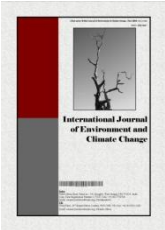

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Estimation of Correlation and Path Coefficient Analysis for Quantitative Traits in Chickpea (*Cicer arietinum* L.): An Experimental Study

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The Field Experimentation Centre conducted the current experiment using 22 genotypes of chickpea. Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj Department of Genetics and Plant Breeding during Rabi 2021–2022 in Randomized block design with three replications. 13 quantitative variables were studied using the data, including analysis of variance, variability assessment, heritability, genetic advance, correlation coefficient analysis, and path coefficient for traits related to yield and yield components. According to the findings of the analysis, there is enough variety among the chickpea germplasm included in the study for substantial deviations to be found for all the traits. For the character number of primary branches per plant, harvest index, and GCV, high estimations of both. Number of major branches, seeds per plant, and harvest index all showed high heritability's along with genetic progress. At both genotypic and phenotypic levels, the characteristics harvest index and number of branches per plant demonstrated a positive significant correlation with seed yield per plant. The traits biological yield, harvest index, days to maturity, number of secondary branches, number of pods per plant, number of seeds per pod, and number of secondary branches all had a positive direct impact on seed production per plant.

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Keywords: Genetic variability; heritability; correlation; path coefficient analysis.

1. INTRODUCTION

The population growth in the latter half of the 20th and the beginning of the 21st centuries has led to a shortage of food grains and related malnutrition issues among the economically disadvantaged parts. Over the previous forty years, there hasn't been a change in the total area under cultivation. Plant breeding requires knowledge of the kind and degree of genetic diversity present in morphological, phenological, quality, and traits related to stressors of chickpea [1-4]. There are several distinct names for chickpeas (*Cicer arietinum* L.), including Chana gram, Bengal gram, kadle, etc. The name Cicer comes from the Greek word "Kiros," which alludes to the well-known Roman family Cicero [5-8]. Arietinum is derived from the Latin word emerge, which means "ram" and alludes to the chickpea's ram-like head form [9-11]. A significant Rabi season legume with a wide geographic distribution is the chickpea. A diploid species, the chickpea has chromosomal number 2n = 2X = 16. It is a self-pollinating crop that belongs to the leguminous tribe Cicereae and subfamily papilionoidae. The "King of Pulses" is Bengal gram.

"The word *Cicer* is a derivative from the Greek word „Kiros" referring to a well-known roman family Cicero. *Arietinum* is derived from the Latin word arise meaning „ram" which refers to the ram"s head shape of the chickpea" [12].

It accounts for 61 percent of the land planted with pulses and generates around 65 percent of the state's total output. Along with ash, calcium, phosphorus, iron, and 17.7 to 38.5 percent protein and 56.5% carbs, chickpeas also include other nutrients. Chickpeas have a specific role in diet and are eaten in a range of dishes. The most common type of usage is dal (flour or parched) [13-17]. Chickpeas are a good source of protein and carbohydrates, which make up about 80% of the dry seed mass. There have been reports of a range in the starch content of chickpea cultivars from 41% to 50%. Between 12.4 and 31.5 percent of chickpeas are considered to have crude protein.Chickpea contains about 6% fat which is important in vegetarian diets of resource for consumers. The protein quality is considered to be better than other pulses [18].

The concept of correlation was first proposed by Galton (1889) which was elaborated by Fisher [19]. Though the correlation reflects the extent of association between a particular character and yield, they do not provide a complete picture as to how these components affect the yield.

Path coefficient analysis developed by Wright [20] is "a standardized partial regression analysis which further permits the partitioning of correlation into the components of direct and indirect effects. It reveals the true nature of cause and effect relationship of the yield contributing characters with yield using path analysis, the direct and indirect of one variable on another variable can be estimate" [21-24].

Objectives:

1. To estimate the phenotypic and genotypic correlation between seed yield and yield contributing characters.
2. To estimate a relationship between quantitative characters with seed yield.
3. To find out direct and indirect effects of yield contributing characters on seed yield.

2. MATERIALS AND METHODS

The present investigation was carried out at the Field Experimentation Centre of Department of Genetics and Plant Breeding, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj, U.P. during *Rabi* 2020-2022. A Randomized Block Design (RBD) was adopted with three replications and row to row spacing is 30cm and plant to plant spacing is 10cm with plot size 1m x 1m.

The observations were recorded on five randomly selected plants from each replication for 13 different quantitative traits i.e., 1) Days to 50 percent flowering 2) days to 50 percent pod setting, 3) days to maturity, 4) plant height, 5) number of primary branches per plant, 6) number of secondary branches per plant, 7) number of pods per plants, 8) number of seeds per plant, 9) number of seeds per pod, 10) biological yield per plant, 11) harvest index, 12) seed yield per plant, 13) 100 seed weight.

The recorded for all the considered characters were subjected to analysis of variance with the formula suggested by Panse and Sukhatme [12]. Further, different components of variance i.e., phenotypic, genotypic and environmental variance were estimated and genetic parameters like genotypic coefficient of variance (GCV), phenotypic coefficient of variance (PCV), heritability in broad sense, genetic advance as percent of mean and correlation analysis were conducted by following appropriate statistical procedure.

Chart 1. Experimental details

Crop	Chickpea
Season	*Rabi,* 2021 – 2022
Experimental design	Randomized Block Design (RBD)
No. of Replications	3
No. of genotypes	22
Plot size	1x1 m^2
Net area	66 sq.mt
Gross area	136.5 sq.mt
Spacing	30x10 cm
Date of sowing	04/12/2021
Fertilizer Dose	20:40:25 (N: P: K) kg/ha
Date of Harvesting	16/04/2022

3. RESULTS AND DISCUSSION

The abundant scope for improving these characters including grain yield per plant provided the material is subjected to judicious selection programme. Due to diverse source of material taken as well as environmental influence affecting the phenotypes the presence of variability might be large.

The mean values, coefficient of variation (C.V.), standard error of the mean (Sem+), critical difference (C.D.) at 5% and 1%, and range of 22 genotypes are shown in which demonstrated a large range of variance for all characteristics tested. GNG-1958 (11.00gm), IPC-08-103 (10.93gm), HIMACHAL-CHANA-2 (10.53gm), and IPC-94-94 (10.47gm) were determined to have the highest grain yields among the 22 genotypes.

3.1 Variability

The variability is classified as low if coefficient of variation (<10%), moderate (10-20%) and high (>20%). High PCV and GCV were observed for the Number of Secondary branches (21.839), Harvest index (21.158). Moderate PCV and GCV were observed for the seed yield per plant (16.12), Number of seeds per pod (11.479), Plant height (11.351). Low PCV and GCV were observed for the Days to maturity (1.157), Days to 50% pod setting (2.063).

3.2 Heritability

The heritability classified as low (<30%), medium (30-60%) and high (>60%) by Johnson *et al.,* (1955). In the present investigation traits having the higher heritability are number of secondary branches (90.093), Seed yield per plant (87.277), Harvest Index (85.062). Medium heritability observed for Days to 50% pod setting (32.46), days to maturity (30.412).

The high heritability values of the considered traits in the present study indicated that those were less influenced by the environment and thus help in effective selection of the traits based on the phenotypic expression by adopting simple selection method and suggested the scope of genetic improvement.

3.3 Genetic Advance as Percent Mean (5%)

The estimation of genetic advance as percent mean is classified as low (<10%), moderate (10 to 20%) and high (>20%) proposed by Johnson et al. [6].

High Genetic Advance as percent mean were observed for Number of primary branches (40.532), Harvest Index (37.074), seed yield per plant (31.023). The following characters show low for Genetic Advance as percent mean are Days to 50% flowering (2.874), Days to 50% pod setting (2.421), Days to maturity (1.314).

3.4 Correlation and Path Analysis

Correlation analysis among the yield and its contributing characters revealed that the genotypic correlation coefficients in most cases were higher than their phenotypic correlation coefficients indicating the association was largely due to genetic reason. At both genotypic and phenotypic levels. The grain yield per plant showed positive significant association with harvest index (0.975**), number of secondary branches (0.501**). Negative significant association with plant height (-0.361*), biological yield (-0.660**), days to 50% flowering (-0.273*), days to 50% pod setting (-0.438**) which indicate strong association of these traits with the yield. Positive direct effect was showed by number of secondary branches per plant (0.090), number of pods per plant (0.172), number of seeds per pod (0.046), biological yield (0.103), harvest index (0.814), days to maturity (0.015).

Table 1. Analysis of Variance for 13 quantitative characters in chickpea

S.No.	Source	Replication	Treatment	Error
	Degrees of freedom	**2**	**21**	**42**
1	Plant height (cm)	1.6530	100.715**	28
2	Number of primary branches	0.0410	0.821**	0.029
3	Number of secondary branches	0.2470	0.687**	0.198
4	Number of pods per plant	25.7130	60.216**	18.971
5	Number of seeds per pod	0.0060	0.099**	0.022
6	Number of seeds per plant	83.4850	215.385**	41.57
7	Seed yield per plant	0.3770	6.546**	0.303
8	Biological yield	10.4770	16.41**	5.262
9	Harvest Index	1.3420	117.706**	6.509
10	Days to fifty percent flowering	13.3330	17.766**	6.049
11	Days to fifty percent pod setting	25.7070	26.087**	10.683
12	Days to maturity	1.7480	16.2*	7.01
13	Seed Index	3.3810	10.745**	1.589

*** and * indicate significant at 1% and 5% level of significance respectively*

Table 2. Estimation of Genetic parameters for 13 quantitative characters

Sl.No.	Characters	GCV	PCV	h2 (Broad Sense)	Genetic Advancement	Gen.Adv as % of mean
1	Plant height (cm)	7.732	11.351	46.399	6.908	10.85
2	Number of primary branches	20.729	21.839	90.093	1.005	40.532
3	Number of secondary branches	6.475	9.646	45.051	**0.558**	8.952
4	Number of pods per plant	5.265	8.123	42.019	4.951	7.031
5	Number of seeds per pod	8.461	11.479	54.328	0.243	12.846
6	Number of seeds per plant	5.366	7.032	58.225	11.965	8.435
7	Seed yield per plant	16.12	17.255	87.277	2.776	31.023
8	Biological yield	6.363	9.89	41.389	2.555	8.432
9	Harvest Index	19.514	21.158	85.062	11.567	37.074
10	Days to fifty percent flowering	2.227	3.556	39.233	2.55	2.874
11	Days to fifty percent pod setting	2.063	3.621	32.46	2.659	2.421
12	Days to maturity	1.157	2.098	30.412	1.988	1.314
13	Seed Index	7.936	9.785	65.768	2.919	13.258

Table 3. Correlation coefficient analysis

Traits		PH	NPB	NSB	NPP	NSP	NSPL	BY	HI	DF50	DP50	DM	SI	SYP
PH	P	1	0.0269	-0.1837	0.2136	-0.0502	0.2122	0.0756	-0.1766	-0.2175	-0.247*	0.0033	-0.0439	-0.2262
	G	1	-0.0197	-0.486**	0.296*	-0.1901	0.318*	0.1968	-0.362*	-0.653**	-0.423**	0.325*	-0.1295	-0.361*
NPB	P		1	0.2043	0.0837	-0.1648	0.1926	-0.1716	0.0133	-0.0184	-0.1173	0.0572	0.2091	-0.1127
	G		1	0.1997	0.2145	-0.264*	0.291*	-0.2233	0.0509	0.1044	-0.1452	0.1370	0.2287	-0.0941
NSB	P			1	0.0216	0.275*	0.1115	0.0215	0.2046	0.1093	0.246*	0.1157	0.1200	0.2186
	G			1	-0.0230	0.373*	0.1210	0.0737	0.333*	0.469**	0.410**	0.0767	0.246*	0.501**
NPP	P				1	-0.1272	0.629**	0.2107	-0.0075	-0.0924	-0.1152	0.0265	0.1694	0.0906
	G				1	-0.0747	0.841**	-0.0818	0.0395	-0.305*	-0.545**	0.1079	0.440**	0.0756
NSP	P					1	-0.0327	-0.0079	-0.0150	0.2242	0.1005	-0.0928	0.0820	0.0365
	G					1	-0.0681	0.245*	-0.0576	0.569**	0.254*	0.0702	0.2215	-0.0221
NSPL	P						1	0.0330	0.0922	-0.1501	-0.245*	-0.0815	0.2398	0.0648
	G						1	-0.0673	0.0461	-0.379*	-0.559**	0.1476	0.372*	0.1421
BY	P							1	-0.579**	0.1988	0.1542	0.1526	0.284*	-0.362*
	G							1	-0.935**	0.307*	0.756**	0.0981	0.377*	-0.660**
HI	P								1	-0.1351	-0.270*	-0.0018	-0.1694	0.832**
	G								1	-0.376*	-0.508**	0.1684	-0.244*	0.975**
DF50	P									1	0.244*	-0.2166	0.0098	-0.1318
	G									1	1.0676	-0.649**	0.393*	-0.273*
DP50	P										1	0.0600	0.1989	-0.284*
	G										1	0.320*	0.543**	-0.438**
DM	P											1	0.1262	0.0388
	G											1	0.386*	0.1080
SI	P												1	-0.1615
	G												1	-0.2324
SYP	P													1
	G													1

PH: *Plant height,* ***NPB:*** *Number of Primary branches per plant,* ***NSB:*** *Number of secondary branches per plant,* ***NPP:*** *Number of pods per plant,* ***NSP:*** *Number of seeds per pod,* ***NSPL:*** *Number of seeds per plant,* ***BY:*** *Biological yield,* ***HI:*** *Harvest index,* ***DF50:*** *Days to 50% flowering,* ***DP50:*** *Days to 50% pod setting,* ***DM:*** *Days to maturity,* ***SI:*** *Seed index,* ***SYP:*** *Seed yield per plant*

Table 4. Path coefficient analysis

Traits		PH	NPB	NSB	NPP	NSP	NSPL	BY	HI	DF50	DP50	DM	SI	SYP
PH	P	**-0.1287**	-0.0035	0.0236	-0.0275	0.0065	-0.0273	-0.0097	0.0227	0.0280	0.0317	-0.0004	0.0057	-0.2262
	G	**-0.1073**	0.0021	0.0522	-0.0317	0.0204	-0.0341	-0.0211	0.0389	0.0701	0.0453	-0.0348	0.0139	-0.361*
NPB	P	-0.0032	**-0.1188**	-0.0243	-0.0099	0.0196	-0.0229	0.0204	-0.0016	0.0022	0.0139	-0.0068	-0.0248	-0.1127
	G	0.0065	**-0.3325**	-0.0664	-0.0713	0.0879	-0.0968	0.0743	-0.0169	-0.0347	0.0483	-0.0455	-0.0761	-0.0941
NSB	P	-0.0165	0.0184	**0.0900**	0.0019	0.0248	0.0100	0.0019	0.0184	0.0098	0.0222	0.0104	0.0108	0.2186
	G	-0.3338	0.1371	**0.6866**	-0.0158	0.2563	0.0831	0.0506	0.2289	0.3220	0.2815	0.0527	0.1689	0.501**
NPP	P	0.0368	0.0144	0.0037	**0.1725**	-0.0219	0.1086	0.0363	-0.0013	-0.0159	-0.0199	0.0046	0.0292	0.0906
	G	-0.0271	-0.0196	0.0021	**-0.0916**	0.0068	-0.1149	0.0075	-0.0036	0.0279	0.0499	-0.0099	-0.0403	0.0756
NSP	P	-0.0023	-0.0077	0.0129	-0.0060	**0.0468**	-0.0015	-0.0004	-0.0007	0.0105	0.0047	-0.0043	0.0038	0.0365
	G	0.0184	0.0256	-0.0361	0.0072	**-0.0966**	0.0066	-0.0237	0.0056	-0.0550	-0.0245	-0.0068	-0.0214	-0.0221
NSPL	P	-0.0252	-0.0229	-0.0132	-0.0747	0.0039	**-0.1187**	-0.0039	-0.0109	0.0178	0.0291	0.0097	-0.0285	0.0648
	G	-0.0135	-0.0124	-0.0051	-0.0533	0.0029	**-0.0425**	0.0029	-0.0020	0.0161	0.0237	-0.0063	-0.0158	0.1421
BY	P	0.0078	-0.0177	0.0022	0.0217	-0.0008	0.0034	**0.1032**	-0.0597	0.0205	0.0159	0.0158	0.0293	-0.362*
	G	-0.0571	0.0648	-0.0214	0.0238	-0.0712	0.0195	**-0.2903**	0.2714	-0.0892	-0.2193	-0.0285	-0.1094	-0.660**
HI	P	-0.1439	0.0109	0.1667	-0.0061	-0.0122	0.0751	-0.4715	**0.8149**	-0.1101	-0.2199	-0.0015	-0.1380	0.832**
	G	-0.1026	0.0144	0.0944	0.0112	-0.0163	0.0131	-0.2648	**0.2832**	-0.1065	-0.1439	0.0477	-0.0690	0.975**
DF50	P	0.0123	0.0010	-0.0062	0.0052	-0.0127	0.0085	-0.0113	0.0077	**-0.0568**	-0.0139	0.0123	-0.0006	-0.1318
	G	0.2276	-0.0364	-0.1634	0.1061	-0.1983	0.1320	-0.1070	0.1310	**-0.3484**	-0.3719	0.2262	-0.1367	-0.273*
DP50	P	0.0357	0.0170	-0.0356	0.0167	-0.0145	0.0354	-0.0223	0.0390	-0.0353	**-0.1446**	-0.0087	-0.0288	-0.284*
	G	0.0869	0.0299	-0.0843	0.1120	-0.0522	0.1150	-0.1554	0.1045	-0.2196	**-0.2057**	-0.0658	-0.1118	-0.438**
DM	P	0.0000	0.0006	0.0012	0.0003	-0.0010	-0.0009	0.0016	0.0000	-0.0023	0.0006	**0.0105**	0.0013	0.0388
	G	-0.0323	-0.0137	-0.0076	-0.0108	-0.0070	-0.0147	-0.0098	-0.0168	0.0647	-0.0319	**-0.0997**	-0.0385	0.1080
SI	P	0.0009	-0.0044	-0.0025	-0.0035	-0.0017	-0.0050	-0.0059	0.0035	-0.0002	-0.0042	-0.0026	**-0.0209**	-0.1615
	G	-0.0264	0.0466	0.0501	0.0898	0.0452	0.0758	0.0769	-0.0497	0.0800	0.1108	0.0787	**0.2039**	-0.2324
SYP	P	-0.2262	-0.1127	0.2186	0.0906	0.0365	0.0648	-0.362*	0.832**	-0.1318	-0.284*	0.0388	-0.1615	**1.0000**
	G	-0.361*	-0.0941	0.501**	0.0756	-0.0221	0.1421	-0.660**	0.975**	-0.273*	-0.438**	0.1080	-0.2324	**1.0000**

PH: *Plant height,* ***NPB:*** *No.of Primary branches per plant,* ***NSB:*** *No.of secondary branches per plant,* ***NPP:*** *No.of pods per plant,* ***NSP:*** *No.of seeds per pod,* ***NSPL:*** *No.of seeds per plant,* ***BY:*** *Biological yield,* ***HI:*** *Harvest index,* ***DF50:*** *Days to 50% flowering,* ***DP50:*** *Days to 50% pod setting,* ***DM:*** *Days to maturity,* ***SI:*** *Seed index,* ***SYP:*** *Seed yield per plant*

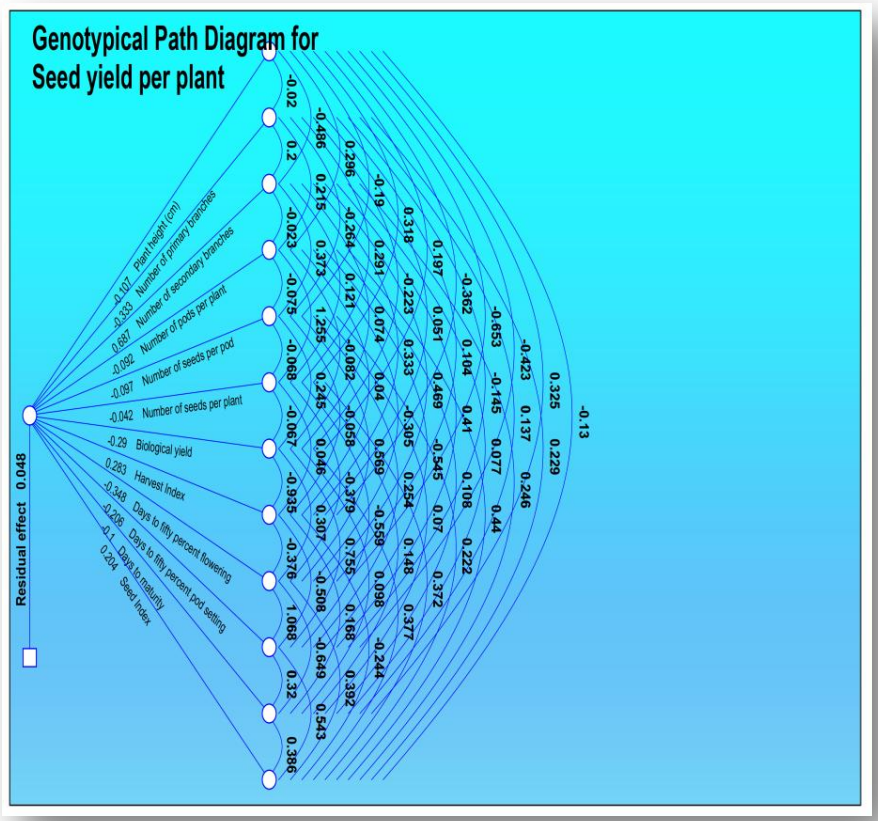

Fig. 1. Genotypic path diagram

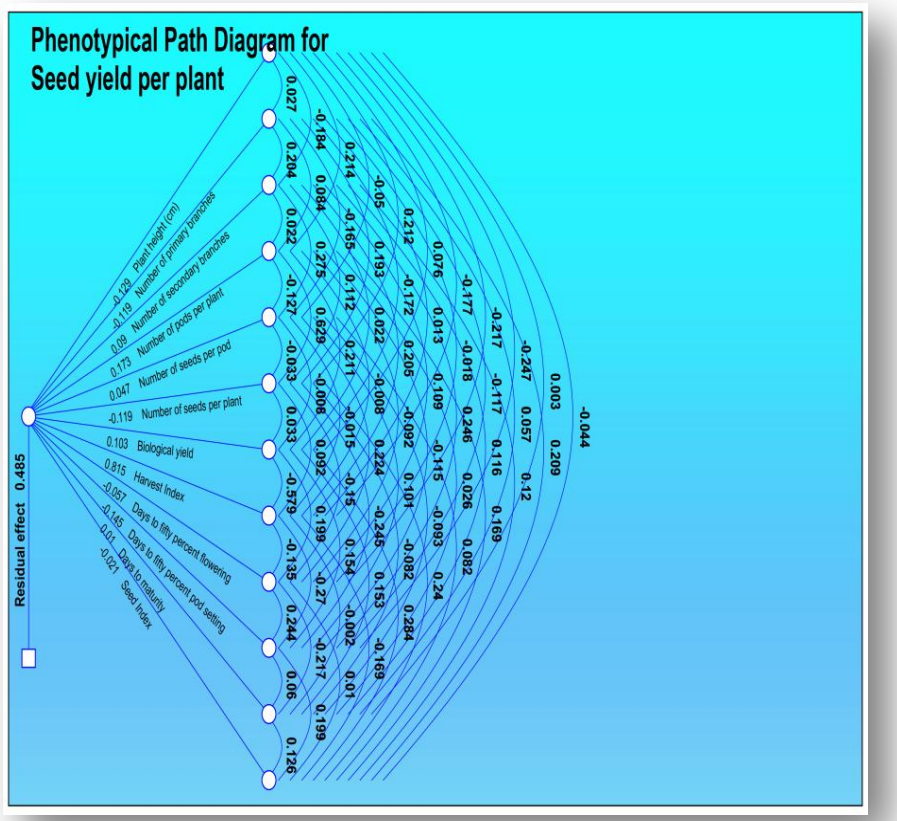

Fig. 2. Phenotypic path diagram

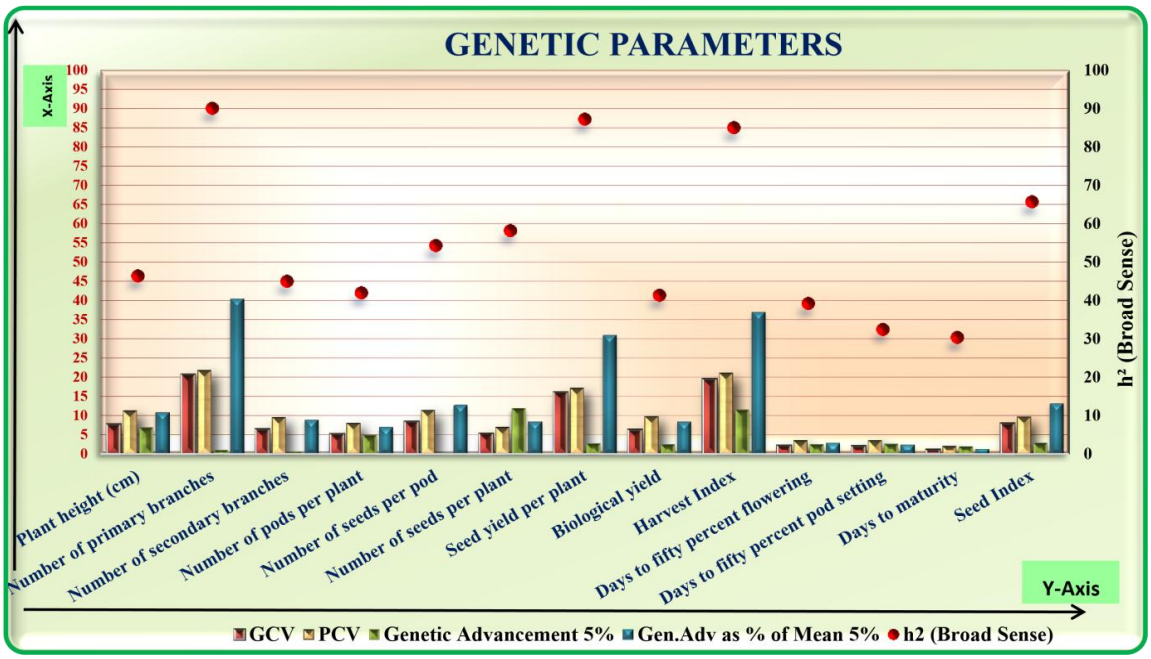

Fig. 3. Histogram representation of relationship among G CV, PCV, Heritability Genetic advance, Genetic advance as percent of mean

4. CONCLUSION

It is concluded that among 22 genotypes of Chickpea based on mean performance GNG-1958 (11.00gm) was found to be superior in seed yield per plant. Number of secondary branches had recorded with high estimates of GCV and PCV and high heritability values were recorded for number of secondary branches. High estimates of heritability coupled with high genetic advance as percent of mean was observed for harvest index. Correlation between seed yield and other traits showed the positive significant correlation with number of secondary branches, number of pods per plant, harvest index. Path analysis showed that the trait had positively direct effect on harvest index, number of secondary branches, number of pods per plant, number of seeds per pod, biological yield, days to maturity.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Abdul G, Niaz H, Muhammad A, Muhammad I, Muhammad N, Khalid H et al. Correlation and path coefficient analysis study for yield improvement in chickpea (*Cicer arietinum* L.). Int J Curr Agric Sci. 2018;8(5):293-5.
2. Arora RN, Kumar K. Genetic variability studies for yield contributing traits in Kabuli chickpea (*Cicer arietinum* L.). J Pharmacogn Phytochem. 2018;7(2): 2675-7.
3. Avinalappa H, Raghunath S. Analysis of genetic variability parameters for seed yield and its attributing traits of desi chickpea (*Cicer arietinum* L.) under different environments in West Bengal. J Agric Res. 2018;5(2):105-9.
4. Ali Q, Tahir MHN, Sadaqat HA, Arshad S, Farooq J, Ahsan M, et al. Genetic variability and correlation analysis for quantitative traits in chickpea genotypes (*Cicer arietinum* L.). ournal of Bacteriology Research. 2011;3:6-9.
5. Indu B, Rama K, Bhupender K. Exploitation genetic variability and determination of selection criteria using path coefficient analysis in chickpea. Bangladesh J Bot. 2015;44(1): 139-42.
6. Johnson HW, Robinson HF, Comstock RE. Estimate of genetic and environmental variability in rice (*Oryza sativa*.L). Agron J. 1955;47(7):314-8. DOI:10.2134/agronj1955.00021962004700070009x

7. Kumar A, Kumar A, Yadav AK, Nath S, Kumar JKYD. Correlation and path coefficient analysis for various quantitative traits in chickpea (*Cicer arietinum* L.). SPI. 2018:2695-9.
8. Manikanteswara O, Lavanya GR, Ranganatha YH, Sai Chandu MM. Estimation of Genetic variability, correlation and path analysis for seed yield characters in chickpea (*Cicer arietinum* L.). Int J Curr Microbiol Appl Sci. 2018; 7(9):843-9.
DOI: 10.20546/ijcmas.2018.709.101
9. Babbar A, Pandey S, Singh R. Genetic studies on chickpea genotypes grown in late sown under rice conditions of Madhya Pradesh. Electron J Plant Breed. 2015;6(3):738-48.
10. Babbar A, Prakash V, Tiwari P, Iquebal MA. Genetic variability of chickpea under late sown season. Legume Res. 2012;35:1-7.
11. Barad SH, Javia RM, Solanki HV, Panera A. Estimation of genetic variability for Kabuli chickpea (*Cicer arietinum* L.) ubder timely and late sowing condition. J Pharmacogn Phytochem. 2018;7(4): 421-3.
12. Singh U. National quality of chickpea (*Cicer arietinum* L.) current status and future research needs. Plant Food Hum Nutr. 1985;35(4):339-51.
DOI: 10.1007/BF01091779.
13. Chauhan MP, Singh IS. Variability estimates and identifying chickpea genotypes for yield and yield attributes in salt affected soil. Madras Agric J. 2000; 81(9):463-5.
14. Desai K, Tank CJ, Gami RA, Patel AM, Chauhan RM. Genetic variability in indigenous collection of chickpea (*Cicer arietinum* L.) genotypes for seed yield and quality traits. An International Journal of Environmental Sciences. 2015;9(1&2):59-62.
15. Dhuria N, Babbar A. Assessment of genetic variability and traits association in Kabuli chickpea (*Cicer arietinum* L.). Prog Res Int J. 2015;11(1):455-8.
16. Gaur RS, Tiwari A, Mishra SP. Correlation and path coefficient analysis for seed yield and its components in chickpea (*Cicer arietinum* L.). Trends Biosci. 2014;7(1):54-7.
17. Hasan MT, Deb AC. Assessment of genetic variability, heritability for quality traits in bengal gram. Indian J Biosci. 2017;10(2):111-29.
18. Hirdyani. Nutritional composition of Chickpea (*Cicer arietinum*-L) and value added products. Indian J Community Health. 2014;26(2):102-6.
19. Fisher RA. The correlation between relative on the supposition of Mendalian Inheritance Trance Royal Soc., Edinburg. 1918;52:399-403.
20. Wright S. Correlation and causation. J Agric Res. 1921;20:557-85.
21. Manoj KS, Singh A, Devi SR. Correlation, path analysis and genetic variability, of yield and yield components in chickpea (*Cicer arietinum* L.). Int J Fauna Biol Stud. 2018;5(3).
22. Panse VG, Sukhatme PV. Stastical methods for Agricultural workers. 4th ed. New Delhi: Indian Council of Agricultural Research; 1985.
23. Shara JH. Correlation and path analysis for seed yield and yield components in chickpea under rainfed condition. J Kerbala Agric Sci. 2019;6(1).
24. Singh MK, Singh A, Rhods DS. Correlation, path analysis and Genetic variability for yield and yield components in chickpea (*Cicer arietinum* L.). Int J Fauna Biol Sci. 2018;5(3):131-5.

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