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Studies on genetic variability, correlation and path analysis of yield attributing traits in chickpea (*Cicer arietinum* L.)

Adephu Shiva Kumar, G M Lal
Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh, India

Abstract
A set of twenty four genotypes of Chickpea including one check, which were grown in the Field to study the amount of genetic variability, association between quantitative traits and seed yield, direct and indirect effect of yield contributing characters on seed yield in chickpea germplasm. High significant variation was obtained for all characters studied. High GCV and PCV in chickpea germplasm were observed higher for number of seeds per plant, number of secondary branches, number of pods per plant, number of seeds per pod, hundred seed weight, biological yield, seed yield. High estimate of heritability coupled with high genetic advance as percent of mean was recorded for number of seeds per plant, seed index, number of pods per plant, harvest index. High values for heritability indicates that it may be due to higher contribution of genotypic components. Traits exhibiting high heritability coupled with genetic advance as percent of mean suggest that the traits are governed by additive gene action, equal contribution of additive and non-additive gene action respectively. Correlation coefficient analysis revealed that seed yield per plant exhibited positive and significant association with number of pods per plant, number of seeds per plant, biological yield per plant, harvest index at genotypic and phenotypic levels. Path analysis revealed that characters plant height, biological yield, harvest index and hundred seed weight, have positive direct effect on seed yield per plant at genotypic and phenotypic level. The above mentioned traits should be given due emphasis for future genetic improvement of chickpea because they possess high genetic variance, heritability coupled with genetic advance a percent of mean and correlation among themselves which leads to more genetic advance under proper selection in a breeding programme.

Keywords: chickpea, genetic variability, correlation and path analysis

Introduction

Chickpea (*Cicer arietinum L.*) belongs to family leguminosae, subfamily papilionaceae. It is a self-pollinated, diploid species with 2n=2x=16 chromosomes, and it is the third most important food legume crop [Ali *et al.* (2002)] [1]. It's an important source as food for human and animal feed, it also helps to improve the soil fertility, specifically in dry lands. Traditionally, chickpea is sown in spring season, for that reason, the crop encounters heat and drought towards maturity of the plant, which results in low and variable yields. However, with developing new cultivars that are resistant to cold and tolerant to ascochyta blight, as their winter sowing provides higher and more stable productivity and increased water-use efficiency. Globally chickpea mean annual production is over 11.60 million tones which is cultivated in an area of 13.20 million hectares with an average productivity of 880 kg/ha (FAOSTAT, 2020). In India, chickpea was grown on 9.93 million hectares area & production contributed 9.53 million ones with the productivity of 960 kg/ha in 2020 (Directorate of Economics and Statistics, 2020). In U.P., Chickpea production was 577 thousand tones with yield of 824 kg/ha from an area of 475 thousands ha in year 2020.

Genetic variability is the foremost important breeding tool in order to break yield stagnation and developing high yielding varieties. Genetic variability refers to the presence of difference among the individuals of the plant population. The large spectrum of genetic variability in segregating population depends on the amount of the genetic variability among genotypes and offer better scope for selection. The variability was highest for number of pods per plant in chickpea obtained by Malik *et al*. and Gul *et al*. (2013) [6]. Lush (1949) [11] gave the concept of broad sense heritability, which is the ratio of genotypic variance (VG) to phenotypic variance (VP). It determines efficiency with which we can utilize the genotypic variability in breeding programme. Burton (1952) [2] suggested that genetic variation along with heritability will give better idea about expected efficiency of selection Genetic advance is improvement in the mean of select families over the base population [Lush (1949) and Johnson *et al*. (1955)] [11, 9] a character exhibiting high heritability may not give not give high genetic advance. Johnson *et al.* (1955) [9] showed that high heritability should accompany with high genetic advance to arrive at a more reliable conclusion. Evaluation of genetic advance helps in interpreting the type of gene action involved in the expression of various polygenic traits. High values and low values genetic advance are indicative of additive gene action and non-additive gene action respectively. On other side, an analysis of the correlation between seed yield and seed yield attributing traits is essential for criteria of selection by Chaudhary *et al*. (1991) [2]. Path analysis developed by Wright (1923) [17] is a standardized partial regression analysis, which further permits the portioning of correlation coefficient into components of direct and indirect effect. By using direct and indirect effect of one variable on another can be estimated. It provides useful information on the relative merit of the traits in the selection criterion.

Materials and Methods

The experimental material for present investigation consists of twenty four genotypes including one check variety (UDAY) of gram obtained from ICAR-Indian Institute of Pulses Research, Kanpur, Uttar Pradesh, was carried out at the Field Experimentation Centre of Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj, U.P. during Rabi 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 20th October, 2020.Plant spacing between row to row and plant to plant is 30 cm × 10 cm.

In each replication and in each plot, selection of five plants are done randomly and tagged except the border plants to minimize border effects. All the 13 characters studied and recorded on five randomly selected plants except days to flowering and days to maturity. Seed weight of the chickpea gram were recorded with the help of physical balance.

Results and Discussion

Analysis of variance revealed siginificant differences among the genotypes for all the characters (Table 01). This indicates that there is ample scope for selection of genotypes from the present gene pool for yield and its components by Fisher (1930) [5]. This in turn indicated that there was sufficient variability in the studied material, which could be utilized for further breeding programmes [Chaurasia *et al*. (2009) and jeena *et al*. (2001)] [4, 8]. The estimation of genetic variability parameters for yield attributing traits are presented in Table 02. The phenotypic coefficient of variation was found to be higher than the genotypic coefficient of variation for all the characters under study. High GCV and PCV in chickpea germplasm were observed higher for number of seeds per plant and hundred seed weight. High GCV was recorded for No. of seeds per plant. Moderate GCV was recorded for hundred seed weight, Harvest index, Seed yield per plant and Biological yield. High PCV was recorded for No. of seeds per plant and Hundred seed weight. Moderate PCV was recorded for Seed yield per plant, Biological yield, No. of secondary branches, Harvest index, No. of seeds per pod, No. of primary branches and No. of primary branches. The highest heritability (broad sense) was recorded for characters Days to 50% pod setting followed by Days to maturity, Days to 50% flowering, Hundred seed weight, No. of seeds per plant, No. of pods per plant and Harvest index. Thus, a character possessing high GCV along with high heritability be valuable in a selection programme by Kumar *et al*. and Musthaq *et al*. (2013) [13]. High heritability coupled with genetic advance showed that it was highest for characters No. of seeds per plant followed by Hundred seed weight, Days to 50% pod setting. So direct selection of these characters based on phenotypic expression by simple selection method would be effective due to accumulation of more additive genes leading to further improvement.

Crop yield is one of the complex character controlled by several interacting genotypic and environmental factors interrelationship existed between yield and its contributing components can significantly improve the efficiency of crop breeding programs through the use of proper selection indices. The correlation coefficient analysis is useful in selection of several traits simultaneously influencing the yield (Table 3). Genotypic correlation analysis revealed that seed yield per plant showed positive and highly significant correlation with No. of pods per plant, No. of primary branches, No. of secondary branches, No. of seeds per plant and Biological yield, Harvest index (Table 3). Phenotypic correlation analysis revealed that seed yield per plant showed positive and significant association with Plant height, No. of secondary branches, No. of pods per plant, No. of seeds per pod, No. of seeds per plant, Biological yield and Harvest index (Table 4). Hence selection for the traits exhibiting positive significant genotypic and positive significant phenotypic correlation would be of major use in indirect and direct selection for seed yield respectively by Obaidullah *et al*. [14] And Yadav *et al*. (2002) [18].

Table 1: Analysis of variance for 13 quantitative characters of chickpea

S. no	Characters	Mean sum of square		
		Replications (df=2)	Treatments (df=23)	Error (df=46)
1	Days To 50%Flowering	0.38	18.36**	2.2
2	Days To 50% Pod Setting	3.93	81.24**	2.82
3	Days To Maturity	2.79	32.15**	2.01
4	Plant Height	111.01	27.7**	24.16
5	Number of Primary Branches per plant	1.28	0.21*	0.28
6	Number of Secondary Branches per plant	18.17	2.68**	1.87
7	Number of Pods Per Plant	65.97	141.92**	45.78
8	Number of Seeds Per Pod	0.04	0.11**	0.11
9	Number of seeds per plant	33.04	338.44**	99.55
10	Biological Yield Per Plant	141.24	95.46**	59.68
11	Harvest Index	37.09	100.04**	32.42
12	100 Seed Weight	16.92	112.98**	19.82
13	Grain Yield Per Plant	17.74	17.6*	11.09

*Siginificant at 5% level of significance

**Siginificant at 1% level of significance

Table 2: Genetic parameters for 13 characters of 24 chickpea genotypes

	Var Genotypical	Var Phenotypical	GCV	PCV	h^2 (%) (Broad Sense)	Genetic Advancement (5%)	Gen. Adv as% of Mean (5%)
Days To 50%Flowering	5.39	6.12	2.83	3.01	88.00	4.49	5.46
Days To 50% Pod Setting	26.14	27.08	4.51	4.59	96.50	10.35	9.13
Plant Height	1.18	9.24	1.93	5.39	12.80	0.80	1.42

Number of Primary Branches per plant	0.02	0.07	8.41	14.91	31.80	0.18	9.78
Number of Secondary Branches per plant	0.27	0.89	9.10	16.56	30.20	5.89	10.31
Days To Maturity	10.05	10.72	2.39	2.47	93.80	6.32	4.78
Number of PodsPer Plant	32.05	47.31	17.50	21.26	67.70	9.60	29.67
Numberof Seeds Per Pod	0.00	0.04	1.95	14.93	17.00	4.07	5.26
Numberof Seeds Per Plant	79.63	112.81	24.90	29.63	70.60	15.44	43.09
Biological Yield Per Plant	11.93	31.82	10.49	17.13	37.50	4.36	13.23
Harvest Index	22.54	33.35	12.41	15.09	67.60	8.04	21.01
100 Seed Weight	31.05	37.66	19.40	21.36	82.40	10.42	36.28
Seed Yield Per Plant	2.17	5.87	11.78	19.38	37.00	1.85	14.76

Table 3: Genotypic correlation among the different traits in chickpea

	DF50%	DP50%	PH	NPB	NSB	DM	NPP	NS Pod	NS Plant	BYPP	HI	HSW	SYLD
DF 50%	1.00	0.9972**	0.2837*	0.1055	0.9068	0.8314	0.324*	-1.6326*	0.1026**	0.7673*	-0.6131**	0.2382	0.1505
DP 50%		1.00	0.0664*	-0.2365	0.7874	0.6904*	0.0934	-2.4552	-0.1318*	0.5587	-0.5857	0.257**	-0.0134
PH			1.00	1.9654**	-3.3718*	0.1003*	-1.256*	-4.8214*	-1.2923*	-1.0061*	-0.5166*	-0.1256*	-1.1552*
NPB				1.00	0.4979**	0.7304*	0.822*	-0.7032*	0.7383*	0.7171*	0.0286	-0.156	0.623*
NSB					1.00	0.6503*	1.2603*	3.89**	1.3818	1.7245*	-0.8472*	0.2149	0.7373*
DM						1.00	0.3263**	1.0729**	0.3693*	0.4392*	-0.4479	0.1474*	-0.0593*
NPP							1.00	1.0758*	0.8944*	0.7792	-0.167	0.0385*	0.5502**
NS Pod								1.00	1.9033	-3.36*	-2.0295*	-2.7015	- 5.4914*
NSPlant									1.00	0.2727	0.0635*	-0.0593	0.3077*
BYPP										1.00	-0.6184*	0.3911	0.3431*
HI											1.00	0.0751*	0.5775*
HSW												1.00	0.5279
SYLD													1.00

DF50%: Days to 50% flowering, DP50%: Days to 50% pod setting, PH: Plant height, NPB: No. of primary branch per plant, NSB: No. of secondary branch per plant, DM: Days to maturity, NPP: No. of pods per plant, NS Pod: No. of seeds per pod, NS Plant: No. of seeds per plant, BYPP: Biological yield per plant, HI: Harvest index, HSW: Hundred seed weight, SYLD: Seed yield per plant

Table 4: Phenotypic correlation among the different traits in chickpea

	DF 50%	DP 50%	PH	NPB	NSB	DM	NPP	NS Pod	NS Plant	BYPP	HI	HSW	SYLD
DF 50%	1.00	0.9641**	0.0885*	-0.0306	0.4796	0.7505*	0.2306	-0.2019	0.0724**	0.427	-0.4999	0.2097	0.0452
DP 50%		1.00	0.0197	0.118	0.4115	0.6506	0.0965	-0.2874	-0.0765	0.3617	-0.4752	0.2351	0.0054
PH			1.00	-0.1697*	-0.4152	0.0623*	-0.3678*	-0.22*	-0.4238	-0.1422*	-0.1615	-0.0758	0.2247*
NPB				1.00	0.141**	-0.3443*	-0.2471*	-0.1162*	-0.3049	-0.0414*	-0.0611	0.1329	-0.0736*
NSB					1.00	0.3982*	0.5952**	0.1164*	0.5938*	0.5593*	-0.3759*	0.1706	0.2134*
DM						1.00	0.2623**	0.163	0.3011	0.2289*	-0.3365	0.1366*	-0.0456*
NPP							1.00	0.2275	0.8557	0.6813**	-0.0404	0.0758	0.5774**
NS Pod								1.00	0.4319	-0.1818	-0.0448	-0.3904	0.2355*
NS Plant									1.00	0.3861	0.1588	-0.0592	0.4545**
BYPP										1.00	-0.3335	0.2631	0.6511*
HI											1.00	0.0745	0.4901*
HSW												1.00	0.331
SYLD													1.00

DF50%: Days to 50% flowering, DP50%: Days to 50% pod setting, PH: Plant height, NPB: No. of primary branch per plant, NSB: No. of secondary branch per plant, DM: Days to maturity, NPP: No. of pods per plant, NS Pod: No. of seeds per pod, NS Plant: No. of seeds per plant, BYPP: Biological yield per plant, HI: Harvest index, HSW: Hundred seed weight, SYLD: Seed yield per plant

Table 5: Direct and indirect effects of 13 traits on seed yield in chickpea at genotypic level

GENOTYPICPATH	DF 50%	DP 50%	PH	NPB	NSB	DM	NPP	NS Pod	NS Plant	BYPP	HI	HSW
DF 50%	-0.0878	-0.0875	-0.0249	-0.0093	-0.0796	-0.073	-0.0285	0.1433	-0.009	-0.0673	0.0538	-0.0209
DP 50%	0.489	0.4904	0.0326	-0.116	0.3861	0.3385	0.0458	-1.2039	-0.0646	0.274	-0.2872	0.126
PH	0.0174	0.0041	0.0613	0.1206	-0.2068	0.0062	-0.0771	-0.2958	-0.0793	-0.0617	-0.0317	-0.0077
NPB	0.0095	-0.0212	0.1762	0.0897	0.0446	0.0655	0.0737	-0.0631	0.0662	0.0643	0.0026	-0.014
NSB	0.0423	-0.0367	0.1573	-0.0232	-0.0466	-0.0303	-0.0588	-0.1814	-0.0644	-0.0804	0.0395	-0.01
DM	0.3356	-0.2787	-0.0405	-0.2948	-0.2625	-0.4036	-0.1317	-0.4331	-0.1491	-0.1773	0.1808	-0.0595
NPP	-0.0388	-0.0112	0.1503	-0.0983	-0.1507	-0.039	-0.1196	-0.1287	-0.107	-0.0932	0.02	-0.0046
NS Pod	0.076	0.1143	0.2246	0.0328	-0.1812	-0.05	-0.0501	-0.0466	-0.0886	0.1565	0.0945	0.1258
NS Plant	0.058	-0.0744	-0.7301	0.4171	0.7806	0.2086	0.5053	1.0753	0.565	0.1541	0.0359	-0.0335
BYPP	0.5278	0.3843	-0.692	0.4932	1.1861	0.3021	0.5359	-2.311	0.1876	0.6878	-0.4253	0.269
HI	-0.5443	-0.52	-0.4586	0.0254	-0.7522	-0.3977	-0.1482	-1.8018	0.0564	-0.549	0.8878	0.0667
HSW	0.0216	0.0233	-0.0114	-0.0141	0.0195	0.0134	0.0035	-0.2447	-0.0054	0.0354	0.0068	0.0906
SYLD	0.1505	-0.0134	-1.1552	0.623	0.7373	-0.0593	0.5502	-5.4914	0.3077	0.3431	0.5775	0.5279

DF50%: Days to 50% flowering, DP50%: Days to 50% pod setting, PH: Plant height, NPB: No. of primary branch per plant, NSB: No. of secondary branch per plant, DM: Days to maturity, NPP: No. of pods per plant, NS Pod: No. of seeds per pod, NS Plant: No. of seeds per plant, BYPP: Biological yield per plant HI: Harvest index, HSW: Hundred seed weight, SYLD: Seed yield per plant

Table 6: Direct and indirect effects of 13 traits on seed yield in chickpea at phenotypic level

Phenotypic Path	DF 50%	DP 50%	PH	NPB	NSB	DM	NPP	NS Pod	NS Plant	BYPP	HI	HSW
DF 50%	0.2002	0.1931	0.0177	-0.0061	0.096	0.1503	0.0462	-0.0404	0.0145	0.0855	-0.1001	0.042
DP 50%	-0.0518	-0.0537	-0.0011	-0.0063	-0.0221	-0.0349	-0.0052	0.0154	0.0041	-0.0194	0.0255	-0.0126
PH	0.0027	0.0006	0.031	-0.0053	-0.0129	0.0019	-0.0114	-0.0068	-0.0131	-0.0044	-0.005	-0.0023
NPB	0.0003	-0.0012	0.0017	-0.0099	-0.0014	0.0034	0.0025	0.0012	0.003	0.0004	0.0006	-0.0013
NSB	0.0078	0.0067	-0.0068	0.0023	0.0163	0.0065	0.0097	0.0019	0.0097	0.0091	-0.0061	0.0028
DM	-0.0708	-0.0614	-0.0059	0.0325	-0.0376	-0.0944	-0.0248	-0.0154	-0.0284	-0.0216	0.0318	-0.0129
NPP	-0.0005	-0.0002	0.0007	0.0005	-0.0012	-0.0005	-0.002	-0.0005	-0.0017	-0.0014	0.0001	-0.0002
NS Pod	-0.006	-0.0086	-0.0065	-0.0035	0.0035	0.0049	0.0068	0.0298	0.0129	-0.0054	-0.0013	-0.0116
NS Plant	-0.0016	0.0017	0.0095	0.0068	-0.0133	-0.0067	-0.0191	-0.0097	-0.0224	-0.0086	-0.0036	0.0013
BYPP	0.3802	0.3221	-0.1267	-0.0369	0.498	0.2038	0.6067	-0.1619	0.3438	0.8905	-0.297	0.2343
HI	-0.4215	-0.4006	-0.1361	-0.0515	-0.3169	-0.2837	-0.0341	-0.0378	0.1339	-0.2811	0.8431	0.0628
SYLD	0.0452	0.0054	-0.2247	-0.0736	0.2134	-0.0456	0.5774	-0.2355	0.4545	0.6511	0.4901	0.331

DF50%: Days to 50% flowering, DP50%: Days to 50% pod setting, PH: Plant height, NPB: No. of primary branch per plant, NSB: No. of secondary branch per plant, DM: Days to maturity, NPP: No. of pods per plant, NS Pod: No. of seeds per pod, NS Plant: No. of seeds per plant, BYPP: Biological yield per plant HI: Harvest index, HSW: Hundred seed weight, SYLD: Seed yield per plant

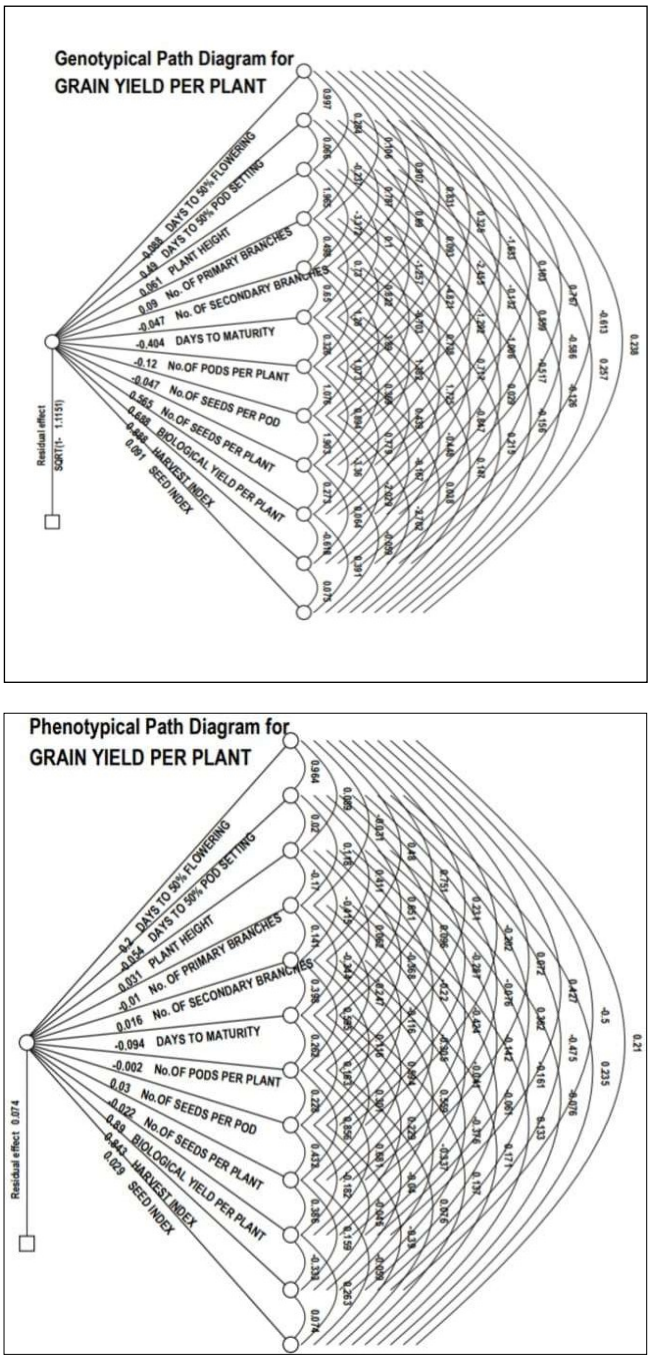

Fig 1: Genotypic and Phenotypic path diagram for Yield contributing traits of Chickpea

Path coefficient analysis suggested by specified the effective measure of direct and indirect causes of association and also depicts the relative importance of each factor involved in contributing to the final product i.e., yield by Hasan *et al*. (2014) [7] and Rao *et al*. (2005) [15]. Among the characters studied both at phenotypic and genotypic levels, plant height, biological yield, and harvest index and hundred seed weight had positive direct effects seed yield per plant. At genotypic level, (Figure 1) positive direct effects was depicted for Days to 50% pod setting followed by No. of primary branches, No. of seeds per plant and negative direct effects are Days to 50% flowering, No. of secondary branches and No. of seeds per pod (Table 5). Whereas, At phenotypic level, (Figure 1) maximum positive direct effects was depicted for Days to 50% flowering followed by No. of seeds per pod, No. of secondary branches and negative direct effects are Days to 50% pod setting, No. of primary branches and No. of seeds per plant (Table 6). Selection of plants on these traits would certainly lead to improvement in grain yield [Zena *et al*. (2008)] [19].

Conclusion

Significant positive association and high direct effect with plant height, number of primary branches, number of secondary branches, number of pods per plant, number of seeds per pod, number of seeds per plant, biological yield, harvest index and hundred seed weight on seed yield per plant. Strong association of these traits revealed that the selection based on these traits would improve the seed yield. Hence, the above mentioned traits should given highest priority while formulating a selection strategy for improvement of yield in chickpea.

References

1. Ali S, Maher AB, Anwand Haqqani AM. Exploitation of genetic variability for grain yield improvement in chickpea. International J. Agric. and Bio, 2002:4(10):148-149.
2. Burton GW. Quantitative inheritance in grasses. Proc. 6th Int. Grassland Cong,1952:1:277-283.
3. Chaudhary BD, Kumar A, Singh P, Singh DP. Yield attributes in chickpea. Legume Res,1991:4(1):20-24.
4. Chaurasia AK, Anurag OJ, Pandey P. Analysis of genetic variability for yield and associated characters in chickpea (*Cicer arietinum* L.). Progressive Res, 2009:4(2):225-227.

5. Fisher RA. The genetic theory of natural selection. Genetics by Strickberger, M.W. published by McMillan Co., New York, 1930, 772.
6. Gul R, Khan H, Bibi M, Ain QU, Imran B. Genetic analysis and interrelationship of yield attributing traits in Chickpea (*Cicer srietinum* L.). J Anim. Plant Sci,2013:23(2):521-526.
7. Hasan MT, Deb AC. Estimates of direct and indirect effects between yield and yield components and selection indices in chickpea (*Cicer arietinum* L.). Tropical Plant Research,2014:1(2):65-72.
8. Jeena AS, Arora PP. Role of variability for improvement in chickpea. Legume Res,2001:24(2):135-136.
9. Johanson HW, Robinson HF, Comstock RE. Genotypic and phenotypic correlations in soyabean and their implication in selection. Agronomy Journal,1955:47:477- 483.
10. Kumar Anurag, Kumar Anubhav, Yadav Anand Kumar, Shiva Nath, Yadav Jay Kumar, Kumar Kumar. Correlation and path coefficient analysis for various quantitative in chickpea (*Cicer arietinum* L.) Journal of Pharmacognosy and phytochemistry,2018:(SPI):2695-2699.
11. Lush JL. Proc. 8th Int. Cong. Genet. Suppl. Heridit,1949:36:356-375.
12. Mallik BA, Khan IA, Mallik MR. Genetic variability and correlations among metric traits in chickpea. Pak. J. Agric. Res,1988:9(3):352-354.
13. Mushtaq MA, Bajwa MM, Saleem M. Estimation of genetic variability and path analysis of grain yield and its components in chickpea (*Cicer arietinum* L.). Inter. J. Sci. Engineer. Res,2013:4:1-4.
14. Obaidullah S, Khan M, Khan H. Genotypic and phenotypic correlation analysis of some important characters in gram. Indus J. Plant Sci,2006:5(1):701-704.
15. Rao CM, Rao YK. Association and path analysis under four environments in chickpea. Legume Res,2005:28(4):272-275.
16. Vavilov NL. The origin, variation, immunity and breeding of cultivated plants. Translated by K. Start. Chronical Botany,1951:13:240-256.
17. Wright S. Correlation and causation. J. of Agric. Res,1923:20:557-585.
18. Yadav VS, Singh D, Yadav SS, Kumar J. Correlation and path analysis in chickpea. Indian J. Pulses Res,2002:15(1):19-22.
19. Zena AS, Arora PP, Upreti MC. Path coefficient for enhancing the yield of chickpea, Bhartiya Krishi Anusandhan Patrika,2008:23:3-4.