Study on association analysis for gum content in clusterbean [*Cyamopsis tetragonoloba* (L) Taub] genotypes

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ABSTRACT

Field experiment was carried out in the forage section of Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar, Haryana during kharif 2012. Thirty three genotypes of clusterbean were evaluated for various biometrical traits. All the genotypes were grown in randomized block design with three replications under rainfed conditions. The study helped in identifying the characters mainly contributing to the gum content. A critical perusal of correlation coefficients revealed that the gum content was positively and significantly associated with 100-seed weight while days to maturity and plant height had negative association. Pod length and number of seeds per pod were significantly correlated. Path coefficient analysis revealed that 100-seed weight had positive and high direct effect on gum content followed by number of seeds per pod and plant height. The results of the present study suggested that selection based on the 100-seed weight might bring improvement in gum content in clusterbean.

Keywords: Clusterbean; correlation; path analysis; direct effect; gum content

INTRODUCTION

Clusterbean [*Cyamopsis tetragonoloba* (L) Taub], popularly known as guar, is one of the most important kharif legumes and is well adapted to arid and semiarid regions of the world. It is a drought resistant crop as its deep taproot system makes it convenient to absorb all the water in the soil. It is self-pollinated crop belonging to family Leguminosae and sub-family Paplionaceae having chromosome number 2n= 14. Guar is named as clusterbean due to the clustering pattern of seed pods. The origin of the crop has been suggested in India and Pakistan (Vavilov 1951) and tropical Africa (Gillett 1958). In India, Guar is the imperative component of cropping system in Rajasthan, Gujarat, Haryana, Punjab and some parts of Uttar Pradesh and Madhya Pradesh. It is an annual plant grown for seed, green fodder, vegetable and green manuring. The endosperm of seed contains an important hydrocolloid named galactomannan having specific qualities as thicker, binder and stabilizer. It helps to diversify industrial applications viz paper, food, cosmetics, explosives, mining, petroleum, pharmaceuticals, well drilling etc (Pathak et al 2009). Guar gum is attributed to its use in mining industry and petrochemical where its use as viscous agent has been revolutionized the petrochemical industry resulting in considerable increase in global natural gas production (Falasca et al 2015).

In world, guar is grown by and large in tropical deserts of Indian sub-continent. India shares 80 per cent of world gum production and only 20 per cent is produced by all other countries like Pakistan, USA, Australia, South Africa, Sudan and Argentina (Kumar and Ram 2013). Average gum production of clusterbean at national level is very low. Therefore development of new clusterbean varieties having high gum content should be the major objective of the breeding programmes. 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 effect relationship provide a basis for formulating suitable selection methods for the gum components and pre-requisite to develop new varieties. Grafius (1959) strongly advocated the use of component breeding approach in order to achieve further improvement in gum. An attempt was made in the present investigations to assess the correlation among promising genotypes of clusterbean crop.

MATERIAL and METHODS

The experimental material for the present investigations comprised thirty three genotypes of clusterbean maintained by forage section of the Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar, Haryana. These genotypes were collected from different major guar growing states viz Haryana, Rajasthan, Gujarat, Punjab and other north Indian states (Table 1). The experimental material was grown in a randomized block design (RBD) with three replications during kharif 2012. Each genotype was planted in two rows of 4 m length with row to row distance of 45 cm with single row hand drill and after germination plant to plant distance of 15 cm was maintained by manual thinning by following all the recommended cultural practices during the crop season to raise a good crop. Observations were recorded on five competitive plants excluding border plants in each genotype. Data on individual plant were recorded for gum content, pod length, 100-seed weight, days to maturity, plant height and number of seeds per pod. Gum content in the seed was estimated by the method of Das et al (1977) and modified by Joshi (2004). The analysis of variance for randomized block design was carried out for individual character to test the significance of difference among the genotypes following the method as suggested by Panse and Sukhatme (1969). Correlation coefficients were determined by using the variance and covariance components as suggested by Al-Jibouri et al (1958). The path analysis was carried out as per the procedure described by Dewey and Lu (1959).

RESULTS and DISCUSSION

Mean squares due to genotypes were highly significant for all the characters except for 100-seed weight indicating existence of significant genetic variability among the genotypes. The coefficient of variation was low for all the traits indicating the effectiveness of the local control of experiment (Table 2).

The correlation coefficient among gum content and its components has been given in Table 3. The genotypic correlation coefficients were higher in magnitude than their subsequent phenotypic correlation coefficients for most of the character combinations suggesting that association between various characters was genetically controlled and environment had little influence in determining phenotypic correlation coefficients. The gum content was found positively associated with 100-seed weight while days to maturity and plant height had negative association. Similar findings were made on clusterbean crop grown at different locations by Hanchinamani (2004), Henry and Mathur (2008) and Girish et al (2012). Non-significant positive correlation of gum content with number of seeds per pod was also desirable association for clusterbean. Gum content and 100-seed weight were found negatively and significantly correlated with days to maturity and plant height. These results indicate that early and dwarf genotypes are more desirable in case of clusterbean. Number of seeds per pod showed positive and significant association with pod length while days to maturity and plant height had negative and significant association. The findings are in agreement with the results of Chaudhary et al (2004), Mahla and Kumar (2006), Henry and Mathur (2008), Saini et al (2010) and Girish et al (2012). Correlation between the characters could be due to linkage, pleiotropy or developmental factors. Correlation due to linkage could be broken through recombination but the later may not be easily controlled without bringing improvement in component characters. The correlations due to developmental causes were what gave rise to the idea of gum component compensation and the comment “man can arrange independent gene systems but the plant rearranges the combined results” (Grafius et al 1976). The inclusion of all the characters in selection programme is obviously not practicable and under these situations, correlation is quite useful in formulating an effective selection programme. In the light of results obtained in the present investigations, it is clear that 100-seed weight was comparatively more important component character for gum content.

Path-coefficient analysis provided more realistic and clear picture of the contribution of independent variables in the manifestation of dependent one (Table 4). Since it takes into consideration the direct as well as indirect effect of one variable through the other on the dependent characters, only those characters were taken into consideration for estimation of path-coefficients which had significant correlation

Table 1. Source of clusterbean genotypes

Source	Number of genotypes	Genotypes
RAU, Durgapura, Rajasthan	11	RGC 936, RGC 471, RGC 986, RGC 1033, RGC 1055, RGC 197, RGC 1066, RGC1003, RGC 1017, RGC1038, RGC 1002
CCS HAU, Hisar, Haryana	14	HG 2-20, HG 3-52, HG 870, HG 2-4, HG 884, HG 563, HG 75, HG 258, HG 365, HG 182, HG 100, HG 832, HVG 2-30, HFG 119
Gujarat Ayurved Universty, Jamnagar, Gujarat	3	GAUG 0013, GAUG 0001, GG 1
Miscellaneous	3	FS 277, ML 119, VIKAS 35
CAZRI, Jodhpur, Rajasthan	1	CAZG 97-1
PAU, Ludhiana, Punjab	1	PNB

Table 2. Analysis of variance for gum content and its component characters in clusterbean

Source of variation/character	Replications df= 2	Treatments df= 32	Error df= 64	$CD_{0.05}$	Coefficient of variation (CV)
Gum content (%)	7.54	19.82**	3.99	3.26	7.99
Pod length (cm)	0.07	2.43**	0.26	0.83	8.90
100-seed weight (g)	0.03	0.12**	0.25	0.26	5.11
Maturity (days)	4.37	535.31**	1.73	2.14	1.25
Plant height (cm)	17.94	3217.19**	21.29	7.54	3.75
Number of seeds/pod	1.98	1.07**	0.27	0.85	6.00

**Significant at 1% level of probability

Table 3. Phenotypic and genotypic correlation coefficient among gum content and its component characters in clusterbean

Character	Gum content (%)	Pod length (cm)	100-seed weight (g)	Maturity (days)	Plant height (cm)	Number of seeds/pod
Gum content (%)	1	-0.131^{NS}	0.674^{**}	-0.259^{**}	-0.159^{NS}	0.009^{NS}
Pod length (cm)	-0.186^{NS}	1	-0.040^{NS}	-0.110^{NS}	-0.039^{NS}	0.623^{**}
100-seed weight (g)	0.559^{**}	-0.046^{NS}	1	-0.357^{**}	-0.368^{**}	0.022^{NS}
Maturity (days)	-0.359^{**}	-0.130^{NS}	-0.497^{**}	1	0.821^{**}	-0.379^{**}
Plant height (cm)	-0.222^{*}	-0.059^{NS}	-0.510^{**}	0.825^{**}	1	-0.258^{**}
Number of seeds/pod	0.076^{NS}	0.798^{**}	0.104^{NS}	-0.539^{**}	-0.358^{**}	1

*Significant at 5% level of probability, **Significant at 1% level of probability, NS= Non-significant

Table 4. Direct and indirect effect of different characters on gum content in clusterbean

Character	Pod length (cm)	100-seed weight (g)	Maturity (days)	Plant height (cm)	Number of seeds/pod	Correlation with gum content
Pod length (cm)	-0.554	-0.027	0.023	-0.021	0.392	-0.186^{NS}
100-seed weight (g)	0.025	0.580	0.089	-0.186	0.051	0.559^{**}
Maturity (days)	-0.442	0.060	0.096	-0.131	0.491	-0.359^{**}
Plant height (cm)	0.032	-0.296	-0.147	0.365	-0.176	-0.222^{*}
Number of seeds/pod	-0.442	0.060	0.096	-0.131	0.491	0.076^{NS}

Residual effect: 0.55179

with gum content. It is obvious from the gist of results of path-coefficient analysis that 100-seed weight had positive and high direct effect whereas pod length had negative and high direct effect. Number of seeds per plant and plant height exerted the highest positive direct effect. However it contributed indirectly via pod length. Pod length had highest negative direct effect. These results are in conformity with the findings of Mahla and Kumar (2006). These results presented that 100-seed weight was the major gum-attributing trait and selection based on this trait would simultaneously improve the gum content in clusterbean.

The multitude of component characters, their positive and negative effects with one another and gum content along with environmental interactions make the prediction and determination of high gum content genotypes extremely difficult. Hence the selection should only be based on above mentioned component traits for faster genetic amelioration of gum in clusterbean. In the light of results obtained in the present investigations it is clear that 100-seed weight is comparatively more important component character for gum content. The improvement and selection based on this trait would also result in increase in gum content.

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