefficient of variation for all the characters under study. The highest PCV was recorded for seed yield per plant (26.20%) followed by 100-seed weight (26.10%), number of primary branches per plant (21.46%), harvest index (19.37%) and plant height (19.32%). The characters *viz.,* days to maturity (2.60%), protein content (4.04%) and days to 50% flowering (4.43%) showed low phenotypic coefficient of variation.

Broad sense heritability was estimated for all the characters under study. High heritability was observed for most of the traits and it was noted highest for 100-seed weight (97.55%) followed by number of secondary branches per plant (97.48%) and plant height (91.46%). However number of seeds per pod (42.64 %) and number of pods per plant (67.01%) exhibited low to moderate estimates of heritability.

The high genetic advance as per cent of mean (genetic gain) was recorded highest for 100-seed weight (52.45%) followed by seed yield per plant (46.25%), number of primary branches per plant (39.51%), plant height (36.40%) and number of secondary branches per plant (35.10%). However days to maturity (4.13%), protein content (6.78%) and days to 50% flowering (7.51%) showed low genetic gain.

The presence of adequate genetic variability is essential and its consideration combined with heritability

(broad sense) may play a significant role in analysing the relative contributions of genetic and non-genetic factors to the total phenotypic variation in a population. To obtain a clear picture about the variability in all the genotypes, the variability was further partitioned into phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV). In the present investigation, phenotypic coefficient of variation (PCV) is marginally higher than the respective genotypic coefficient of variation (GCV) for all the characters indicating negligible influence on the characters by the environmental fluctuations. The 100-seed weight depicted highest genotypic coefficient of variation followed by seed yield per plant, number of primary branches per plant, plant height and number of secondary branches per plant, while highest phenotypic coefficient of variation (PCV) was observed for seed yield per plant followed by 100-seed weight. The magnitude of GCV and PCV were low for days to maturity and protein content. Similar results were reported by (10,11,12, 13,14,15).

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