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STUDY ON CORRELATION AND PATH COEFFICIENT ANALYSIS FOR SEED YIELD AND YIELD ATTRIBUTING TRAITS IN CLUSTER BEAN [*CYAMOPSIS TETRAGONALOBA* (L.) TAUB]

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SUMMARY

Correlation coefficient and path coefficient analysis was studied in the present study for seed yield with a set of 40 genotypes of clusterbean (*Cyamopsis tetragonaloba* (L.) Taub) at Instructional Farm, Department of Agronomy, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar using RBD with four replications. Based on the mean performance, five genotypes *viz.,* GG 1, GG 2, IC 41057, IC 311444, and IC 113432 were found elite genotypes. The correlation coefficient at genotypic level was found to be higher than corresponding phenotypic level, indicating that there is a strong association between yield and yield related traits. Seed yield per plant showed highly significant and positive association with test weight followed by number of pods per plant, number of clusters per plant, number of seeds per pod, pod length, number of branches per plant, gum content and protein content both at genotypic and phenotypic level. The association of days to flowering and maturity with seed yield per plant was positive, but non-significant whereas, plant height displayed negative and non-significant association with seed yield per plant at genotypic and phenotypic level. Path coefficient analysis revealed the positive direct effect on seed yield per plant by test weight, number of pods per plant and number of seeds per pod.

Key words : Correlation, Path analysis, clusterbean

INTRODUCTION

Clusterbean [*Cyamopsis tetragonoloba* (L.) Taub.] (2n=2x=14) is a short-day self-pollinated crop belonging to family Fabaceae and is one of the underexploited agricultural crops (Undersander *et al.*, 1991). It commonly known as guar, chavli kayi, guari and khutti *etc*. Vavilov (1951) suggested India as the geographic center of variability of guar, though no wild species were reported in this region. The word "guar" represents a derivation from the Sanskrit word "Gaaahar" which means cow food or fodder of livestock (Bhosle and Kothekar, 2010). Clusterbean is a versatile legume crop cultivated mostly as animal feed, green manure (Chudzikowski, 1971 and Siddaraju *et al.,* 2010), green leaves as fodder and cover crop (Arora and Pahuja, 2008). Clusterbean is one of the most potential vegetable as well as industrial crop grown for its tender pods for vegetable purpose and for endospermic gum (30-35%). Tender pods are nutritionally rich in energy (16 kcal), moisture (81 g), protein (3.2 g), fat (1.4 g), carbohydrate (10.8 g), Vitamin A (65.3 IU), Vitamin 'C' (49 mg), calcium (57 mg) and iron (4.5 mg) for every 100 g of edible portion (Kumar and Singh, 2002).

Correlation analysis defines about the nature and degree of association between various morphological traits including yield. It could be effectively exploited to formulate selection strategies for improving yield and quality. Since studying correlation does not reveal the direct and indirect contribution of individual character towards yield and to solve this purpose and have clarity about yield components for effective selection programme, it is desirable to consider the relative magnitude of various characters contributing towards yield. Yield is a complex trait and is associated with several component characters which are highly influenced by environmental variation and are them self-interrelated. Such interrelation affects the direct relationship of

TABLE 1
Weekly mean meteorological data recorded during the crop season (July-2019 to October-2019)

Month	Standard weeks	Temperature (°C)		Relative Humidity (%)		Bright sunshine hours (h/day)	Rainfall (mm)	Rainy days (RD)	Evaporation (mm/day)
		Max.	Min.	Morning	Evening				
1	2	3	4	5	6	7	8	9	10
July-2019	26	37.6	25.8	72	61	7.8	33.5	2	6.9
	27	36.6	24.6	71	61	4.6	55	1	6.1
	28	36.2	25.7	69	63	1.7	0	0	6.2
	29	37.6	26.6	61	59	5.6	20	1	8.3
August-2019	30	37.2	25.6	71	66	5.4	19.2	2	6.3
	31	32.5	25.6	81	77	0.9	28	2	4.6
	32	31.3	25.0	83	78	0.0	105	4	3.9
	33	30.3	23.9	82	80	1.4	103	4	3.3
	34	33.2	24.7	78	68	7.8	24	1	4.7
September-2019	35	30.3	24.9	81	81	1.6	150.2	4	2.8
	36	33.1	25.2	76	73	4.4	34.7	3	3.7
	37	32.5	25.1	81	75	1.3	29	3	4.6
	38	33.6	24.4	77	72	6.2	25	3	5.8
October-2019	39	31.8	24.1	79	78	4.3	68.8	4	3.9
	40	32.7	23.3	76	63	5.6	80	1	4.9
	41	35.4	21.0	68	54	9.2	0	0	5.9
	42	36.5	21.5	72	55	9.0	0	0	5.3
	43	34.6	17.5	53	56	8.2	0	0	4.7
	44	34.7	18.3	60	67	5.3	14	1	4.9

Source : Agricultural Meteorology Department, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar.

contributing factors with yield, thereby making correlation coefficients unreliable as selection indices. Thus, specification of causes and measuring relative importance of each of yield component can be achieved by separating the direct effects from indirect ones through other characters. Path coefficient analysis splits the correlation coefficient into direct and indirect affects to measure the relative contribution of each variable towards the yield (Al-jibouri *et al.,* 1958). Thus, the present study was undertaken to estimate the correlation and path analysis between yield and its contributing traits in cluster bean.

MATERIALS AND METHODS

The experimental materials used for study consist of Forty genotypes of clusterbean which were procured from the Pulses Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar. The climatic conditions in which the work has been carried out are presented in Table 1 and graph described in the list of forty genotypes of clusterbean is given in Table 2. A set of forty diverse genotypes of clusterbean were sown in a randomized block design (RBD) with four replications at Agronomy Instructional Farm, Sardarkrushinagar during *kharif,* 2019. Each genotype was accommodated in a single row of 4 m length with a spacing 45 cm between rows and 15 cm between plants. Observations from five Randomly selected plants of each genotype in each replication were recorded observations except days to days to 50% flowering, days to maturity and test weight which were recorded on plot basis. Phenotypic and genotypic correlation coefficient for all the pair wise characters was worked out as per Al-Jibouri *et al.* (1958). Path coefficient analysis was carried out as per the procedure suggested by Dewey and Lu (1959) respectively.

RESULTS AND DISCUSSION

A group of forty genotypes of cluster bean were constituted to assess the genetic parameters for exploitation of genetic variability. The mean

TABLE 2
List of Genotypes included in the studied

Sr. No.	Genotypes	Sr. No.	Genotypes	Sr. No.	Genotypes	Sr. No.	Genotype
1	IC 41057	11	IC 113537	21	GG 1609	31	GG 1806
2	IC 102828	12	IC 116629	22	GG 1612	32	GG 1807
3	IC 102853	13	IC 116633	23	GG 1702	33	GG 1808
4	IC 113269	14	IC 116645	24	GG 1703	34	GG 1809
5	IC 113289	15	IC 311444	25	GG 1709	35	GG 1810
6	IC 113294	16	IC 319038	26	GG 1710	36	GAUG 1304
7	IC 113298	17	IC 373497	27	GG 1801	37	GAUG1305
8	IC 113427	18	GG 1	28	GG 1803	38	GAUG 1501
9	IC 113432	19	GG 2	29	GG 1804	39	GAUG 1502
10	IC 113498	20	GG 1607	30	GG 1805	40	GAUG 1507

Note : All the genotypes were collected from Pulses Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat.

performance for twelve characters is presented in Table 3. It was observed from the result that GG 2 (3.74 g/plot) and GAUG 1502 (1.81 g/plot) produce highest and lowest yield among all tested genotypes respectively. Based on the mean performance, five genotypes *viz.,* GG 1, GG 2, IC 41057, IC 311444 and IC 113432 were found elite genotypes.

Correlation

The study revealed that the genotypic correlation coefficients were higher than their phenotypic counter parts (Table 4). Higher value of genotypic correlation than phenotypic correlation coefficients was also observed. This indicated high degree of association between two variables at genotypic levels and its phenotypic expression may deflect by the influence of environment. This was in confirmation with Choyal *et al.* (2018) and Kumar and Khatri (2019).

Highly significant positive correlation was observed between seed yield per plant with test weight (rg = 0.845 and rp = 0.757) followed by number of pods per plant (rg = 0.804 and rp= 0.666), number of cluster per plant (rg = 0.753 and rp = 0.604), number of seeds per pod (rg = 0.567 and rp = 0.438), pod length (rg = 0.447 and rp = 0.397), number of branches per plant (rg = 0.357 and rp = 0.330) and gum content (rg = 0.334 and rp = 0.316). Similarly, significant positive correlation also observed for protein content (rg = 0.217 and rp =0.201) at genotypic level and phenotypic level. This indicated the dependency of these characters with each other and was considered useful in selection. Significant positive correlation of number of clusters per plant with seed yield per plant was reported by Ramanjaneyulu *et al.* (2018), Reddy *et al*. (2018), Patel *et al.* (2018), Preeti and Prasad (2018) and Aswini *et al*. (2019). Similarly, significant positive correlation of test weight with seed yield per plant was recorded by Preeti and Prasad (2018) and Kumar *et al.* (2019). Similar results for number of pods per plant with seed yield per plant were recorded by Reddy *et al.* (2018), Patel *et al*. (2018), Ramanjaneyulu *et al*. (2018) and Kumar *et al.* (2019). Number of branches per plant, number of seeds per pod and pod length also showed positive correlation with seed yield reported by Panchta and Khatri (2017). Higher values of genotypic correlations than their corresponding phenotypic correlations were recorded by most of the character pairs. This indicated high degree of association between two variables at the genotypic level, its phenotypic expression was deflated by the influence of environmental factors.

Days to flowering showed positive and significant correlation with days to maturity and gum content at both genotypic and phenotypic levels. Days to maturity showed positive and significant correlation with protein content. Number of branches per plant showed significant and positive correlations with number of clusters per plant, number of pods per plant and gum content. Number of clusters per plant was positive and significantly correlated with number of pods per plant, test weight and gum content. Number of pods per plant had a positive and significant association with test weight. Pod length (cm) was positively and significantly correlated with number of

TABLE 3
Mean performance of 40 genotypes for different characters in cluster bean

S. No.	Genotype	Days to flowering	Days to maturity	Plant height (cm)	No. of branches/ plant	No. of cluster/ plant	No. of pods/ plant	Pod length (cm)	No. of seeds/ pod	Test weight (g)	Protein content (%)	Gum content (%)	Seed yield/ plant (g)
	1	2	3	4	5	6	7	8	9	10	11	12	13
1.	IC 41057	30.75	81.75	71.28	2.45	5.10	15.20	4.99	7.45	3.24	23.40	25.38	3.70
2.	IC 102828	30.00	80.25	73.63	3.40	6.00	16.00	4.89	7.00	2.54	23.30	26.24	2.85
3.	IC 102853	32.25	85.25	76.10	3.20	5.00	14.75	4.42	6.55	2.77	23.51	24.49	2.67
4.	IC 113269	26.75	75.25	94.58	1.50	4.05	11.85	5.36	7.45	2.59	23.54	25.34	2.28
5.	IC 113289	36.25	88.00	83.00	1.10	4.00	11.90	5.01	7.20	2.52	23.99	25.59	2.27
6.	IC 113294	31.25	77.75	72.08	2.75	4.85	13.60	5.29	7.10	2.64	23.48	27.45	2.54
7.	IC 113298	30.25	84.75	92.23	1.10	2.30	10.70	5.59	7.75	2.65	24.01	25.51	2.19
8.	IC 113427	22.75	72.50	65.98	4.10	4.75	13.43	5.43	7.35	2.43	22.54	27.46	2.44
9.	IC 113432	22.75	87.75	72.57	2.25	5.45	14.85	5.64	7.80	2.73	23.45	28.45	3.15
10.	IC 113498	52.50	78.50	85.00	1.35	5.95	14.70	4.58	7.00	2.63	23.44	25.22	2.82
11.	IC 113537	27.75	81.75	68.38	3.00	5.35	14.00	4.01	6.30	2.08	24.51	25.32	1.84
12.	IC 116629	27.75	80.50	81.75	4.80	4.20	12.20	4.91	7.00	2.43	23.50	24.35	2.07
13.	IC 116633	28.75	78.75	103.43	2.60	4.65	13.40	4.49	7.80	2.07	24.12	25.63	2.14
14.	IC 116645	26.25	83.25	84.25	5.05	4.80	13.35	4.70	7.00	2.27	23.37	26.83	2.18
15.	IC 311444	30.75	82.50	73.73	4.50	6.15	15.25	5.49	7.70	2.72	24.16	25.34	3.19
16.	IC 319038	31.00	78.00	73.80	4.40	4.65	13.45	4.67	7.15	1.95	23.53	25.78	2.13
17.	IC 373497	28.50	89.25	85.18	3.30	5.20	14.20	5.32	7.20	2.17	22.44	24.71	2.20
18.	GG 1	36.50	78.25	63.10	6.05	7.35	17.23	5.75	8.25	3.20	25.21	28.42	4.87
19.	GG 2	28.50	82.50	76.45	5.10	6.20	15.85	5.35	7.40	3.41	25.62	29.03	3.74
20.	GG 1607	31.50	86.00	69.65	4.25	4.65	13.15	5.44	7.50	2.32	25.61	27.19	2.79
21.	GG 1609	32.50	87.25	60.43	2.25	4.25	11.33	4.90	7.10	2.00	25.13	28.26	2.02
22.	GG 1612	33.70	97.50	60.18	3.05	5.10	14.05	4.84	7.10	2.55	24.39	26.74	2.94
23.	GG 1702	44.25	67.00	75.58	2.65	4.85	14.00	4.63	6.85	2.54	23.12	24.79	2.61
24.	GG 1703	34.50	69.25	79.28	3.60	4.30	12.60	4.69	6.80	2.49	23.53	25.59	2.16
25.	GG 1709	43.75	73.25	70.98	2.50	3.55	11.33	4.75	6.95	2.55	24.48	26.38	1.99
26.	GG 1710	26.25	94.25	69.78	3.35	5.30	14.50	5.47	7.45	2.53	22.41	25.55	2.73
27.	GG 1801	27.75	64.25	90.23	3.25	5.05	14.20	4.69	7.05	2.32	22.57	27.04	2.48
28.	GG 1803	27.00	66.00	63.03	4.35	4.65	13.10	5.42	7.30	2.51	22.43	26.39	2.43
29.	GG 1804	28.00	67.50	60.78	3.40	4.45	13.70	5.46	7.20	2.52	23.37	25.70	2.60
30.	GG 1805	30.00	68.25	53.60	3.20	4.80	13.85	4.77	7.20	2.22	23.53	24.66	2.07
31.	GG 1806	32.75	73.25	64.30	4.00	4.80	13.15	4.57	6.90	2.30	23.23	26.50	2.07
32.	GG 1807	34.00	75.25	73.53	3.20	4.85	13.35	5.53	7.50	2.26	23.47	25.42	2.36
33.	GG 1808	35.25	78.50	66.45	3.25	4.35	12.30	5.45	7.65	2.19	22.49	25.77	2.01
34.	GG 1809	29.50	77.75	69.80	3.00	4.40	13.25	5.14	7.25	2.49	22.44	27.92	2.57
35.	GG 1810	27.25	76.00	72.13	4.40	5.25	14.50	4.51	6.75	2.23	22.83	26.35	2.17
36.	GAUG 1304	32.25	76.25	72.88	2.85	4.10	12.20	5.20	7.25	2.17	24.37	25.52	1.99
37.	GAUG1305	36.75	75.75	65.28	2.80	4.70	13.25	5.29	7.30	2.26	25.35	29.32	2.17
38.	GAUG 1501	34.25	77.00	64.28	4.25	5.15	14.50	4.96	7.00	2.36	25.28	27.53	2.47
39.	GAUG 1502	55.25	112.75	58.43	2.45	4.55	12.75	4.35	6.48	2.20	24.55	26.76	1.81
40.	GAUG 1507	44.00	96.50	51.95	3.50	4.75	13.40	5.61	7.80	2.41	23.95	27.88	2.62
	General Mean	32.88	80.15	72.72	3.29	4.85	13.61	5.04	7.22	2.47	23.74	26.34	2.51
	Range	22.75-55.25	64.25-112.75	51.95-103.42	1.10-6.05	2.30-7.35	10.70-17.22	4.01-5.75	6.30-8.25	1.95-3.41	22.41-25.62	24.34-29.31	1.81-4.87
	S.Em. ±	0.72	0.86	1.63	0.11	0.32	0.50	0.09	0.16	0.08	0.16	0.14	0.09
	C.D. @ 5 %	1.50	2.40	4.55	0.32	0.89	1.39	0.24	0.44	0.22	0.44	0.40	0.24
	C.V. %	4.37	2.14	4.47	6.88	13.18	7.30	3.46	4.35	6.33	1.33	1.08	6.89

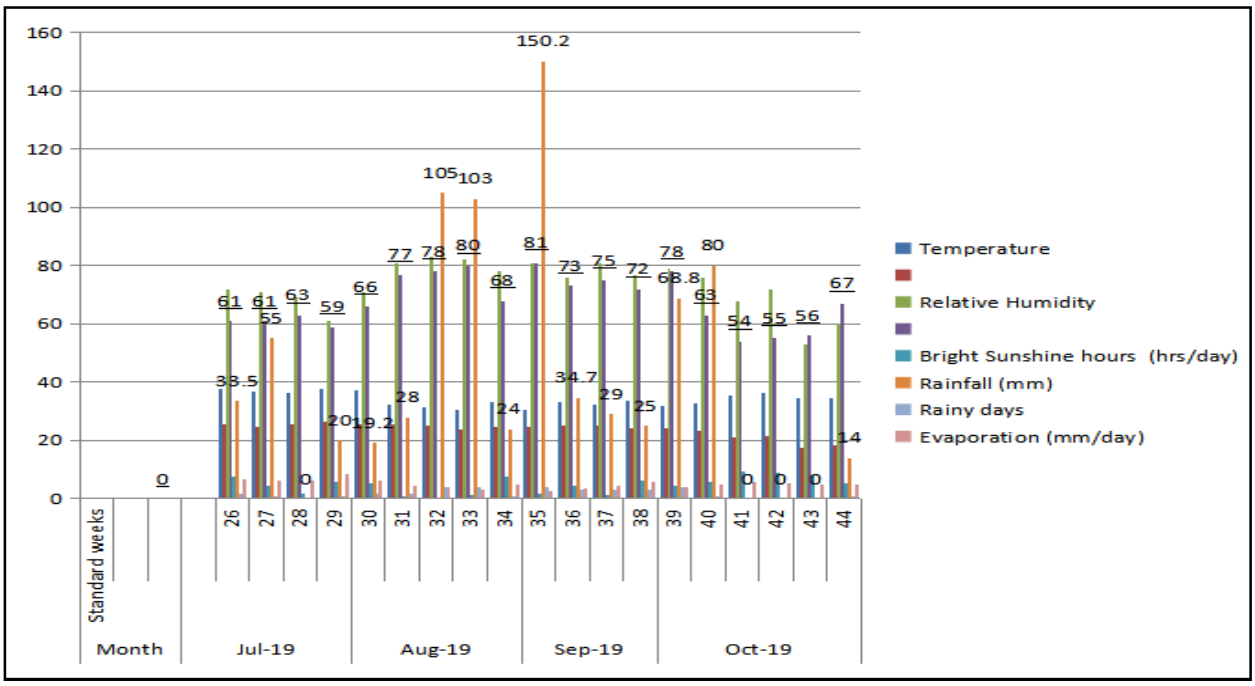

Fig. 1. Agro-meterological Data Graph.

seeds per pod, test weight and gum content and number of seeds per pod. Number of seeds per pod showed highly significant and positive correlation with test weight and gum content. Test weight showed highly significant and positive correlation with protein content and gum content. Protein content showed significant positive correlation with gum content. Overall, the correlation study revealed that the character like test weight, number of pods per plant, number of clusters per plant, number of seeds per pod, pod length, number of branches per plant, gum content and protein content were important attributes which contributed towards higher seed yield per plant. Therefore, more emphasis should be given to these components during selection for higher seed yield per plant.

Path coefficient analysis revealed that test weight (0.485) exhibited a high positive direct effect on seed yield per plant followed by number of pods per plant (0.473), number of seeds per pod (0.379), thereby indicating a true relationship between them. These traits turned out to be major components of seed yield for direct selection. Protein content (0.074), days to flowering (0.024), number of branches per plant (0.021) recorded low positive indirect effects on seed yield per plant, while number of clusters per plant (0.002) exhibited a negligible positive direct effect on seed yield per plant. Another hand pod length (-0.092), plant height (-0.054), gum content (-0.027) and days to maturity (-0.018) had shown the negligible negative direct effect (Table 5 and Fig. 2).

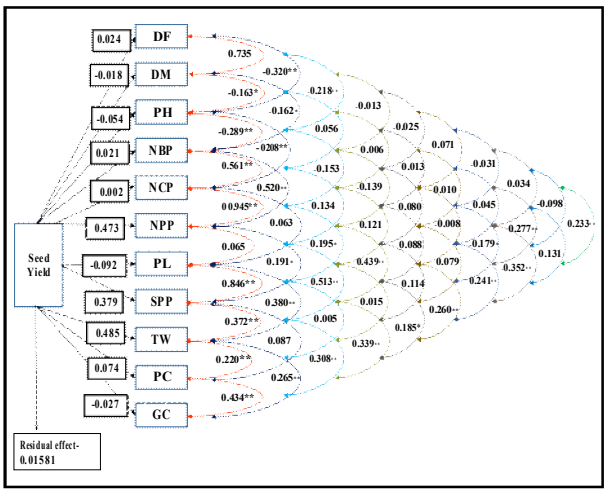

Fig. 2. Diagrammatic representation of factor influencing seed yield in clusterbean, double arrowed line indicates correlation coefficients and single arrowed lines indicate direct effects.

The positive direct effect of test weight, number of pods per plant, number of seeds per pod and number of branches per plant on seed yield per plant was also reported by Ramanjaneyulu *et al.* (2018) and Kumar *et al.* (2019).

The correlation studies revealed positive and significant association between seed yield per plant, test weight, number of pods per plant, number of clusters per plant, number of seeds per pod, pod length, number of branches per plant, gum content and protein content in clusterbean. This suggested that there were little or no indirect effects of these traits on seed yield

TABLE 4
Phenotypic (rp) and genotypic (rg) correlation coefficients among seed yield and its related characters in clusterbean

Characters		Days to flowering	Days to maturity	Plant height (cm)	No. of branches/ plant	No. of cluster/ plant	No. of pods/ plant	Pod length (cm)	No. of seeds/ pod	Test weight (g)	Protein content (%)	Gum content (%)	Seed yield/ plant (g)
Days to flowering	pr	1.000	0.714**	-0.299**	-0.207**	-0.013	-0.026	0.052	-0.024	0.028	0.096	0.218**	0.009
	gr	1.000	0.735**	-0.320**	-0.218**	-0.013	-0.025	0.071	-0.031	0.034	0.098	0.233**	0.011
Days to maturity	pr		1.000	-0.152	-0.148	0.02	-0.012	0.01	0.01	0.036	0.264**	0.125	0.043
	gr		1.000	-0.163*	-0.162*	0.056	0.006	0.013	0.01	0.045	0.277**	0.131	0.049
Plant height (cm)	pr			1.000	-0.264**	-0.149	-0.122	-0.131	0.057	-0.012	-0.162*	-0.341**	-0.093
	gr			1.000	-0.289**	-0.208**	-0.153	-0.139	0.08	-0.008	-0.179*	-0.352**	-0.102
Number of branches/ plant	pr				1.000	0.432**	0.394**	0.091	0.05	0.074	0.079	0.229**	0.330**
	gr				1.000	0.561**	0.520**	0.134	0.121	0.088	0.079	0.241**	0.357**
Number of clusters/ plant	pr					1.000	0.910**	-0.018	0.014	0.252**	0.094	0.202*	0.604**
	gr					1.000	0.945**	0.063	0.195*	0.439**	0.114	0.260**	0.753**
Number of pods/plant	pr						1.000	0.013	0.039	0.314**	0.031	0.147	0.666**
	gr						1.000	0.065	0.191*	0.513**	0.015	0.185*	0.804**
Pod length	pr							1.000	0.744**	0.300**	0.01	0.300**	0.397**
	gr							1.000	0.846**	0.380**	0.005	0.339**	0.447**
Number of seeds/pod	pr								1.000	0.240**	0.091	0.226**	0.438**
	gr								1.000	0.372**	0.087	0.308**	0.567**
Test weight (g)	pr									1.000	0.195*	0.223**	0.757**
	gr									1.000	0.220**	0.265**	0.845**
Protein content (%)	pr										1.000	0.410**	0.201*
	gr										1.000	0.434**	0.217**
Gum content (%)	pr											1.000	0.316**
	gr											1.000	0.334**
Seed yield/ plant (g)	pr												1.000
	gr												1.000

TABLE 5
Path coefficient analysis showing direct (diagonal and bold) and indirect (above and below diagonal) effects of different characters on seed yield per plant in cluster bean

Characters	Days to flowering	Days to maturity	Plant height (cm)	No. of branches/ plant	No. of cluster/ plant	No. of pods/ plant	Pod length (cm)	No. of seeds/ pod	Test weight (g)	Protein content (%)	Gum content (%)	Seed yield/ plant (g)
Days to flowering	0.024	0.018	-0.008	-0.005	0.000	-0.001	0.002	-0.001	0.001	0.002	0.006	0.011
Days to maturity	-0.013	-0.018	0.003	0.003	-0.001	0.000	0.000	0.000	-0.001	-0.005	-0.002	0.049
Plant height (cm)	0.017	0.009	-0.054	0.016	0.011	0.008	0.007	-0.004	0.000	0.010	0.019	-0.102
No. of branches/ plant	-0.005	-0.003	-0.006	0.021	0.012	0.011	0.003	0.003	0.002	0.002	0.005	0.357**
Number of cluster/ plant	0.000	0.000	0.000	0.001	0.002	0.002	0.000	0.000	0.001	0.000	0.000	0.753**
No. of pods/	-0.012	0.003	-0.072	0.246	0.447	0.473	0.031	0.090	0.242	0.007	0.087	0.804**
Pod length (cm)	-0.007	-0.001	0.013	-0.012	-0.006	-0.006	-0.092	-0.078	-0.035	-0.001	-0.031	0.447**
No. of seeds/pod	-0.012	0.004	0.030	0.046	0.074	0.072	0.320	0.379	0.141	0.033	0.117	0.567**
Test weight (g)	0.017	0.022	-0.004	0.043	0.213	0.249	0.184	0.180	0.485	0.106	0.128	0.845**
Protein content (%)	0.007	0.021	-0.013	0.006	0.008	0.001	0.000	0.006	0.016	0.074	0.032	0.217**
Gum content (%)	-0.006	-0.004	0.010	-0.007	-0.007	-0.005	-0.009	-0.008	-0.007	-0.012	-0.027	0.334**

and whatever relationship existed with seed yield was direct. Positive and non-significant association of days to maturity and days to flowering with seed yield per plant was recorded whereas plant height showed a negative and non-significant association with seed yield per plant. In case of clusterbean, the genotypes should possess early maturity, a greater number of branches per plant, greater number of pods per plant, maximum pod length and a greater number of seeds per pod. Selection based on the above criteria would improve the efficiency of the crop improvement programme.

An important thing to remember while carrying out path analysis is that all the causal factors affecting seed yield should be included in the study, since yield being very complex character which is affected by so many factors, that it may not be possible to have an all-inclusive path diagram. Under these circumstances, provision is made for residual path which take care of all such factors which are not included. In the present study, the effect of residual; factor on yield was 0.0158. This suggested that there were few more minor components other than studied in this investigation, which influenced the seed yield.

CONCLUSION

It can be concluded from the present findings in a breeding program aiming to improve seed yield in cluster bean, more weightages should be given mainly to the number of branches per plant, number of clusters per plant, days to maturity and number of seeds per pod.

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