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Correlation and path coefficient analysis studies in cluster bean [*Cyamopsis tetragonoloba* (L.) Taub

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Abstract
The investigation was laid out in RBD with three replication during *kharif*- 2016 at the Horticulture research farm, Department of Horticulture SHUATS, Allahabad. The correlation coefficient at genotypic level is higher than corresponding phenotypic level, indicating that there is a strong association between these traits and pod yield genetically. Pod yield/plant showed significant and positive correlation with plant height 45 days, number of pods/plant and days to 50% flowering at both phenotypic and genotypic level. Seed yield/plant (g) showed non-significant and positive correlation with fruit cluster/plant, pod/cluster and 100 seed weight at both phenotypic and genotypic level. The path coefficient analysis which splits total correlated coefficient of different characters into direct and indirect effects on pod and seed yield per plant in such a manner that the sum of direct and indirect effects is equal to total genotypic correlated. Pods/plant had positive direct effect on pod yield/plant. Fruit clusters/plant had direct negative effect on seed yield/plant. Seeds/pod had direct negative effect on seed yield/plant.

Keywords: cluster bean [*Cyamopsis tetragonoloba* (L.)], pod and seed yield, correlation and path analysis

Introduction
Cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.], also known as guar, is arid legume crop that is cultivated mostly in the arid and semi arid areas as it is drought resistant. Seeds of cluster bean have a large endosperm when compared to other legumes, and contains galactomannan type of gum, which forms a viscous gel and has diversified industrial applications *viz*., paper, food, cosmetics, mining, petroleum, well drilling, pharmaceuticals etc**.** (Pathak *et al*., 2009) [13]. Correlation coefficient is a statistical measure which is used to find out the degree (strength) and direction of relationship between two or more variable. A positive correlation between desirable characters is favorable to the plant breeder because it helps in simultaneous improvement of both the characters. A negative correlation, on the other hand, will hinder the simultaneous expression of both the characters with high values. The genetic improvement in dependent traits can be achieved by applying strong selection to a character which is genetically correlated with the dependent character. This is called correlated response (Al-Jibouri *et al.*, 1958) [1]. Path coefficient analysis is simply a standardized partial coefficient which splits the correlation coefficient into the measures of direct and indirect effects (Wright, 1921) [17]. In other words, it measures of direct and indirect selection for genetic improvement of yield. Selection for a component tarit with a view to improve yield is called indirect selection, while selection for yield per se is termed as direct selection. A greater yield response is obtain when the characters for which indirect selection is practiced has a high heritability and a high correlation with yield.

Materials and Methods
The experiment will be carried out at the Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad. The experiments were laid out in randomized block design with three replicates during *kharif* seasons keeping line to line distance of 45 cm. and plant to plant distance of 30 cm. The sowing of experimental material was done on 12/07/2016 during the year 2016-2017. Each plot size was 1.8m× 2m. Five competitive plants were selected at randomly tagged from each plot to record observation on various characters viz, plant height

45 & 90 days (cm), no. of branches 45 & 90 days, days to 1st flowering, days to 50 per cent flowering, days to 1st pod picking, pod length (cm), pod width (cm), ten fresh pod weight (g), number of clusters per plant, number of pods per cluster, no. of pods per plant, pod yield per plant (g), pod yield per hectare (q), ten dry pod weight (g), no. of seed per pod, hundred seed weight (g), seed yield per plant (g), seed yield/ha.(q).

Result

The analysis of variance showed that significant difference among the genotypes for all 20 characters studied. Similar findings were reported by Vir *et al*., (2015) [10], kumar *et al*., (2015) [4], Malaghan *et al.*, (2014) [5], Preeti *et al*, (2018) [7] Rai *et al.*, (2012) [8] also recorded highly significant difference among the cluster bean genotypes with respect to all the characters under studied.

Correlation coefficient analysis

Correlation studies on vegetable pod yield and its component traits revealed that the values of genotypic correlation coefficients were higher than phenotypic correlation coefficient this was in confirmation with Patel and Chaudhary (2001). This suggests the strong inherent association among the traits. The results of the correlation cofficient for different pod yield characters of cluster bean are presented in (Table 1&2). Pod yield/plant showed significant and positive correlation with plant height 45 days (0.88), number of pods/plant (0.88), days to 50% flowering (0.53), days to 1st flowering (0.50), plant height 90 days (0.46), 10 fresh pod weight (0.41), and pod length (0.39) which indicate strong association with these components traits, yield may easily pushed up suggesting the selection for these characters will be useful in improving vegetable pod yield. Plant height 90 days showed significant and positive correlation with pod length (0.64), pod width (0.54), 10 fresh pod weight (0.47), pod yield/plant (0.46) and pods/plant (0.37). Ten fresh pod weight showed significant and positive correlation with pod length (0.87), pod width (0.60) and pod yield per plant (0.41). Pod length (cm) showed significant and positive with pod width (0.57) and pod yield per plant (0.39). Pod width (cm) showed non-significant and positive with (0.10).

Table 2: Estimates of genotypic correlation coefficient (r_g) for vegetable pod yield and its component characters

characters	1	2	3	4	5	6	7	8	9	10	11	12
1	1.00	0.99**	0.65**	0.11	-0.39*	-0.45*	0.95**	0.29	0.42*	-0.08	0.43*	0.50*
2		1.00	0.71**	0.10	-0.45*	-0.50*	0.97**	0.31	0.43*	-0.01	0.44*	0.53**
3			1.00	0.53**	-0.31*	-0.30	0.40	0.39*	0.45*	-0.00	0.81**	0.88**
4				1.00	-0.23	-0.17	-0.29	0.47*	0.64**	0.54*	0.37*	0.46*
5					1.00	1.00**	-0.15	-0.45*	-0.49**	-0.46*	-0.33*	-0.50**
6						1.00	-0.27	-0.35*	-0.44*	-0.41*	-0.30	-0.47*
7							1.00	-0.12	0.02	-0.29	0.33	0.21
8								1.00	0.87**	0.60**	0.09	0.41*
9									1.00	0.57**	0.21	0.39*
10										1.00	-0.14	0.10
11											1.00	0.88**
12												1.00

* And ** significant at 5% and 1% level of significance, respectively.

1. Days to 1st Flowering
2. Days to 50% Flowering
3. Plant height 45days (cm)
4. Plant height 90 Days (cm)
5. Branches/plant 45 days
6. Branches/plant 90 days
7. Days to 1st pod picking
8. 10 Fresh pod weight (g)
9. Pod length (cm)
10. Pod width (cm)
11. Pods/plant
12. Pod yield/plant (g)

Seed yield/ plant (g) showed non-significant and positive correlation with fruit cluster/plant (0.29), pod/cluster (0.28) and 100 seed weight (0.02). Fruit cluster per plant showed significant and positive correlation with pod per cluster (0.99) which indicates strong association with these characters with seed yield per plant. Pods/cluster showed non-significant and positive correlation with 10 dry pod weight (0.17), seed yield per plant (0.28) which indicates strong association with these two character.

10 dry pod weight showed positive and significant correlation with seed per pod (0.43). 100 Seed weight (g) showed positive and non-significant correlation with seed per pod (0.05). The results are in agreement with the earlier findings in cluster bean by Girish *et al*., (2012), for number of clusters per plant, number of pods per cluster, dry pod yield per plant and hundred seed weight and Rakesh *et al*., (2011) for seeds per pod in cow pea and Manggoel *et al*., (2012) also reported similar result for number of pods per plant and 100 seed weight.

Table 2: Matrix of Genotypic Correlations for seed yield and component characters in cluster bean

Characters	Fruit clusters/ Plant	Pods/cluster	10 dry pod weight (g)	Seeds/pod	100 seed weight (g)	Seed yield/ plant (g)
Fruit clusters/ Plant	1.00	0.99*	0.15	-0.46*	-0.62*	0.29
Pods/ Cluster		1.00	0.17	-0.34	-0.68*	0.28
10 Dry Pod Weight (g)			1.00	0.43*	-0.36	-0.54**
Seeds/ Pod				1.00	0.05	-0.66**
100 Seed Weight (g)					1.00	0.02
Seed Yield/ Plant (g)						1.00

Path coefficient analysis

The path coefficient analysis (presented in table 3&4) which splits total correlated coefficient of different characters into direct and indirect effects on fruit yield per plant in such a manner that the sum of direct and indirect effects is equal to total genotypic correlated. Pods/plant had positive direct

effect (1.0585) on pod yield/plant. It exhibited positive indirect effect through days to 1st flowering (0.4625), days to 50% flowering (0.4672), plant height 45 days (0.8618), plant height 90 days (0.3918), days to 1st pod picking (0.3505), ten fresh pod weight (0.1043), pod length (0.2252) and pod yield/plant (0.9415), while the other characters like negative indirect effect were seen through branches/plant 45 days (-0.3579), branches/plant 90 days (-0.3193) and pod width (-0.1550). Days to 50% flowering had direct negative effect (-0.4607) on pod yield/plant. It exhibited positive indirect effect through branches/plant 45 days (0.2109), branches/plant 90 days (0.2320) and pod width (0.0052). Plant height 90 days had direct negative effect (-0.1677) on pod yield/plant. It exhibited positive indirect effect through branches/plant 45 days (0.0390), branches/plant 90 days (0.0293) and days to 1st pod picking (0.0491). Branches/plant 90 days had direct negative effect (-0.4977) on pod yield/plant. It exhibited positive indirect effect through days to 1st flowering (0.2276), days to 50% flowering (0.2507), plant height 45 days (0.1532), plant height 90 days (0.0869), days to 1st pod picking (0.1361), ten fresh pod weight (0.1718), pod length (0.2233), pod width (0.2046), pods/plant (0.1501) and pod yield/plant (0.2354). Ten fresh pod weight had positive direct effect (0.6536) on pod yield/plant. It exhibited positive indirect effect through days to 1st flowering (0.1960), days to 50% flowering (0.2057), plant height 45 days (0.2554), plant height 90 days (0.3128), pod length (0.5746), pod width (0.3968), pods/plant (0.0644) and pod yield/plant (0.2719). Pod length had direct negative effect (-0.3924) on pod yield/plant. It exhibited positive indirect effect through branches/plant 45 days (0.1945) and branches/plant 90 days (0.1760).

Table 3: Genotypic path coefficient analysis for vegetable pod yield and its component characters

Characters	1	2	3	4	5	6	7	8	9	10	11	12
1	-0.9893	-1.0030	-0.6507	-0.1102	0.3897	0.4523	-0.9495	-0.2966	-0.4235	0.0795	-0.4323	-0.4984
2	-0.4671	-0.4607	-0.3275	-0.0482	0.2109	0.2320	-0.4492	-0.1450	-0.1990	0.0052	-0.2033	-0.2446
3	0.3149	0.3403	0.4787	0.2572	-0.1518	-0.1474	0.1945	0.1871	0.2181	-0.0044	0.3897	0.4215
4	-0.0187	-0.0176	-0.0901	-0.1677	0.0390	0.0293	0.0491	-0.0802	-0.1089	-0.0920	-0.0621	-0.0779
5	-0.1426	-0.1657	-0.1148	-0.0843	0.3619	0.3621	-0.0556	-0.1645	-0.1794	-0.1676	-0.1224	-0.1835
6	0.2276	0.2507	0.1532	0.0869	-0.4980	-0.4977	0.1361	0.1781	0.2233	0.2046	0.1501	0.2354
7	0.1422	0.1445	0.0602	-0.0434	-0.0228	-0.0405	0.1482	-0.0189	0.0030	-0.0444	0.0491	0.0312
8	0.1960	0.2057	0.2554	0.3128	-0.2972	-0.2339	-0.0832	0.6536	0.5746	0.3968	0.0644	0.2719
9	-0.1680	-0.1695	-0.1788	-0.2549	0.1945	0.1760	-0.0079	-0.3449	-0.3924	-0.2264	-0.0835	-0.1560
10	0.0180	0.0025	0.0020	-0.1228	0.1037	0.0920	0.0671	-0.1359	-0.1292	-0.2238	0.0328	-0.0232
11	0.4625	0.4672	0.8618	0.3918	-0.3579	-0.3193	0.3505	0.1043	0.2252	-0.1550	1.0585	0.9415
12	-0.7398	-0.7798	-1.2932	-0.6825	0.7448	0.6946	-0.3093	-0.6110	-0.5839	-0.1522	-1.3062	-1.4686

Days to 1st Flowering 4. Plant height 90 Days (cm) 7. Days to 1st pod picking
2. Days to 50% Flowering 5. Branches/plant 45 days 8. 10fresh pod weight (g)
3. Plant height 45days (cm) 6. Branches/plant 90 days 9. Pod length (cm)
10. Pod width (cm) 11. Pods/plant 12. Pod yield/plant (g)

Pod width had direct negative effect (-0.2238) on pod yield/plant. It exhibited positive indirect effect through days to 1st flowering (0.0180), days to 50% flowering (0.0025), plant height 45 days (0.0020), branches/plant 45 days (0.1037), branches/plant 90 days (0.0920), days to 1st pod picking (0.0671) and pods/plant (0.0328). This result is in line with the findings of Kalaiselvan and Irulappan (1985) [11] in winged bean, Kumaran *et al*. (1995) [12], Ramesh and Tewatia (2002) [15] and Shridhar (2005) [16] in peas, Ramaprasad *et al*. (2007) [14] in french bean, Ibrahim *et al*. (2012) [3] in cluster bean for the above characters.

Table 4: Genotypic path coefficient analysis for seed yield and its component characters

Characters	Fruit clusters/ Plant	Pods/cluster	10 dry pod weight (g)	Seeds/pod	100 seed weight (g),
Fruit clusters/ Plant	-0.5156	-0.5410	-0.0785	0.2420	0.3207
Pods/ Cluster	0.4918	0.4687	0.0836	-0.1629	-0.3193
10 Dry Pod Weight (g)	0.1066	0.1248	0.7003	0.3031	-0.2572
Seeds/ Pod	0.4331	0.3208	-0.3994	-0.9228	-0.0528
100 Seed Weight (g)	-0.1625	-0.1780	-0.0959	0.0150	0.2612
Seed Yield/ Plant (g)	0.2902	0.2818	-0.5432	-0.6609	0.0299

Fruit clusters/plant had direct negative effect (-0.5156) on seed yield/plant. It exhibited positive indirect effect through seeds/pod (0.2420) and 100 seed weight (0.3207), while the other characters like negative indirect effect were seen through pods/cluster (-0.5410) and 10 dry pod weight (-0.0785).

Pods/cluster had positive direct effect (0.4687) on seed yield/plant. It exhibited positive indirect effect fruit clusters/plant (0.4918) and 10 dry pod weight (0.0836), while the other characters like negative indirect effect were seen through seeds/pod (-0.1629) and 100 seed weight (-0.3193). 10 dry pod weight had positive direct effect (0.7003) on seed yield/plant. It exhibited positive indirect effect through fruit clusters/plant (0.1066), pods/cluster (0.1248) and seeds/pod (0.3031), while the other characters like negative indirect effect were seen through100 seed weight (-.2572). Seeds/pod had direct negative effect (-0.9228) on seed yield/plant. It exhibited positive indirect effect through fruit clusters/plant (0.4331) and pods/cluster (0.3208), while the other characters like negative indirect effect were seen through10 dry pod weight (-0.3994) and 100 seed weight (-0.0528). 100 seed weight had positive direct effect (0.2612) on seed yield/plant. It exhibited positive indirect effect through seeds/pod (0.0150), while the other characters like negative indirect effect were seen through fruit clusters/plant (-0.1625), pods/cluster (-0.1780) and 10 dry pod weight (-0.0959).

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