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Association study for seed yield and quality and their contributing traits in cluster bean [*Cymopsis tetragonoloba* (L.) Taub.] genotypes

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Abstract
A correlation study was conducted using cluster bean genotypes collected from ACRIPIDA, RARS, Vijayapura. This study helps in identifying the characters which mainly contributing to the seed yield. Fifteen genotypes of cluster bean were evaluated during Kharif 2017 and observations recorded on growth and seed yield parameters. Correlation studies indicated that seed yield per plant had shown significant and highly positive correlation with parameters *viz.*, dry pod yield per plant (0.51), seed yield per hectare (0.47) and gum content (0.38) and shown positive correlation with number of seeds per pod and protein content. It is negative significantly and correlated with pod length (0.53), number of pods per plant (0.65), seed yield per plot (0.50) suggesting that which parameters may be considered as prime traits during the course of selection to have the higher potential of yield.

Keywords: *Cyamopsis tetragonoloba*, clusterbean, correlation, gum

Introduction
Cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] is popularly known as guar, is one of the most important kharif legumes and is well adapted to arid and semiarid regions of the world. The long deep taproot system enables the plant to grasp all the water in the soil making it an ultimate drought resistant crop. It is a self-pollinated crop belongs to family leguminosae having chromosome number 2n = 14. The seed pods grow in clusters giving guar the common name cluster bean. The origin of the crop has been suggested in India and Pakistan and tropical Africa. In India, this crop is mainly grown in Rajasthan, Gujarat, Haryana, Punjab and some parts of Uttar Pradesh and Madhya Pradesh and is an important component of cropping system in these regions. It is an annual plant, is grown for seed, green fodder, vegetable and green manuring. The endosperm of guar seed contains an important hydrocolloid named galactomannan. The galactomannan due to its specific qualities as thicker, binder and stabilizer has diversified industrial applications *viz.* paper, food, cosmetics, explosives, mining, petroleum, pharmaceuticals and well drilling etc. (Pathak *et al*., 2009) [15]. Recent rise in demand of guar in international market as a gum is attributed to its use in mining and petrochemical industries, where its use as viscous agent has been revolutionized the petrochemical industry and resulted in considerable increase in global natural gas production (Falasca *et al*., 2015) [5].

Throughout the world, guar is grown mostly in tropical deserts of Indian sub-continent. India share 80% of world gum production and only 20% is produced by all other countries like Pakistan, USA, Australia, South Africa, Sudan and Argentina (Kumar *et al*., 2013) [10]. Average gum production of cluster bean at national level is very low. Therefore, development of new cluster bean varieties having high gum content should be the major objective of the breeding program. Direct selection for gum content *per se* generally results in low genetic gain because of its low heritability in general, dictating plant breeders to realize the importance of component traits. Thus, for achieving rational improvement in gum content and its components, information about patterns of interrelationship among quantitative characters and knowledge of effective relationship provides a basis for formulating suitable selection methods for seed yield and gum components and pre-requisite to develop new varieties. The objective of present investigation was to assess the correlation among promising genotypes of cluster bean crop for seed yield and gum content. Hence, the present study was formulated to understand correlation.

Material and Methods
The present investigation was carried out at College of Agriculture Vijayapura, during Kharif-2017. The site is located at an altitude of 593 m above mean sea level and is geographically

positioned at 16^0 49' N latitude, 75^0 43' E longitude. It experiences hot humid summer and mild winter climate. The experimental material comprising of fifteen genotypes of cluster bean collected from All India Coordinated Research Project on Dry land Agriculture, [AICRP (DLA)], Regional Agricultural Research Station (RARS), Vijayapura. All recommended package of practices were followed to raise good crop. Experimental field was laid out in randomized block design with 15 genotypes and replicated thrice. The unit plot size was 3.6m x 2.4m, the row-to-row and plant-to-plant spacing was 45cm and 20cm, respectively. Fertilizers as 25 kg N_2, 75 kg P_2O_5 and 60 kg K_2O kg/ha were applied to rise good crop. All necessary cultural operations were done as and when required during the growing period. Data was recorded on five randomly selected plants per entry per replication for various characters namely, days to 50 per cent flowering, plant height (cm), pod length (cm), number of pods per plant, number of seeds per pod, number of seed per dry pod, 100 seed weight (g), dry pod yield per plant (g), seed yield per plant (g), seed yield per hectare (kg). The data were analyzed for estimation of phenotypic coefficient of variation. Simple correlation coefficients among the characters at phenotypic levels were analyzed following (Hayes *et al*, 1995 and Singh and Chaudhary 2003) [8, 18]. The phenotypic coefficient of variation was estimated according to the method of Panse and Sukhatme 1969 [13].

Result and discussion

The degree and direction of the inherent association (genotypic correlation) of characters apart from the observable correlation (phenotypic correlation) between two characters are important for the simultaneous selection of characters for genetic improvement. Correlation coefficients gave an idea about the mutual relationship between various plant characters and determined the component characters on which selection can be based for genetic improvement in yield. If a positive genotypic correlation was observed for pair of characters, certainly the improvement in one character will in turn improve the correlated character. If the improvement in one character results in a decrease in other character, this will also help the breeder in the selection of characters if necessary.

Seed yield parameters

For days to 50 per cent flowering positive and highly significant correlation with dry pod yield per plant (0.51**), seed yield per hectare (0.47**) and gum content (0.38**) was observed. While, plant height at 90 DAS had positive correlation with all the parameters *viz.*, pod length (0.23), number of pods per plant (0.26), hundred seed weight (0.08), number of seeds per pod (0.22), dry pod yield per plant (0.06), seed yield per plot (0.04), seed yield per hectare (0.05) and seed yield per plant (0.06). Whereas, pod length had positive and highly significant correlation with number of pods per plant (0.67**), dry pod yield per plant (0.53**), seed yield per plot (0.47**), seed yield per hectare (0.50**), gum content (0.40**) and hundred seed weight (0.33**). Meanwhile, number of pods per plant had positive and highly significant correlation with pod length (0.67**), number of seeds per pod (0.41**), dry pod yield per plant (0.81**), seed yield per plot (0.80**) and seed yield per hectare (0.80**). These findings are in line with the works of Kamleshwar Kumar (2013) [10] in case of green gram and Shabarish and Dharmatti (2014) [17] in cluster bean. Whereas, hundred seed weight had a positive and significant correlation with pod length (0.33*). These results are in conformity with those of Brindha *et al*. (1996) [3], Patel and Choudhari (2001) [14], Hanchinamani (2004) [7], Girish (2011) [6] and Malaghan (2012) [12] in cluster bean.

Number of seeds per pod had positive and highly significant correlation with number of pods per plant (0.41**) and dry pod yield per plant (0.51**). Whereas, it had a positive and significant correlation with seed yield per plot (0.34*), seed yield per hectare (0.32*) and gum content (0.03*). While, dry pod yield per plant had positive and highly significant correlation with days to 50 per cent flowering (0.51**), number of pods per plant (0.81**), pod length (0.53**), number of seeds per pod (0.51**), seed yield per plot (0.77**), seed yield per hectare (0.77**) and protein content (0.52**). Obviously, dry pod yield per hectare registered positive and highly significant correlation with days to 50 per cent flowering (0.47**), pod length (0.50**), number of pods per plant (0.80**) and seed yield per plot (0.98**). Similar kind of observations was made by Arumugarangarajan *et al*. (2000) [1], Hanchinamani (2004) [7] and Girish (2011) [6] in cluster bean.

Quality parameters

Protein content observed highly significant and positively correlation with dry pod yield per plant (0.52**). Whereas, it had positive correlation with plant height at 90 DAS (0.17), gum content (0.03) and seed yield per plant (0.52). Gum content on the other hand had, positive and highly significant correlation with days to 50 per cent flowering (0.38**) and pod length (0.40**). But, it had significant and positively correlated with number of seeds per pod (0.03*) and had positively correlated with seed yield per plot (0.18), seed yield per hectare (0.18), protein content (0.03) and seed yield per plant (0.12). Similar results were also reported by Biju *et al*. (2001) [2], Savitha *et al.* and (2012) [16] in dolichos bean.

Table 1: Phenotypic correlation coefficients analysis among growth, earliness and seed yield and quality parameters

Parameters	Days to 50% flowering	Plant height at 90 DAS	Pod length	Number of pods per plant	Hundred seed weight	Number of seeds per pod	Dry pod yield per plant	Seed yield per plot	Seed yield per hectare	Protein content	Gum content	Seed yield per plant
Days to 50% flowering	1.00	-0.10	-0.53**	-0.65**	-0.21	0.22	0.51**	-0.50**	0.47**	0.17	0.38**	-0.51
Plant height at 90 DAS		1.00	0.23	0.26	0.08	0.22	0.06	0.04	0.05	-0.05	-0.26	0.06
Pod length			1.00	0.67**	0.33*	0.17	0.53**	0.47**	0.50**	-0.26	0.40**	0.53
Number of pods per plant				1.00	0.21	0.41**	0.81**	0.80**	0.80**	-0.41**	-0.42**	0.81
Hundred seed weight					1.00	0.23	0.002	0.08	0.08	-0.03*	-0.51	0.002
Number of seeds per pod						1.00	0.51**	0.34*	0.32*	-0.49*	0.03*	0.51
Seed yield per							1.00	0.77**	0.77**	0.52**	-0.21	1.00

plant												
Seed yield per plot								1.00	0.98**	-0.43**	0.18	0.77
Seed yield per hectare									1.00	-0.43**	0.18	0.77
Protein content										1.00	0.03	0.52
gum content											1.00	0.12

Critical r_p value @ 1%= 0.29 ** → Indicates significant at p=0.01
Critical r_p value @ 5%= 0.38 * → Indicates significant at p=0.05

Conclusion

The yield and its component characters were studied to know their relationship. Seed yield per plant were days to 50% flowering, plant height at 90 days after sowing, pod length, number of pods per plant, hundred seed weight, number of seeds per pod, dry pod yield per plant, seed yield per plot and seed yield per hectare. Protein content showed highly significant and positive correlation with dry pod yield per plant (0.52). However, it had positive correlation with plant height at 90 DAS (0.17), gum content (0.03) and seed yield per plant (0.52), while for gum content the parameters like days to 50 per cent flowering (0.38**) and pod length (0.40**) had positive and highly significant correlation.

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