GENETIC ANALYSIS FOR SEED YIELD AND ITS YIELD COMPONENTS IN CHICKPEA (Cicer arietinum L)

Abstract

Modern plant breeding and agricultural systems has narrowed base for the genetic variability of cultivated chickpea and explore to new sources of variation that might be used in plant breeding programmes. An investigation was undertaken to carried out to assess the genetic variability parameters, correlation and path analysis in 23 chickpea genotypes for 12 quantitative traits in Rabi, 2021-22 season at field experimentation center, Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Uttar Pradesh in Randomized Block Design in three replications. Analysis of variance indicated highly significant differences among the genotypes for all the traits. Considerable variability existed in the genotypes for all the characters studied. These were the genotypes with high mean values in the desirable direction i.e., From the present investigation it is concluded that among 23 genotypes of chickpea, PG – 06102 showed early flowering (66 days), 04 – 01 showed early pod setting (82 days). IPC-97-29 had characters like early maturity (112 days), WCK – 3 showed high plant height (69.7 cm), IPC - 98-12 showed high Number of seeds per plant (68), PG – 06102 is showing high Biomass (19.8 g), and PG – 05 shown high Seed Yield per Plant (12.7 g). Highest GCV were depicted Number of secondary branches, Number of seeds per plant. 100 seed weight (g). The highest Heritability was observed for Number of secondary branches followed by Number of primary branches, Number of seeds per plant, 100 seed weight (g). In the present investigation Seed Yield per Plant per plant showed positive and significant association with Number of Primary Branches, Number of Secondary Branches Number of seeds per plant, Number of pods per plant, biological yield per plant, 100 seed weight (g), Harvest Index (%). Positive direct effect on Seed Yield per Plant per Plant at both genotypic and phenotypic levels with Biomass, Harvest Index, Seed weight. This character should be given due consideration during selection for crop improvement.

Key words: Chick pea, Genetic variability, Path analysis, correlation

Introduction

The chick pea(Cicer arietinum) is an annual legume of the family Fabaceae, Chickpea seeds are high in protein. It is one of the earliest cultivated legumes, and 9,500-year-old remains have been found in the Middle East. Chickpeas are a nutrient-dense food, providing rich content (20% or higher of the Daily Value) of protein, dietary fiber, folate, and certain dietary minerals, such as iron and phosphorus in a 100-gram reference amount (see adjacent nutrition table). Thiamine, vitamin B_6, magnesium, and zinc contents are moderate, providing 10–16% of the daily value. Germination of chickpeas improves protein digestibility, although at a lower level than cooking. Germination degrades proteins to simple peptides, improving crude protein, nonprotein nitrogen, and crude fibre content.

Agricultural yield for chickpeas is often based on genetic and phenotypic variability, which has recently been influenced by artificial selection. The uptake of macronutrients such as inorganic phosphorus or nitrogen is vital to the plant development of Cicer arietinum, commonly known as the perennial chickpea. Heat cultivation and macronutrient coupling are two relatively unknown methods used to increase the yield and size of the chickpea. Recent research has indicated that a combination of heat treatment along with the two vital macronutrients, phosphorus and nitrogen, are the most critical components to increasing the overall yield of Cicer arietinum.

"Chickpea plant is cool season crop very sensitive to excess moisture, high humidity and cloudy weather, which adversely affect its yield through limited flower production and seed set (Kay, 1979). To formulate proficient breeding programme and for developing high-yielding varieties, it is essential to understand the genetics of the yield and related traits. Genetic parameters, viz PCV, GCV, Heritability, Genetic Advance helps the researchers in adopting the suitable breeding procedure to apply the selection for the improvement of deferent traits related to yield. The correlation studies between yield and contributing traits will be helpful in sorting out most associated contributing traits to yield". (Kusuma *et al.,* 2021).

Objectives

1. To assess variability for yield component characters and seed yield in chickpea
2. To estimate the nature and magnitude of inter relationship among yield component characters to aid in selection breeding programme
3. To study the direct and indirect effects of yield component characters on seed yield in chickpea

2. Materials and Methods

The genetic material for this study comprised of 23 diverse genotypes of Chickpea from different geographical origin were sown in the Randomized block design with 3 replications for entitled "Genetic Analysis for Seed Yield and its Yield Components in Chickpea (Cicer aretinum L.)".

The present investigation was carried out at the Field Experimentation Center of Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (Allahabad), U.P. during Rabi 2021-22. The university is situated on the left side of Allahabad Rewa National Highway, about 5km from Prayagraj city.

Prayagraj is located in South Eastern part of Uttar Pradesh state of India. The site of experiment is located at 25.57^0N latitude, 81.56^0N longitude and 98 meters above mean sea level. This region has subtropical climate with extreme of summer and winter. The temperature falls down to as low as 1°C-2°C during Rabi season especially in the month of December and January. The mercury rises up to 46°C - 48°C during Zaid. The average rainfall in this area is around 1013.4 mm annually with maximum concentration in Kharif during July to September with few showers and drizzles during winter also.

"The Panse and Sukhatme (1967) method were used to analyse the variance in all of the recorded data for the characters under under consideration. Additionally, the genetic parameters genotypic coefficient of variation (GCV), Phenotypic coefficient of varation (PCV), Heritability in the broad sense, Genetic advance as percent of mean and correlation

analysis was carried out by using the statistical methods. The additional components of variance include Phenotypic variance, Genotypic variance and Environmental Variance". **(Reddy *et al.*, 2023).**

The Software called R-Studio, OPSTAT and SPSS were used to perform the analysis mentioned above.

Experimental material

The experimental material for present study is obtained from the Department of Genetics and Plant Breeding, SHUATS, Prayagraj (Allahabad). The details of experimental material as shown in table 1.

Table 1. Experimental material.

S.no	Genotype	S.no	Genotype
1	JG-130	13	GOURI-K-49
2	RBG-203	14	PG-06102
3	PHULE-4-5	15	PG-05
4	IPC-97-29	16	04-01
5	ICC-4958	17	IPC-08-103
6	C-1027	18	IPC-12-100
7	C-207	19	ICC-11847
8	IPC-18-120	20	IPC-11-85
9	ICCC-37	21	ICC-11019
10	WCK-3	22	IPC-98-12
11	WBG-29	23	UDAY (Check)
12	C-1044		

3. RESULTS AND DISCUSSION

3.1 Analysis of variance

Analysis of variance indicated significant difference among the genotypes for all the traits. This indicates that there was an ample scope for selection of promising lines from the present gene pool for yield and its components traits. The presence of large amount variability might be due to diverse source of material taken as well as environmental influence affecting the phenotypes.

On the basic of mean performance, the highest Seed Yield per Plant per hill was observed for chickpea genotypes PG - 05 (12.7 gm), PG-06102 (12.2 g), IPC-98-12 (11.5 g), and IPC-11-85 (11.4 g). IPC-18-120 (6.1 g) were found to be superior in Seed Yield per Plant.

3.2 Phenotypic and Genotypic coefficient of variance

The present investigation, the PCV was higher than the corresponding GCV for all the traits indicating that there was an influence of the environment. GCV (%) values ranged between least of 3.51 (Days to 50% Flowering) to a highest value of 27.64 (Number of Secondary Branches). PCV (%) followed a similar pattern had a range of least of 1.92 (Days to 50% Flowering) to a highest value of 27.21 (Number of Secondary Branches).

3.3 Heritability

The present investigation, Number of Secondary Branches (96.87%) showed the highest heritability among all the characters followed by Number of primary branches (89.09%), Number of seeds per plant (86.67%), 100 seed weight (82.19 %), Number of pods per plant (77.48%), Biomass (72.92%), Plant height (72.81%) and Seed yield per plant (72.68%), Moderate heritability is seen in Harvest Index (40.99), Days to 50% flowering (29.87), Days to 50% pod setting (29.7) and Days to maturity (29.7). "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". (Reddy et al., 2023)

3.4 Genetic advance

In the present investigation all the characters showed highest genetic advance as a percentage of mean the highest genetic advance seen in Number of secondary branches (55.16%), Number of seeds per plant (41.92%), 100 seed weight (g) (40.5%), Seed yield per plant (g) (34.13%), Number of primary branches (31.81%), Biological yield per plant (31.61%), Number of pods per plant (29.11%) and low genetic advance of the character is in Days to 50% flowering (2.16 %), Days to maturity (2.67 %) and Days to 50% pod setting (4.08 %).

"All the characters under study showed high heritability coupled with high genetic advance as percent mean which indicates that the characters mostly governed by additive gene action" (Reddy *et al.,* 2023). 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 as shown in table 2 and 3.

Table 2. Analysis of variance among 23 chickpea genotypes of 12 quantitative traits.

Sl.No.	Source	Mean Sum of Squares (MSS)		
	Degrees of freedom	Replication	Treatment	Error
		2	22	44
1	Number of primary branches	0.0390	0.496**	0.019
2	Plant height (cm)	17.3650	78.639**	8.705
3	Days to 50% flowering	8.0620	9.204**	4.041
4	Days to 50% pod setting	16.5660	50.498*	22.27
5	Number of secondary branches	0.2960	9.603**	0.102
6	Days to maturity	38.9420	44.302*	19.538
7	Number of seeds per plant	29.1540	299.67**	14.612
8	Number of pods per plant	29.4130	167.354**	14.78
9	Biological yield per plant	5.9210	26.944**	2.968
10	100 seed weight (g)	9.3460	69.482**	4.681
11	Harvest Index (%)	26.920	41.606**	13.492
12	Seed yield per plant (g)	2.410	10.84**	1.207

Table 3. Genetic parameters of 12 quantitative traits in chickpea genotypes

Sl.No.	Characters	GCV	PCV	h2 (Broad Sense)	Genetic Advancement 5%	Gen.Adv as % of Mean 5%
1	Number of primary branches	16.363	17.336	89.085	0.775	31.814
2	Plant height (cm)	8.994	10.54	72.811	8.487	15.81
3	Days to 50% flowering	1.916	3.506	29.866	1.477	2.157
4	Days to 50% pod setting	3.633	6.666	29.701	3.444	4.079
5	Number of secondary branches	27.205	27.641	96.873	3.608	55.16
6	Days to maturity	2.38	4.366	29.701	3.226	2.672
7	Number of seeds per plant	21.856	23.476	86.671	18.694	41.916
8	Number of pods per plant	16.052	18.236	77.482	12.931	29.108
9	Biological yield per plant	17.97	21.044	72.919	4.973	31.611
10	100 seed weight (g)	21.686	23.92	82.19	8.68	40.499
11	Harvest Index (%)	5.296	8.273	40.988	4.037	6.985
12	Seed yield per plant (g)	19.432	22.793	72.682	3.147	34.127

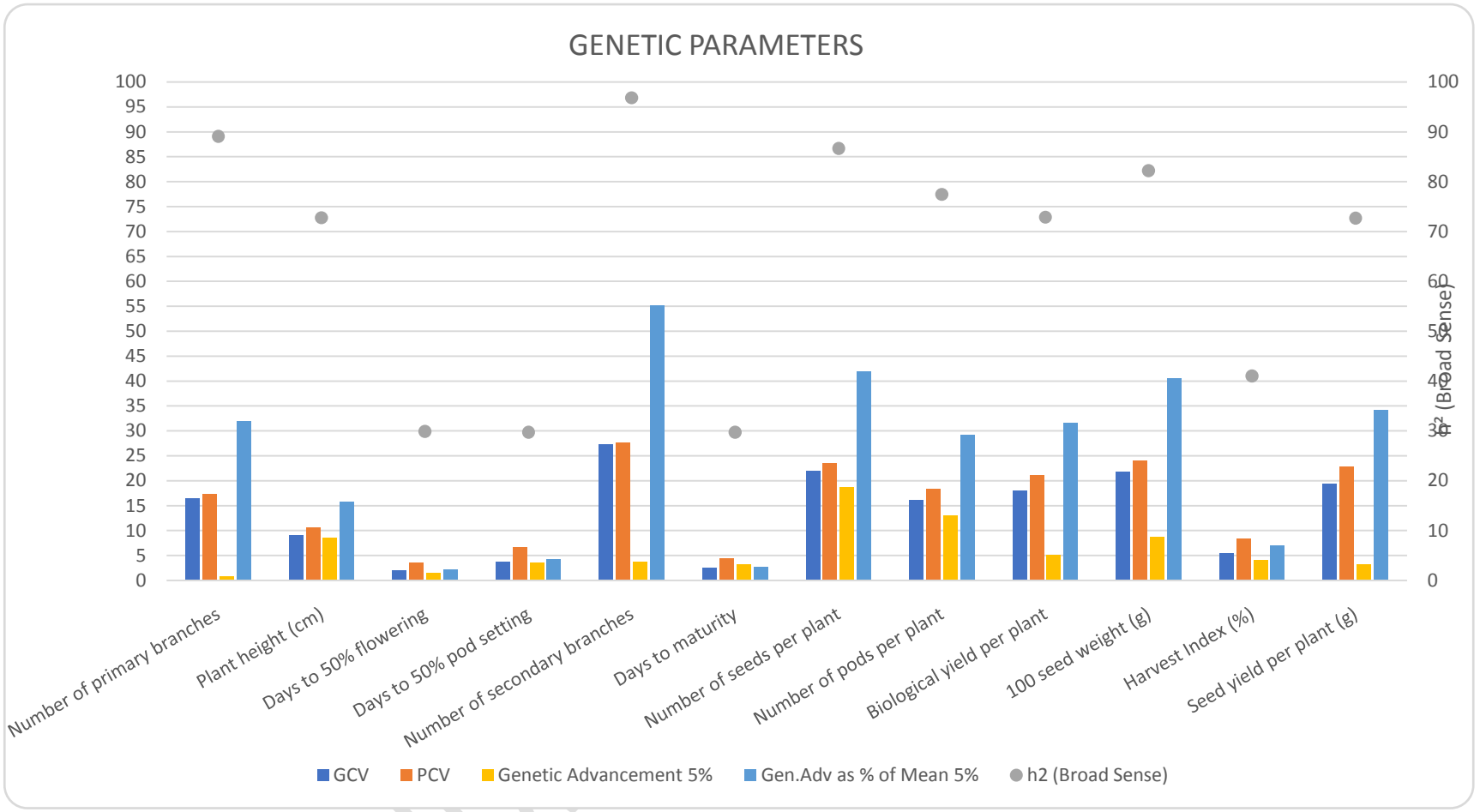

Fig 1. Bar diagram depicting GCV, PCV, Heritability and Genetic advance for 12 quantitative characters in chickpea.

Sl. No.	GENOTYPES	Number of primary branches	Plant height (cm)	Days to 50% flowering	Days to 50% pod setting	Number of secondary branches	Days to maturity	Number of seeds per plant	Number of pods per plant	Biological yield per plant	100 seed weight (g)	Harvest Index (%)	Seed yield per plant (g)
1	JG - 130	2.267	47.2	68.667	85	7.133	116.333	43	45.6	16.267	26.667	59.7	10
2	RBG - 203	3	52.533	69.333	83.333	6.667	126	38.267	47.733	19.4	30.667	52.867	10
3	PHULE-4-5	2.533	54.4	70	83.333	5.533	123	40.467	40.867	17.933	30	59.4	10.467
4	IPC-97-29	2.267	58.167	67.667	82.667	7.333	112	53.667	51.067	17.8	20	57.2	10.2
5	ICC-4958	2.267	52.367	67.667	84.333	4.333	116.667	28.667	34.2	11.6	24	57.133	6.8
6	C - 1027	2.133	49.9	70.333	83.667	4.333	123.333	41.867	39.933	12.533	17.333	56.833	7.2
7	C - 207	3.067	48	69.333	84	5.333	121.333	43.6	44.6	12.067	18.333	58.767	7.333
8	IPC - 18-120	2.333	48.6	68.667	83.667	4.333	115.667	40.2	36.2	10.8	16.333	55.867	6.133
9	ICCC - 37	2.4	56.733	66.667	82.667	7.467	117.333	37.267	46.267	18.133	26	50.967	9.267
10	WCK - 3	1.467	69.667	66.333	83	6.933	120.333	32	36.533	11.8	20	52.233	6.267
11	WBG - 29	2.267	59.3	68	84.333	5.2	122.333	34.2	41.8	15.533	25.667	54.7	8.467
12	C - 1044	2.067	51.633	67	83.667	5.667	124.333	63.667	41.467	14.2	13.667	61.333	8.8
13	GOURI -K-49	2.2	53.5	66	83	6.2	124.333	51.933	38.2	16	19.667	58.033	9.467
14	PG - 06102	2.6	51.833	65.667	84.667	9.533	122.667	48.867	56.533	19.8	24.667	60.033	12.2
15	PG - 05	2.933	49.967	69	84	7.933	119.667	40.6	44.933	19.6	27.333	64.1	12.667
16	04--01	2.533	53.733	68.667	82.333	5.467	119	36.533	42.667	13.133	20.333	56.633	7.533
17	IPC - 08-103	2.133	50.933	68.333	83.333	5.067	118.667	44	33.933	13.667	18.333	55.333	8.067
18	IPC - 12-100	1.933	59.033	71	83	4.867	124.333	50.467	55.6	12.267	14.667	57.367	7.2
19	ICC - 11847	2.4	55.933	68.667	83	7	123.667	54.133	53.333	16.667	16.667	60.467	10.2
20	IPC - 98-12	3.333	49.867	67.667	84	10.867	120.333	67.6	56.6	16.467	17.333	68.067	11.467
21	IPC - 11-85	2.6	60.367	68.333	84	9.333	115.667	56.8	53.2	19.333	21.667	58.6	11.4
22	ICC - 11019	2.733	50.267	68	84	8.467	122.667	44.933	48.067	17.267	24.667	57.667	10.133
23	Uday (Check)	2.533	50.753	73.667	103	5.45	127.333	33.067	32.47	19.567	18.933	56.103	10.833
Mean		2.43	53.68	68.46	84.43	6.54	120.74	44.6	44.43	15.73	21.43	57.8	9.22
CV		5.73	5.5	2.94	5.59	4.89	3.66	8.57	8.65	10.95	10.09	6.35	11.91
SEm		0.08	1.7	1.16	2.72	0.18	2.55	2.21	2.22	0.99	1.25	2.12	0.63
CD at 5%		0.23	4.85	3.31	7.77	0.53	7.27	6.29	6.33	2.83	3.56	6.04	1.81
CD at 1%		0.31	6.49	4.42	10.37	0.7	9.72	8.4	8.45	3.79	4.76	8.07	2.42

Table 4. Mean performances of different characters to the different genotypes of chick pea

Traits		NPB	PH	DF50	DPS50	NSB	DM	NSP	NPP	BYP	SW100	HI	SYPP
NPB	P	1.0000	-0.483**	0.1030	0.0513	0.469**	0.0639	0.469**	0.407**	0.466**	0.289*	0.362*	0.511**
	G	1.0000	-0.601**	0.2042	0.1303	0.481**	0.0750	0.481**	0.390**	0.481**	0.329*	0.629**	0.606**
PH	P		1.0000	-0.1884	-0.1241	0.0586	-0.1170	0.0586	0.0377	-0.0342	0.0034	-0.327*	-0.1580
	G		1.0000	-0.398**	-0.285*	0.0895	-0.0771	0.0895	0.1294	-0.0511	-0.0353	-0.528**	-0.2033
DF50	P			1.0000	0.408**	-0.278*	0.2122	-0.278*	-0.1005	0.0659	-0.1099	-0.1091	-0.0502
	G			1.0000	0.825**	-0.572**	0.647**	-0.572**	-0.303*	-0.0630	-0.1524	0.1423	-0.0285
DPS50	P				1.0000	-0.0705	0.257*	-0.0705	-0.241*	0.1914	-0.0980	0.0174	0.1674
	G				1.0000	-0.1469	0.560**	-0.1469	-0.463**	0.413**	-0.0529	-0.1130	0.290*
NSB	P					1.0000	-0.1014	0.782**	0.662**	0.608**	0.2132	0.351*	0.708**
	G					1.0000	-0.2280	0.782**	0.715**	0.662**	0.2342	0.574**	0.776**
DM	P						1.0000	-0.1014	0.0015	0.1740	-0.0434	0.1193	0.0875
	G						1.0000	-0.2280	-0.1248	0.0841	-0.0853	-0.0891	0.0965
NSP	P							1.0000	0.662**	0.608**	0.2132	0.351*	0.708**
	G							1.0000	0.715**	0.662**	0.2342	0.574**	0.776**
NPP	P								1.0000	0.443**	0.0302	0.326*	0.462**
	G								1.0000	0.387*	0.0330	0.523**	0.541**
BYP	P									1.0000	0.473**	0.0871	0.803**
	G									1.0000	0.609**	0.291*	0.786**
SW100	P										1.0000	-0.0982	0.356*
	G										1.0000	-0.255*	0.449**
HI	P											1.0000	0.319*
	G											1.0000	0.732**
SYPP	P												1.0000
	G												1.0000

Table 5. Correlation coefficient analysis for 12 quantitative characters in chickpea

NPB: Number of primary branches, PH: Plant height (cm), DF50: Days to 50% flowering, DPS50: Days to 50% pod setting, NSB: Number of secondary branches, DM: Days to maturity, NSP: Number of seeds per plant, NPP: Number of pods per plant, BYP: Biological yield per plant, SW100 seed weight (g), HI: Harvest Index (%), SYPP: Seed yield per plant (g)

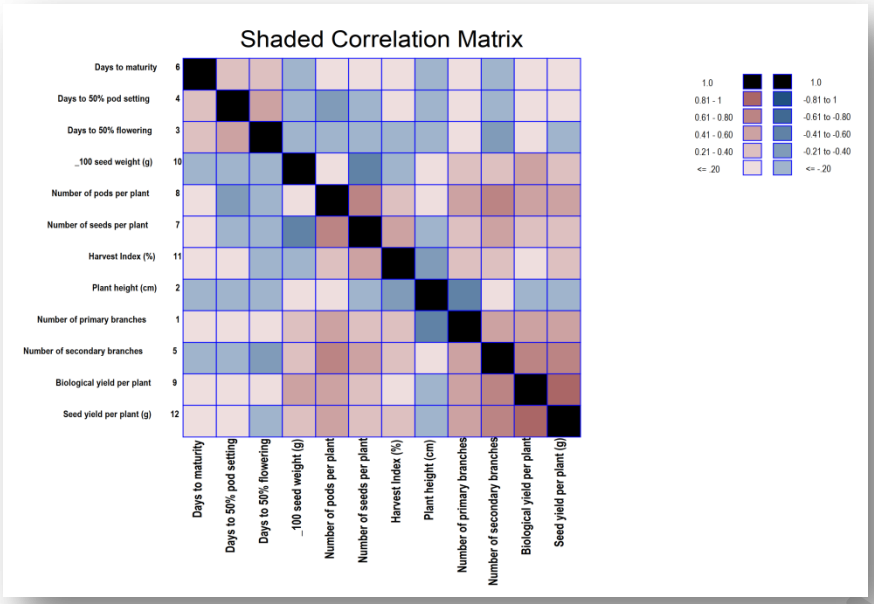

Fig 2. Phenotypical correlation matrix

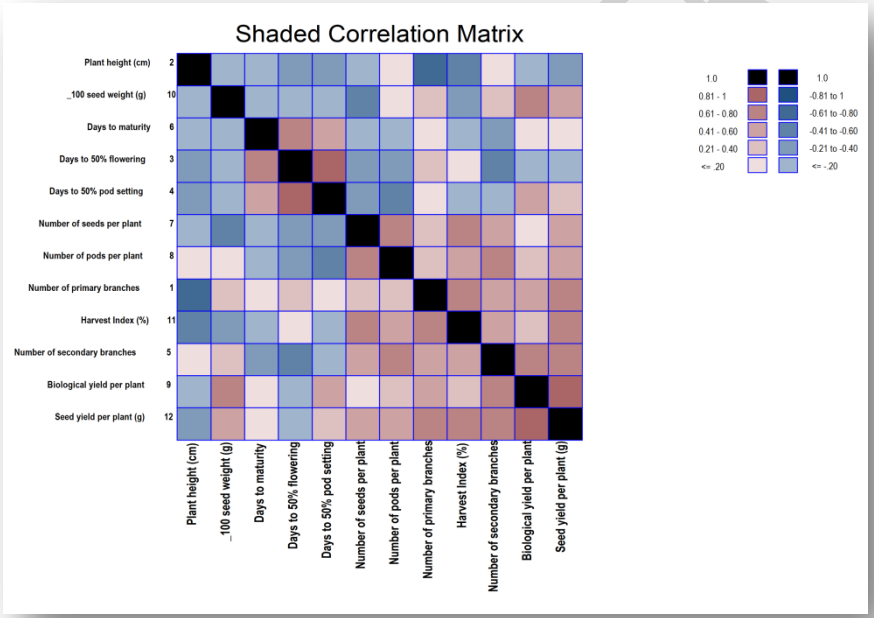

Fig 3. Genotypical correlation matrix

Table 6. Path coefficient analysis for 12 quantitative characters in chickpea

Traits		NPB	PH	DF50	DPS50	NSB	DM	NSP	NPP	BYP	SW100	HI	SYPP
NPB	P	-0.0167	0.0080	-0.0017	-0.0009	-0.0078	-0.0011	-0.0078	-0.0068	-0.0078	-0.0048	-0.0060	0.511**
	G	-0.1315	0.0789	-0.0268	-0.0171	-0.0632	-0.0099	-0.0632	-0.0513	-0.0632	-0.0432	-0.0826	0.606**
PH	P	0.0583	-0.1207	0.0227	0.0150	-0.0071	0.0141	-0.0071	-0.0046	0.0041	-0.0004	0.0395	-0.1580
	G	-0.1674	0.2788	-0.1108	-0.0793	0.0250	-0.0215	0.0250	0.0361	-0.0142	-0.0098	-0.1472	-0.2033
DF50	P	-0.0030	0.0054	-0.0289	-0.0118	0.0080	-0.0061	0.0080	0.0029	-0.0019	0.0032	0.0032	-0.0502
	G	0.0073	-0.0142	0.0358	0.0375	-0.0205	0.0231	-0.0205	-0.0108	-0.0023	-0.0055	0.0051	-0.0285
DPS50	P	0.0038	-0.0092	0.0304	0.0745	-0.0053	0.0192	-0.0053	-0.0179	0.0143	-0.0073	0.0013	0.1674
	G	-0.0471	0.1029	-0.3788	-0.3616	0.0531	-0.2024	0.0531	0.1674	-0.1494	0.0191	0.0409	0.290*
NSB	P	0.1564	0.0195	-0.0929	-0.0235	0.3336	-0.0338	0.3336	0.2208	0.2029	0.0711	0.1171	0.708**
	G	-0.1718	-0.0320	0.2044	0.0525	-0.3574	0.0815	-0.3574	-0.2555	-0.2365	-0.0837	-0.2052	0.776**
DM	P	-0.0013	0.0024	-0.0043	-0.0053	0.0021	-0.0205	0.0021	0.0000	-0.0036	0.0009	-0.0024	0.0875
	G	0.0126	-0.0129	0.1084	0.0938	-0.0382	0.1676	-0.0382	-0.0209	0.0141	-0.0143	-0.0149	0.0965
NSP	P	-0.026	0.0161	0.0264	0.0268	-0.061	-0.043	-0.1147	-0.0713	-0.0253	0.0532	-0.0766	0.708**
	G	0.0055	0.082	-0.35	0.1213	-0.163	-0.192	-0.3664	-0.164	-0.0803	0.2245	-0.3649	0.776**
NPP	P	-0.0140	-0.0013	0.0035	0.0083	-0.0228	-0.0001	-0.0228	-0.0345	-0.0153	-0.0010	-0.0112	0.462**
	G	-0.1219	-0.0405	0.0948	0.1448	-0.2235	0.0390	-0.2235	-0.3127	-0.1210	-0.0103	-0.1634	0.541**
BYP	P	0.2721	-0.0200	0.0385	0.1118	0.3553	0.1016	0.3553	0.2587	0.5843	0.2763	0.0509	0.803**
	G	0.6154	-0.0654	-0.0806	0.5288	0.8472	0.1076	0.8472	0.4952	1.2801	0.7796	0.3726	0.786**
SW100	P	0.0090	0.0001	-0.0034	-0.0030	0.0066	-0.0013	0.0066	0.0009	0.0147	0.0311	-0.0031	0.356*
	G	0.0185	-0.0020	-0.0086	-0.0030	0.0132	-0.0048	0.0132	0.0019	0.0343	0.0563	-0.0144	0.449**
HI	P	0.0467	-0.0423	-0.0141	0.0022	0.0454	0.0154	0.0454	0.0421	0.0113	-0.0127	0.1293	0.319*
	G	0.5915	-0.4969	0.1339	-0.1064	0.5403	-0.0838	0.5403	0.4919	0.2739	-0.2397	0.9411	0.732**

NPB: Number of primary branches, PH: Plant height (cm), DF50: Days to 50% flowering, DPS50: Days to 50% pod setting, NSB: Number of secondary branches, DM: Days to maturity, NSP: Number of seeds per plant, NPP: Number of pods per plant, BYP: Biological yield per plant, SW100 seed weight (g), HI: Harvest Index (%), SYPP: Seed yield per plant (g)

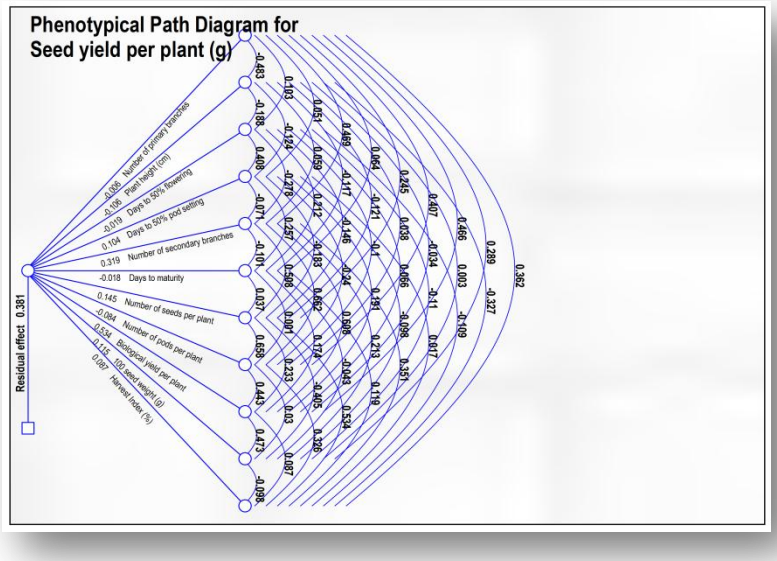

Fig 4. Phenotypical path diagram

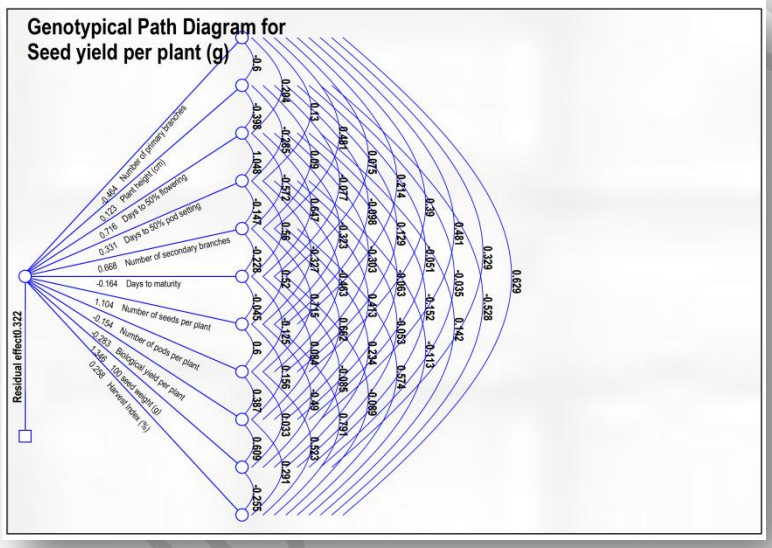

Fig 5. Genotypical path diagram

3.5 Correlation coefficient 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, significant positive correlations were observed for Number of Primary Branches, Number of Secondary Branches Number of seeds per plant, Number of pods per plant, biological yield per plant, 100 seed weight (g), Harvest Index (%).

3.5 Path coefficient analysis

The results of the path coefficient analysis revealed that both phenotypic and genotypic levels, had positive direct effects on Seed Yield per Plant while compare with Parameters like Biomass, Harvest Index, Seed weight.Selection of plants on these traits would certainly lead to improvement in Seed Yield per Plant

4. Conclusion

Considerable variability existed in the genotypes for all the characters studied. These were the genotypes with high mean values in desirable direction i.e., From the present investigation it is concluded that among 23 genotypes of chickpea, PG – 06102 showed early flowering (66 days), 04-01 showed pod setting (82 days). IPC-97-29 had characters like early maturity (112 days), WCK – 3 showed high plant height (69.7 cm), IPC - 98-12 showed high Number of seeds per plant (68), PG – 06102 is showing high Biomass (19.8 g), and PG – 05 shown high Seed Yield per Plant (12.7 g). Highest GCV were depicted Number of secondary branches, Number of seeds per plant. 100 seed weight (g). The highest Heritability was observed for Number of secondary branches followed by Number of primary branches, Number of seeds per plant, 100 seed weight (g). In the present investigation Seed Yield per Plant per plant showed positive and significant association with Number of Primary Branches, Number of Secondary Branches Number of seeds per plant, Number of pods per plant, biological yield per plant, 100 seed weight (g), Harvest Index (%). Positive direct effect on Seed Yield per Plant per Plant at both genotypic and phenotypic levels with Biomass, Harvest Index, Seed weight. This character should be given due consideration during selection for crop improvement.

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