



## **Estimation of Genetic Variability and Character Association for Yield Characters in Chickpea (*Cicer arietinum* L.)**

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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 present study entitled "Estimation of genetic variability and character association for yield characters in Chickpea (*Cicer arietinum* L.)" was designed to assess the extent of variability, genetic advance, heritability and correlation of different traits of 22 chickpea genotypes using randomized block design with three replications. The observations were recorded on five randomly selected plants from each treatment and replication for 13 different quantitative traits. Based on the mean performance, high seed yield per plant were identified for the genotype ICC-13348, GNG-469 and IPC-9-50. High estimates of GCV and PCV were recorded for number of seeds per plant, biological yield per plant, seed yield per plant, Seed Index, number of pods per plant. Genetic parameters revealed that heritability and genetic advance as % mean values are high were recorded for biological yield per plant, Number of seeds per plant, seed index, Number of pods per plant. Correlation coefficient analysis revealed that seed yield per plant exhibited positive and significant association with biological yield, seed index and harvest index at genotypic and phenotypic levels. Path coefficient analysis revealed that characters seed index, biological yield

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and harvest index have positive direct effect on seed yield per plant at genotypic and phenotypic levels. Hence, these traits should be preliminary included in selection criteria for crop improvement programme in chickpea.

**Keywords:** Correlation coefficient; genetic advance; genotypic correlation coefficient; heritability; path coefficient; phenotypic correlation coefficient; variability.

## 1. INTRODUCTION

Chickpea (*Cicer arietinum* L.), also known as 'Bengalgram', 'Indian pea', and 'Senagalu' in Telugu, is an edible legume. It is the only widely cultivated species of the genus *Cicer* and belongs to the Fabaceae family. It is a major food crop in tropical and subtropical climates [1], and is grouped as one of the world's ancient and most frequently cultivated legumes in the Fabaceae (Leguminosae) family [2]. It is a winter season pulse crop [3]. Self-pollinated crop, cross-pollination may occur by insects occasionally [4]. Chickpea seed is the main edible part of the plant and is a rich source of 18-23% protein, 52-70% total carbohydrates, 4-10% fat, 3-6% crude fiber, 2-3% ash, 3-8% soluble sugar and minerals (calcium, phosphorus and iron) especially for the vegetarian population [5].

"India produces around 97.65 lakh tons of chickpea annually from about 95.66 lakh hectares of area, and an average productivity of 1021 kg per hectare. And Uttar Pradesh produces around 58.95 lakh tons annually from about 50.48 lakh hectares of area, and an average productivity of 1168 kg per hectare". (Source: Normal Estimates of Area, production, and yield of selected principal crops by Govt of India, May 2021.)

Genetic variability in base community population for economic characters is the prior for breeding program as the degree of response to evaluation depending on the quantum of variability. separation of phenotypic and genotypic variation, heritability, variation in environment, relationship between traits, path and principal component analysis is the important for any breeding programme. "The achievement of many crop improvement programs mainly depends on the genetic variability present in the population. Heritability evaluation are useful to decide the amount difference present in the population. Heritability combined with the genetic advance will bring out the genetic gain assumed from selection" [6].

"The correlation between seed yield and yield components are important in choosing selection standards. The phenotypic and genotypic correlations are the values to show the intercorrelation between quantitative characters with the economical characters" [7].

Further, the path coefficient analysis is useful in separating the coefficient into direct and indirect effects which depicts the inter-relationship of yield components among all the genotypes. Chickpea is rich in nutritional components and can be adopted and consumed in alter to green pea which are less nutrient than chickpea.

The present investigation has been made with the following objectives:-

1. To study the extent of genetic variability present in the germplasm
2. To estimate the association between quantitative traits and seed yield
3. To assess direct and indirect effects of yield attributing traits on seed yield

To determine major yield attributing traits by genetic variability.

## 2. MATERIALS AND METHODS

The present experiment comprised of 22 genotypes with one check in Randomized Block Design in three replication with row to row distance 30 cm and plant to plant distance 10 cm, conducted in Experimental Farm of the Department Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh during *rabi*, 2021.

### 2.1 Statistical Analysis

- Analysis of variance [8]
- Genetic variability [9]

Genotypic Coefficient of Variation (**GCV**)  
Phenotypic Coefficient of Variation (**PCV**)

- Estimation of Heritability (Broad sense) [10]

- Genetic advance [11]
- Correlation co-efficient analysis [12]
- Path coefficient analysis [13]

## 2.2 Observed Traits

1. Plant height (cm)
2. Days to 50% flowering
3. Days to 50% pod initiation
4. Days to maturity
5. Number of primary branches
6. Number of secondary branches
7. Number of pods per plant.
8. Number of seeds per pod
9. Number of seeds per plant
10. Biological yield per plant (g)
11. Harvest Index (%)
12. Seed index
13. Seed yield per plant (g)

## 3. RESULTS AND DISCUSSION

Analysis of variance showed significant differences among genotypes for all 13 characters (Table 2) indicating that the material has adequate genetic variability to support the breeding programmer for improving the seed yield of chickpea.

Analysis of variance shows that every treatment is differ from each other so genetic variability exists. 1% level of significance is highest for number of seeds per plant (689.139\*\*) and lowest for number of primary branches (0.185\*\*).

Based on mean performance among the lines, ICC-13348 (23.303) recorded the highest seed yield per plant followed by the genotypes GNG-469 (20.027), IPC-9-50 (19.293), BPM (14.567), IPC-08-69 (14.287), IPC-07-67 (14.18).

“In phenotypic correlation coefficient seed yield per plant shown positive and significant

association with biological yield per plant (0.803\*\*), harvest Index (0.397\*\*), seed index (0.688\*\*). positive and non-significant with days to fifty percent flowering (0.1342), days to maturity (0.0231) number of primary branches (0.0810), number of seeds per pod (0.0954) in (Table 4.1). In genotypic correlation coefficient seed yield per plant shown positive and significant association with biological yield per plant (0.835\*\*), harvest Index (0.465\*\*), seed index (0.718\*\*). Positive and non-significant with days to fifty percent flowering (0.1581), number of primary branches (0.1367), number of seeds per pod (0.0867) in (Table 4.2)”. Similar observations were noted by, Ojha et al. [14] and Singh and Shiva, [15], Hasan; Deb, [16], Kumar et al. [17].

In Phenotypic Path coefficient analysis positive direct effect was showed by plant height (0.1461), primary branches per plant (0.3300), pods per plant (0.0780), number of seeds per plant (0.0988), biological yield per plant (1.3587), harvest index (0.9358) in (Table 5.1). In Genotypic Path coefficient analysis maximum direct positive effect on seed yield per plant was observed in biological yield per plant (1.3587) followed by harvest index (0.9358), number of primary branches (0.3300), plant height (0.1461) and number of seeds per pod (0.0988) in (Table 5.2) The available literatures have also identified these characters as major direct contributors to seed yield per plant in chickpea Thakur and Sirohi, [18], Yucel et al. [19] and Ojha et al. [14].

Among the 13 quantitative characters, high estimates of GCV and PCV were recorded respectively for number of seeds per plant (43.731, 44.532), biological yield per plant (41.809, 42.877), seed yield per plant (39.921, 41.02), Seed Index (34.882, 35.549), number of pods per plant (31.908, 32.934).

**Table1. List of experimental material used in the present investigation**

S.No	Genotypes	S.No	Genotypes
1	IPC-08-69	12	KLDR-108
2	IPC-07-67	13	JGK-2
3	IPC-05-24	14	FLIP-07-20K
4	IPC-08-011	15	IPCK-9-40
5	ILC-1202	16	BPM
6	ILC-6335K	17	GNG-469
7	ILC-1142	18	CSJ-556
8	ILC-3892	19	IPC-9-50
9	ICC-13348	20	ICCV-9802
10	ICC-20-08	21	IPCK-04-29
11	ILC-59468	22	UDAY (check)

Source: Dept. of Genetics and Plant Breeding, SHUATS

Moderate estimates of GCV and PCV were recorded respectively for harvest index (17.933, 19.998), Moderate estimates of PCV recorded for number of secondary branches (12.154), Plant height (11.405), number of primary branches (10.208). Low estimates of GCV were observed for number of secondary branches (9.815), Plant height (9.205), number of primary branches (8.199). Low estimates of GCV and PCV were observed for days to 50% flowering (2.868, 4.129), days to 50% pod setting (1.346, 2.108), days to maturity (1.639, 2.618).

High heritability values were recorded for biological yield per plant (98.026), number of

seeds per plant (96.988), number of pods per plant (93.866). Moderate heritability values were recorded for days to 50% flowering (48.24), days to 50% pod setting (40.77), days to maturity (39.199).

Highest genetic advance estimated for number of seeds per plant (30.59), followed by seed index (27.627), biological yield per plant (23.118), number of pods per plant (18.339), harvest index (15.115), seed yield per plant (9.616), plant height (8.164), days to 50% flowering (3.015), days to maturity (2.519), days to 50% pod setting (1.497), secondary branches per plant (1.026), primary branches per plant (0.378), and number of seeds per pod (0.519).

**Table 2. Analysis of variance for yield and its contributing traits in chickpea**

SI.No.	Characters	Mean sum of squares		
		Replication	Treatment	Error
	<b>Degrees of freedom</b>	<b>2</b>	<b>21</b>	<b>42</b>
1	Days to fifty percent flowering	4.2880	18.084**	4.764
2	Days to fifty percent pod setting	4.6930	5.764**	1.88
3	Days to maturity	11.1060	17.357**	5.916
4	Plant height	14.3780	85.224**	12.899
5	Number of primary branches	0.0850	0.185**	0.029
6	Number of secondary branches	0.0770	1.343**	0.203
7	Number of pods per plant	1.0240	258.803**	5.517
8	Number of seeds per pod	0.0070	0.238**	0.013
9	Number of seeds per plant	3.5680	689.139**	7.061
10	Seed yield per plant	2.6560	70.297**	1.284
11	Biological yield per plant	1.0640	388.024**	2.587
12	Harvest Index	13.4150	217.142**	16.303
13	Seed Index	12.7670	567.638**	7.213

\* 5% Level of Significance; \*\* 1% Level of Significance

**Table 3. Genetic parameters for 13 quantitative traits of 22 chickpea genotypes**

SI.No.	Parameters	GCV	PCV	h <sup>2</sup> (Broad Sense) %	Genetic Advance 5%	Gen. Adv as % of Mean 5%
1	Days to fifty percent flowering	2.868	4.129	48.24	3.015	4.104
2	Days to fifty percent pod setting	1.346	2.108	40.779	1.497	1.771
3	Days to maturity	1.639	2.618	39.199	2.519	2.114
4	Plant height (cm)	9.205	11.405	65.144	8.164	15.305
5	Number of primary branches	8.199	10.208	64.511	0.378	13.565
6	Number of secondary branches	9.815	12.154	65.219	1.026	16.329
7	Number of pods per plant	31.908	32.934	93.866	18.339	63.683
8	Number of seeds per pod	19.585	21.254	84.91	0.519	37.177
9	Number of seeds per plant	43.731	44.532	96.988	30.59	88.739
10	Seed yield per plant (g)	39.921	41.02	94.713	9.616	80.034
11	Biological yield per plant (g)	41.809	42.877	98.026	23.118	85.273
12	Harvest Index (%)	17.933	19.998	80.417	15.115	33.128
13	Seed Index (g)	34.882	35.549	96.282	27.627	70.51

GCV: Genotypic Coefficient of Variation, PCV: Phenotypic Coefficient of Variation h<sup>2</sup> bs: heritability (Broad sense), GA: Genetic Advance, GAM: Genetic Advance as Percent of Mean

**Table 4.1. Estimation of phenotypic correlation coefficient between yield and yield attributing traits in 13 quantitative traits of 22 Chickpea genotypes**

Traits	Days to fifty percent flowering	Days to fifty percent pod setting	Days to maturity	Plant height (cm)	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 per plant (g)	Harvest Index (%)	Seed Index (g)	Seed yield per plant (g)
Days to fifty percent flowering	1.0000	0.0765	0.0733	0.0723	0.0682	0.0262	-0.1530	-0.2354	-0.267*	0.1231	0.0790	0.0672	0.1342
Days to fifty percent pod setting		1.0000	0.1556	-0.0136	0.0650	0.301*	0.342*	0.1218	0.1835	-0.0541	0.0529	-0.2151	-0.0574
Days to maturity			1.0000	-0.0607	-0.1289	-0.1352	0.0155	0.1076	0.0946	-0.0725	0.1555	-0.247*	0.0231
Plant height (cm)				1.0000	-0.1371	-0.1974	-0.2283	-0.2124	-0.350*	-0.1079	0.0771	-0.0061	-0.0669
Number of primary branches					1.0000	0.367*	0.1957	-0.0931	0.0132	0.0185	0.0654	0.1577	0.0810
Number of secondary branches						1.0000	0.455**	0.1565	0.304*	-0.1043	0.0500	-0.1982	-0.0657
Number of pods per plant							1.0000	0.368*	0.737**	-0.419**	0.1847	-0.542**	-0.291*
Number of seeds per pod								1.0000	0.785**	0.0155	0.0209	-0.274*	0.0954
Number of seeds per plant									1.0000	-0.1853	0.1725	-0.362*	-0.0188
Biological yield per plant (g)										1.0000	-0.0707	0.691**	0.803**
Harvest Index (%)											1.0000	0.0982	0.397**
Seed Index (g)												1.0000	0.688**
Seed yield per plant (g)													1.0000

**Table 4.2. Estimation of genotypic correlation coefficient between yield and yield attributing traits in 13 quantitative traits of 22 Chickpea genotypes**

Traits	Days to fifty percent flowering	Days to fifty percent pod setting	Days to maturity	Plant height (cm)	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 per plant (g)	Harvest Index (%)	Seed Index (g)	Seed yield per plant (g)
Days to fifty percent flowering	1.0000	-0.286*	0.1270	0.295*	0.0782	0.0667	-0.1391	-0.403**	-0.339*	0.1856	0.2075	0.1230	0.1581
Days to fifty percent pod setting		1.0000	0.752**	0.666**	0.772**	0.721**	0.821**	0.973**	0.821**	-0.2008	-0.0931	-1.693**	-0.492**
Days to maturity			1.0000	0.0623	-0.1728	-0.315*	0.1697	0.1748	0.1688	-0.1569	0.392*	-0.494**	-0.0715
Plant height (cm)				1.0000	-0.293*	-0.1904	-0.302*	-0.400**	-0.451**	-0.1260	0.0895	0.0020	-0.0598
Number of primary branches					1.0000	0.440**	0.268*	-0.1410	0.0482	0.0396	0.1460	0.1944	0.1367
Number of secondary branches						1.0000	0.544**	0.287*	0.374*	-0.1310	0.0757	-0.2325	-0.0759
Number of pods per plant							1.0000	0.459**	0.763**	-0.435**	0.1801	-0.577**	-0.300*
Number of seeds per pod								1.0000	0.879**	0.0130	0.0655	-0.295*	0.0867
Number of seeds per plant									1.0000	-0.1921	0.1937	-0.378*	-0.0295
Biological yield per plant (g)										1.0000	-0.0696	0.715**	0.835**
Harvest Index (%)											1.0000	0.0939	0.465**
Seed Index (g)												1.0000	0.718**
Seed yield per plant (g)													1.0000

Table 5.1. Phenotypic path between yield and yield attributing traits in 13 quantitative traits of 22 Chickpea genotypes

Traits	Days to fifty percent flowering	Days to fifty percent pod setting	Days to maturity	Plant height (cm)	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 per plant (g)	Harvest Index (%)	Seed Index (g)	Seed yield per plant (g)
Days to fifty percent flowering	<b>0.0367</b>	0.0028	0.0027	0.0027	0.0025	0.0010	-0.0056	-0.0086	-0.0098	0.0045	0.0029	0.0025	0.1342
Days to fifty percent pod setting	-0.0013	<b>-0.0168</b>	-0.0026	0.0002	-0.0011	-0.0051	-0.0057	-0.0020	-0.0031	0.0009	-0.0009	0.0036	-0.0574
Days to maturity	0.0035	0.0074	<b>0.0479</b>	-0.0029	-0.0062	-0.0065	0.0007	0.0051	0.0045	-0.0035	0.0074	-0.0118	0.0231
Plant height (cm)	0.0019	-0.0004	-0.0016	<b>0.0262</b>	-0.0036	-0.0052	-0.0060	-0.0056	-0.0092	-0.0028	0.0020	-0.0002	-0.0669
Number of primary branches	0.0025	0.0024	-0.0048	-0.0051	<b>0.0370</b>	0.0136	0.0072	-0.0034	0.0005	0.0007	0.0024	0.0058	0.0810
Number of secondary branches	0.0005	0.0057	-0.0026	-0.0037	0.0070	<b>0.0190</b>	0.0086	0.0030	0.0058	-0.0020	0.0010	-0.0038	-0.0657
Number of pods per plant	0.0158	-0.0354	-0.0016	0.0236	-0.0203	-0.0471	<b>-0.1036</b>	-0.0381	-0.0763	0.0434	-0.0191	0.0562	-0.291*
Number of seeds per pod	-0.0159	0.0082	0.0073	-0.0143	-0.0063	0.0106	0.0249	<b>0.0675</b>	0.0530	0.0010	0.0014	-0.0185	0.0954
Number of seeds per plant	-0.0383	0.0263	0.0136	-0.0502	0.0019	0.0436	0.1056	0.1125	<b>0.1434</b>	-0.0266	0.0247	-0.0519	-0.0188
Biological yield per plant (g)	0.0837	-0.0368	-0.0493	-0.0733	0.0126	-0.0709	-0.2850	0.0105	-0.1260	<b>0.6797</b>	-0.0481	0.4694	0.803**
Harvest Index (%)	0.0319	0.0213	0.0627	0.0311	0.0264	0.0202	0.0745	0.0084	0.0696	-0.0285	<b>0.4036</b>	0.0396	0.397**
Seed Index (g)	0.0132	-0.0423	-0.0486	-0.0012	0.0310	-0.0390	-0.1067	-0.0539	-0.0713	0.1359	0.0193	<b>0.1967</b>	0.688**
Seed yield per plant (g)	0.1342	-0.0574	0.0231	-0.0669	0.0810	-0.0657	-0.291*	0.0954	-0.0188	0.803**	0.397**	0.688**	1.0000

Residual effect: - 0.344; \* 5% Level of Significance; \*\* 1% Level of Significance

**Table 5.2. Genotypic path between yield and yield attributing traits in 13 quantitative traits of 22 Chickpea genotypes**

Traits	Days to fifty percent flowering	Days to fifty percent pod setting	Days to maturity	Plant height (cm)	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 per plant (g)	Harvest Index (%)	Seed Index (g)	Seed yield per plant (g)
Days to fifty percent flowering	-0.0710	0.0203	-0.0090	-0.0209	-0.0056	-0.0047	0.0099	0.0286	0.0240	-0.0132	-0.0147	-0.0087	0.1581
Days to fifty percent pod setting	0.0052	-0.0183	-0.0335	-0.0122	-0.0215	-0.0249	-0.0468	-0.0178	-0.0263	0.0037	0.0017	0.0310	-0.492**
Days to maturity	-0.0967	-1.3970	-0.7617	-0.0475	0.1316	0.2399	-0.1293	-0.1332	-0.1286	0.1195	-0.2982	0.3759	-0.0715
Plant height (cm)	0.0430	0.0972	0.0091	0.1461	-0.0428	-0.0278	-0.0441	-0.0584	-0.0659	-0.0184	0.0131	0.0003	-0.0598
Number of primary branches	0.0258	0.3889	-0.0570	-0.0967	0.3300	0.1453	0.0885	-0.0465	0.0159	0.0131	0.0482	0.0642	0.1367
Number of secondary branches	-0.0333	-0.6798	0.1573	0.0951	-0.2200	-0.4996	-0.2717	-0.1435	-0.1867	0.0654	-0.0378	0.1161	-0.0759
Number of pods per plant	0.0190	-0.3506	-0.0232	0.0414	-0.0367	-0.0744	-0.1369	-0.0628	-0.1044	0.0596	-0.0247	0.0790	-0.300*
Number of seeds per pod	-0.0314	0.0758	0.0136	-0.0312	-0.0110	0.0224	0.0358	0.0780	0.0685	0.0010	0.0051	-0.0230	0.0867
Number of seeds per plant	-0.0334	0.1420	0.0167	-0.0446	0.0048	0.0369	0.0754	0.0868	0.0988	-0.0190	0.0191	-0.0374	-0.0295
Biological yield per plant (g)	0.2522	-0.2729	-0.2132	-0.1712	0.0538	-0.1780	-0.5913	0.0176	-0.2611	1.3587	-0.0946	0.9708	0.835**
Harvest Index (%)	0.1942	-0.0871	0.3664	0.0838	0.1367	0.0709	0.1686	0.0613	0.1812	-0.0651	0.9358	0.0879	0.465**
Seed Index (g)	-0.1154	1.5890	0.4631	-0.0019	-0.1825	0.2182	0.5417	0.2766	0.3549	-0.6705	-0.0881	-0.9384	0.718**
Seed yield per plant (g)	0.1581	-0.492**	-0.0715	-0.0598	0.1367	-0.0759	-0.300*	0.0867	-0.0295	0.835**	0.465**	0.718**	1.0000

Residual effect: - 1.06; \* 5% Level of Significance; \*\* 1% Level of Significance



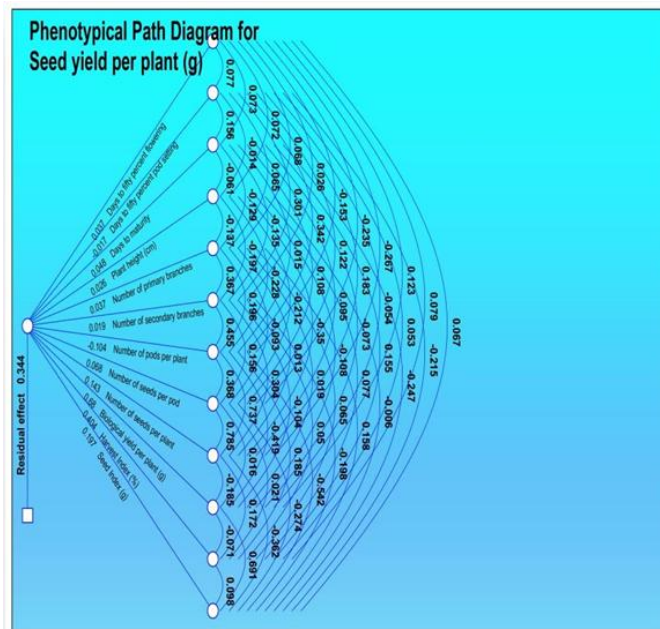


Fig. 1. Phenotypical path diagram

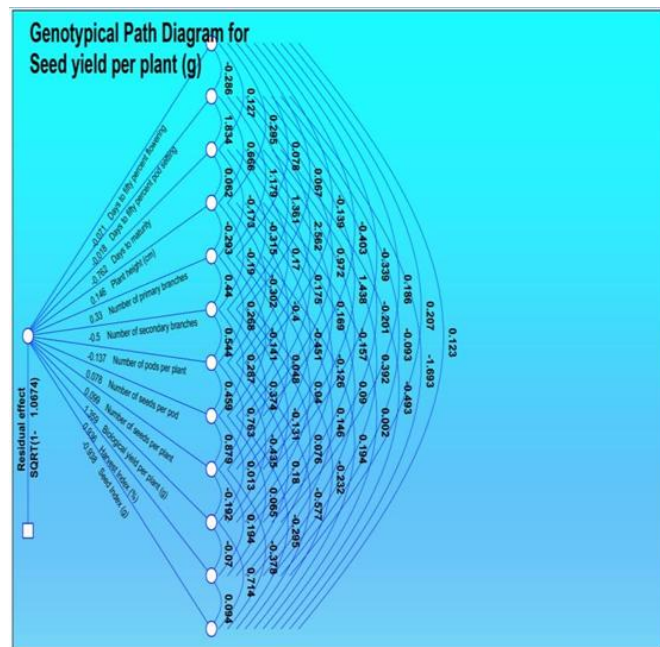


Fig. 2. Genotypical path diagram

#### 4. CONCLUSION

This study was conducted to estimate the genetic variability, heritability, and genetic advance for the yield attributing characters in chickpea. According to the analysis the concluded results has positive and direct effect and also positive and significant over biological yield, seed index, harvesting index at genotypic and phenotypic

level. Hence utmost importance should be given to these characters during selection for seed yield per plant.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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