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Correlation and Path Coefficient Studies among Yield and Yield Contributing Traits in Chickpea (*Cicer arietinum* L.)

Sardar Sunil Singh[1]; Birender Singh[2*]; S.B. Mishra[3]; Amarendra Kumar[4]

[1]Department of Plant Breeding and Genetics, Mandan Bharti Agriculture College, Agwanpur, Saharsa
[2]Department of Plant Breeding and Genetics, Bihar Agricultural University, Sabour, Bhagalpur
[3]Department of Plant Breeding, Tirhut College of Agriculture, Muzaffarpur
[4]Department of Plant Pathology, Bihar Agricultural University, Sabour, Bhagalpur
***Corresponding Author**: Birender Singh (Email: bsinghphd@gmail.com)

ABSTRACT: The experiment with forty one genotypes was conducted during Rabi 2005-06 and 2006-07 in RBD with three replications at three different agro-climatic locations of Bihar. The analysis of variance revealed considerable variability among the treatments for ten characters namely days to 50 % flowering, plant height number of secondary branches, number of pods per plant, 100-seed weight, score of wilt infestation, pod borer infestation per cent, total protein, soluble protein and grain yield while number of primary branches and insoluble protein have shown significant difference among genotypes only in E_3, E_6 and E_2, E_6 respectively, it reflected the presence of significant variability in the base material. IPC 2003-55 exhibited the highest mean grain yield (1438 kg/ha) across the six location along with the high protein per cent and least infestation of wilt having the plant height (45.6 cm), followed by SAKI 9516 (1384 kg/ha), also exhibited resistance against wilt infestation, DCP 92-3 (1271 kg/ha), with highest protein percentage (20.5%) and moderately resistant to wilt, IPC 2003-45, (1224 kg/ha) and IPC 2003-57 (1169 kg/ha). The magnitude of genotypic correlations were greater than phenotypic correlations in each and every environment, suggesting the significant phenotypic association between characters were primarily due to genetic causes, which might be due to apheliotropic effect rather than linkage between genes effecting different character. Grain yield kg/ha was found to be associated significantly and positively with number of primary branches per plant and number of pods per plant across the six environments along with its high positive direct effect on grain yield of both the character as well as positive indirect effect via wilt infestation and total protein. Suggesting that the true relationship of these characters with grain yield and selection based on these traits might lead to the increase of grain yield.

Keywords: Correlation, path coefficient, yield, chickpea, *Cicer arietinum* L

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INTRODUCTION

Chickpea (*Cicer arietinum* L.) is one of the earliest grain crops cultivated by man. Even today, Chickpea continues to play an important role in agricultural system, ranking third after dry beans (*Phaseolus species*) and field pea (*Pissum sativum* L.) in terms of world pulses production. It is a low input requiring crop, and fulfil over 70 per cent of its nitrogen requirements through symbiotic nitrogen fixation. Being a legume, it is particularly important to the farmers as rotation or second crop after cereals, often maturing in the driest and hottest part of the year. Chickpea seed is a protein rich supplement to the cereal based diet, especially critical to the poor in the developing countries, where people can't afford animal protein or are vegetarians. It has importance in human food and animal feed, chickpea also plays an important role in sustaining soil fertility by fixing up to 141 kg nitrogen per hectare (Rupela, 1987). The principal objectives of chickpea breeding programme are improvement in yield, quality, stability and adaptation over a wide array of environments. All morphological and physiological properties that influence the yield are controlled by a complex genetic mechanism, which by nature can only be a complex multiplicative group of genes. The inherent yielding ability of chickpea may be expressed mainly through four components: number of primary branches, number of secondary branches and number of pods per plant and 100-seed weight.

MATERIALS AND METHODS

The present investigations were carried out with forty one genotypes in RBD design with three replications at three different locations during Rabi 2005-06 and Rabi 2006-07. Spacing was maintained at 30 cm between rows and 10 cm between plants within a row. The plot size of an entry within a replication for the experiment was 6 m^2. The experimental materials for the present investigation comprised of 41 different genotypes of chickpea (*Cicer arietinum* L.) are presented in (Table 1). These genotypes exhibited wide range of variation with respect to height,

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days to 50% flowering, number of primary branches, number of secondary branches, number of pod per plant, number of seed per pod and 100 seed weight. The experiment s were carried at three different locations of Bihar and all locations were considered individual environment i.e. E1: RAU, Pusa, E2: TCA, Dholi and E3: Gaya KVK Farmer's field. Good agricultural practices were followed to raise the crops. Data were recorded on thirteen characters namely days to 50% flowering, plant height (cm), number of primary branches, number of secondary branches, number of pod per plant, number of grain per pod, 100-seed weight (g), per cent infestation of pod borer, Score of wilt infestation, total protein (%), soluble protein (%) insoluble protein (%) and grain yield (Kg/ha).

Table 1 : List of genotypes, pedigree and source of the experimental materials

Sl. No.	Genotype	Pedigree	Source
1.	IPC 2000-33	L 412 x KPT 1	IIPR Kanpur
2.	IPC 2001-02	ICCV 10 x PDG 84-16	IIPR Kanpur
3.	ICP 2001-21	Selection from 84396	IIPR Kanpur
4.	IPC 2002-26	NARC 9004 x C 235	IIPR Kanpur
5.	IPC 2002-35	PG 5 x IPC 92-39	IIPR Kanpur
6.	IPC 2002-51	DCP 95-3 x KTP 1	IIPR Kanpur
7.	IPC 2002-71	Phule G 5 x H 82-2	IIPR Kanpur
8.	IPC 2002-75	Phule G 5 x H 82-80	IIPR Kanpur
9.	IPC 2003-06	ICCV 10 x JG-315	IIPR Kanpur
10.	IPC 2003-07	DCP 92-3 x BG 256	IIPR Kanpur
11.	IPC 2003-10	NARC 9004 x C 235	IIPR Kanpur
12.	IPC 2003-27	L 411 x BG 256	IIPR Kanpur

13.	IPC 2003-31	ICC x 490220	IIPR Kanpur
14.	IPC 2003-35	IXCC x 94049	IIPR Kanpur
15.	IPC 2003-37	Phule G 5 X IPC 92-39	IIPR Kanpur
16.	IPC 2003-45	PG 5 x IPC 92-1	IIPR Kanpur
17.	IPC 2003-46	BG 364 x PDG 84-16	IIPR Kanpur
18.	IPC 2003-51	IPC 71 x ICCV 10	IIPR Kanpur
19.	IPC 2003-52	DCP 92-1 x KPT 1	IIPR Kanpur
20.	IPC 2003-54	PG 5 x H 82-2	IIPR Kanpur
21.	IPC 2003-55	ICCV2 x ICC 202	IIPR Kanpur
22.	IPC 2003-56	PG 5 x L 144	IIPR Kanpur
23.	IPC 2003-57	(ICC 4958 x ICC 11322) x ICCV 10	IIPR Kanpur
24.	IPC 2003-60	(IPC 6 x ICCV 10) x ICC 4958	IIPR Kanpur
25.	IPC 2003-66	ICC 4958 x BG-364	IIPR Kanpur
26.	IPC 2003-68	IPC 94-37 x KWR 108	IIPR Kanpur
27.	IPC 2003-69	PG 5 x KWR 108	IIPR Kanpur
28.	IPC 2003-71	KPG 59 x KPT 1	IIPR Kanpur
29.	ICP 2004-63	NARC 9008 x C 235	IIPR Kanpur
30.	ICP 2004-64	PG 5 x ICC 4958	IIPR Kanpur
31.	SAKI-9516	ICCC 42 x ICCV 10	Jabbalpur (MP)
32.	DCP-92-3	Selection from germplasm	IIPR Kanpur
33.	ICCV-10	P 1231 x P 1265	ICRISAT
34.	BG-2019	Pusa 362 x (Avrodhi X Pusa 212)	IARI New Delhi
35.	BG 2032	(BG 361 x ICC 14309) X ICCV 89230	IARI New Delhi
36.	BG-2024	(BG 261 x ICC 88503) x (GL 920 x BG 1003)	IIPR Kanpur

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37.	IPC 2003-11	IPC 9511 X PDG 84-16	IIPR Kanpur
38.	IPC 99-18-6	Selection from ICCV 940253	IIPR Kanpur
39.	BG 256	(BG 62 x K 850-3/127) x (L 280 x H 75-35)	IARI New Delhi
40.	BG 362	(Pusa 303 x P 179) x Pusa 303	IARI New Delhi
41.	BG 372	P 1231 x P 1265	IARI New Delhi

RESULTS AND DISCUSSION

The analysis of variance revealed considerable variability among the treatments for ten characters namely, days to 50% flowering, plant height, number of secondary branches, number of pods per plant, 100-seed weight, score of wilt infestation, pod borer infestation per cent, total protein per cent, soluble protein, and grain yield, while number of primary branches and insoluble protein have shown the significant difference among the genotypes only in E_3, E_6 and E_2, E_6 respectively. It reflected the presence of wide range of variability in the base material (Table 2). All possible phenotypic correlation for genotypes were worked out for all the character under study in six environments. Though, the significance of genotypic correlation could not be tested as no suitable statistical test is available (Nasr *et al*. 1973), yet there magnitude is considered in relation to the corresponding phenotypic estimates (Table 3).

The magnitude of genotypic correlation was greater than phenotypic correlation in each and every environment. Hence, the significant phenotypic association between characters were primarily due to genetic causes, which might be due to pleiotropic effect rather than linkage between genes affecting different characters. The self pollinated mechanism is a pre Lade to the fixation of blocks of genes as well as due to limited chances for breaking linkage compare with the random mating system, prevailing cross pollinated crops. Such reports have been made by Johnson *et al*. (1955). In present investigation the number of primary branches and number of pods per plant exhibited positive and significant correlation with grain yield in all the six environments. Similar association were also reported by Singh *et al*. (2002), Ciffci *et al*. (2004), Jeena *et al*. (2005), Sharma *et al*. (2005), Khan *et al*. (2006) and Singh (2007). The total protein percentage revealed significant and positive correlation with grain yield only in E_6 environment, this finding is similar to the Kumar and Krishna (2000). Insoluble protein exhibited

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significant and high values positive correlation with grain yield in E_1, E_2, E_3 and E_5. The high magnitude of genotypic correlation expected might be due to the pleiotropic gene effect. Score of wilt infestation revealed negative and significant correlation with grain yield in all the six environments. Days to 50 % flowering revealed significant and positive correlation with plant height (E_1, E_4); pod borer infestation (E_1, E_2, E_4, E_5) and insoluble protein (E_1, E_4), where as negative and significant correlation with insoluble protein in (E_3, E_5). Plant height exhibited positive and significant correlation to the number of primary branches per plant (E_2, E_3, E_5 and E_6), number of secondary branches and Soluble protein (E_6), insoluble protein (E_1, E_2), while negative and significant. Number of primary branches had shown positive and significant correlation with number of secondary branches in all the environments with 100-seed weight (E_1, E_4), pod borer infestation (E_1, E_2), where as negative and significant correlation was observed with insoluble protein (E_3, E_5). From perusal of the table it is evident that the number of secondary branches exhibited positive and significant correlation with number of pod per plant and pod borer infestation (E_2, E_5), and score of wilt infestation (E_3).

Number of pods per plant revealed positive and significant correlation with pod borer infestation in all the six environments, score of wilt infestation (E_3), total protein (E_2), soluble protein (E_2, E_6). This character also exhibited negative and significant correlation with insoluble protein (E_2, E_5). 100-seed weight exhibited negative and significant correlation with soluble protein (E_6) and with insoluble protein (E_2, E_5). Pod borer infestation revealed positive and significant correlation with insoluble protein (E_1), while negative and significant correlation with soluble protein (E_6) and to the insoluble protein (E_2, E_3, E_5 and E_6). Score of wilt infestation exhibited positive and significant correlation with total protein (E_6) and with insoluble protein (E_2, E_3 and E_5), while negative and significant correlation to insoluble protein (E_1). Total protein exhibited positive and significant correlation with soluble protein (E_5 E_6), where as negative and significant correlation with insoluble protein (E_2). Soluble protein exhibited positive and significant correlation with insoluble protein (E_3 E_6) and with grain yield (E_2, E_5) where as significant and negative correlation observed with insoluble protein (E_2) (Table 4).

Genotypic path analysis being free from environmental effect can give a better picture of cause and effect relationship than phenotypic path analysis. A perusal of the table (Table 5) revealed that number of primary branches per plant exhibited high positive direct effect on grain yield (E_3, E_4, F_5 and E_6) as well as positive indirect effect via wilt infestation and total protein (E_1), days to 50% flowering, number of secondary branches, number of pods per plant, wilt infestation score, soluble and insoluble protein (E_2) days to 50 % flowering, number of pods per plant,

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total and insoluble protein (E_2), soluble protein (E_4), insoluble protein (E_5) and with total protein (E_6), while high negative direct effect with grain yield was observed (E_1, E_2). From the table it is evident that number of pods per plant had high positive direct effect with grain yield in all six environment and positive indirect effect via wilt infestation score and insoluble protein (E_1), number of secondary branches and soluble protein (E_2), days to 50 % flowering (E_3), total protein (E_4), insoluble protein (E_5) and with soluble protein (E_6). The present finding are also in agreement with Singh *et al*. (2001), Singh *et al*. (2002). Suggesting that the true relationship of these character with grain yield and selection based on these traits might lead to the increase of grain yield (Table 5). The magnitude of genotypic correlations were greater than phenotypic correlations in each and every environment, suggesting the significant phenotypic association between characters were primarily due to genetic causes, which might be due to peliotropic effect rather than linkage between genes effecting different character. Grain yield kg/ha was found to be associated significantly and positively with number of primary branches per plant and number of pods per plant across the six environments along with its high positive direct effect on grain yield of both the character as well as positive indirect effect via wilt infestation and total protein. Suggesting that the true relationship of these characters with grain yield and selection based on these traits might lead to the increase of grain yield. IPC 2003-55 exhibited the highest mean grain yield (1438 kg/ha) across the six location along with the high protein per cent and least infestation of wilt having the plant height (45.6 cm), followed by SAKI 9516 (1384 kg/ha) also exhibited resistance against wilt infestation, DCP 92-3 (1271 kg/ha) with highest protein percentage (20.5%) and moderately resistant to wilt, IPC 2003-45, (1224 kg/ha) and IPC 2003-57 (1169 kg/ha). Suggesting that these genotypes may be utilized directly is commercial cultivation as well as may be used in chickpea crop improvement programme.

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Table 2: Analysis of variance for thirteen characters of chickpea in each environment

Sl. No.	Characters	Source of variation	Mean sum of square							
			d.f.	E_1	E_2	E_3	E_4	E_5	E_6	Pooled
1.	Days to 50% flowering	G	40	71.819**	71.575**	71.098**	72.025**	71.059**	69.198**	71.129**
		E	80	1.750	1.404	1.338	1.330	1.314	1.342	1.413
2.	Plant height (cm)	G	40	139.941**	81.369**	67.915**	140.88**	80.160**	66.037**	55.950**
		E	80	1.880	3.064	2.229	1.788	4.199	2.391	2.591
3.	No. of Primary branches	G	40	1.247	0.863	4.065**	1.213	0.796	4.051**	2.042**
		E	80	0.205	0.205	0.115	0.185	0.189	0.118	0.286
4.	No. of Secondary branches	G	40	38.398**	24.461**	175.663**	40.033**	23.947**	129.957**	71.243*
		E	80	20.454	1.423	0.716	1.683	1.370	15.569	6.869
5.	No. of pods per plant	G	40	743.120**	368.976**	1059.491**	755.638**	368.735**	1076.725**	464.022**
		E	80	5.650	11.301	3.604	5.317	11.166	3.574	6.768
6.	No. of grain per pod	G	40	0.212	0.212	0.212	0.207	0.181	0.182	0.201
		E	80	0.273	0.273	0.273	0.270	0.289	0.275	0.275
7.	100 seed weight (g)	G	40	42.801**	42.743**	42.302**	42.427**	44.47**	30.681**	40.904*
		E	80	0.115	0.178	9.815	8.744	0.321	6.231	1.217
8.	Pod bore infestation (%)	G	40	49.390**	16.947**	30.797**	51.738**	158.478**	31.192**	48.49**
		E	80	3.491	2.001	2.260	3.224	1.77	2.230	4.675
9.	Score of wilt infestation	G	40	4.537**	4.842**	4.932**	4.180**	4.095**	5.320**	4.651*
		E	80	0.273	0.483	0.360	0.311	0.333	0.314	0.346
10.	Total protein (%)	G	40	3.369**	3.074**	3.186**	3.317**	3.186**	3.120**	3.202**
		E	80	5.787	2.501	5.519	5.141	2.63	4.107	1.277
11.	Soluble protein (%)	G	40	3.490**	3.411**	2.878**	3.424**	3.392**	6.250**	28.80*
		E	80	0.253	0.323	0.265	0.236	0.208	0.506	16.058
12.	Insoluble protein (%)	G	40	0.148	9.887**	0.198	0.539	0.219	1.574**	2.077**
		E	80	-0.146	0.919	0.152	0.185	0.123	0.250	0.31
13	Yield (kg/ha)	G	40	153307.62**	162444.71**	144352.8**	155737.88*	157689.39**	154463.56**	15466.06*

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		E	80	960.575	1119.83	462.341	410.885	347.397	104.741	567.628

* Significant at P = 0.05
** Significant at P = 0.01

Table 3: Pooled mean performance of 41 genotypes for twelve quantitative traits

Sl. No.	Genotypes	Days to 50% flowering	Plant height (cm)	No. of primary branches	No. of secondary branches	No. of pods per plant	100 seed weight (cm)	Pod borer infestation	Score of wilt infestation	Total protein (%)	Soluble protein (%)	Insoluble protein (%)	Yield (kg/ha)
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	IPC 2000-33	80.39	43.97	5.60	19.39	47.93	25.56	15.23	4.11	17.42	14.80	2.42	724.22
2	IPC 2001-02	80.56	59.00	5.58	19.77	44.08	21.81	9.96	3.72	17.41	14.88	2.61	558.83
3	ICP 2001-21	82.56	54.42	5.59	17.55	39.22	22.71	9.52	3.37	18.32	15.42	2.44	880.17
4	IPC 2002-26	83.50	60.25	4.53	19.25	49.88	19.51	11.88	3.83	19.41	16.47	2.72	693.28
5	IPC 2002-35	81.89	55.23	5.35	21.59	57.01	21.19	15.23	3.94	18.32	15.81	2.58	714.44
6	IPC 2002-51	76.00	56.70	6.19	23.32	54.72	20.96	9.51	3.94	18.54	15.65	2.67	587.28
7	IPC 2002-71	82.17	55.65	5.22	25.55	57.15	21.61	13.03	4.22	17.74	15.26	2.41	728.94
8	IPC 2002-75	82.56	58.61	5.41	16.93	44.37	20.83	9.51	3.72	19.46	24.13	2.46	862.67
9	IPC 2003-06	73.75	51.34	5.09	19.58	41.94	19.51	9.25	4.28	18.51	16.19	2.50	667.22
10	IPC 2003-07	74.67	48.21	4.34	16.95	33.68	23.42	7.70	3.72	19.39	16.45	2.50	763.78
11	IPC 2003-10	76.17	50.78	4.48	13.66	45.70	23.11	8.81	2.11	17.41	15.08	2.78	1068.61
12	IPC 2003-27	75.22	55.66	4.33	20.87	41.27	17.09	7.88	2.56	19.46	16.42	2.50	1019.11
13	IPC 2003-31	79.83	54.16	4.26	17.25	45.81	19.39	9.11	6.17	19.42	16.28	2.69	487.22
14	IPC 2003-35	82.83	55.43	4.48	15.52	45.59	31.01	11.56	3.61	18.35	15.99	2.53	487.22
15	IPC 2003-37	84.17	53.20	4.25	28.60	39.70	17.11	10.28	3.83	17.23	14.93	2.54	764.67
16	IPC 2003-45	79.94	47.43	4.65	15.90	33.61	20.41	10.06	1.83	19.35	16.29	2.50	1224.28
17	IPC 2003-46	88.28	47.82	4.17	17.58	51.39	22.53	13.02	4.22	17.37	14.99	2.71	755.94

18	IPC 2003-51	87.28	52.30	4.92	19.59	71.17	32.03	12.62	3.83	19.52	16.29	2.56	789.28
19	IPC 2003-52	74.33	54.81	5.45	24.91	42.59	25.33	11.17	4.44	18.43	16.24	2.50	699.89
20	IPC 2003-54	81.17	51.12	4.72	16.74	44.28	18.07	12.94	3.78	17.41	14.80	2.81	851.22
21	IPC 2003-55	86.78	54.64	4.79	17.93	53.12	19.66	10.99	1.00	20.47	17.37	2.41	1438.44
22	IPC 2003-56	88.83	56.36	5.76	23.52	49.57	22.10	15.05	1.28	19.14	16.86	2.56	1283.17
23	IPC 2003-57	79.56	55.84	4.53	15.74	39.36	19.82	12.21	1.50	17.53	14.73	2.72	1169.39
24	IPC 2003-60	88.89	56.92	5.30	17.36	50.64	31.46	13.96	2.06	18.51	15.90	2.48	1017.06
25	IPC 2003-66	82.11	57.49	5.39	16.63	46.76	22.54	13.88	1.94	19.32	16.75	2.49	1045.78
26	IPC 2003-68	89.78	50.89	4.76	14.46	49.05	21.62	14.60	1.94	17.48	14.55	2.54	1036.67
27	IPC 2003-69	89.00	56.04	4.35	13.99	47.93	20.57	12.43	2.49	13.36	15.87	2.37	983.11
28	IPC 2003-71	81.56	51.78	4.33	14.23	43.03	19.97	13.43	3.56	20.45	17.75	2.55	872.00
29	ICP 2004-63	75.61	47.17	4.95	13.91	53.26	26.54	12.61	2.05	17.41	14.88	2.62	1017.56
30	ICP 2004-64	77.72	50.55	4.51	18.14	53.28	18.31	13.23	3.44	19.49	16.57	2.82	800.61
31	SAKI-9516	87.67	55.21	4.71	16.44	41.73	20.49	11.82	1.00	18.62	16.31	2.50	1383.89
32	DCP-92-3	78.50	46.54	3.88	14.81	45.12	17.71	10.96	1.61	20.51	17.77	2.60	1271.17
33	ICCV-10	80.44	47.96	5.25	19.82	46.32	17.14	13.99	1.83	19.54	16.94	2.61	1093.28
34	BG-2019	84.33	43.53	4.55	18.11	41.90	22.17	13.03	3.17	20.41	17.63	2.30	867.72
35	BG 2032	89.28	54.6	3.86	13.68	40.26	21.49	11.69	3.61	19.40	16.45	2.61	824.83
36	BG-2024	86.78	48.46	3.94	12.12	35.38	22.04	11.65	4.31	18.37	15.46	2.55	737.22
37	IPC 2003-11	77.33	54.92	4.43	16.32	53.20	18.28	12.63	4.44	17.54	15.24	2.53	664.39
38	IPC 99-18-6	77.34	56.51	4.43	17.81	51.80	17.09	11.31	4.11	18.53	16.42	2.12	747.32
39	BG 256	89.50	56.02	4.73	17.50	60.96	22.69	10.93	3.28	20.49	17.41	2.67	883.50
40	BG 362	88.69	55.65	4.74	21.10	91.35	21.21	15.94	3.78	19.62	16.81	2.78	748.61
41	BG 372	87.17	51.70	4.75	23.70	74.83	19.19	16.12	3.50	19.57	16.96	2.80	841.11
	Mean ($\overline{X}$)	**82.92**	**53.04**	**4.77**	**18.23**	**54.80**	**21.60**	**11.94**	**3.28**	**19.11**	**16.26**	**2.56**	**901.98**

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Table 4: Pooled Genotypic and Phenotypic correlation coefficient between different characters combinations among twelve traits in chickpea

Sl. No.	Character		Days to 50% flowering	Plant height (cm)	No. of primary branches	No. of secondary branches	No. of pods per plant	100 seed weight (g)	Pod borer infestation (%)	Score of wilt infestation	Total protein (%)	Soluble protein (%)	Insoluble protein (%)	Yield (kg/ha)
			1	2	3	4	5	6	7	8	9	10	11	12
1	Days to 50% flowering	G	1.000	0.179	0.371**	-0.022	0.320*	0.570**	0.253	0.185	0.145	-0.669**	-0.080	0.218
		P	1.000	0.148	0.082	-0.012	0.302*	0.426**	0.250	0.184	0.140	-0.096	-0.079	0.212
2.	Plant ht. (cm)	G		1.000	0.430**	0.162	0.243	-0.085	0.074	-0.067	-0.074	0.303*	0.105	-0.093
		P		1.000	0.110	0.149	0.223	0.031	0.063	-0.052	-0.036	0.101	0.055	-0.090
3.	No. of primary branches	G			1.000	0.156	-0.186	0.134	0.476**	-0.476**	-0.463**	-0.696**	0.806*	0.339*
		P			1.000	0.071	-0.045	0.038	0.104	-0.089	-0.002	-0.080	0.125	0.359*
4.	No. of secondary branches	G				1.000	0.295*	0.077	-0.111	-0.121	-0.084	-0.038	0.105	-0.221
		P				1.000	0.289*	0.112	-0.108	-0.112	-0.059	-0.019	0.065	-0.212
5.	No. of pods per plant	G					1.000	0.602**	0.166	0.154	0.184	0.450**	0.062	+0.190*
		P					1.000	0.479**	0.160	0.145	0.124	0.058	0.063	+0.277*
6.	100 seed at (g)	G						1.000	0.183	-0.015	0.091	0.120	-0.228	0.098
		P						1.000	0.146	-0.021	0.047	-0.055	-0.114	0.077
7.	Pod borer infestation (%)	G							1.000	-0.115	-0.136	-0.715**	0.024	-0.113
		P							1.000	-0.114	-0.123	-0.129	0.016	-0.113
8.	Score of wilt infestation	G								1.000	0.950**	-0.177	-0.292*	-0.270*
		P								1.000	0.899**	-0.023	-0.245	-0.266*
9.	Total protein (%)	G									1.000	0.353*	-0.224	0.272*
		P									1.000	0.004	-0.204	0.238
10	Soluble protein (%)	G										1.000	0.656**	+0.429**
		P										1.000	-0.011	+0.061

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11.	Insoluble protein (%)	G											1.000	0.770**
		P											1.000	0.118

Table 5: Pooled Genotypic and Phenotypic Path coefficient between different characters combinations among twelve traits in chickpea

Sl. No.	Character		Days to 50% flowering	Plant height (cm)	No. of primary branches	No. of secondary branches	No. of pods per plant	100 seed weight (g)	Pod borer infestation (%)	Score of wilt infestation	Total protein (%)	Soluble protein (%)	Insoluble protein (%)	Yield (kg/ha)
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	Days to 50% flowering	G	**0.017**	0.124	-0.360	-0.006	-0.600	0.908	0.063	0.302	-0.210	-0.005	-0.028	0.218
		P	**0.211**	-0.004	0.011	0.001	-0.040	0.009	-0.040	0.011	0.009	0.004	0.045	0.212
2.	Plant ht. (cm)	G	0.003	**0.694**	-0.417	0.045	-0.456	-0.135	0.018	-0.116	0.108	0.002	0.037	-0.093
		P	0.031	**-0.032**	0.015	-0.021	-0.030	0.000	-0.010	-0.003	-0.000	-0.005	-0.031	-0.090
3.	No. of primary branches	G	0.006	0.298	**-0.970**	0.043	0.348	0.213	0.118	-0.778	0.668	-0.006	0.284	0.339*
		P	0.017	-0.003	**0.836**	-0.010	0.006	0.000	-0.016	-0.005	-0.000	0.004	-0.071	0.359*
4.	No. of secondary branches	G	-0.001	0.112	-0.152	**0.279**	-0.553	0.123	-0.027	-0.198	0.121	-0.003	0.037	-0.221
		P	-0.002	-0.004	0.009	**-0.146**	-0.039	0.002	0.017	-0.007	-0.001	0.001	-0.037	-0.212
5.	No. of pods per plant	G	0.005	0.169	0.180	0.082	**1.874**	0.959	0.041	0.253	-0.222	0.003	0.022	+0.290*
		P	0.063	-0.007	-0.006	-0.042	**-0.135**	0.010	-0.025	0.009	0.003	-0.003	-0.036	+0.277*
6.	100 seed at (g)	G	0.010	-0.059	-0.130	0.021	-1.129	**1.592**	0.045	-0.024	-0.132	0.001	-0.080	0.098
		P	0.090	-0.001	0.005	0.016	-0.064	**0.021**	-0.023	-0.001	0.001	0.002	0.065	0.077
7.	Pod borer infestation (%)	G	0.004	0.051	-0.462	-0.031	-0.312	0.292	**0.249**	-0.188	0.196	-0.006	0.008	-0.113
		P	0.052	-0.002	0.014	0.016	-0.021	0.003	**-0.160**	-0.007	-0.003	0.006	-0.009	-0.113
8.	Score of wilt infestation	G	0.003	-0.046	0.462	-0.034	-0.290	-0.024	-0.028	**1.634**	-1.372	-0.001	-0.103	-0.270*
		P	0.038	0.001	-0.012	0.016	-0.019	-0.000	0.018	**0.064**	0.021	0.001	0.139	-0.266*
9.	Total protein (%)	G	0.002	-0.052	0.449	-0.023	-0.288	0.146	-0.033	1.553	**-1.443**	0.003	-0.079	0.272*
		P	0.029	0.001	-0.000	0.008	-0.016	0.001	0.019	0.057	**0.024**	-0.000	0.116	0.238

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10	Soluble protein (%)	G	0.011	0.210	0.008	-0.010	-0.845	0.192	0.178	-0.290	-0.510	**0.675**	0.231	+0.429**
		P	-0.020	-0.003	-0.011	0.002	-0.007	-0.001	0.020	-0.001	0.000	**-0.050**	0.006	-0.061
11.	Insoluble protein (%)	G	-0.001	0.073	-0.782	0.029	-0.117	-0.363	0.006	-0.477	0.323	0.005	**0.352**	0.770**
		P	-0.016	-0.001	0.017	-0.009	-0.008	-0.002	-0.002	-0.015	-0.004	0.000	**-0.568**	0.118

Residual effect of **Genotypic** = **0.567**
Phenotypic = **0.531**

