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Estimation of Genetic Variability, Correlation and Path Analysis for Yield and Yield Contributing Traits in Desi Chickpea (*Cicer arietinum* L.)

K. Ujwala[1], L.K. Sharma[1], G.U. Kulkarni[1], S. Jeannie[1], K.P. Deepthi[1] and S.P. Singh[2]
[1]*Department of Genetics and Plant Breeding, Junagadh Agricultural University, Junagadh, Gujarat*
[2]*CSAUAT–Agriculture Research Station, Kalai, Aligarh, U.P.*

Abstract

The present empirical study was conducted to evaluate variability, correlation coefficient and path coefficient analysis in forty-eight genotypes of desi chickpea (*Cicer arietinum* L.) by involving eleven quantitative characters. The experiment was carried out at Pulses Research Station, Junagadh Agricultural University, Junagadh during rabi2019-20 in randomized block design with three replications. The high GCV and PCV was observed for seed yield per plant, biological yield per plant, and harvest index. The estimates of high heritability coupled with high genetic advance expressed as a per cent of mean were observed for seed yield per plant, first pod bearing node, biological yield per plant, harvest index, number of pods per plant, and 100-seed weight. Correlation coefficients revealed that the number of pods bearing branches per plant, 100-seed weight and biological yield per plant were the most important traits and may contribute considerably high seed yield per plant. The genotypic and phenotypic path coefficient analysis revealed that biological yield per plant, 100-seed weight and days to maturity exhibited high and positive direct effects on seed yield per plant. Path coefficient analysis revealed that the contribution of residual effects that influenced seed yield per plant was low at both genetic and phenotypic levels, reflecting that the traits in the study were sufficient to account for the variability in the dependent variable.

Key words : *Genetic variability, heritability, correlation, path analysis.*

Introduction

Chickpea is an ancient cultivated pulse crop, domesticated during the early age of civilization and being cultivated throughout the world. Its nomenclature is well documented in different countries such as gram, Bengal gram, homes, chole, garbanzo bean, hommos, chana, chieting vetch, nakhud, nakhut, kicher, poischice, *etc.* The genus *Cicer* belongs to the sub-family Papilionaceae of the family Leguminoceae (1). The *Cicer* genus presently comprises 43 species, out of which 9 are annual and 34 are perennial species (2). Most of these species are found in West Asia and North Africa, covering Turkey in the north to Ethiopia in the south and Pakistan in the east to Morocco in the west. The genus consists of 39 known species distributed mainly in Central and Western Asia of which two species *viz., Cicer arietinum* (2n=16) and *C. soongaricum* (2n=16) are cultivated in India. The origin of the crop is considered in Western Asia from where it started spreading to India and also the other parts of the world. India is the largest chickpea producing country accounting for 72% of the global production. During 2018-19 in world, chickpea is cultivated about an area of 137.18M ha with total production of 142.46 MT with a productivity of 10384 kg ha^{-1}. In India, is cultivated in about 9.67 M ha with a total production of 10.09 MT with a productivity of 1043kg ha^{-1}. In Gujarat, area, production, and productivity are 0.29 M ha, 0.38 MT and 1285kg ha^{-1}, respectively (3).

Materials and Methods

A field experiment was conducted at the Pulses Research Station, Junagadh Agricultural University, Junagadh during rainy season 2019-20 in randomized block design with three replications by using forty-eight genotypes of desi chickpea (*Cicer arietinum* L.) by involving eleven quantitative characters.

Variability is the prerequisite step for the organization of breeding programmes and its evaluation helps in the realization of response to selection as the progress in breeding depends upon its amount, nature and magnitude of variability. The better index for measuring the genetic variation is the genetic coefficient of variation (GCV) as described by (4) for comparing the genetic variability present in different traits. The close relationship between the genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) was observed for all the characters. The magnitude of PCV was slightly greater than GCV revealed a scanty influence of environmental variation for their expression on these characters and suggesting a sufficient amount of variability and thus offer better scope for genetic improvement through the selection of these traits. The genotypic coefficient of variation (GCV %) does not imitate the amount of heritable variation. Thus, the knowledge of the heritability of a character helps the plant breeders in predicting the genetic advance for any

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Table-1 : Mean, Range, Coefficient of range, Phenotypic and genotypic coefficients of variation, heritability (Board sense), genetic advance and genetic advance expressed as percentage of mean for 11 characters in desi chickpea.

Characters	Mean	Range	Coefficient of range (%)	Phenotypic coefficient of variation (%)	Genotypic coefficient of variation (%)	Heritability (Broad sense) (%)	Genetic advance	Genetic advance expressed as % of mean
Days to 50% flowering	50.28	58.00-45.33	12.26	6.26	5.33	72.71	4.71	9.37
Days to maturity	110.84	118.27-104.67	6.10	2.83	2.14	57.33	3.71	3.34
Plant height (cm)	38.93	54.47-29.87	29.16	13.08	10.67	75.80	7.95	20.43
Number of pods bearing branches per plant	4.71	6.00-3.87	21.58	12.50	9.54	72.90	0.89	18.77
Number of pods per plant	21.25	28.47-13.20	36.64	18.84	17.66	87.87	7.25	34.10
First pod bearing node(cm)	18.60	31.00-11.40	46.22	27.50	26.87	95.47	10.06	54.07
Number of seeds/pods	1.17	1.53-1.00	20.94	9.02	7.73	73.40	0.16	13.64
100-Seed weight (g)	22.90	34.47-16.40	35.52	16.66	15.26	83.86	6.59	28.79
Seed yield per plant (g)	4.01	6.43-1.69	58.37	28.68	27.93	94.84	2.25	56.02
Biological yield per plant(g)	13.38	18.51-3.65	67.05	26.78	25.99	94.17	6.96	51.95
Harvest index (%)	30.82	50.58-16.84	50.04	23.74	22.42	89.21	13.45	43.63

Table-2 : Genotypic (r_g) and phenotypic (r_p) correlation coefficients among 11 characters in desi chickpea.

Characters		Days to 50% flowering	Days to maturity	Plant height (cm)	Number of pods bearing branches/ plant	Number of pods per plant	First pod bearing node (cm)	Number of seeds/ pod	100-Seed weight (g)	Biological yield per plant (g)	Harvest index (%)
Seed yield per plant (g)	r_g	0.2395	0.4170**	0.0940	0.6962**	0.3704**	0.0261	0.3655*	0.8441**	0.6396**	0.2410
	r_p	0.2054	0.3123*	0.0776	0.5757**	0.3306*	0.0288	0.3174*	0.7455**	0.6274**	0.2586
Days to 50% flowering	r_g	1.0000	0.4534**	0.1460	0.2746	0.0906	-0.0877	0.3391*	0.2085	0.0549	0.0782
	r_p	1.0000	0.2779	0.0927	0.2156	0.0530	-0.0525	0.2279	0.1975	0.0875	0.0337
Days to maturity	r_g		1.0000	0.4371**	0.5151**	0.2789	0.2290	0.2837	0.1407	0.2225	0.0165
	r_p		1.0000	0.2397	0.3161*	0.2209	0.1448	0.1931	0.0643	0.1543	0.0135
Plant height (cm)	r_g			1.0000	0.3912**	0.0257	0.7985**	0.2117	0.1557	0.0476	-0.0234
	r_p			1.0000	0.3127*	0.0492	0.6944**	0.1872	0.1048	0.0433	-0.0351
Number of pods bearing branches per plant	r_g				1.0000	0.2593	0.0995	0.0827	0.4229**	0.3789**	0.2415
	r_p				1.0000	0.2251	0.0733	0.0600	0.3339*	0.3318*	0.1628
Number of pods per plant	r_g					1.0000	-0.0033	0.1499	0.2642	0.2468	0.0038
	r_p					1.0000	-0.0107	0.1172	0.2314	0.2351	-0.0238
First pod bearing node	r_g						1.0000	0.1588	0.1615	-0.0073	-0.0929
	r_p						1.0000	0.1527	0.1423	0.0022	-0.0873
Number of seeds/ pod	r_g							1.0000	0.4066**	0.3645*	-0.1176
	r_p							1.0000	0.2770	0.3001*	-0.0769
100-Seed weight (g)	r_g								1.0000	0.3188*	0.4661**
	r_p								1.0000	0.2964*	0.3896**
Biological yield per plant (g)	r_g									1.0000	-0.5343**
	r_p									1.0000	-0.5171**
Harvest index (%)	r_g										1.0000
	r_p										1.0000

*, ** Significant at 5% and 1% levels, respectively

Table-3 : Genotypic path coefficient analysis showing direct (diagonal and bold) and indirect effects of different characters on seed yield in desi chickpea.

Character	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of pods bearing branches/ plant	Number of pods per plant	First pod bearing node (cm)	Number of seeds/ pod	100-Seed weight (g)	Biological yield per plant (g)	Harvest index (%)	Genotypic correlation with seed yield/plant
Days to 50% flowering	-0.0213	0.1010	-0.0423	0.0730	0.0006	-0.0100	-0.0077	0.1105	0.0234	0.0123	0.2395
Days to maturity	-0.0097	0.2228	-0.1266	0.1368	0.0018	0.0261	-0.0064	0.0745	0.0950	0.0026	0.4170**
Plant height	-0.0031	0.0974	-0.2896	0.1039	0.0002	0.0909	-0.0048	0.0825	0.0203	-0.0037	0.0940
Number of pods bearing branches per plant	-0.0059	0.1148	-0.1133	0.2657	0.0017	0.0113	-0.0019	0.2240	0.1618	0.0379	0.6962**
Number of pods per plant	-0.0019	0.0621	-0.0074	0.0689	0.0066	-0.0004	-0.0034	0.1399	0.1054	0.0006	0.3704*
First pod bearing node (cm)	0.0019	0.0510	-0.2312	0.0264	0.0000	0.1139	-0.0036	0.0855	-0.0031	-0.0146	0.0261
Number of seeds/pod	-0.0072	0.0632	-0.0613	0.0220	0.0010	0.0181	-0.0227	0.2154	0.1556	-0.0185	0.3655*
100-Seed weight (g)	-0.0045	0.0313	-0.0451	0.1124	0.0017	0.0184	-0.0092	0.5297	0.1361	0.0732	0.8441**
Biological yield per plant (g)	-0.0012	0.0496	-0.0138	0.1007	0.0016	-0.0008	-0.0083	0.1689	0.4269	-0.0839	0.6396**
Harvest index (%)	-0.0017	0.0037	0.0068	0.0642	0.0026	-0.0106	0.0027	0.2469	-0.2281	0.1571	0.2410

*, ** Significant at 5% and 1% levels, respectively. Residual effect = 0.264.

Table-4 : Phenotypic path coefficient analysis showing direct (diagonal and bold) and indirect effects of different characters on seed yield in desi chickpea.

Character	Days to 50% flowering	Days to maturity	Plant height (cm)	Number of pods bearing branches/ plant	Number of pods per plant	First pod bearing node (cm)	Number of seeds/pod	100-Seed weight (g)	Biological yield per plant (g)	Harvest index (%)	Genotypic correlation with seed yield/plant (g)
Days to 50% flowering	0.0167	0.0337	-0.0083	0.0263	0.0030	-0.0039	0.0070	0.0457	0.0667	0.0185	0.2054
Days to maturity	0.0046	0.1212	-0.0215	0.0386	0.0126	0.0108	0.0059	0.0149	0.1176	0.0074	0.3123*
Plant height (cm)	0.0015	0.0291	-0.0895	0.0382	0.0028	0.0517	0.0058	0.0242	0.0330	-0.0192	0.0776
Number of pods bearing branches per plant	0.0036	0.0383	-0.0280	0.1222	0.0129	0.0055	0.0018	0.0772	0.2530	0.0891	0.5757**
Number of pods per plant	0.0009	0.0268	-0.0044	0.0275	0.0572	-0.0008	0.0036	0.0535	0.1792	-0.0130	0.3306*
First pod bearing node (cm)	-0.0009	0.0175	-0.0622	0.0090	-0.0006	0.0744	0.0047	0.0329	0.0016	-0.0478	0.0288
Number of seeds/ pod	0.0038	0.0234	-0.0168	0.0073	0.0067	0.0114	0.0308	0.0641	0.2288	-0.0421	0.3174*
100-Seed weight (g)	0.0033	0.0078	-0.0094	0.0408	0.0132	0.0106	0.0085	0.2314	0.2259	0.2133	0.7455**
Biological yield per plant (g)	0.0015	0.0187	-0.0039	0.0406	0.0135	0.0002	0.0092	0.0686	0.7623	-0.2832	0.6274**
Harvest index (%)	0.0006	0.0016	0.0031	0.0199	-0.0014	-0.0065	-0.0024	0.0901	-0.3942	0.5477	0.2586

*, ** Significant at 5% and 1% levels, respectively. Residual effect = -0.268

quantitative characters and aids in exercising the necessary selection procedures.

The study of genotypic correlation gives an idea of the extent of the relationship between different variables. This relationship among yield contributing characters as well as their association with yield provides information for exercising selection pressure for bringing genetic improvement in yield. Correlation analysis among the yield and its contributing characters revealed that the genotypic correlation coefficients in most of the cases were higher than their phenotypic correlation coefficients. The path coefficient analysis aids correlation investigations by revealing the interrelationships between distinct independent components (cause) and dependent components (effect). This procedure measures the direct effect of one variable over the other and facilitates the partitioning of the correlation coefficient into direct and indirect effects (5).

Results and Discussion

Analysis of variance revealed that the mean square for genotypes was highly significant for all the traits. This point out comes with substantial variability provides a good prospect for improving traits of interest in chickpea breeding programmes. While the presence of non-significant variation for replications implicating that the low amount of error due to the environment. A similar result has been reported by (5, 6, 7).

The magnitude of PCV was slightly greater than GCV revealed a scanty influence of environmental variation for their expression on these characters and suggesting a sufficient amount of variability and thus offer better scope for genetic improvement through the selection of these traits. This indicated that phenotypic variability may be considered a reliable measure of genotypic variability. Analogous results were reported by (6, 8).

The high of magnitude genotypic coefficient of variation and phenotypic coefficient of variation was observed for seed yield per plant, biological yield per plant and harvest index. High genotypic and phenotypic coefficient of variation was reported in chickpea for seed yield per plant, biological yield per plant, harvest index, seed yield per plant showing high GCV and PCV reported by (9, 10, 11).

The steeply elevated heritability was observed in the first pod bearing node (95.47 %) accompanied by seed yield per plant (94.84 %), biological yield per plant (94.17 %), harvest index (89.21 %), number of pods per plant (87.87 %), 100-seed weight (83.86 %). High heritability for the characters which are controlled by polygenes might be useful for plant breeder for effective selection. High heritability estimates for seed yield per plant, hundred seed weight, the number of pods per plant, harvest index. It was noticed that high heritability for plant height (75.80%); for the number of seeds per pod (73.4%), days to 50 % flowering (72.71%) was also reported by (12, 13).

The highest values of genetic advance expressed as per cent of mean was reported for seed yield per plant, biological yield per plant, harvest index, the number of pods per plant, 100-seed weight, plant height was reported by (12, 13). Seed yield per plant had a significant and positively correlated with number of pods bearing branches per plant, 100-seed weight, and biological yield at both genotypic and phenotypic levels indicating that these attributes were more influencing the seed yield per plant and therefore these were important characters for bringing genetic improvement in seed yield. Similar results were obtained for days to maturity,number of pods per plant, number of seeds per pod,100-seed weight, biological yield per plant by (14, 15, 16).

Genotypic path coefficient analysis : Hundred seed weight and biological yield per plant both exhibited high and positive direct effects on seed yield per plant. Whereas, days to maturity possessed moderate and positive direct effect towards seed yield per plant. Harvest index had a positive direct effect and low magnitude on seed yield per plant. Further days to 50 % flowering and the number of seeds per pod had a negligible and negative direct effect. The number of pods per plant had a negligible and positive direct effect. Similar results were obtained by (15, 16).

Phenotypic path coefficient analysis : Harvest index and biological yield per plant both exhibited high and positive direct effects on seed yield per plant. Days to 50 % flowering and the number of pods per plant had a negligible and positive direct effect. Plant height had a negligible and negative direct effect. Days to maturity exhibited a low and negative direct effect on seed yield per plant. Similar results were obtained by (15, 16).

Conclusions

In a nutshell, through the current research investigation, it can be concluded from variability parameters that, additive gene action was operating for traits *viz.,* seed yield per plant, first pod bearing node, biological yield per plant, harvest index, number of pods per plant and 100-seed weight. Besides, number of pods bearing branches per plant, 100-seed weight, and biological yield per plant were the characters that displayed positive and significant association with seed yield per plant. However, biological yield along with the number of pods per plant and harvest index as they displayed a great and positive direct effect on it. Hence, these traits deserve strategic

importance while formulating effective breeding strategies with the aim of yield enhancement.

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