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CORRELATION AND PATH ANALYSIS FOR CLUSTERBEAN VEGETABLE POD YIELD

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ABSTRACT
Study was conducted mainly using clusterbean lines collected around North Karnataka area of India. This study helps in identifying the characters which mainly contributing to the pod yield. Thirty one genotypes of clusterbean were evaluated during rainy season 2009 and observations recorded on growth and vegetable pod yield parameters. Correlation studies indicated positive associations of vegetable pod yield per hectare (t) with plant height (0.315, 0.309), pods per cluster (0.322, 0.298), pods per plant (0.443, 0.389) and pod yield per plant (0.905, 0.787) at genotypic and phenotypic levels respectively. Genotypic path analysis shows that yield per plant exhibited positive direct effect (1.138) and had strong positive association with yield per hectare (rG = 0.905). The positive indirect effects were through days to 50% flowering (0.015), pods per cluster (0.035) and pod breadth (0.046). Phenotypic path coefficient shows that yield per plant had high positive direct effect (0.879) and strong degree of association (0.787) for pod yield per hectare. This direct effect is mainly due to the indirect effect of trait positively through plant height (0.043), pods per plant (0.023), pod length (0.025) and pod width (0.002). Suggesting that these parameters may be considered as prime traits during the course of selection to have the higher potential of yield in case of green gram.

INTRODUCTION

Clusterbean [*Cyamopsis tetragonoloba* (L.) Taub] (2n = 14) is an annual under exploited vegetable which is drought hardy, deep rooted, annual and, summer grown. It a potential vegetable and industrial crop grown for tender pods as a vegetable and for endospermic gum. Tender pods are 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).

Clusterbean is mainly exported to USA, Germany, Netherlands, Italy, UK, Japan and France (Singh *et al.*, 2009). The per capita availability of protein in the country is 28g/ day, while WHO recommended it should be 80 g/day, consequently most serious problem of the malnutrition existing among the poor people, where most of the people have vegetarian diet and avoid the animal protein (Prasad *et al.*, 2013). It is needs fulfil its demand through pulses protein. Therefore, it is necessary to increase the production of clusterbean in underutilized areas, which could be done opting suitable, breeding methods.

Yield is a complex character and is known to be associated with a number of component characters and is highly affected by environmental variations. These characters are themselves interrelated. Such inter-dependence of the contributing factors affects their direct relationship with yield, thereby making correlation coefficients unreliable as selection indices (Shoran, 1982). Several path coefficient analysis have been conducted in guar, using grain-type cultivars (Mital and Thomas (1969); Choudhary and Lodhi (1980); Brindha *et al.* (1996); Arumugarangarajan *et al.*, 2000; Singh *et al.* (2002), Hanchinamani (2004); Singh *et al.* (2005).

Breeding and selection programmes often encompass several characters simultaneously (Hill *et al.*, 1998). When considering several traits, it is desirable to choose individuals with the best combination of these traits. The basis for such a selection is selection index, which takes, into account a combination of traits according to their relative weight.

Clusterbean is adaptable to arid drought conditions and, there is a need for its improvement. Breeding for varieties suited to specific agro ecological conditions for use as a vegetable. Evaluation of local, or related, genotypes to determine variability and association of characters. Improvement made in crop varieties is mainly concentrated on increasing yield and yield attributing characters. A study of correlation between quantitative characters provides an idea of association of characters. To have a clear picture of yield components for effective selection, it is desirable to consider the relative magnitude of various characters contributing toward yield. Path coefficient helps in building the correlation towards yield. The path coefficient analysis provides a more realistic evidence of the interrelationship, as it considers direct and indirect effects of the variables by partitioning the correlation coefficients. Correlation alone may not give complete information but when used in conjunction with path coefficient analysis will give a better measure of cause and effect relationship existing between different pairs of characters.

In guar, selection indices have been effectively used in

Table 1: Source and place of collection used in the study of clusterbean genotypes

Source	Number of genotypes	Genotypes
Dharwad	1	Pusa Navbahar
UAS, Dharwad	13	BJ-1, RB-1, JKD-1, Line16, Line17, Line18, Line19, Line20, Line21, Line22, Line23, Line24, Line25.
KRCCH, Arabhavi	15	Line1, Line2, Line3, Line4, Line5, Line6, Line7, Line8, Line9, Line10, Line 11, Line 12, Line 13, Line 14, Line 15.
Sarphan Seeds Ltd.	1	Sarphan
Mahyco	1	Varsha

Table 2: Analysis of variance (mean sum of squares) for growth and yield parameters in clusterbean genotypes

Source of variation/ character	Replication df=1	Treatment(genotype) df=30	Error df=30	SEm ±	CD(5%)
Growth parameters					
Plant height	6.588	462.976 **	2.615	1.143	2.335
Number of branches	2.284	12.268 **	0.313	0.395	0.807
Vegetable pod yield parameters					
Days to 50% flowering	0.403	19.213 **	0.437	0.467	0.954
Number clusters per plant	65.262	178.965 **	14.021	2.648	5.407
Number pods per cluster	0.528	5.667 **	0.161	0.283	0.579
Number pods per plant	1417.748	1436.537 **	77.790	6.237	12.737
Pod length (cm)	0.0152	4.915 **	0.0372	0.136	0.279
Pod width (cm)	0.0068	1.401**	0.0781	0.198	0.404
Number seed per pod	0.0645	1.1053**	0.1365	0.261	0.534
Pod yield per plant(g)	125.1	6457.5 **	42.0	4.581	9.355
Pod yield (Mt ha^{-1})	2.127	16.688**	0.521	0.511	1.043

* * Significant at 1% ANOVA

Table 3: Genotypic and phenotypic correlation coefficients of different characters in Clusterbean

	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}
X_1	0.02	0.153	0.014	0.43	0.03	-0.382*	-0.577**	-0.261	0.095	0.169
	0.028	0.145	-0.017	0.39*	0.003	-0.365	-0.534**	-0.195	0.077	0.156
X_2		-0.354	-0.235	0.628**	-0.259	0.595**	0.625**	0.282	0.234	0.315*
		-0.345	-0.231	0.608**	-0.245	0.589	0.585**	0.258	0.209	0.309
X_3			0.719**	-0.282	0.493**	-0.736**	-0.423*	-0.621**	0.351*	0.082
			0.671**	-0.263	0.487**	-0.711**	-0.382	-0.572**	0.358*	0.07
X_4				-0.206	0.635**	-0.467*	-0.313	-0.408*	0.426*	0.131
				-0.17	0.615**	-0.428	0.26	0.33	0.417*	0.09
X_5					-0.111	0.317	-0.055	0.24	0.208	0.322
					-0.078	0.313*	-0.033	0.2	0.218	0.298
X_6						-0.318	-0.248	-0.401*	0.649**	0.443*
						-0.298	-0.211	-0.358	0.645**	0.389*
X_7							0.709**	0.784**	-0.163	-0.031
							0.665**	0.715**	-0.143	-0.03
X_8								0.4	-0.015	0.051
								0.321*	0.003	0.037
X_9									-0.327	-0.231
									-0.298	-0.197
X_{10}										0.905**
										0.787**

** significant at 1% and 5% level; Values with bold indicate phenotypic correlation; X_1 = Days to 50% flowering, X_2 = Plant height (cm), X_3 = Number of branches, X_4 = Clusters per plant, X_5 = pods per cluster, X_6 = Pods per plant, X_7 = Pod length (cm), X_8 = number of seeds per pod, X_9 = Pod breadth (cm), X_{10} = yield per plant (g) and X_{11} = yield (Mt ha^{-1})

identifying some traits as selection criteria to improve seed yield. Choudhary and Joshi (1996); Elsyed (1999), concluded that maximum efficiency of selection was obtained when all the important yield components were included in the index.

To provide basis for selection and yield improvement in guar the present investigation was undertaken to determine the degree of association among characters and to measure direct and indirect effects of various component characters on yield.

MATERIALS AND METHODS

The experimental material was comprised of 31 genotypes from different regions of Karnataka (Table 1). All genotypes were evaluated in a randomized complete block design with two replications at the Olericulture unit, Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, India, during Rainy season 2009. Each treatment was sown in a line 10 m long with spacing of 45 cm between rows and 20 cm between plants. Cultural and management practices as per University of Agricultural Sciences, Dharwad, package of practice recommendation were followed for raising the crop (POP, UAS Dharwad).

The mean values of the genotypes in each replication were used for analysis of variance. Results and values were subjected to randomized complete block design as per the method out lined by Sundarraj *et al.* (1972). Critical differences were calculated at five per cent level. Five plants in each plot were randomly selected; plants in border rows were not used. Observations were recorded for plant height, number of branches per plant, days to 50% flowering, number of pod clusters per plant, number of pods per plant, number of pods per cluster, pod length, pod width, seed per pod, total yield per plant and yield ha^{-1}. Data were subjected to statistical analysis for estimating correlation co-efficient among all possible combination at phenotypic and genotypic levels using formula of Al-Jibouri *et al.* (1958) and path co-efficient analysis of Dewey and Lu (1959).

RESULTS AND DISCUSSION

The results of the analysis of variance for different quantitative characters for 31 genotypes of clusterbean are presented (Table 2). The results indicated that there is highly significant variation among the genotypes for almost all the characters under study, *viz.*, plant height (cm), number of branches, days to 50% flowering, pods per plant, clusters per plant, pods per cluster, pod length (cm), number of seeds per pod, yield per plant (g), yield per hectare (t) and pod breadth (cm). These results were in accordance with Dabas *et al.* (1982), Anila and Balakrishnan (1990), Hanchinamani (2004) and Saini *et al.* (2010).

The genotypic and phenotypic correlation studies were carried out for all the 11 characters to know the nature of relationship existing between vegetable pod yield and its component characters and are presented in Table 3.

Plant height was significantly and positively, correlated with pods per cluster, pods length and number of seed per pod.

Numbers of branches were significantly and positively, correlated with clusters per plant, pods per plant and with yield per plant and these findings were corroborated with Kamleshwar Kumar *et al.* (2013) in green gram. Days to 50% flowering had significant, negative, correlation with number of seeds per pod and pod length. Number of clusters per plant had a significant, negative, correlation with branches per plant, pods per plant and a positive, correlation with yield per plant and these findings with Kamleshwar Kumar *et al.* (2013) in green gram. Pods per plant had a significant, positive, correlation with clusters per plant, number of branches, yield per plant and a negative correlation with pod width. Pod length had a positive correlation with number of seed per pod, pod width and plant height. Number of seeds per pod had positive correlations with pod length and plant height and these findings are found in works of Kamleshwar Kumar (2013) in green gram. Pod width had significant, positive, correlations with pod length. Vegetable pod yield per plant had a positive correlation with pod yield ha^{-1} and a positive correlation with pods per plant and plant height. Yield ha^{-1} had significant, positive, correlation with yield and pods per plant.

There was a significant, positive correlation of pod yield ha^{-1} with plant height, pods per plant, pods per cluster and pod yield per plant which were supported with results of Arumugarangaraja *et al.* (2000), Menon *et al.* (1973), Singh *et al.* (2002) in clusterbean and Sharma *et al.* (2011) in Dolichos bean. Pod yield ha^{-1} is highly heritable, correlated in the desired direction, and should be considered for selection of genotypes for improvement.

Genotypic correlations were higher in magnitude than the phenotypic correlation indicting strong inherent relationship among the characters except few which could be due to modifying effects in the environment studied. Similar findings were reported by Saroj *et al.* (2013) in pigeon pea.

Correlation coefficients only indicate relationships of independent variables without specifying cause and effect.

Table 4: Genotypic and phenotypic path co-efficient analysis for total yield in clusterbean

	$^aX_1$	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	rG
X_1	0.155	-0.007	-0.03	-0.001	0.073	-0.006	-0.021	-0.138	0.036	0.108	0.169
	(0.027)	(0.006)	(-0.035)	(0.004)	(-0.028)	(0)	(0.064)	(0.05)	(0.001)	(0.068)	(0.156)
X_2	0.003	-0.346	0.07	0.022	0.106	0.05	0.033	0.15	-0.039	0.266	0.315*
	(0.001)	(0.208)	(0.083)	(0.047)	(-0.044)	(-0.009)	(-0.104)	(-0.055)	(-0.001)	(0.183)	(0.309)
X_3	0.024	0.123	-0.197	-0.068	-0.048	-0.095	-0.041	-0.101	0.087	0.399	0.082
	(0.004)	(-0.072)	(-0.242)	(-0.135)	(0.019)	(0.017)	(0.125)	(0.036)	(0.003)	(0.314)	(0.07)
X_4	0.002	0.081	-0.142	-0.094	-0.035	-0.123	-0.026	-0.075	0.057	0.485	0.131
	(0)	(-0.048)	(-0.162)	(-0.202)	(0.012)	(0.022)	(0.075)	(0.024)	(0.002)	(0.367)	(0.09)
X_5	0.067	-0.217	0.056	0.019	0.169	0.021	0.017	-0.013	-0.034	0.237	0.322
	(0.01)	(0.126)	(0.064)	(0.034)	(-0.072)	(-0.003)	(-0.055)	(0.003)	(-0.001)	(0.191)	(0.298)
X_6	0.005	0.09	-0.097	-0.06	-0.019	-0.193	-0.018	-0.059	0.056	0.739	0.443*
	(0)	(-0.051)	(-0.118)	(-0.124)	(0.006)	(0.035)	(0.052)	(0.02)	(0.002)	(0.567)	(0.389*)
X_7	-0.059	-0.206	0.145	0.044	0.054	0.062	0.055	0.17	-0.109	-0.186	-0.031
	(-0.01)	(0.123)	(0.172)	(0.086)	(-0.023)	(-0.011)	(-0.176)	(-0.062)	(-0.004)	(-0.126)	(-0.03)
X_8	-0.09	-0.216	0.083	0.029	-0.009	0.048	0.039	0.239	-0.056	-0.017	0.051
	(-0.014)	(0.122)	(0.092)	(0.052)	(0.002)	(-0.007)	(-0.117)	(-0.094)	(-0.002)	(0.003)	(0.037)
X_9	-0.04	-0.098	0.123	0.038	0.041	0.078	0.043	0.096	-0.139	-0.372	-0.231
	(-0.005)	(0.054)	(0.138)	(0.067)	(-0.014)	(-0.013)	(-0.126)	(-0.03)	(-0.005)	(-0.262)	(-0.197)
X_{10}	0.015	-0.081	-0.069	-0.04	0.035	-0.126	-0.009	-0.004	0.046	1.138	0.905**
	(0.002)	(0.043)	(-0.086)	(-0.084)	(-0.016)	(0.023)	(0.025)	(0)	(0.002)	(0.879)	(0.787**)

** significant at 1% and 5% level; Genotypic Residual = 0.0690 phenotypic Residual = 0.2800; Values in parentheses indicate phenotypic path coefficient; $^a X_1$ - Days to 50% flowering, X_2 = Plant height (cm), X_3 = Number of branches, X_4 = Clusters per plant, X_5 = pods per cluster, X_6 = Pods per plant, X_7 = Pod length (cm), X_8 = number of seeds per pod, X_9 = Pod breadth (cm), X_{10} = yield per plant (g) and X_{11} = yield (Mt ha^{-1}); r^G = Genotypic correlation coefficient

Use of path analysis makes it possible to resolve the correlation and provides direct, and indirect, contributions of characters. This enables breeders to specifically identify important component traits of yield and utilize the genetic stock for improvement.

The genotypic as well as phenotypic correlation coefficients between pod yield per hectare and different traits were subjected to path coefficient analysis separately partitions into direct as well as indirect effects via various yield contributing characters are summarized in (Table 4). Results of path analysis identified the positive, direct, effects of number of days to 50% flowering, number of branches, clusters per plant, pods per cluster, pods per plant and pod length on yield. Number of branches had positive, indirect, effects through, plant height, pod width, and pod yield per plant. Days to 50 % flowering had negative, indirect, effects through pods per cluster, pod width and yield per plant. Pods per plant had positive, indirect, effects through plant height, yield per plant and pod width. Pod width had positive, indirect, effects through numbers of branches, clusters per plant, pods per cluster and pod length. Indirect effects imply that selection for any of these characters would improve yield through the associated character. These results agree with Hanchinamani (2004) and Saini *et al.* (2010);

There is a positive association of plant height, pods per cluster, pods per plant and yield per plant with pod yield ha^{-1}. Pods per cluster, pod length, number of seed per pod and yield per plant were chief contributing characters towards yield ha^{-1}. Through present path anlysis study in clusterbean, it may be concluded that improvement in pod yield ha^{-1} could be bought by selection for component character like days to 50% flowering, pods per cluster, pod length, number of seeds per pod and pod yield per plant. Saroj *et al.* (2013) reported that revealed that pods/plant, days to 50% flowering, primary branches and secondary branches had maximum direct effect resulted significantly positive correlation with grain yield/plant in pigeonpea.

So, it may be concluded from these findings that correlation alone may not give complete information but when used in conjunction with path coefficient analysis will give a better measure of cause and effect relationship existing between different pairs of characters. Similar conclusions were reported by many workers like Elshiekh *et al.* (2012); Kamleshwar Kumar (2013)

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