Original Research Article

Genetic Analysis For Quantitative Characters Of Chickpea (*Cicer arietinum* L.)

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ABSTRACT

The aim of present study was to estimate the genetic variability, genetic advance, correlation, between yield and yield contributing traits and direct and indirect effect of yield component on yield through path analysis. Seed index, seed yield per plant, harvest index, number of seeds per plant showed high genotypic and phenotypic coefficients of variation. Seed index, days to 50% pod setting, plant height, days to 50% flowering, seed yield per plant, days to maturity expressed high heritability. Harvest index showed high genetic advance. Seed index, seed yield per plant, harvest index, number of seeds per pod and plant height expressed high genetic advance as percent of mean. Seed yield per plant significantly positive correlated with harvest index and number of secondary branches per plant at genotypic and phenotypic levels. Harvest index, biological yield, days to 50% pod initiation showed high positive direct effect with seed yield per plant at genotypic and phenotypic levels. Thus, these traits are identified as the efficient and potential for the improvement of chickpea productivity in the present experimental materials.

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Keywords: Chickpea, genetic variability, heritability, genetic advance, correlation, path analysis

Introduction

Chickpea [*Cicer arietinum* (**L.**) 2n = 2x = 16] self pollinated crop belongs to family Fabaceae, and subfamily Papilionaceae. It is commonly called gram, bengal gram, is the most important cool season food grain legume in the world after common bean (*Phaseolus vulgaris* **L.**) and pea (*Pisum sativum* **L.**) **(Johnson *et al.*, 2018).** Chickpea is the world's second most important food legume crop grown as rainfed in cool and dry climate in semi-arid regions. It is also a major and cheap source of protein compared to animal protein. Chickpea with protein (25-29%), carbohydrates (41-50.8%) and high percent of other mineral nutrients and unsaturated

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oleic and linoleic acid is one of the important crop for human consumption. Two types of chickpea, one namely Kabuli is grown in temperate regions while the Desi type chickpea is grown in the semi-arid tropics **(Bhanu *et al.*, 2017).**

In India, chickpea is cultivated in an area of 10.573 million tones/ha with production of 11.158 million tonnes/ha and productivity of 1056 kg/ha. Where, UP is covering an area of 0.16 million tonnes/ha with production of 0.684 million tonnes/ha and productivity of 930 kg/ha. India is the largest chickpea producer with 65% of global production (Thakur *et al.*, 2018).

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Chickpea has high variation for different quantitative and qualitative characters which helps breeders to select excellent genotypes. Genetic variability and heritability for various quantitative traits play an important role in selection of desirable genotypes. On the other hand, heritability also provides information about heritable portion of different traits. (**Lakmes *et al.*, 2022**).

Objectives:

1. To study nature and extent of genetic variability in the chickpea germplasm for seed yield characters
2. To assess character association in chickpea germplasm for yield and its attributing characters
3. To estimate direct and indirect effect of yield attributing on seed yield of chickpea

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Materials and Methods

The present experiment was carried out at Field Experimentation Centre, Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during Rabi-2022. The experiment was carried out in Randomized Block Design with three replications.

Table 1: List of 20 chickpea genotypes

S. No	GENOTYPES	S. No	GENOTYPES
1	ICC -1882	11	ICC-8058
2	AVT-1G2	12	ICC-14199
3	ICC-11019	13	ICC-283
4	ICC-4958	14	ICC-8261
5	ICC-14799	15	ICC-3325
6	ICC-7272	16	ICC-14778
7	ICC-7373	17	ICC-5680
8	ICC-10448	18	ICC-3776
9	C-203	19	ICC-94194
10	ICC-16796	20	ICC-867

Data for 12 quantitative characters were collected from five randomly selected plants for each genotype in all three replications *viz.*, days to 50% flowering, days to 50% pod setting, plant height (cm), number of primary branches per plant, number of secondary branches per plant, days to maturity, number of pods per plant, number of seeds per plant, biological yield per plant (g), seed index, harvest index (%) and seed yield per plant (g).

The data were subjected to the analysis of variance (Panse and Sukhatme, 1967) and further, biometrical procedures were followed to estimate genotypic and phenotypic coefficient of variation (Burton, 1952), heritability in broad sense (Burton and Devane, 1953), genetic advance (Johnson *et al.* 1955), correlation analysis was performed by using the formula published by (AI Jibouri *et al.*, 1958) and path coefficient analysis was performed using the approach proposed by (Deway and Lu, 1959).

Firstly measure of variability is figured with the aid of Coefficient of variation, which is the ratio of standard deviation of a sample to its mean and expressed in percentage. In the present investigation two types of coefficient of variations were estimated *viz*., phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV).

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Coefficient of variation (CV): It is the measure of variability evolved. Coefficient of variation is the ratio of standard deviation of a sample to its mean and expressed in percentage.

CV (%) = Standard deviation / Mean X 100

The formulae used to calculate PCV and GCV were stated by **(Burton, 1952)**

PCV (%) = Phenotypic standard deviation /Grand mean X 100

GCV (%) = Genotypic standard deviation / Grand mean x 100

Heritability calculated by the formula given by **Lush (1949) and Burton and Devane (1953).** Correlation Coefficient was calculated according to the formula suggested by **Miller *et al.*, (1958)**. Path coefficient analysis is normally to measures the direct and indirect effects of independent variables on the dependent variables. This technique was firstly used by **Dewey and Lu (1959)**.

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Results and Discussion

Analysis of variance revealed that genotypes were significantly different for all the characters except number of pods per plant and biological yield studied at 1% level of significance. This indicates that there is ample scope for selection of genotypes from the present gene pool for yield and its component traits.

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High genotypic coefficient of variation were observed for traits seed index (46.68%), seed yield per plant (30.64%), harvest index (26.78%) and number of seeds per plant (21.33%) while the low genotypic coefficient of variation was found for biological yield, number of primary branches per plant, number of secondary branches per plant, number of pods per plant, days to 50% flowering, days to 50% pod setting, days to maturity. High phenotypic coefficient of variation were observed for traits seed index (46.84%), harvest index (35.38%), seed yield per plant (34.11%), number of seeds per plant (28.75), number of pods per plant (24.75%) while the low phenotypic coefficient of variation was found for number of secondary branches per plant, days to 50% flowering, days to 50% pod setting, days to maturity indicates the presence of exploitable genetic variability for these traits. Similar findings were reported by Mohibullah *et al*. (2020) for seed yield per plant, Pramila *et al*. (2015) for harvest index and number of seeds per plant, Rathod *et al*. (2020) for days to maturity and number of pods per plant.

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Table 2: Genetic parameters for 12 quantitative characters in 20 chickpea genotypes

Characters	GCV	PCV	h^2 (Broad Sense)	Genetic Advance(%)	Genetic advance as % of mean
DF50	4.77	5.25	82.60	6.66	8.94
DPI50	4.35	4.62	88.50	8.95	8.43
DM	2.70	3.10	75.80	6.06	4.85
PH	12.69	13.59	87.20	17.15	24.40
NPBP	7.42	11.49	41.70	0.22	9.86
NSBP	6.31	9.22	46.90	0.43	8.90
NSPP	21.33	28.75	55.00	10.89	32.59
NPPP	5.98	24.75	5.80	0.90	2.98
BY	8.34	17.44	22.90	1.06	8.23
SI	46.68	46.84	99.30	18.39	95.85
HI	26.78	35.38	57.30	21.88	41.77
SYPP	30.64	34.11	80.70	3.61	56.69

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PH: Plant Height, NPBP: Number of Primary Branches per Plant, NSBP: Number of Secondary Branches per Plant, NPPP: Number of Pods per Plant, BYP: Biological Yield per Plant, DF50: Days to 50% Flowering, DM: Days to Maturity, DP50% Days to 50% Pod Initiation, NSPP: Number of Seeds per Plant, SI: Seed Index, HI: Harvest Index, SYPP: Seed Yield per Plant.

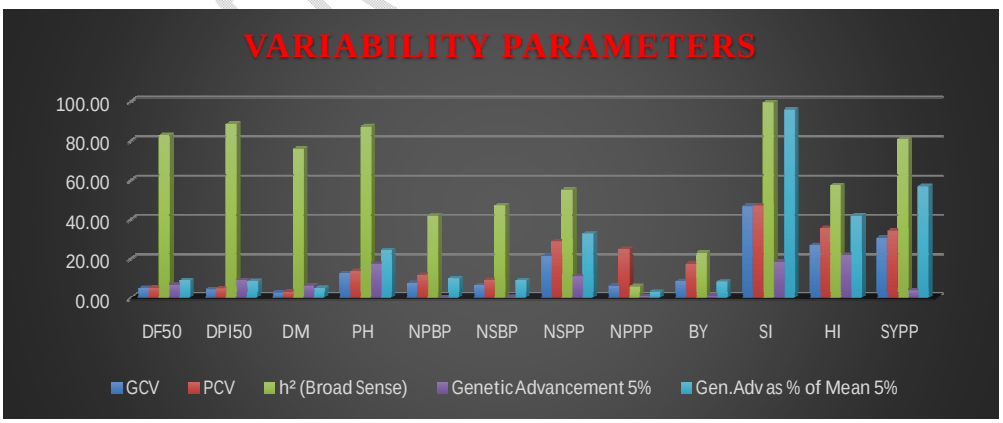

Figure 1: Histogram depicting GCV, PCV, Heritability, Genetic advance and Genetic advance Mean for 12 quantitative characters of chickpea genotypes

Greater heritability estimates for such traits as seed index, days to 50% pod setting, plant height, days to 50% flowering, seed yield per plant and days to maturity indicate that these characters can be used as the genetic parameters for the improvement and selection of high yielding genotypes. Similar findings were reported by Makarand *et al.* (2019) for seed index and plant height, Kumar *et al*. (2019) for seed yield per plant and Hagos *et al.* (2018) for days to maturity. High heritability coupled with high genetic advance observed for plant height, number of seeds per plant, seed index, harvest index and seed yield per plant indicating that these characters were governed largely by the additive gene effect. Similar findings reported by Hagos *et al*. (2018) for seed index, Kumar *et al.* (2020) for harvest index and seed yield per plant.

In this study, the results indicated that the values of genotypic correlation were higher than their phenotypic counterparts. Number of secondary branches and harvest index showing positive significant correlation with seed yield at both genotypic and phenotypic levels, suggesting that a strong inherent association exists for the traits studied and phenotypic selection may be rewarding. Similar findings reported by Pramila *et al. (*2015) for number of secondary branches and Singh *et al.* (2021) for harvest index.

Seed yield is a result of direct and indirect effects of various yield contributing traits. Thus, the path coefficient analysis was carried out in this study to analyze the relative contribution of seed yield related factors. Days to 50% pod imitation, days too maturity, number of primary branches per plant, number of secondary branches per plant, number of pods per plant, biological yield and harvest index had high direct positive effect on seed at genotypic and at phenotypic levels. Similar findings reported by Nikita et al. (2022) for days to maturity, days to 50% pod initiation, number of pods per plant and biological yield, Paul et al. (2015) for number of secondary branches per plant and number of primary branches.

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Table 3: Genotypic and Phenotypic correlation coefficient for yield and yield contributing characters of Chickpea

Traits		DPI50	DM	PH	NPBP	NSBP	NSPP	NPPP	BY	SI	HI	SYPP
DF50	r_g	0.526**	0.082	-0.003	-0.096	-0.285*	0.168	-0.152	0.279*	-0.047	-0.330*	-0.171
	r_p	0.435**	0.063	-0.033	-0.083	-0.112	0.16	0.07	0.1	-0.041	-0.145	-0.078
DPI50	r_g	1	0.312*	0.272*	0.11	0	0.163	-1.154**	0.058	0.145	-0.249	-0.145
	r_p	1	0.211	0.212	0.091	0.003	0.093	-0.324*	-0.13	0.14	-0.11	-0.144
DM	r_g		1	0.172	-0.226	0.249	-0.145	0.318*	-0.394**	0.04	0.242	0.107
	r_p		1	0.151	-0.145	0.1	0.016	0.132	0.087	0.047	0.036	0.117
PH	r_g			1	0.336**	0.069	-0.359**	-1.414**	0.717**	0.714**	0.002	0.206
	r_p			1	0.214	0.057	-0.260*	-0.341**	0.403**	0.663**	-0.05	0.21
NPBP	r_g				1	-0.199	-0.315*	-1.500**	0.036	0.386**	0.295*	0.219
	r_p				1	-0.119	-0.11	-0.107	-0.026	0.259*	0.183	0.136
NSBP	r_g					1	0.172	-0.145	-0.107	-0.015	0.495**	0.451**
	r_p					1	0.023	0.105	-0.033	-0.002	0.293*	0.273*
NSPP	r_g						1	-0.639**	-0.604**	-0.670**	0.267*	0.007
	r_p						1	0.345**	-0.095	-0.493**	0.094	0.038
NPPP	r_g							1	-0.540**	-1.296**	0.166	0.044
	r_p							1	-0.004	-0.305*	0.065	0.075
BY	r_g								1	0.948**	0.196	0.456**
	r_p								1	0.470**	-0.357**	0.229
SI	r_g									1	-0.18	0.14
	r_p									1	-0.144	0.125
HI	r_g										1	0.965**
	r_p										1	0.796**

** and * significant at 1 and 5 percent probability respectively

PH: Plant Height, NPBP: Number of Primary Branches per Plant, NSBP: Number of Secondary Branches per Plant, NPPP: Number of Pods per Plant, BYP: Biological Yield per Plant, DF50: Days to 50% Flowering, DM: Days to Maturity, DP50% Days to 50% Pod Initiation, NSPP: Number of Seeds per Plant, SI: Seed Index, HI: Harvest Index, SYPP: Seed Yield per Plant.

Table 4: Genotypic and Phenotypic path coefficient for yield and yield contributing characters of Chickpea

Traits		DF50	DPI50	DM	PH	NPBP	NSBP	NSPP	NPPP	BY	SI	HI	SYPP
DF50	r_g	-0.033	0.064	0.001	0	-0.002	-0.023	-0.013	-0.003	0.115	0.005	-0.282	-0.171
	r_p	-0.031	0.037	0	-0.002	0.004	0.003	-0.006	0.004	0.061	0.002	-0.149	-0.078
DPI50	r_g	-0.017	0.121	0.003	-0.018	0.002	0	-0.013	-0.019	0.024	-0.015	-0.213	-0.145
	r_p	-0.014	0.085	-0.001	0.011	-0.004	0	-0.004	-0.017	-0.08	-0.007	-0.113	-0.144
DM	r_g	-0.003	0.038	0.01	-0.011	-0.004	0.021	0.011	0.005	-0.162	-0.004	0.207	0.107
	r_p	-0.002	0.018	-0.004	0.008	0.007	-0.003	-0.001	0.007	0.053	-0.002	0.037	0.117
PH	r_g	0.001	0.033	0.002	-0.065	0.006	0.006	0.028	-0.024	0.295	-0.076	0.001	0.206
	r_p	0.001	0.018	-0.001	0.05	-0.01	-0.002	0.01	-0.018	0.246	-0.034	-0.052	0.21
NPBP	r_g	0.003	0.013	-0.002	-0.022	0.018	-0.016	0.024	-0.025	0.015	-0.041	0.252	0.219
	r_p	0.003	0.008	0.001	0.011	-0.046	0.003	0.004	-0.006	-0.016	-0.014	0.189	0.136
NSBP	r_g	0.009	0	0.002	-0.005	-0.004	0.082	-0.013	-0.002	-0.044	0.002	0.423	0.451**
	r_p	0.004	0	0	0.003	0.006	-0.026	-0.001	0.006	-0.02	0	0.302	0.273*
NSPP	r_g	-0.006	0.02	-0.001	0.023	-0.006	0.014	-0.077	-0.011	-0.249	0.071	0.228	0.007
	r_p	-0.005	0.008	0	-0.013	0.005	-0.001	-0.04	0.019	-0.058	0.026	0.097	0.038
NPPP	r_g	0.005	-0.14	0.003	0.092	-0.027	-0.012	0.049	0.017	-0.223	0.137	0.142	0.044
	r_p	-0.002	-0.028	-0.001	-0.017	0.005	-0.003	-0.014	0.054	-0.003	0.016	0.067	0.075
BY	r_g	-0.009	0.007	-0.004	-0.046	0.001	-0.009	0.047	-0.009	0.412	-0.101	0.168	0.456**
	r_p	-0.003	-0.011	0	0.02	0.001	0.001	0.004	0	0.611	-0.024	-0.368	0.229
SI	r_g	0.002	0.018	0	-0.046	0.007	-0.001	0.052	-0.022	0.391	-0.106	-0.154	0.14
	r_p	0.001	0.012	0	0.033	-0.012	0	0.02	-0.016	0.287	-0.052	-0.148	0.125
HI	r_g	0.011	-0.03	0.002	0	0.005	0.041	-0.021	0.003	0.081	0.019	0.854	0.965**
	r_p	0.005	-0.009	0	-0.003	-0.009	-0.008	-0.004	0.004	-0.218	0.008	1.031	0.796**

** and * significant at 1 and 5 percent probability respectively

PH: Plant Height, NPBP: Number of Primary Branches per Plant, NSBP: Number of Secondary Branches per Plant, NPPP: Number of Pods per Plant, BYP: Biological Yield per Plant, DF50: Days to 50% Flowering, DM: Days to Maturity, DP50% Days to 50% Pod Initiation, NSPP: Number of Seeds per Plant, SI: Seed Index, HI: Harvest Index, SYPP: Seed Yield per Plant.

Conclusion

The results revealed that there was considerable variability among genotypes for all the characters except of number of pods per plant, seed index, harvest index and seed yield per plant. High heritability recorded per plant and biological yield. High genotypic coefficient of variation and phenotypic coefficient of variation were recorded for seed index, higher heritability coupled with genetic advance recorded for seed index. Number of secondary branches per plant and harvest index showing positive correlation with seed yield at both genotypic and phenotypic levels. Days to 50% pod initiation, biological yield and harvest index had direct positive effect on seed yield at both genotypic and phenotypic levels. Selection based on these characters can be helpful for improving the seed yield per plant.

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