Assessment of Genetic Variability and different Character Association in Chickpea (*Cicer arietinum* L.) under late sown condition

ABSTRACT

In the present study, 102 chickpea germplasm showed wide range of variation for various characters evaluated during *Rabi* 2017-18 along with BG 372, Udai and Pant G 186 as checks varieties. The experiment was conducted in Augmented Block Design at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.). The observations were recorded on 11 quantitative characters *viz.*, days to 50 per cent flowering, days to maturity, primary branches per plant, secondary branches per plant, plant height (cm), pods per plant, seeds per pod, biological yield per plant (g), seed yield per plant (g), harvest index (%) and 100-seed weight (g). After analyzing the data statistical study of each characters genotypes revealed a wide range of results Genotypes GJG 1416 followed by BG 256, GJG 1416, PhuleG0819, IPC 2011-141 and IPC 1014 produced higher seed yield per plant and these genotypes constituted the top significant group for these traits..On other hand genotypes PDG 84-16, IPC 1014, H06-6, GJG 1401, GJG 1403 and JG2016-44 for early maturity;; BG 256, GJG 1209, GJG 1401, GJG 1416 and JG 11 were identified for high number of pods per plant; GJG 1416, GJG 1001, BG 256, RS 2011-06 and BG 3027 were identified for bold seed size; IPC 1014, PhuleG0805 and IPC 2010-134 for harvest index were found promising which may be used as potential donors for the traits in chickpea improvement programme. Seed yield per plant exhibited positive and highly significant correlations with secondary branches per plant, pods per plant, seeds per pod, biological yield per plant, harvest index and 100-seed weight. The positive significant correlations of seed yield per plant were found with primary branches per plant and non-significant with plant height. It exhibited negative non-significant association with days to 50 per cent flowering and days to maturity.

Keywords: Genetic variability; correlation; *Cicer arietinum* L., heritability; genetic advance; grain yield

INTRODUCTION

A pulse sometimes called a "grain legume" is an annual leguminous crop yielding from one to twelve seeds of variable size, shape, and color within a pod. "Chickpea is important cool season food legume pulse crop in India as well as world covering about 30 % of the total area and 40 % of the pulse production in India. The word *Cicer* is a Latin origin and *Cicer arietinum* is a self pollinated crop that belongs to family Fabaceae. It is a diploid species with 2n = 2x = 16" (Arumuganathan, K., & Earle,(1991). "Having a genome size of approximately 931 Mbp" (**http//www.rbgkew.org.uk/cval**). "It is a highly self-pollinated crop with an out crossing rate of less than 1%. The genus *Cicer* comprises one cultivated species (*Cicer arietinum* L.) and 42 wild species. The major chickpea producing states in India are Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, Karnataka, Andhra Pradesh and Gujarat and which contribute more than 90 per cent of total acreage. In India chickpea occupies 10.17 million ha area, with a production of 11.35 million tonnes registering the productivity of 1116 kg/ha. In Uttar Pradesh, chickpea crop occupied 0.62 million hectares area, 0.85 million tonnes production and 1371 kg/ha productivity" **(Anonymous, 2021).** "Germplasm serves as the most valuable natural reservoir, providing needed attributes for developing high yielding input responsive varieties with wide genetic base having desired level of resistance for various biotic and abiotic stresses in any crop improvement programme. The knowledge of factors responsible for high yield has been rather difficult since yield is a complex character" (**Wang *et al.*, 2017**). Therefore, for attaining higher yield levels, the breeder is required to simplify this complex situation through handling of the yield components. For a rational approach in breeding for high yield, the use of component approach is advocated for a successful production-breeding programme. Several studies on character association in chickpea have been reported by **Sultana *et al.*, 2014; Singh & Pratap, 2014; Basu *et al.*, 2016 and Rubialas *et al.*, 2018.** However, most of these studies were based on limited sample materials. In order to derive reasonably unbiased and broad understanding, it may be desirable to conduct such studies on large diverse germplasm collection.

"The choice of genetically diverse potential parents for use in hybridization programme is based on the hypothesis that crosses involving divergent parents offer greater possibility of obtaining desirable segregants in the segregating generation. Several workers have emphasized need of parental diversity in optimum magnitude to obtain superior genotypes in the segregating" generations **Nisar *et al.,* 2007; Ahmad *et al.,* 2010; Dwevedi *et al.,* 2009 and Agrawal *et al.,* 2018.** Therefore, effort should be made to increase the wider use of existing diversity from germplasm collection.

Although there haven't been many genetic studies on chickpea's germplasm evaluation, variability, and correlation, the majority of these have relied on testing a small number of germplasm lines. Furthermore, it is impossible to generalize the findings of earlier studies of these aspects because they are only applicable to the specific materials and environments used in the study.

MATTERIALS AND METHODS

The experiment was conducted to evaluate the 105 varieties /strains of chickpea including elite lines and land races with three popular check varieties *viz.*, Udai, Pant G186 and BG 372. The experimental material was evaluated at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj, Ayodhya (U.P.) in Augmented Block Design during *Rabi* 2017-18. The meteorological data were recorded during the experimental period with temperatures of 4.9^0C to 39.0^0C. The experimental field was divided into six block of equal size. Twenty entries including checks were accommodated in each block. Each treatment was planted in single row of 4 m length, the inter and intra row spacing done 30 cm and 10 cm, respectively. To avoid the border effects the experimental plot was surrounded from all sides by non-experimental rows. Recommended cultural practices were followed to raise a good crop. To ensure a successful harvest, all recommended agronomic techniques were implemented in every plot replication. Five plants from each treatment were selected randomly for recording following observations except days to 50% flowering and days to maturity which were recorded on plot basis. To ensure a successful harvest, all recommended agronomic techniques were implemented in every plot replication. On five randomly selected plants from each genotype in each replication we recorded data on eleven different quantitative characteristics, including plant height (cm), number of primary and secondary branches and pods and seeds per pod, the weight of 100 seeds (g), the number of days until 50% flowering, the number of days until maturity, biological yield per plant(g), harvest index(%) and seed yield per plant(g). The average performance value was derived using statistical analysis of the data from each replication. The statistical analysis was done by using the techniques for analysis of "Augmented Block Design" developed by **Federer (1956).** Path coefficient analysis was done according to the given formula by **Dewey and Lu (1959)** and simple correlation was calculated by using 'R' software.

RESULT AND DISCUSSION

The analysis of variance for the design of experiment (Augmented Block Design) involving 105 chickpea germplasm including three checks evaluated in 6 blocks was done for each of the eleven characters. The mean squares due to blocks, checks and error for all the characters are presented in **Table-1**. The variation due to blocks were significant for days to 50% flowering, days to maturity, secondary branches per plant, plant height, pods per plant, biological yield per plant, seed yield per plant, harvest index, 100 seed weight at 1% probability and seeds per pod at 5% probability level . The variation due to checks were significant for days to maturity, plant height, pods per plant, biological yield per plant, seed yield per plant, secondary branches per plant, no. of seeds per pod, primary branches per plant and 100 seed weight at 1% probability level. Whereas, days to 50 per cent flowering, seed yield and harvest index were found non-significant. And the mean performance of the different characters of fifteen genotypes is shown in **Table 2**.

Table 1: Analysis of variance of checks for eleven characters in chickpea

Source of variation	d.f.	Mean squares										
		Days to 50 per cent flowering	Days to maturity	Plant height (cm)	Primary branches per plant	Secondary branches per plant	Pods per plant	Seeds per pod	Biological yield per plant (g)	100-seed weight (g)	Harvest index (%)	Seed yield per plant

Blocks	5	99.08**	102.54**	581.65**	0.018	1.29**	175.67**	0.068*	53.04**	22.74**	186.13**	12.03**
Checks	2	11.05	110.05**	77.96**	5.51**	21.80**	66.81**	0.48**	387.79**	50.95**	28.18	33.27**
Error	10	4.78	9.12	5.14	0.039	0.038	2.23	0.013	1.61	0.09	13.07	0.16
Total	17											

* Significant at 5% probability level

** Significant at 1% probability level

Table-2: Range, mean and least significant differences for eleven characters of chickpea genotypes

Characters	Range		Mean Value	Range of parameters			
				LSD_1	LSD_2	LSD_3	LSD_4
	Min.	Max.		5%	5%	5%	5%
Days to 50% flowering	54.56	84.22	69.77	2.81	6.89	7.96	6.08
Days to maturity	112.94	142.28	126.19	3.88	9.51	10.98	8.39
Plant height (cm)	22.26	344.99	38.34	2.91	7.14	8.25	6.30
primary branches/Plant	0.93	1.66	1.31	0.25	0.61	0.71	0.54
Secondary branches/plant	2.78	6.18	4.30	0.24	0.61	0.70	0.53
No. of Pods/plant	11.84	43.41	20.67	1.92	4.71	5.43	4.15
No. of seeds /Pod	0.98	1.78	1.17	0.14	0.35	0.41	0.31
Biological yield/Plant (g)	8.78	36.07	13.36	1.63	4.00	4.62	3.52
100-seed weight	12.76	27.29	18.66	0.40	0.98	1.14	0.87
Harvest index (%)	17.76	45.74	33.42	4.65	11.39	13.15	10.04
Seed yield/Plant	1.73	10.41	4.52	0.52	1.27	1.47	1.12

LSD_1= Least significant difference between two check means. **LSD_3** = Least significant difference between adjusted mean of two genotypes in different block. **LSD_2** = Least significant difference between adjusted mean of two genotypes in same block. **LSD_4**= Least significant difference between adjusted mean of genotypes and checks

Table 3: Estimates of simple correlation coefficients between eleven characters in chickpea genotypes

Character	Days To Maturity	Plant height (cm)	Primary branches per Plant	Secondary branches per Plant	Pods per Plant	Seeds per Pod	Biological yield per Plant (g)	Harvest index (%)	100-seed weight	Seed yield per Plant
Days to 50% Flowering	0.94**	0.00	-0.08	0.00	0.07	-0.21*	0.01	-0.07	-0.06	-0.02
Days to Maturity		0.03	-0.19*	-0.05	0.01	-0.24*	-0.03	-0.13	-0.09	-0.08
Plant height (cm)			-0.08	0.05	0.21*	0.11	0.01	0.14	-0.14	0.08
primary branches per Plant				0.54**	0.38**	0.03	0.12	0.36**	0.18	0.28*
Secondary branches per plant					0.46**	0.06	0.33**	0.41**	0.18	0.48**
Pods per Plant						-0.06	0.59**	0.60**	0.20*	0.77**
Seeds per Pod							0.17	0.33**	0.09	0.29**
Biological yield per Plant(g)								0.22*	0.40**	0.81**
Harvest index (%)									0.50**	0.72**
100-seed weight										0.55**

*** Significant at 5% probability level and ** Significant at 1% probability level.**

Table 4: Direct and indirect effects of ten characters on seed yield per plant in chickpea germplasm

Characters	Days to 50% Flowering	Days to Maturity	Plant height (cm)	primary branches per Plant	Secondary branches per plant	Pods per Plant	seeds per Pod	Biological yield per Plant (g)	Harvest index (%)	100-seed weight (g)	Correlation with seed yield per plant
Days to 50% flowering	**0.007**	-0.002	0.000	0.004	0.000	0.007	-0.005	0.005	-0.038	-0.001	-0.02
Days to maturity	0.007	**-0.002**	-0.001	0.009	-0.002	0.001	-0.006	-0.017	-0.065	-0.002	-0.08
Plant height (cm)	0.000	0.000	**-0.028**	0.004	0.002	0.020	0.003	0.009	0.072	-0.003	0.08
Primary branches per plant	-0.001	0.000	0.002	**-0.047**	0.023	0.037	0.001	0.071	0.183	0.004	0.28
Secondary branches per plant	0.000	0.000	-0.002	-0.025	**0.043**	0.045	0.001	0.203	0.210	0.004	0.48
Pods per plant	0.000	0.000	-0.006	-0.018	0.020	**0.098**	-0.001	0.363	0.308	0.004	0.77
Seeds per pod	-0.002	0.001	-0.003	-0.001	0.002	-0.006	**0.023**	0.106	0.167	0.002	0.29
Biological yield per plant (g)	0.000	0.000	0.000	-0.005	0.014	0.057	0.004	**0.618**	0.114	0.009	0.81
Harvest index (%)	-0.001	0.000	-0.004	-0.017	0.018	0.059	0.008	0.138	**0.512**	0.011	0.72
100-seed weight	0.000	0.000	0.004	-0.009	0.008	0.019	0.002	0.250	0.254	**0.022**	0.55

Residual effect=0.169607 Bold values shows direct and normal values shows indirect effects.

The present study, correlation coefficients were computed among the eleven characters **(Table 3).**

The correlations between seed yield per plant and secondary branches per plant, pods per plant, seeds per pod, biological yield per plant, harvest index, and 100 seed weight were all positive and highly significant. "The positive significant correlations of seed yield per plant were found with primary branches per plant and non-significant with plant height. It exhibited negative non-significant association with days to 50 per cent flowering and days to maturity" (**Qurban *et al.*, 2011**). "These characters emerged as most important factors in influencing seed yield in chickpea. The strong positive correlation of seed yield with the characters mentioned above has also been reported earlier in chickpea" (**Sreelakshmi *et al.*, 2010, Yadav *et al.*, 2010, Ojha *et al.*, 2011** and **Singh** and **Shiva Nath, 2012; Tadesse *et al.*, 2016 and Hasan Deb, 2017)**

The correlations between biological yield per plant and secondary branches per plant, pods per plant, seed yield per plant, and seed weight per 100 seeds were all positive and highly significant. It showed a significant positive correlation with the harvest index. However, it showed positively non-significant correlations with days to 50 per cent flowering, plant height, primary branches per plant, seed per pod and negative non-significant correlation with day to maturity. Such associations of biological yield per plant with the characters mentioned above looks logical as these traits are responsible for increasing either vegetative phase contributing straw yield or seed yield. Furthermore; days to maturity, plant height, secondary branches per plant, pods per plant and harvest index and 100 seed weight were strongly associated with each other and these traits add towards higher biomass. The above observations have also been reported by previous workers (**Sirohi, 2009, Yaqoob *et al.*, 2009, Sreelakshmi *et al.*, 2010, Yadav *et al.*, 2010; Ojha *et al.*, 2011; Kumar *et al.*, 2016 and Kumar *et al.*, 2017).**

The days to 50 per cent flowering showed positive and highly significant correlations with days to maturity and negative significant correlation with seed per pods. Positive non-significant correlation of days to 50 per cent flowering was noted with pods per plant, biological yield per plant. Pods per plant showed positive and highly significant correlations with biological yield per plant, harvest index, seed yield per plant, primary branches per plant and secondary branches per plant. It showed positive significant correlation with 100-seed weight and plant height. Harvest index showed positive and highly significant correlations with pods per plant, 100-seed weight and seed yield per plant, primary branches per plant, and secondary branches per plant and seeds per pod. It showed positive significant correlation with biological yield per plant. Fortunately, the correlation coefficients between important yield components were positively significant bearing a few exceptions due to weather differences. In the context of the chickpea germplasm used in the current study, this indicates a less complex situation in achieving a proper balance between yield and its important components as compared to complexities that frequently arise due to existence of strong negative and positive associations among various characters in this crop as well as many other crops. The majority of the correlation coefficients found in this study are generally consistent with earlier reports in chickpea **(Yadav *et al.*, 2010, Ojha *et al.*, 2011** and **Singh** and **Shiva Nath, 2012 and Joshi *et al.*, 2015).**

Conclusion

A very high degree of variability for all the characters in the evaluated germplasms was evident from the wide range of variation for various characters and the comparison of means of germplasm lines using least significant differences. The genotypes, GJG 1416 followed by BG 256, GJG 1416, PhuleG0819, IPC 2011-141, IPC 1014, JG 11, GJG 1001,GJG 1209, GJG 1401 and GJG 1403 produced higher seed yield per plant and these ten genotypes constituted the top significant group for this traits. Most desirable genotypes for characters other than the seed yield, were IPC 1014 for early flowering, PDG 84-16 for early maturity, BG 256 for primary branches per plant, JG 2016-9605 for number of secondary branches per plant, H 11-58 for higher plant height, BG 256 for number of pods per plant, RG 2011-02 for number of seeds per pod, GJG 1416 for biological yield per plant, IPC 1014 for harvest index and GJG 1416 for 100 seed weight. These promising lines can be used as donor parents in hybridization programme for improving the characters for which they showed very high mean performances. Biological yield per plant, harvest index, pods per plant, 100-seed weight, secondary branches per plant, and seed per pod all showed positive and highly significant correlations with seed yield per plant. It displays significant positive correlations with the primary branches of each plant. It demonstrates, respectively, positive non-significant and negative non-significant correlations with plant height and days until 50% flowering. Biological yield per plant (g) and harvest index were found to be significant direct components of seed yield per plant through path analysis. The traits mentioned above that were significant direct and indirect components deserve to be taken into account when creating a chickpea selection strategy that will produce high yielding varieties.

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