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Genetic variability, correlation and path co-efficient analysis for quantitative traits in chickpea (*Cicer arietinum* L.) genotypes

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Abstract
The present experiment was carried out at field experimental centre site of the Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj to study about Genetic Variability, Correlation And Path Co-Efficient Analysis in thirty one chickpea germplasm during *Rabi*-2020-21. The analysis of variance revealed significant differences among the genotypes for all the quantitative characters under the study, indicating high amount of variability present in the chickpea germplasm. The values of PCV were found greater than GCV for all the traits studied indicating environmental factors influencing the characters. High PCV and GCV were observed for Biological Yield Per Plant (28.075 and 29.334) followed by Seed Yield Per Plant (23.732 and 26.369), Number Of Seeds Per Plant (24.903 and 27.643), Number Of Pods Per Plant (24.519 and 28.234) indicated large extent of Genetic Variability for these traits in the material. High Heritability were recorded by Biological Yield Per Plant (91.6), Days To 50% Pod Setting(94.1), Seed Yield Per Plant(81), Number Of Secondary Branches Per Plant(88.5), Number Of Seeds Per Plant(81.2), Number Of Pods Per Plant (75.4). High Heritability along with high Genetic Advance was observed for the traits, *viz*., Days To 50% Pod Setting, Number Of Seeds Per Seeds Per Plant, Number Of Pods Per Plant, Biological Yield Per Plant indicated that the characters were mostly governed by additive gene effects. 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. The present study revealed that Seed Yield Per Plant was Positively and significantly Correlated with 100-Seed weight (g), Harvest Index Per Plant (%), Biological Yield Per Plant(G), Number Of Pods Per Plant, Number Of Seeds Per Plant where as significant and negatively Correlated with Days To 50% Pod Setting respectively. Path Co-efficient analysis revealed that traits, *viz*., number of seeds per plant, number of pods per plant, 100-seed weight(g), harvest index(%), and biological yield per plant(g) showing the direct positive effect on Seed Yield Per Plant(g) at Phenotypic and Genotypic level had given the highest contribution of Seed Yield Per Plant. So the utmost importance should be given to these traits during the selection for Seed Yield improvement in Chickpea.

Keywords: *Cicer arietinum L* genetic variability, correlation, path co-efficient analysis, seed yield

Introduction

Chickpea (*Cicer arietinum* L.) belonging to the family Fabaceae is a self-pollinated leguminous crop (2n=2x=16). Chickpea (*Cicer arietinum* L.) commonly known as Gram, Chana, Bengal gram and Garbanzo bean is the most important pulse crop of arid and semi-arid regions. Chickpea is one of the major pulses cultivated and consumed in India. Chickpea is also a major and cheap source of proteins compared to animal protein. Domestication leads the formation of two major cultivar types designated as 'desi' (microsperma) and "kabuli" (macrosperma). Desi chickpea are small and angular with rough brown to yellow testas. While kabuli types are relatively large, plump and with smooth cream colored testas. Kabuli types are considered relatively more advanced because of their larger seed size and reduced pigmentation achieved through conscious selection (Smartt and Simmonds 1995). Desi chickpea cultivated mostly in Indian subcontinents, Ethiopia, Mexico and Iran.

Desi chickpea is good for people with blood sugar problems because having markedly higher fiber content and low glycemic index. Kabuli, mainly grown in southern Europe, Northern Africa, Afghanistan, Pakistan, Turkey and India. Chickpea (*Cicer arietinum* L.) is the third most important food legume, grown in over 45 countries around the world. Chickpea acquires importance as it provides food for humans as well as for livestock. Furthermore, Chickpea pod covers and seed coats can also be used as fodder. India contributes major share of worlds chickpea area (137.18 lakh. ha), and production (146.46 lakh tons) and the productivity is (1038.4 kg/ha) (FAOSTAT 2019). In India chickpea is cultivated mostly in as a rainfed crop.

India is the largest Chickpea growing nation in the world with an area of production about 96.9 lakh.ha, the production of the country is about 110.78 lakh tones with the productivity of about 1142 kg/ha.

The area cultivated under chickpea in Uttar Pradesh is about 6.21 lakh ha, while the production of chickpea in U.P Is about 8.51 lakh tones, with the productivity about 1371 kg/ha (SOURCE: Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and farmers Welfare, GOI, 2019-20). Among the temperate pulses, Chickpea is the most tolerant crop to heat and drought stress and is suitable for cultivation in low fertile soils. Chickpea also helps to maintain soil fertility through biological nitrogen fixation

and contributes to the sustainability of cropping system in the cereal-legume crop rotations.

Chickpea crop meets 80 percentage of its nitrogen (N) requirement from symbiotic nitrogen fixation and can fix up to 140 kg N ha from air. It leaves a substantial amount of residual nitrogen for subsequent crop and adds plenty of organic matter to maintain and improve soil health.

Chickpea is eaten fresh as a green vegetable or parched, fried, roasted, or boiled seeds. Dal (split Chickpea without seed coat) and flour are used extensively in India as a thick soup for making breads. Sprouted seeds are eaten as a vegetable or added salads. Young seedlings and green pods are also eaten.

Chickpea seeds contains 21% starch, which is suitable for textile sizing, giving light finish in silk, wool and cotton cloth (Duke, 1981).

Even though India is the largest producer of Chickpea, it still imports Chickpea from other countries. Keeping in view, the ever-increasing demand for this legume crop, it is essential to improve the production and area under cultivation, at the same time minimizing the stress on this crop plant.

Progress in any breeding programme depends upon the extent and nature of variability existing in the base population. Thus, the success of any breeding programme depends on choice of breeding stocks that have sufficient variability.

Genetic Variability in a population can be portions in to heritable and non-heritable variations with the aid of genetic parameters such as variance, genotypic Co-efficient of variation, Heritability and Genetic Advance, which serves as a basic for selection of some outstanding genotypes from the existing ones.

Heritability combined with genetic advance will bring out genetic gain expected from selection (Kumar *et al.*, 2013) [15]. The knowledge of Inter-relationships between different characters is important in breeding direct and indirect selection of characters that are not easily measured and those with low heritability. However, it is self-pollinating and possesses limited variability and relationships among characters in germplasm will help in the selection and breeding of high yielding, good quality cultivars that will increase production. Keeping, the above points in view, this study was carried out in 31 chickpea germplasm to assess the genetic variability, heritability, genetic advance and interrelation ships between yield and its components and the direct and indirect effects of some Quantitative traits.

Materials and Methods

The experimental materials comprised of thirty one Chickpea germplasm including check were sown on 9^{th} October, 2020 at department of Genetics and Plant Breeding, SHUATS, Prayagraj. The experiment was laid in Randomized Complete Block Design (RBD) with three replications. The experimental plot size 5.0 m width and length 40.6 m. inter row spacing was kept 30cm and plant to plant spacing was 10cm. the recommended crop practices were followed for raise a healthy crop. Data for 13 quantitative traits were recorded *viz*., Days to 50% flowering, Days to 50% pods setting, Plant height (cm), Number of primary branches per plant, Number of secondary branches per plant, Number of days to maturity, Number of seeds per plant, Number of pods per plant, Number of seeds per pod, Biological yield per plant (g), 100-Seed weight (g), Harvest index (%), Seed yield per plant (g).

The days to 50% flowering and days to maturity were accounted on a plot basis and rest of the characters was documented from random sample of five plants in each plot from all the three replications. The recommended agronomical practices and crop protection measures were followed during the crop growth period. Biometrical analysis were followed to estimate Analysis of variance (ANOVA) Fisher and Yates (1936), Genotypic and Phenotypic Co-efficient of Variation (Burton and De vane, 1952), heritability in broad sense (Lush, 1940), genetic advance (Johnson *et al.*, 1955) and Correlation and Path Co-efficient analysis (Al Jibouri, 1958).

Results and Discussion

The analysis of variance revealed significant differences among the genotypes for all the characters under study (Table 1). Thus, it indicated considerable amount of genetic variability among thirty one Chickpea germplasm. Similar, results has been reported by Dehal *et al.*, (2016) [8] and Kumar *et al.*, (2014).

Estimation of Genetic Parameters

Estimation of genetic parameters, correlation and path co-efficient analysis helps to explore important traits during the selection for improving yield of chickpea. Heritability, Genotypic Co-efficient of variation (GCV), Phenotypic Co-efficient of variation (PCV), Genetic Advance (GA), Genetic Advance as percentage of mean GA (%) for all the yield contributing traits are shown in Table 2. PCV was higher than the corresponding GCV for all the characters indicating that there was an influence of the environment. Highest PCV and GCV were observed for Biological Yield Per Plant (28.075 and 29.334) followed by Seed Yield Per Plant (23.732 and 26.369), Number Of Seeds Per Plant (24.903 and 27.643), Number Of Pods Per Plant (24.519 and 28.234) in Table 2. High GCV for Number of seeds per plant (24.903), Number of pods per plant (24.19), Biological yield per plant (28.075), Seed yield per plant (23.732) were also earlier reported by Jeena *et al.*, (2005) [12], Alwani *et al.*, (2010) and Babbar *et al.*, (2012). Similar results were reported by Arora and Jeena (2001), Kumar *et al.*,(2001), Jeena *et al.*,(2005) [12], Alwani *et al.*, (2010) and Qurban *et al.*, (2011) [17], Shweta *et al.*, (2013) [18] and Peerzada *et al.*, (2014) [16]. Where, as moderate PCV and GCV were recorded for Plant height (12.084 and 7.765), whereas the lowest PCV and GCV were observed for Days to maturity (5.028 and 4.296)

The high estimates of GCV and PCV for these traits suggested the possibility of yield improvement through selection of these characters. With the help of GCV alone, it is not possible to determine the extent of variation that is heritability. Hence, the knowledge of heritability helps the plant breeders in prediction. The genetic advance for quantitative traits aids in exercising necessary selection procedure. The traits studied performed high heritability ranging from (75.4% to 94.1%). Among the traits studied the highest heritability was recorded by Days to 50% Pod setting (94.1%) followed by Biological Yield Per Plant (91.6%), Seed Yield Per Plant (81%), Number Of Secondary Branches Per Plant (88.5%), Number Of Seeds Per Plant (81.2%), Number Of Pods Per Plant (75.4%) (Table 2). Similar, results were been reported by Ali *et al.*,

(2011), Kumar *et al.,* (2014), Sachin *et al.,* (2014), Mohamed *et al.,* (2015). The high heritability values of the considerable traits in the present study indicated that these characters were less influenced by the environment and thus helps in effective selection of the traits based on the phenotypic expression by adopting simple selection method and suggested the scope of genetic improvement. Similar results were also reported by Bicer and Sarkar (2008) [6] and Younis *et al*., (2008).

The genetic advance as percent of mean was higher for Biological yield per plant (55.352), seed yield per plant (43.998), harvest index (34.571), Number of seeds per plant (46.213), Number of pods per plant (43.864), 100-seed weight (26.57), Days to 50% Pod setting (37.852) indicating that direct selection for these traits would be effective for the yield improvement similar findings related to high genetic advance as percent of mean for various traits have been reported by Vaghela *et al.,* (2009) [20] Tomar *et al.,* (2009) [19] and Kumar *et al.,* (2014) the characters having high heritability coupled with high genetic advance generally indicates that heritability is more due to additive gene effect and advocated the use of high estimates of heritability along with high magnitude of genetic advance for genetic improvement in any trait through selection high heritability coupled with high genetic advance as percent mean was observed for seed yield per plant, Number of seeds per plant, Number Of pods per plant, biological yield per plant, Days to pod setting.

High heritability coupled with high genetic advance as percent of mean for seed yield per plant and number of pods per plant has also been reported by Shweta *et al.,* (2013) [18], Vaghela *et al.,* (2009) [20], Waseem *et al.,* (2014) and Kumar *et al.,* (2014).

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.

Estimation of Correlation Co-Efficient Among the Traits

Yield is a complex quantitative character governed by large number of genes and is greatly affected by environment. Hence, the selection of superior genotypes based on yield will not give a fruitful results. Association of yield components and yield thus, assumed special importance as the basis for selecting desired strains. The results on phenotypic and genotypic correlation Co-efficient among the studied 31 chickpea germplasm between yield and its components in the present investigation are presented in Table 3.

Correlation Coefficient analysis were revealed that the genotypic correlation coefficient in most cases were higher than the phenotypic correlation coefficients indicating the association was largely due to genetic reason (Bhattacharya *et al*., 2007) [5] the phenotypic correlation coefficients in some cases were higher than their genotypic correlation, which indicated the suppressing effect of the environment that can alter the expression of characters at the phenotypic levels. Grain yield per plant showed positive significant genotypic and phenotypic correlations with Number of seeds per plant (0.553*, 0.581**), number of pods per plant (0.478**, 0.496**), 100- seed weight (0.372**, 0.219**), harvest index (0.340**, 0.390**), biological yield per plant (0.632**,0.610**) where as significant negative correlation with days to pod setting (-0.243*), days to maturity (-0.220*).

correlation analysis revealed that seed yield per plant showed significant and positive correlation association with number of seeds per plant, number of pods per plant, seed weight, harvest index, and biological yield per plant where as it showed negative and significant association with days to maturity, days to pod setting, at both genotypic and phenotypic levels respectively (Table 3) similar finding were reported by Ali *et al.,* (2011), Babbar *et al.,* (2012), Kumar *et al.,* (2017) [14], Agrawal *et al.,* (2018).

Estimation of Path Co-Efficient Analysis

The results of path coefficient analysis for phenotypic and genotypic correlations are shown in Table 4. Path co-efficient analysis was carried out by taking seed yield per plant as dependent variables and rest of the quantitative traits as independent variables. Path co-efficient for seed yield per plant recorded the highest positive direct effect contributing to seed yield per plant is Number of primary branches per plant, followed by Number of seeds per plant, Number of pods per plant, 100-seed weight, Harvest index, Biological yield per plant (table 4), the results corroborate the findings of Jeena *et al.,* (2005) [12] and Dehal *et al.,* (2016) [8]. Where as negative direct effects on seed yield per plant were observed due to Days to 50% pod setting. Similar findings were reported by Farshadfar (2008) [10], Vaghela *et al.,* (2009) [20], Borate *et al.,* (2010) [3], and Pandey *et al.,* (2013) [15].

It exhibited positive indirect effect via., Days to 50% pod setting (-0.243*), Number of days to maturity(-0.220*), where as positive and direct effect on seed yield per plant is exhibited by number of primary branches per plant (0.275**), number of pods per plant (0.478**, 0.496**), number of seeds per plant (0.553**, 0.581**), 100-seed weight (0.372**, 0.219*), Harvest index (0.3490**, 0.390**), Biological yield per plant (0.632**,0.610**).

Thus, the present study suggests that selection for high seed yield should be based on Number of seeds per plant, Number of pods per plant, 100-seed weight, Harvest index, Biological yield per plant in Chickpea. Therefore, due emphasis may be given on these characters for selecting high yielding genotypes in Chickpea.

Table 1: Analysis of variance (ANOVA) among 31 Chickpea genotypes for 13 quantitative traits

S.No	Characters	Mean sum of squares		
		Replication (DF=2)	Treatments (DF= 30)	Error (DF=60)
1	Days to 50% flowering	283.624	81.341**	15.935
2	Days to 50% pod setting	364.848	1757.481**	35.746
3	Days to maturity	279	152.826**	16.772
4	Plant height (cm)	251.303	126.648**	40.726
5	Number of primary branches per plant	0.125	0.158**	0.025
6	Number of secondary branches per plant	0.855	4.214**	0.175
7	Number of seeds per plant	541.74	1514.921**	108.844
8	Number of pods per plant	391.213	819.086**	80.272
9	Number of seeds per pod	0.208	0.176**	0.042
10	100-seed weight (g)	11.393	42.812**	9.578
11	Harvest index (%)	284.086	191.919**	16.457
12	Biological yield per plant (g)	62.626	424.158**	12.58
13	Seed yield per plant (g)	17.445	48.39**	3.51

Table 2: Genetic parameters performed by 31 genotypes for 13 quantitative traits of chickpea

S.no	Characters	GCV	PCV	h^2 (Broad sense)%	GA (5%)	GA as % mean (5%)
1	Days to 50% flowering	5.268	6.931	57.8	7.311	8.249
2	Days to 50% pod setting	18.938	19.519	94.1	47.882	37.852
3	Days to maturity	4.296	5.028	73	11.853	7.561
4	Plant height (cm)	7.765	12.084	41.3	7.084	10.278
5	Number of primary branches per plant	9.996	12.525	63.7	0.346	16.434
6	Number of secondary branches per plant	17.338	18.431	88.5	2.248	33.6
7	Number of seeds per plant	24.903	27.643	81.2	40.176	46.213
8	Number of pods per plant	24.519	28.234	75.4	28.074	43.864
9	Number of seeds per pod	12.233	16.998	51.8	0.313	18.135
10	100-seed weight (g)	17.612	24.049	53.6	5.021	26.57
11	Harvest index (%)	18.997	21.504	78	13.917	34.571
12	Biological yield per plant (g)	28.075	29.334	91.6	23.093	55.352
13	Seed yield per plant (g)	23.732	26.369	81	7.171	43.998

Table 3: Genotypic and phenotypic correlation coefficient between yield and its related traits in 31chickpea genotypes

Characters		Days to 50% flowering	Days to 50% pod setting	Days to maturity	Plant height	Pri. branches per plant	Sec. branches per plant	Number of seeds per plant	Number of pods per plant	Number of seeds per pod	100-seed weight	Harvest index	Biological yield per plant	Seed yield per plant
Days to 50% flowering	G	1	0.428**	0.349**	-0.306**	-0.346**	0.1842	0.445**	0.300**	0.661**	-0.655**	0.1498	-0.1789	-0.0213
	P	1	0.3318 **	0.4556 ***	-0.0284	-0.1068	0.1617	0.2881 **	0.2007	0.2394 *	-0.3663 ***	0.1236	-0.1557	-0.054
Days to 50% pod setting	G		1	1.0664	-0.554**	-0.474**	0.1217	0.1661	0.251*	0.737**	-0.584**	0.215*	-0.438**	-0.243*
	P		1	0.8476 ***	-0.4322 ***	-0.3661 ***	0.1256	0.2031	0.2754 **	0.5707 ***	-0.3461 ***	0.1745	-0.3727 ***	-0.1747
Days to maturity	G			1	-0.800**	-0.542**	0.0954	0.245*	0.362**	0.940**	-0.548**	0.282**	-0.441**	-0.1669
	P			1	-0.1988	-0.2815 **	0.0277	0.0956	0.1734	0.3840 ***	-0.4385 ***	0.1937	-0.4095 ***	-0.220*
Plant height	G				1	0.649**	-0.0345	-0.1466	-0.1761	-0.251*	0.693**	-0.1334	0.271**	0.236*
	P				1	0.3532 ***	-0.1098	-0.2040 *	-0.2414 *	-0.3595 ***	0.1743	-0.0757	0.099	0.0336
Pri. Branches per plant	G					1	0.517**	0.1773	0.1377	-0.484**	0.281**	-0.406**	0.628**	0.275**
	P					1	0.4310 ***	0.1124	0.0754	-0.3603 ***	0.155	-0.2835 **	0.4663 ***	0.1928
Sec. branches per plant	G						1	0.506**	0.302**	-0.0893	-0.166	-0.411**	0.466**	0.1049
	P						1	0.4879 ***	0.3162 **	-0.0068	-0.092	-0.3117 **	0.4514 ***	0.1471
Number of seeds per plant	G							1	0.821**	0.238*	-0.399**	-0.04	0.536**	0.553**
	P							1	0.8030 ***	0.3126 **	-0.2167 *	0.0155	0.5412 ***	0.581**
Number of pods per plant	G								1	0.274**	-0.437**	-0.0542	0.413**	0.478**
	P								1	0.2475 *	-0.1826	-0.004	0.4277 ***	0.496**
Number of seeds per pod	G									1	-0.799**	0.561**	-0.459**	0.0415
	P									1	-0.2851 **	0.3667 ***	-0.2781 **	0.0832
100-seed weight	G										1	-0.0103	0.364**	0.372**
	P										1	-0.1082	0.3137 **	0.219*
Harvest index	G											1	-0.489**	0.340**
	P											1	-0.4577 ***	0.390**
Biological yield per plant	G												1	0.632**
	P												1	0.610**

* indicates significance level at 5%
**indicates significance level at 1%

Table 4: Direct (Diagonal) and indirect effects for different quantitative characters on seed yield at genotypic and phenotypic levels.

Characters		Days to 50% flowering	Days to 50% pod setting	Days to maturity	Plant height	Pri. branches per plant	Sec. branches per plant	Number of seeds per plant	Number of pods per plant	Number of seeds per pod	100-seed weight	Harvest index	Biological yield per plant	Seed yield per plant
Days to 50% flowering	G	-0.0304	-0.013	-0.0106	0.0093	0.0105	-0.0056	-0.0135	-0.0091	-0.0201	0.0199	-0.0045	0.0054	-0.0213
	P	-0.0056	-0.0019	-0.0026	0.0002	0.0006	-0.0009	-0.0016	-0.0011	-0.0013	0.0021	-0.0007	0.0009	-0.054
Days to 50% pod setting	G	0.0363	0.0848	0.0904	-0.047	-0.0402	0.0103	0.0141	0.0213	0.0625	-0.0495	0.0182	-0.0371	-0.243*
	P	0.0367	0.1107	0.0939	-0.0479	-0.0405	0.0139	0.0225	0.0305	0.0632	-0.0383	0.0193	-0.0413	-0.1747
Days to maturity	G	-0.0451	-0.1377	-0.1291	0.1032	0.07	-0.0123	-0.0316	-0.0468	-0.1213	0.0707	-0.0364	0.0569	-0.1669
	P	-0.0339	-0.0631	-0.0745	0.0148	0.021	-0.0021	-0.0071	-0.0129	-0.0286	0.0327	-0.0144	0.0305	-0.220*
Plant height	G	-0.0527	-0.0956	-0.138	0.1725	0.1119	-0.0059	-0.0253	-0.0304	-0.0432	0.1195	-0.023	0.0468	0.236*
	P	-0.0016	-0.0236	-0.0109	0.0547	0.0193	-0.006	-0.0112	-0.0132	-0.0197	0.0095	-0.0041	0.0054	0.0336
Pri. Branches per plant	G	0.0859	0.1179	0.1347	-0.1611	-0.2484	-0.1284	-0.044	-0.0342	0.1203	-0.0698	0.1008	-0.156	0.275**
	P	0.0009	0.0032	0.0024	-0.0031	-0.0087	-0.0037	-0.001	-0.0007	0.0031	-0.0013	0.0025	-0.004	0.1928
Sec. branches per plant	G	0.0185	0.0122	0.0096	-0.0035	0.0519	0.1004	0.0508	0.0303	-0.009	-0.0167	-0.0412	0.0468	0.1049
	P	-0.0106	-0.0083	-0.0018	0.0072	-0.0283	-0.0657	-0.0321	-0.0208	0.0004	0.006	0.0205	-0.0297	0.1471
Number of seeds per plant	G	-0.0784	-0.0293	-0.0431	0.0258	-0.0312	-0.0891	-0.1761	-0.1446	-0.0419	0.0703	0.007	-0.0944	0.553**
	P	-0.0169	-0.0119	-0.0056	0.012	-0.0066	-0.0286	-0.0586	-0.0471	-0.0183	0.0127	-0.0009	-0.0317	0.581**
Number of pods per plant	G	0.0883	0.0741	0.1068	-0.0519	0.0406	0.0891	0.2419	0.2948	0.0807	-0.1287	-0.016	0.1218	0.478**
	P	0.0248	0.0341	0.0215	-0.0299	0.0093	0.0392	0.0994	0.1238	0.0306	-0.0226	-0.0005	0.053	0.496**
Number of seeds per pod	G	0.0512	0.0571	0.0729	-0.0194	-0.0375	-0.0069	0.0184	0.0212	0.0775	-0.0619	0.0435	-0.0356	0.0415
	P	0.0084	0.0199	0.0134	-0.0125	-0.0126	-0.0002	0.0109	0.0086	0.0349	-0.0099	0.0128	-0.0097	0.0832
100-seed weight	G	-0.027	-0.024	-0.0225	0.0285	0.0116	-0.0068	-0.0164	-0.018	-0.0329	0.0411	-0.0004	0.015	0.372**
	P	0	0	0	0	0	0	0	0	0	-0.0001	0	0	0.219*
Harvest index	G	0.1213	0.1743	0.2285	-0.1081	-0.3287	-0.3329	-0.0324	-0.0439	0.4545	-0.0084	0.8102	-0.3963	0.340**
	P	0.101	0.1427	0.1583	-0.0619	-0.2318	-0.2548	0.0127	-0.0033	0.2998	-0.0885	0.8175	-0.3741	0.390**
Biological yield per plant	G	-0.1894	-0.4634	-0.4664	0.2871	0.6646	0.493	0.5674	0.4375	-0.4856	0.3851	-0.5178	1.0585	0.632**
	P	-0.1573	-0.3765	-0.4137	0.1	0.4711	0.4561	0.5468	0.4321	-0.281	0.3169	-0.4624	1.0103	0.610**

* indicates significance level at 5%
**indicates significance level at 1%

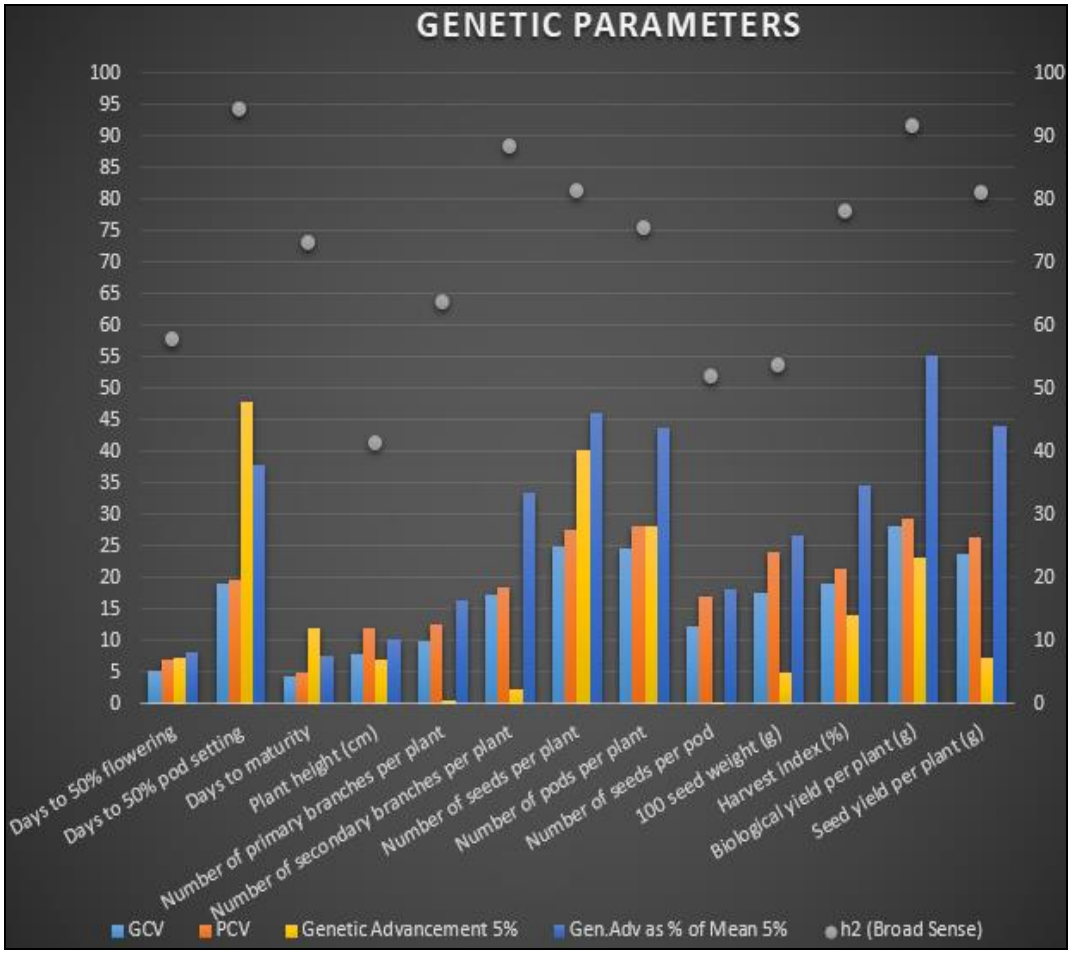

Fig 1: Histogram depicting GCV, PCV, Heritability (bs), Genetic advance, Genetic advance as % Mean for 13 Quantitative traits of 31 chickpea genotypes

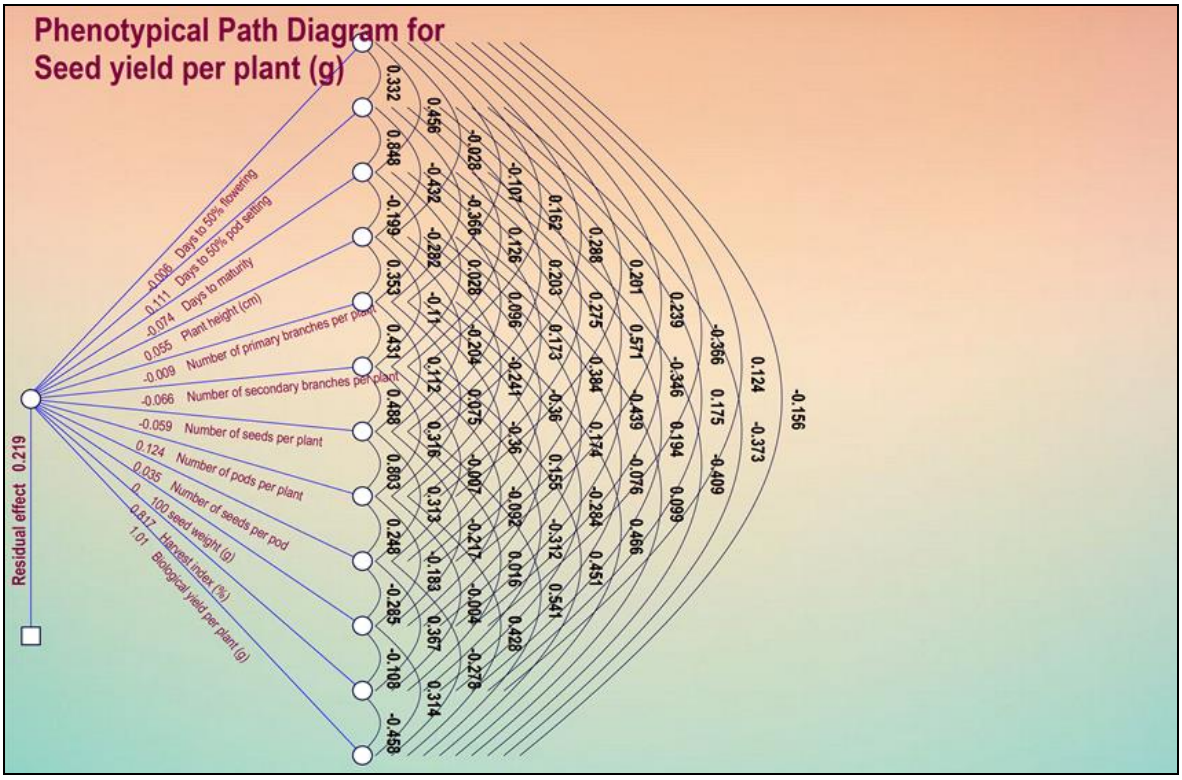

Fig 2: Phenotypic path diagram for seed yield per plant (g)

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