

RESEARCH ARTICLE

Estimation of genetic variability and correlation studies in chickpea (*Cicer arietinum* L.) germplasm suited to Eastern plain zone of Uttar Pradesh

■ Avula Ramana Reddy and Gabriel M. Lal

SUMMARY

A set of thirty genotypes of chickpea were evaluated for studying of estimation of genetic variability and correlation studies in elite chickpea (*Cicer arietinum* L.) germplasm suited to eastern plain zone of Uttar Pradesh. The experiment was conducted in a Randomized Block Design with three replications during the *Rabi* season, 2020-21 at Naini Agriculture Institute, Naini. Analysis of variance showed significant differences among genotypes for all 11 characters. High GCV and PCV in chickpea germplasm were observed for No. of effective pods per plant, no. of pods per plant, seed yield per plant, biological yield per plant, no. of secondary branches per plant and seed index. High estimate of heritability coupled with high genetic advance as per cent of mean was recorded for no. of effective pods per plant, no. of pods per plant, biological yield per plant, seed index, seed yield per plant, no. of primary branches per plant, no. of secondary branches per plant. Phenotypic and genotypic correlation co-efficients of 11 characters revealed that seed yield per plant exhibited positive and highly significant correlation at both the levels with days to 50% flowering, plant height, no. of primary branches per plant, no. of secondary branches per plant, no. of pods per plant, no. of effective pods per plant, biological yield per plant and harvest index. Path analysis revealed that direct effect of biological yield per plant, harvest index and no. of pods per plant were of high magnitude. The high positive association of other characters with seed yield per plant (g) was also due to high indirect effect through these characters. This indicated that seed yield was mainly a product of direct and indirect effects of above three characters.

Key Words : *Cicer arietinum*, Correlation, Genotypic, Phenotypic

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In India the area under chickpea was 9.539 million ha with a production of 90.75 million tons while the productivity was 951 kg/ha. In Uttar Pradesh, it is grown on 5.89 lakh ha area with total production of 5.967 lakh tons and average productivity of 1013 kg/ha during 2018-19. It occupies 61 per cent of total area under pulses producing about 65 per cent of total production in Uttar Pradesh. Chickpea contains about 17.7 to 38.5 per cent

protein and 56.5 per cent carbohydrates besides ash, calcium, phosphorus and iron. Chickpea has got special importance in diet and is consumed in a variety of ways. It is mostly used in the form of dal (flour or parched). In other aspects, dal obtained after milling either from chickpea or from red gram forms a major part of regular diet of vegetarian. Chickpea flour is cheap source for the preparation of different forms of Indian confectionery, tender leaves are used as vegetables, while dry plant parts above ground are used as cattle feed. The kabuli chickpea or kabuli chana is one of the different forms of chickpea, which is comparatively bold in size and shape, cream colored with thin seed coat and wrinkled. Generally kabuli chickpea is used for the purpose of roasted chana, “chhole” as the best pulse for curry preparation and also uses as raw or green for direct consumption. Therefore, because of various domestic uses of chickpea (*i.e.* shev, laddu, pakoda, parched seed, etc.) there is wide scope for production of chickpea and developing small scale industries.

As far as human diet is concerned the protein requirement for normal individual's health is about 25 g per day for which about 120 g dal is required in one's daily diet. Along with this, chickpea is important in the agriculture as it is legume crop it has unique place in the cropping sequence regarding improving the soil nutrient content (especially nitrogen) and microbial activity etc.

Chickpea is one of the most important *Rabi* pulse crops in Asia. India is largest producer (25%), importer (20%) and consumer (20%) of pulses in the world. In pulses, chickpea accommodates third position in the world.

Though India is the largest producer of this crop, it imports 25% chickpea because its productivity is low as compared to countries like Italy, Turkey, Iron, etc, there is a good scope to improve the productivity of this crop by varietal improvement and adopting the improved production technology on larger areas of the country.

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MATERIAL AND METHODS

The present investigation was made to understand the genetic variability, heritability, correlation and path analysis of chickpea. The details of the materials used and the methods adopted in the investigation, which was

Table A : These are list of genotypes

Sr. No.	Germplasm Name
1.	IPC- 0921
2.	ICC-15903
3.	IG-0914
4.	ICC-1877
5.	ICC-7356
6.	ICC-1608
7.	ICC-15561
8.	ICC-10489
9.	BKG-21 191
10.	IPC05-74
11.	ICC-15896
12.	ICC-676
13.	ICC-4648
14.	ICC-15911
15.	ICC-21170
16.	GPF-02
17.	ICC-15680
18.	SADABAHAR (check)
19.	BKG-21 164
20.	ICC-15857
21.	IPC-06 127
22.	RSG-945
23.	ICC-15928
24.	JBT-34166
25.	ICC-15683
26.	ICC-15926
27.	ICC-15226
28.	IPC-0559
29.	ICC-17007
30.	ICC-7549

carried out at Department of Genetics and Plant breeding, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Naini during the *Rabi* season of 2020-2021.

The soil of experimental site was loamy mixed with pH ranging from 7.3 to 7.6. The land was prepared by two harrowing followed by planking. The experiment was conducted in Randomized Block Design (RBD) with three replications. The genotypes were sown on raised bed on 11th Nov, 2020. The row to row and plant to plant distance was kept at 30×10 cm² spacing. The crop was fertilized with 25 kg N₂, 50 kg P₂O₅ and 25kg K₂O per hectare. The nitrogen was applied in two splits, one at the time of sowing and other at 25 days after sowing. Entire phosphorus was applied as basal dose. All recommended practices were followed and timely plant protection measures were taken to avoid damage through insect-pests and diseases.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Genotypic co-efficient of variation:

Genotypic co-efficient of variation (GCV) ranged from 1.92 for days to maturity to 33.85% (Number of effective pods per plant per plant). High GCV (>20%) was recorded for number of effective pods per plant (33.85%) followed by no. of pods per plant (33.829), seed yield per plant (26.123), biological yield per plant (28.492), no. of secondary branches per plant (30.008),

number of primary branches (21.377) and seed index (20.452). Moderate GCV (>10%) was recorded harvest index (14.070) plant height (14.449). Low GCV (<10%) was recorded for days to maturity (1.926%), days to 50% flowering (3.271%).

Phenotypic co-efficient of variation :

Phenotypic co-efficient of variation (PCV) ranged from 4.232 for days to maturity to 35.758% (no. of effective pods for plant). High PCV (>20%) was recorded for no. of effective pods for plant (35.758), no. of pods per plant (34.998), biological yield per plant (30.617), no. of secondary branches per plant (30.440), seed yield per plant (28.836), No. of primary branches (22.057) and seed index (21.578). Moderate PCV (>10%) was recorded for harvest index (17.861) and plant height (15.890). Low PCV (<10%) was recorded for days to 50 % flowering (6.387), days to maturity (4.232).

Heritability(%) (Broad sense) :

The estimates of heritability (%) in the broad sense for 11 characters studied, which ranged from 20.70 to 97.20%. high heritability (broad sense) (>60%) was recorded for character no. of secondary branches per plant (97.20), no. of primary branches per plant (93.90), No. of pods per plant (93.40), seed index (89.80), number of effective pods per plant (89.70) biological yield per plant (86.60), plant height (82.70), seed yield per plant (82.10), harvest index (62.10). Moderate heritability (broad sense) (30-60%) was recorded for characters *i.e.* days to 50% flowering (26.20) days to maturity (20.70).

Table 1: Genetic parameters (Summary)

Characters	GCV	PCV	² h (Broad sense)	Genetic advancement 5%	General mean
Days to 50% flowering	3.271	6.387	26.200	2.849	82.566
Days to maturity	1.926	4.232	20.700	2.226	123.333
Plant height (cm)	14.449	15.890	82.700	19.208	70.971
Number of primary branches per plant	21.377	22.057	93.900	1.311	3.071
Number of secondary branches per plant	30.008	30.440	97.200	2.367	3.884
Number of pods per plant	33.829	34.998	93.400	43.428	64.469
Number of effective pods per plant	33.858	35.758	89.700	38.190	57.826
Biological yield per plant (g)	28.492	30.617	86.600	19.039	34.858
Harvest index (%)	14.070	17.861	62.100	11.337	49.654
Seed Index (%)	20.452	21.578	89.800	8.241	20.637
Seed yield per plant (g)	26.123	28.836	82.100	8.215	16.851

Genetic advance as % of mean :

Genetic advance as % of mean varied from 2.226 to 43.428. high genetic advance as % mean (>20%) was recorded for no. of pods per plant (43.428) no. of effective pods per plant (38.190). Moderate genetic advance as % mean (10-20%) was recorded for plant height (19.208), biological yield per plant (19.039) and harvest index (11.337). Low genetic advance as % mean (<10%) was recorded for seed index (8.241), seed yield per plant (8.215) days to 50% flowering (2.849), no. of Secondary branches (2.367), days to maturity (2.226) no. of primary branches (1.311).

Genotypic correlation co-efficient of different characters:

The genotypic correlations were computed to know the nature and magnitude of relationship existing between yield and its component characters as well as the association among the component characters themselves.

Correlations of other components characters with seed yield per plant:

Analysis of correlation co-efficient revealed that

seed yield per plant exhibited positive and highly significant correlation with no. of secondary branches (0.932**), biological yield per plant (0.892**), no. of effective pods per plant (0.810**), no. of pods per plant (0.803**), days to 50% flowering (0.372**), plant height (0.338**), days to maturity (0.292**), seed index (0.275**). It exhibited positive and non-significant correlation with harvest index (0.0728). It exhibited negative and non-significant correlation with no. of Primary branches (-0.0501) phenotypic correlation co-efficient of different characters.

The phenotypic correlation was computed to know the nature and magnitude of relationship existing between yield and its component characters as well as the association among the component characters themselves.

Correlations of other components characters with seed yield per plant:

Analysis of correlation co-efficient revealed that seed yield per plant exhibited positive and highly significant correlation with number of secondary branches per plant (0.902**), biological yield per plant (0.745**), number of pods per plant (0.715**) number of effective pods

Table 2: Correlation co-efficient between yield and its contributing traits at genotypic level

Characters	Days to 50% 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 effective pods per plant	Biological yield per plant (g)	Harvest index (%)	Seed index (%)	Seed yield per plant (g)
Days to 50% flowering	1.0000	0.956**	-0.1555	-0.617**	0.454**	0.256*	0.314**	0.492**	-0.304**	-0.1299	0.372**
Days to maturity	0.956**	1.0000	-0.0220	-0.491**	0.322**	0.287**	0.337**	0.412**	-0.293**	-0.484**	0.292**
Plant height (cm)	-0.1555	-0.0220	1.0000	0.323**	0.252*	0.256*	0.1682	0.449**	-0.362**	0.222*	0.338**
Number of primary branches per plant	-0.617**	-0.491**	0.323**	1.0000	-0.0905	-0.0282	-0.0626	-0.362**	0.491**	0.0870	-0.0501
Number of secondary branches per plant	0.454**	0.322**	0.252*	-0.0905	1.0000	0.764**	0.785**	0.848**	0.1394	0.248*	0.932**
Number of pods per plant	0.256*	0.287**	0.256*	-0.0282	0.764**	1.0000	0.981**	0.678**	0.1190	-0.1077	0.803**
Number of effective pods per plant	0.314**	0.337**	0.1682	-0.0626	0.785**	0.981**	1.0000	0.667**	0.1472	-0.1684	0.810**
Biological yield per plant (g)	0.492**	0.412**	0.449**	-0.362**	0.848**	0.678**	0.667**	1.0000	-0.385**	0.1884	0.892**
Harvest index (%)	-0.304**	-0.293**	-0.362**	0.491**	0.1394	0.1190	0.1472	-0.385**	1.0000	0.0787	0.0728
Seed Index (%)	-0.1299	-0.484**	0.222*	0.0870	0.248*	-0.1077	-0.1684	0.1884	0.0787	1.0000	0.275**
Seed yield per plant (g)	0.372**	0.292**	0.338**	-0.0501	0.932**	0.803**	0.810**	0.892**	0.0728	0.275**	1.0000

Table 3: Correlation co-efficient between yield and its contributing traits at phenotypic level

Characters	Days to 50% 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 effective pods per plant	Biological yield per plant (g)	Harvest index (%)	Seed index (%)	Seed yield per plant (g)
Days to 50% flowering	1.0000	0.6831 ***	-0.0550	-0.2956 **	0.2405 *	0.1492	0.1754	0.2784 **	-0.2319 *	-0.0798	0.1424
Days to maturity	0.6831 ***	1.0000	-0.0483	-0.2043	0.1843	0.1497	0.1709	0.2228 *	-0.2070	-0.2154 *	0.1032
Plant height (cm)	-0.0550	-0.0483	1.0000	0.2925 **	0.2305 *	0.2544 *	0.1858	0.3761 ***	-0.2552 *	0.2158 *	0.262*
Number of primary branches per plant	-0.2956 **	-0.2043	0.2925 **	1.0000	-0.0810	-0.0231	-0.0539	-0.3338 **	0.3812 ***	0.0881	-0.0493
Number of secondary branches per plant	0.2405 *	0.1843	0.2305 *	-0.0810	1.0000	0.7247 ***	0.7285 ***	0.7807 ***	0.0932	0.2308 *	0.902**
Number of pods per plant	0.1492	0.1497	0.2544 *	-0.0231	0.7247 ***	1.0000	0.9793 ***	0.6303 ***	0.0697	-0.0812	0.715**
Number of effective pods per plant	0.1754	0.1709	0.1858	-0.0539	0.7285 ***	0.9793 ***	1.0000	0.6148 ***	0.0820	-0.1301	0.708**
Biological yield per plant (g)	0.2784 **	0.2228 *	0.3761 ***	-0.3338 **	0.7807 ***	0.6303 ***	0.6148 ***	1.0000	-0.4359 ***	0.1729	0.745**
Harvest index (%)	-0.2319 *	-0.2070	-0.2552 *	0.3812 ***	0.0932	0.0697	0.0820	-0.4359 ***	1.0000	0.0225	0.233*
Seed Index (%)	-0.0798	-0.2154 *	0.2158 *	0.0881	0.2308 *	-0.0812	-0.1301	0.1729	0.0225	1.0000	0.221*
Seed yield per plant (g)	0.1424	0.1032	0.262*	-0.0493	0.902**	0.715**	0.708**	0.745**	0.233*	0.221*	1.0000

Table 4: Direct and indirect effect of yield contributing characters on seed yield at genotypic level

Characters	Days to 50% 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 effective pods per plant	Biological yield per plant (g)	Harvest index (%)	Seed index (%)	Seed yield per plant (g)
Days to 50% flowering	-0.0610	-0.0746	0.0095	0.0376	-0.0277	-0.0156	-0.0191	-0.0300	0.0185	0.0079	0.372**
Days to maturity	-0.8095	-0.6614	0.0145	0.3245	-0.2131	-0.1899	-0.2226	-0.2722	0.1941	0.3201	0.292**
Plant height (cm)	-0.0777	-0.0110	0.4994	0.1614	0.1259	0.1279	0.0840	0.2241	-0.1810	0.1106	0.338**
Number of primary branches per plant	0.5259	0.4180	-0.2753	-0.8519	0.0771	0.0240	0.0533	0.3086	-0.4182	-0.0741	-0.0501
Number of secondary branches per plant	0.5176	0.4498	-0.0304	-0.5678	0.8830	-0.0799	0.0226	0.3931	0.8741	0.9650	0.932**
Number of pods per plant	0.6869	0.7719	0.6886	-0.0759	-0.0205	0.6880	-0.0081	0.4776	0.3198	-0.2893	0.803**
Number of effective pods per plant	-0.8795	-0.9438	-0.4718	0.1755	0.0661	-0.1144	-0.8040	0.6454	-0.4129	0.4722	0.810**
Biological yield per plant (g)	-0.2782	-0.3165	-0.2114	0.4269	0.0865	-0.1319	0.0827	0.7773	-0.9650	0.8520	0.892**
Harvest index (%)	0.7139	0.6903	0.8524	-0.9320	-0.3278	-0.2799	-0.3463	0.9064	-0.9220	-0.1851	0.0728
Seed Index (%)	0.0813	0.3028	-0.1386	-0.0544	-0.1551	0.0673	0.1053	-0.1179	-0.0492	-0.6256	0.275**
Seed yield per plant (g)	0.372**	0.292**	0.338**	-0.0501	0.932**	0.803**	0.810**	0.892**	0.0728	0.275**	1.0000
Partial R ²	-0.0227	-0.1930	0.1685	0.0427	0.8990	0.5599	0.4968	-0.8580	-0.1712	-0.1721	

Table 5: Direct and indirect effect of yield contributing characters on seed yield at phenotypic level

Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	Number of primary branches per plant	Number of secondary branches per plant	Number of pods per plant
Days to 50% flowering	0.0034	0.0023	-0.0002	-0.001	0.0008	0.0005
Days to maturity	0.01	0.0147	-0.0007	-0.003	0.0027	0.0022
Plant height (cm)	-0.003	-0.0026	0.0542	0.0159	0.0125	0.0138
Number of primary branches per plant	-0.0032	-0.0022	0.0032	0.0108	-0.0009	-0.0002
Number of secondary branches per plant	0.0284	0.0217	0.0272	-0.0096	0.1179	0.0854
Number of pods per plant	-0.0118	-0.0118	-0.0201	0.0018	-0.0572	-0.0789
Number of effective pods per plant	0.0154	0.015	0.0164	-0.0047	0.0641	0.0862
Number of biological yield per plant (g)	0.2494	0.1996	0.3369	-0.299	0.6994	0.5646
Harvest index (%)	-0.1447	-0.1291	-0.1592	0.2378	0.0582	0.0435
Seed index (%)	-0.0016	-0.0044	0.0044	0.0018	0.0047	-0.0017
Seed yield per plant (g)	0.1424	0.1032	0.262*	-0.0493	0.902**	0.715**
	0.0005	0.0015	0.0142	-0.0005	0.1064	-0.0564

per plant (0.708**), plant height (0.262*), harvest index (0.233*) and seed index (0.221*). It exhibited positive and non-significant correlation with days to 50% flowering (0.1424), days to maturity (0.1032). Seed yield per plant exhibited very low negative and non-significant correlation with number of primary branches (-0.0493).

Path co-efficient analysis for seed yield per plant :

Path co-efficients which are worked out from correlation co-efficient are referred to as path co-efficient analysis. It splits the correlation coefficient into the measures of direct and indirect effects.

Genotypic path co-efficient analysis for seed yield per plant :

At genotypic level, maximum positive direct effects was depicted number of secondary branches per plant (0.8830), biological yield per plant (0.7773), number of pods for plant (0.6880), plant height (0.4994), it has negative direct effect depicted by harvest index (-0.9220), number of primary branches (-0.8519), number of effective pods per plant (-0.8040), days to maturity (-0.6614), seed index (-0.6256), days to 50% flowering (-0.0610).

Phenotypic path co-efficient analysis for seed yield per plant :

At phenotypic level, maximum positive direct effects was depicted by number of effective pods per plant (0.5507), seed index (0.221*), no. of pods per plant

(0.0862), days to 50% flowering (0.01), plant height (0.0032), harvest index (0.0005). It has negative effect was depicted by biological yield per plant (-0.2719), number of primary branches (-0.0096), number of secondary branches (-0.00572), days to maturity (-0.0026).

Conclusion:

From the present investigation it can be concluded that Out of 25 chickpea genotypes evaluated for various characters, 10 genotypes were found superior for different characters. Among the lines, IPC 05-28, IPC 57-29, IPCK 06-78, IPC 10-72 and GNG 1581 possess significantly higher seed yield as compared to the check Pusa-362. These genotypes may be utilized in future breeding programme.

High estimate of heritability coupled with high genetic advance as per cent of mean was recorded for no. of seeds per plant, no. of pods per plant, biological yield per plant, 100-seed weight, grain yield per plant, chlorophyll content, no. of seed per pod, no. of primary branches per plant, no. of secondary branches per plant. These traits are governed by additive gene effects and therefore, may be improved through direct selection.

Seed yield per plant exhibited positive and highly significant correlation with days to 50% pod setting, plant height, no. of primary branches per plant, no. of secondary branches per plant, no. of pods per plant, no. of seeds per plant, biological yield per plant and harvest index. These attributes were mainly influencing the grain

yield in chickpea .

The characters *viz.*, biological yield per plant, harvest index and no. of seeds per plant had the highest direct positive effect on seed yield per plant. Thus, selections for these characters will proved efficient for the improvement of seed yield of chickpea.

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