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Genetic variability and character association for seed yield in chickpea (*Cicer arietinum* L.)

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Abstract
The present investigation was conducted to estimate the genetic variability and character association existing among 18 chickpea genotypes including one local check which were evaluated during *Rabi* 2016-17 under randomized block design having three replications. The data was recorded for days to 50% flowering, plant height, number of primary branches per plant, number of pods per plant, days to maturity, biological yield per plant, harvest index, seed-index and seed yield per plant. Analysis of variance revealed significant differences among the genotypes for all the characters studied. Number of pods per plant followed by days to maturity and seed-index exhibited high estimates of heritability (bs) as well as genetic advance. Seed-index and number of pods per plant exhibited high estimates of genetic advance expressed as percent of mean. Correlation coefficient analysis revealed that seed yield per plant exhibited significant and positive correlation both at genotypic and phenotypic level with biological yield per plant, harvest-index and only at genotypic level with number of pods per plant. Hence, these characters may serve as effective selection criterion for yield improvement in chickpea.

Keywords: Chickpea (*Cicer arietinum* L.), Genetic variability, heritability, genetic advance, character association, correlation

Introduction
Chickpea (*Cicer arientinum* L.) is an important cool-season food legume having extensive geographical distribution. It originated from South West Asia – probably Afghanistan and Persia. Chickpea is a diploid species with 2n=16 chromosomes. It is a self-pollinated crop. It belongs to sub-family Papilionaceae of the family Leguminaceae. Chickpea is the third most important pulse crop of the world after soybean and dry pea and widely cultivated in west and south Asia.

In Asia, India is the largest producer of chickpea contributing about 70 percent of the total world production occupying an area of 9.93 million hectares with a production of 9.53 million tonnes and with productivity of 960 kg ha^{-1} in 2013-14 *(All India Coordinated Research Project on Chickpea)* [2]. Gram is a good source of protein (18-22%), carbohydrate (52-70%), fat (4-10%), minerals (calcium, phosphorus, iron) and vitamins. It is an excellent animal feed. Its straw has also good forage value (Yadav *et al.* 2016) [10].

Genetic variability is an essential component for any breeding programme desired to improve the characteristics of crop plant. The progress due to selection in nature for quantitative traits depends upon the nature and magnitude of variability present in the population to be improved. Genetic variability can be observed for various characters of plant on heterogeneous population in the form of genotypic differences. Information on certain genetic parameters for seed yield and associated characters is essential for the success of breeding programme of any crop. The knowledge of interrelationship of characters plays a vital role in developing appropriate selection criteria for the improvement of complex character like seed yield. Seed yield is the most economic as well as very complex character in nature because it is governed by polygene and greatly influenced by environmental factors. Therefore, direct selection for yield may not be effective in a polygenic character. Hence, it is necessary to consider yield contributing traits during selection. In view of the above facts the present investigation was undertaken to estimate the genetic variability and association between seed yield and its component characters in chickpea.

Materials and Methods
The experiment was conducted during *Rabi*, 2016-17 at the Field Experimentation Centre of the Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, (U.P.). The experimental material comprised of 18 chickpea genotypes including one local check obtained

from the Directorate of Research, SHUATS, Allahabad, which were evaluated for variability studies. The experiment was laid out in Randomized Block Design (RBD) in three replications with 30 × 10 cm inter- and intra- row spacing in 1 × 1 m plots. Recommended agronomic practices were followed to raise a competent crop. Observations on days to 50% flowering, days to maturity and seed-index were recorded on plot basis, whereas for characters like plant height, number of primary branches per plant, number of pods per plant, biological yield per plant, seed yield per plant and harvest-index were recorded on five randomly selected plants. The mean data of each character was subjected to analysis of variance to test the level of significance among the genotypes for different characters according to the method suggested by Panse and Sukhatme, (1967) [7]. The mean data over replications was used for calculating the genetic parameters according to Burton and De vane (1953) [3] and Johnson *et al.* (1955) [5]. The genotypic and phenotypic correlation coefficients were calculated according to the method suggested by Al-Jibouri *et al.* (1958) [1].

Results and Discussion

The grain yield is a highly variable and complex character and is a result of cumulative effects of its component characters. The analysis of variance revealed that the mean sum of square due to treatments (genotypes) for all the characters studied is found to be significant. This suggested that the genotypes selected for research were quite variable and considerable amount of variability existed among them. Hence, it provides ample scope for selection of different quantitative and qualitative characters for yield improvement in chickpea (Table 1). Similar results were reported by Dhameliya *et al.* (2008) [4]. An estimate of GCV and PCV for all characters studied revealed that the phenotypic coefficient of variation (PCV) was higher than their corresponding genotypic coefficient of variation (GCV), indicating the influence of environment on the expression of these characters. Higher magnitudes of GCV and PCV were recorded for seed yield per plant followed by biological yield per plant, seed-index and number of pods per plant, suggesting sufficient amount of variability and thus offer better scope for genetic improvement through selection of these traits. Similar results were reported by Thakur *et al.* (2008) [9]. Estimates of high heritability (bs) coupled with high genetic advance as percent of mean were observed for seed-index followed by number of pods per plant and seed yield per plant indicating to the preponderance of additive gene action and selection pressure could profitably be applied on these characters for yield improvement (Table 2). Similar results were reported by Jivani *et al.* (2013) [6]. Correlation coefficient analysis revealed that seed yield per plant exhibited significant and positive correlation both at genotypic and phenotypic level with biological yield per plant, harvest-index and only at genotypic level with number of pods per plant. Hence, direct selection for these traits would therefore be most effective in the improvement of chickpea genotypes (Table 3). Similar results were reported by Sharanappa *et al.* (2014) [8].

Table 1: Analysis of variance for different quantitative characters in chickpea

S. No.	Characters	Mean sum of squares		
		Replication (d.f.= 2)	Treatments (d.f.= 17)	Error (d.f.= 34)
1.	Days to 50% Flowering	13.463	24.505**	8.267
2.	Plant Height	0.761	26.324**	1.213
3.	No. of Primary branches per plant	0.029	0.696**	0.015
4.	No. of Pods per plant	0.379	105.202**	1.008
5.	Days to Maturity	0.130	17.667**	0.051
6.	Biological Yield per plant	70.584	47.333*	24.117
7.	Harvest Index	25.609	47.017**	11.562
8.	Seed Index	1.223	38.248**	1.434
9.	Seed Yield per plant	1.887	12.529*	6.288

* and ** indicate significance at 5% and 1% level, respectively

Table 2: Estimation of genetic parameters for nine quantitative characters in chickpea genotypes

S. No.	Characters	GCV	PCV	h^2(bs) %	GA	GA as % of mean
1.	Days to 50% Flowering	3.26	5.18	39.57	3.01	4.22
2.	Plant Height	5.01	5.36	87.34	5.57	9.64
3.	No. of Primary branches per plant	9.01	9.30	93.89	0.95	17.99
4.	No. of Pods per plant	14.87	15.08	97.18	11.97	30.19
5.	Days to Maturity	2.10	2.11	99.14	4.97	4.31
6.	Biological Yield per plant	15.95	32.35	24.29	2.82	16.19
7.	Harvest Index	8.07	11.35	50.55	5.03	11.82
8.	Seed Index	15.83	16.73	89.54	6.83	30.86
9.	Seed Yield per plant	19.59	39.30	24.86	1.48	20.12

Where, GCV= Genotypic coefficient of variation, PCV= Phenotypic coefficient of variation, h^2(bs) % = Heritability (broad-sense),GA= Genetic advance

Table 3: Estimation of genotypic and phenotypic correlation among quantitative characters and with seed yield in chickpea

Characters	Correlation coefficient	Plant Height	No. of Primary branches per plant	No. of Pods per plant	Days to Maturity	Biological Yield per plant	Harvest Index	Seed Index	Seed Yield per plant
Days to 50% Flowering	r_g	-0.387**	-0.165	0.331*	-0.211	0.063	0.399**	-0.357**	0.178
	r_p	-0.304*	-0.120	0.192	-0.120	-0.023	0.123	-0.092	0.081
Plant Height	r_g	1.000	0.137	0.421**	0.230	-0.211	0.080	0.341*	-0.196
	r_p	1.000	0.112	0.375**	0.214	-0.135	0.061	0.282*	-0.107
No. of Primary branches per plant	r_g		1.000	-0.070	-0.225	0.249	-0.037	0.276*	0.194
	r_p		1.000	-0.062	-0.214	0.163	-0.018	0.254	0.140
No. of Pods per plant	r_g			1.000	-0.028	0.361**	0.463**	0.273*	0.517**
	r_p			1.000	-0.031	0.202	0.339*	0.250	0.259
Days to Maturity	r_g				1.000	0.089	0.003	-0.037	-0.009
	r_p				1.000	0.040	-0.007	-0.031	0.004
Biological Yield per plant	r_g					1.000	0.271*	0.087	0.965**
	r_p					1.000	0.202	0.037	0.899**
Harvest Index	r_g						1.000	0.168	0.797**
	r_p						1.000	0.069	0.441**
Seed Index	r_g							1.000	0.119
	r_p							1.000	0.031

* and ** indicate significance at 5% and 1% level, respectively

Conclusion

From the results from the present investigation, it can be concluded that the genotypes C-207, C-213 and C-206 are better genotypes compared to Avrodhi (check) in terms of seed yield per plant for this agro-climatic region. The characters like number of pods per plant and seed-index exhibited high genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (broad-sense), genetic advance and genetic advance expressed as percent of mean. Biological yield per plant, harvest-index and number of pods per plant showed positive and significant correlation with seed yield per plant. Hence, direct selection for these traits would therefore be most effective and should be taken into consideration for the improvement of seed yield in chickpea.

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