

## Variability and Character Association Studies of Yield and Its Attributing Character in Chickpea (*Cicer arietinum* L.)

S.K. Kaushik\*

Senior Scientist (Plant Breeding & Genetics)

Krishi Vigyan Kendra-Ujjain (MP)

(Rajamata Vijayaraje Scindhia Krishi Vishwa Vidyalaya-Gwalior)

\*Corresponding Author E-mail: [kaushik.surendra@rediffmail.com](mailto:kaushik.surendra@rediffmail.com)

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### ABSTRACT

Gram or Chickpea (*Cicer arietinum* L.) is considered as an important pulse crop and a regular source of human nutrition. Despite its nutritional values and economic importance, chickpea production is relatively low in our country due to poor genetic variability of cultivars available. The effectiveness of selection depends on magnitude of variability, GCV, PCV, heritability and genetic advance for yield and its component traits. Study of inter-relationships among yield and its contributing traits is also necessary. The study was conducted to determine the variability, heritability and correlations between yield and yield components in 39 genotypes of desi chickpea (*Cicer arietinum* L.). Present study was evaluated in completed randomized block design replicated thrice at research farm of Krishi Vigyan Kendra, Ujjain during rabi-2017-18. Observations were recorded on plant height (PH), days to 50 per cent flowering (DTF), days to maturity (DTM), number of pods per plant, number of primary branches per plant (PBN), seed index (SI) and seed yield (SY). Present study revealed highly significant differences for days to 50 per cent flowering, days to maturity, plant height (cm), number of primary branches, number of pods per plant, 100-seed weight(gram) and seed yield (kg/ha). The value of PCV was slightly higher than its respective value of GCV. The genotypic variance was highest for number of pods per plant followed by number of primary branches per plant. Broad sense heritability ranged from 53.8% (seed yield) to 99% (days to 50 per cent flowering). In this study heritability was high (greater than 80%) for all studied characters except seed yield. The genotypic correlation coefficients were in general, observed to be higher than that of phenotypic correlation coefficient for all the traits studied. Positive and significant relationships were determined between seed yield and number of pods per plant. On the basis of mean performance of all the characters except seed yield over all the checks i.e. BG-256, JG-16, & GCP-101 and Ujjain-21 (local check) only four genotypes (10 % genotypes) namely; HIR-70, Tungbhadra, RKG-135 and BDNG 2001-2-1 found promising indicated that these promising genotypes can be utilised for further improvement of chickpea.

**Keywords:** Chickpea, genetic variability, GCV, PCV, heritability, genetic advance, correlation coefficient analysis, days to flowering, pods per plant, 100-seed weight, seed yield.

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## INTRODUCTION

Chickpea (*Cicer arietinum* L.) considered as an important pulse crop and a regular source of human nutrition. This crop known as climate smart crop due to its unique production system reflecting resilient to climate change. It is prime food legume among pulses due to its manifold uses by the populations. It covered 149.66 lakh ha area, with production of 162.25 lakh tonnes and productivity of 1252 kg/ha during 2017-18 in the world (FAOSTAT, 2019). India placed on 1<sup>st</sup> position in area (71 %) and production (70 %) but lags behind several countries regarding productivity due to poor spread of improved varieties and technologies. It is the fifth place among food legume crop in the world following soybean, groundnut, drybean and dry pea. It is the major pulse crop of *rabi* season of India predominantly cultivated on rainfed area. It improves the soil fertility in arid land due to leguminaceae. In India, chick raised on 105.61 lakh ha area with production of 112.29 lakh tonnes and 1063 kg/ha productivity during 2017-18. Madhya Pradesh is leading state regarding area (34%) and production (40%) in the nation (Annual Report 2017-18, Directorate of Pulses Development). The introduction of chickpea in a cereal based rotation, which is used particularly in developing countries, can break the disease and pest cycle, and increase the productivity of the entire rotation (Jodha & Subba Rao, 1987). There are two major types of chickpea *i.e.* kabuli and desi (brown). The former is grown in temperate regions while later *i.e.* desi chickpea is grown in semi-arid tropics (Muehlbauer & Singh, 1987). Chickpea plant is very sensitive to excess moisture, high humidity and cloudy weather which adversely affect its yield through limited flower production and seed set (Key, 1979).

Gram is the cheapest and readily available source of protein (19.5%), fats (11.4%), carbohydrates (57-60%), ash (4.8%) and moisture (4.9% - 15.59%) (Huisman & Vander Poel, 1994). Despite its nutritional values and economic importance, chickpea production is relatively low in our country due

to majorly its poor genetic diversity among available cultivars. Hence, to enhance the genetic variability is first most requisite for any breeding programme targeted for improvement of crop yields. Because of increased recognition and its importance, evaluation and characterization of chickpea germplasm has received attention of the plant breeders (Virmani et al., 1983; & Bakhs et al., 1992).

The main objective of the most of the breeding programmes is to increase the yield (Lal & Tomer, 1980). To evolve cultivars having high yield potential, it becomes necessary to study the extent of variability in the available germplasm. The effectiveness of selection depends on magnitude of variability for yield and its component traits. Keeping all these facts in view, the present investigation was planned to study the variability present in different selection parameters and associations between yield and its components in advance breeding lines of chickpea.

## MATERIALS AND METHODS

The experimental material comprised of 39 diverse genotypes of desi chickpea including three checks namely; BG-256, JG-16, & GCP-101 and one local check (Ujjain-21) were evaluated in completed randomized block design replicated thrice at research farm of Krishi Vigyan Kendra, Ujjain during *rabi*-2017-18. Each plot has four rows of four meter row length spaced at 30 cm apart. The recommended package of practices was followed to raise a good crop. Observations were recorded on days to 50 per cent flowering (DTF), days to maturity (DTM), seed index (SI) and seed yield (SY) on plot basis whereas plant height (PH), number of pods per plant and number of primary branches per plant (PBN) were recorded on ten randomly selected plant basis. Mean data of various characters were subjected to statistical analysis (Panse & Sukhatme, 1969). The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV), heritability in broad sense ( $h^2$ ) and genetic advance as per cent of mean were estimated using the

procedure suggested by Johanson et al. (1955) as cited by Singh and Chaudhary (1979). Genotypic and phenotypic correlation coefficients were computed as per method suggested by Fisher (1918). Lush (1949) method was used to estimate expected genetic advance.

## RESULTS AND DISCUSSION

Analysis of variance disclosed highly significant differences among the genotypes for all the characters studied indicated that there is significant variability present among genotypes and have bright scope for improvement in the these traits though which we can alter the yield levels. The various parameters (general mean, range, genotypic & phenotypic coefficient of variation, heritability etc.) of genetic variability presented in table 1. Table 1 Unfolded that sufficient variability was present for days to 50 per cent flowering, plant height, primary branches per plant, number of pods per plant, seed index and seed yield. This variability can be utilized effectively to develop high yielding chickpea cultivars through hybridization followed by selection. Genotypic and phenotypic variations play an important role to understand the significant of each component on the expression of different characters. Table 1 showed low GCV and PCV for all the characters except for number of pods per plant and primary branches per plant only. In spite of this table 1 showed that phenotypic coefficient of variation are slightly higher than its respective genotypic coefficient of variation for all the traits indicating that environment played a minor role in the expression of traits and showing the pre dominance of additive type of gene action. Hence selection for these traits will be beneficial for improving the genetic make up of plant. Phenotypic coefficient of variation was maximum for number of pods per plant followed by primary branches per plant, seed yield, seed index, plant height, days to 50 per cent flowering and days to maturity. The genotypic variances for days to flowering, days to maturity, plant height and seed index are same as their

phenotypic variances resulting in minimal environmental variances. This makes the heritability of these characters nearby 100%. The offspring of these lines will be exactly like their parents because there are no visible environmental effects on the expression of these characters. Low coefficients of variation of phenotype and genotype for all the characters except the yield parameters encourages the use of yield parameters in selection of suitable parents for crosses or lines for further improvement. The significant difference between the phenotypic and genotypic coefficient of variation of seed yield emphasized the significant role of environment in the inheritance of the characters. Genotypic coefficient of variation was found high for number of pods per plant and number of primary branches per plant. It was moderate for 100-seed weight, seed yield and plant height whereas low for days to 50 per cent flowering. Hasan et al. (2008) low genotypic coefficient of variation value for days to 50 per cent flowering and days to maturity, moderate for plant height, seed index and seed yield. Khan and Sharma (1999) reported high genotypic coefficient of variation for number of pods per plant. Similar trend was found for genotypic coefficient of variation (GCV) for all the traits though they were slightly low compared to PCV.

Heritability is the percentage of phenotypic variance that is attributed to genetic variance. In the present study heritability, was high (greater than 80%) for all studied characters except seed yield. High heritability indicates that the environmental influence is minimal on characters. Any of the characters can, therefore, be used for selection. The selection for improvement of these characters may not be useful because broad sense heritability is based on total genetic variance which includes both fixable (additive) and non-fixable (dominance and epistatic) variances. Hasan et al. (2008) reported high heritability for seed index, days to 50 per cent flowering, plant height, number of primary branches per plant. Arun and Ram (1998) reported high heritability for days to 50 per

cent flowering and seed index; Tripathi (1998) and Kumar et al. (1999) reported high heritability for number of pods per plant and seed index. In the present study, seed yield showed moderate heritability (53.8%). The comparatively lower heritability for seed yield, in this study, may be due to the fact that yield is a low heritable character which that is controlled by many genes. The progress in selection for this character in chickpea is general slow. Earlier study of Kumar and Krishna (1998) reported low heritability for seed yield. Though high heritability indicates the effectiveness of selection on the basis of phenotypic performance, it does not show any indication of the amount of genetic progress for selecting the best individuals. The high genetic advance was observed for seed yield (44.9%) indicated that the character (seed yield) is governed by additive genes and selection would be rewarding for improvement of the yield. The moderate genetic advance was recorded for number of pods per plant (28.6%), plant height (13.6%) and days to 50 per cent flowering (12.2%) whereas seed index, days to maturity and primary branches per plant revealed low genetic advance indicated non-additive type governance and heterosis breeding for improvement of days to maturity, seed index and number of primary branches per plant may be useful.

Heritability and genetic advance are the important selection parameters. The expected genetic advance that was low for days to maturity, primary branches per plant and seed index may be compensated by their high heritability. Ali et al. (2002), Najeeb et al. (2009) found that high heritability may not always linked with high genetic advance. Since high value heritability does not always indicate a high genetic gain, heritability is recommended to be considered in association with genetic advance to predict the effect of selecting superior crops genotypes. The characters namely; days to maturity, number of primary branches per plant, and 100-seed weight showed high heritability accompanied with low genetic advance indicated the non-additive type of gene action. The high

heritability is being exhibited due to favourable influence of environment rather than genotype and selection for these traits may not be rewarding. Similarly, Arshad et al. (2003) observed high heritability and low genetic advance for days to flower, days to maturity and hundred seed weight in chickpea and indicated that these characters were controlled by dominant and epistatic genes. The characters namely; days to flowering, plant height, and number of pods per plant showed high heritability coupled with moderate genetic advance indicated that these traits are governed by the additive type of gene action. The selection of genotypes based on these traits would be rewarding. The main economic trait *i.e.* seed yield had moderate heritability accompanied with high genetic advance showed that character was governed by additive gene effects. The moderate heritability is being exhibited due to environmental effects and selection would be rewarding for this character.

**Character Association:** The inter-relationship among different characters of gram was given in table 2. In the present investigation, the genotypic correlation coefficients were in general, observed to be higher than that of phenotypic correlation coefficient indicating the strong inherent association for the various traits studied pointing out the possibility of effective phenotypic selection. At phenotypic level, association of seed yield was positive and significant with number of pods per plant and 100-seed weight. These results suggested that any positive increase in such traits will enhance the seed yield. These results were in accordance with those reported by Güler et al. (2000) and Uddin et al. (1990). Whereas it revealed significantly negative association with days to 50 per cent flowering and days to maturity. It indicated that late flowering genotypes had short reproductive period that results into low yield. In this case early flowering lines could be selected for higher yield. Days to 50 per cent flowering revealed highly significant and positive association with days to maturity and plant height but highly significant negative correlation with number of

Pods per plant and seed yield, indicated that early flowering had more number of pods per plant that results into high yield. Days to maturity showed highly significant positive association with days to 50 per cent flowering and plant height whereas it was negative with seed yield. Plant height revealed significant positive association with days to 50 per cent flowering, days to maturity and number of pods per plant. Number of primary branches per plant showed positive correlation with number of pods per plant. Number of pods per plant revealed highly significant positive association with seed yield, number of primary branches per plant and plant height whereas it was negatively correlated with days to 50 per cent flowering. Mather and Mathur (1996) and Arshad et al. (2003) reported negative correlation of days to 50 per cent flowering with grain yield in chickpea. Tripathi (1998) and Yucel et al. (2005) found significant positive correlation of number of pods per plant with seed yield. Hasan et al. (2008) reported that seed yield showed positive significant association with number of pods per plant. Deshmukh and Patil (1995) and Khorgade (1995) also reported positive correlation of seed yield with number of pods per plant.

**Promising genotypes:** The promising genotypes which were significantly superior to the checks for various characters are given in table 3. Only one genotype BG-3004(2444 kg ha<sup>-1</sup>) found higher seed yield over checks for central zone (GCP-101 and JG-16 ) and local check (U-21) for seed yield whereas fifteen genotypes revealed seed yield superiority over another zonal check (BG-256).

**Days to 50 per cent flowering:** Fourteen genotypes revealed earliness in flowering than Check JG-16 (60.7 days), twenty one genotypes showed early flowering than check GCP-101(62.3 days), twenty five genotypes showed early flowering than check BG-256(63.7 days) and thirty one genotypes disclosed earliness in flowering than U-21(local check, 66.3 days) whereas remaining seven genotypes could not showed earliness in flowering over any check used in the trial.

**Days to maturity:** Nine genotypes revealed early maturity than Check JG-16 (99.0 days), fifteen genotypes showed early maturity than check GCP-101(103.0 days), twenty nine genotypes showed early maturity than check BG-256(105.3 days) and all thirty eight genotypes disclosed earliness than U-21(local check, 109.7 days) in the present study.

**Plant Height(cm):** Twenty-six genotypes showed tallness over local check U-21(47.6 cm), twenty-three genotypes revealed higher plant height than check GCP-101(48.3 cm), nineteen genotypes showed tallness over check JG-16(49.9 cm) and only four genotypes namely; GNG-1958(59.5 cm), CSJ-515(60.9 cm), GJG-0703(63.6 cm) and H 04-75(66.1 cm) disclosed higher plant height over check BG-256.

**Number of primary branches:** Thirteen genotypes showed superiority in primary branches over check JG-16(10.1), four genotypes revealed higher primary branches than check BG-256(12.0), none of the genotype showed superiority in primary branches over check GCP-101(16.3) whereas all thirty eight genotypes disclosed superiority in primary branches over U-21(local check, 3.5) in the present study.

**Number of pods:** Ten genotypes showed superiority over check JG-16(48.9), fifteen genotypes revealed higher pods than check BG-256(45.3), none of the genotype showed superiority in pod numbers over check GCP-101(83.6) whereas twenty five genotypes disclosed superiority in pod numbers over local check, U-21(41.0).

**100-seeds weight(g):** Two genotypes (JG 9-3 & GNG-1958) showed superiority over check BG-256(29 g), twenty four genotypes revealed higher seed index than check JG-16(21 g), thirty two genotype showed superiority over check GCP-101(18.7 g) whereas thirty five genotypes disclosed superiority over local check, U-21(17.7 g).

**Seed Yield(kg/ha):** Eighteen genotypes showed yield superiority over check BG-256(1861 kg/ha), three genotypes namely; BG-3004(2444 kg/ha), U-21,LC(2425 kg/ha) & JG-16,C(2278 kg/ha) revealed higher seed

yield than check GCP-101(2274 kg/ha), two genotypes {BG-3004(2444 kg/ha), U-21,LC(2425 kg/ha)} showed superiority over check JG-16(2278 kg/ha) whereas only BG-3004(2444 kg/ha) disclosed yield superiority over local check, U-21(2425 kg ha<sup>-1</sup>). These promising genotypes could be used as parental lines in in future hybridization programme for developing high yielding varieties of desi chickpea.

As per the table 3; The present study revealed that only seven genotypes found promising over check (JG-16), nine genotypes including check JG-16 disclosed promising

over check (GCP-101), ten genotypes exhibited superiority over check (BG-256) and twenty four genotypes including all three checks utilised for the study revealed superiority in desired direction for most of the characters studied. On the basis of all the characters except seed yield over all the checks *i.e.* BG-256, JG-16, & GCP-101 and Ujjain-21 (local check) only four genotypes(10 % genotypes) namely; HIR-70, Tungbhadra, RKG-135 and BDNG 2001-2-1 found promising indicated that these promising genotypes can be utilised for further improvement of chickpea yield plateau.

**Table 1: Genetic variability for seed yield and its component characters in chickpea**

Character	Mean	Range	GCV (%)	PCV (%)	h <sup>2</sup> (%)	GA	GA (as % of mean)
Days to 50% flowering (Nos)	61.0	45.3 - 70.3	9.76	9.81	99.0	12.2	20.0
Days to maturity (Nos)	102.9	94.0 - 109.7	3.41	3.60	88.6	6.8	6.6
Plant height (cm)	49.9	33.0 - 66.1	13.52	13.78	96.2	13.6	27.3
Number of primary branches per plant	9.2	3.5 - 16.3	28.3	29.0	95.5	5.2	57.1
Number of pods per plant	44.7	19.5 - 83.6	31.5	32.0	97.3	28.6	64.1
Seed Index(g)	23.1	16.0 - 31.7	18.9	19.0	98.8	8.9	38.7
Seed Yield (kg/ha)	1815	1167 - 2444	16.4	22.4	53.8	44.9	24.8

**Table 2: Genotypic (G) and phenotypic (P) correlation coefficients for seed yield and its component characters in chickpea**

Character		DTF (50%)	DTM	PH(cm)	PBN	Pods/Pl	SI(g)
DTM	G	0.559**					
	P	0.523**					
PH(cm)	G	0.355**	0.300**				
	P	0.346**	0.269**				
PBN	G	-0.017	0.150	-0.108			
	P	-0.018	0.152	-0.105			
Pods/Pl	G	-0.265**	-0.171	0.196*	0.356**		
	P	-0.261**	-0.148	0.189*	0.352**		
SI(g)	G	0.012	-0.107	-0.123	-0.010	-0.087	
	P	0.010	-0.102	-0.123	-0.006	-0.088	
SY(kg/ha)	G	-0.267**	-0.353**	-0.094	0.056	0.482**	-0.302**
	P	-0.198*	-0.243**	-0.068	0.036	0.329**	-0.205*

\*, \*\* significant at 5 and 1 per cent level of significance, respectively

DTF(50%)= Days to 50% flowering; DTM = Days to maturity; PH(cm) = Plant height (cm);

PBN = Number of primary branches per plant; Pods/Pl. = Number of pods per plant;

SI (g) = Seed Index(g); SY (kg/ha) = Seed Yield (kg/ha)

**Table 3: Promising genotypes over different checks for all the traits in chickpea**

SN	Check	Promising genotype	Check	Promising genotype	Check	Promising genotype	Local Check	Promising genotype
1	JG-16	Phule G 00110	GCP-101	HIR-70	BG-256	HIR-70	U-21	GJG-0703
2		HIR-70		JG-16(C)		JG-16(C)		H-04-08
3		Tungbhadra		Tungbhadra		Tungbhadra		HIR-70
4		RVSSG-1		RVSSG-1		GCP-101(C)		JG-16(C)
5		BG-3004		RKG-135		GNG-1936		H-04-75
6		RKG-135		JG-14-11		BG-3004		Tungbhadra
7		BDNG 2001-2-1		PBC-161		RKG-135		BG-256(C)
8				GL-26083		PBC-161		IPC-2004-1
9				BDNG 2001-2-1		BGM-569		GNG-1958
10						BDNG 2001-2-1		KGD-1209
11								IPC-1204-17
12								BAUG-7
13								GCP-101(C)
14								BAUG-12
15								GL-26054
16								RKG-135
17								RVSSG-2
18								RKG-141
19								JG-14-11
20								Phule G 97030
21								PBC-161
22								BGM-569
23								BDNG 2001-2-1
24								PBC--88

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