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Study the inheritance of branching behaviour and bearing pattern in clusterbean (*Cyamopsis tetragonoloba* (L.) Taub.)

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Abstract

The present study was carried out to know about inheritance of two characters namely branching behavior and bearing pattern in clusterbean [*Cyamopsis tetragonoloba* (L.) Taub] in F₂ segregating population. The initial experimental material consisted of F₁ seeds of three different crosses along with parents of clusterbean viz., F5 × RGC-1066, PNB × CAZG-16-10-3, IDB-29-2 × BSL(11×15). The segregating progenies were raised at 50 cm row to row and 20 cm plant to plant spacing. All the F₂ segregating plants of a cross were tagged and observations were recorded periodically till confirmation of the phenotype. The statistical analysis done by chi square method to find the goodness of fit for genetic ratio for different gene action involved in these segregating populations. The present study revealed that the branching behavior was controlled by two pairs of genes interacting in different pattern in two segregating F₂ population viz., PNB × CAZG-16-10-3 (9:6:1) exhibited polymeric gene action, F5 × RGC-1066 (9:3:4) exhibited with supplementary gene action, while IDB-29-2 × BSL (3:1) branching and bearing pattern controlled by one pair of gene which exhibited monogenic inheritance.

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Introduction

Guar (*Cyamopsis tetragonoloba* L.) as a legume crop of warm season with the deep and well-developed root system is drought tolerant which is cultivated mainly as a rain-fed crop in arid and semi-arid areas. Guar has been traditionally used as a vegetable, livestock feed and a green manure crop in agriculture. It could be cultivated in poor and marginal lands and requires lower agronomic

inputs. As a grain legume, it is able to symbiotic nitrogen fixation. Therefore, it can improve the soil quality in a cost-effective and natural way as a consequence the yield of subsequent crops. Although cluster bean is a minor crop but due to its better and finer guar gum qualities it is considered as an important cash crop for industrial gum production (Hymowitz & motlock 1963; Sharma & Gummagolmath 2012; Pathak & Singh 2010).

In agriculture guar gum is utilized as water retainer, soil aggregate and anticrusting agent. Guar gum has also greater utility in pollution control and acts as absorbent in waste water treatment in textile industry as flocculating and exchanging agent (Mahalonobis 1936). A mature clusterbean seed is composed of three parts: germ (43-47%), endosperm (35-42%), and seed coat (14-17%). About 80-90% of the endosperm is composed of highly viscous water-soluble hetero-polysaccharide called gaur gum (or) galactomannan, having a 1:2 ratio of galactose to mannose. Young pods are good source of protein, carbohydrate, vitamins ('A' and 'C'), and important minerals like calcium and iron (Kumar & Singh 2002). The crop due to cleistogamous nature is considered strictly self pollinated, however, out crossing to the tune of 0.5 to 7.9% has been reported (Saini et al. 1981). Understanding the inheritance of traits is an important step in plant breeding to augment such traits. This allows efficient incorporation of inherited desirable traits in the well-adapted lines/varieties with higher production potential. This study investigates the inheritance of the two characters branching and bearing habit (qualitative) in cluster bean.

Materials and Methods

The initial experimental material consisted of F₁ seeds of three different crosses along with parents of clusterbean [*Cyamopsis tetragonoloba* (L.) Taub] viz., F5 × RGC-1066, PNB × CAZG-16-10-3, IDB-29-2 × BSL (11X15), were provided by the guar improvement project executed at the ICAR-

CAZRI, Jodhpur. The segregating progenies were raised at 50 cm row to row and 20 cm plant to plant spacing for study branching and bearing pattern. All the F₂ segregating plants of a cross were tagged and observations were recorded periodically till confirmation of the phenotype.

Statistical analysis:

Chi-square method was used as per Singh and Chaudhary (1977) to test the goodness of fit for segregating ratios observed for branching and bearing pattern in Guar.

The chi square statistic is defined as

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

where, O_i is the observed number of cases in category i, and E_i is the expected number of cases in category i.

Results and Discussion

PNB × CAZG-16-10-3

In a cross PNB × CAZG-16-10-3 parent PNB is single stem and regular in bearing but parent CAZG-16-10-3 branched (bushy) in nature. All F₁ plants of the cross had single stem regular trait but in F₂ segregating population a total of 58 plants were detected as single stem while 38 plants were branched and 8 plants exhibited basal revealing gene interaction ratio of 9:6:1 for single stem, branched and basal plants. The χ^2 test for goodness- of- fit gave 0.36 value having the probability of 0.8-0.9 (Table 1). This suggested that two pairs of genes were segregating with polymeric gene effects where both the genes are required in dominant form to produce single stem (unbranched) trait.

Table 1. Chi-square analysis of F₂ segregating population of a cross PNB × CAZG-16-10-3

PNB × CAZG-16-10-3	O _i	E _i	O _i - E _i	(O _i - E _i) ²	(O _i - E _i) ² /E _i
Single stem	58	58.5	-0.5	0.25	0.004
Branched	38	39	-1	1	0.025

Basal	8	6.5	1.5	2.25	0.34
	104			χ^2	0.369
				P	0.8-0.9

#Expected ratio 9:6:1, non allelic gene interaction, polymeric gene effect

IDB-29-2 × BSL

In the cross IDB-29-2 × BSL, parent IDB-29-2 is single stem and regular in bearing but parent BSL bears branches on basal nodes only where upper part remains branchless with regular podding in nature. All the F_1 plants of this cross were found single stem regular. In F_1 single stem trait behaved as dominant on basal trait. In F_2 population a total of 130

plants were detected as single stem regular while 40 plants exhibited basal branching. Trait seems to follow simple Mendelian monogenic inheritance. A goodness-of-fit test revealed a good fit of ratios in 3:1 segregation pattern for single stem regular and basal plants having a probability of 0.5-0.7 (Table 2). Single stem apparently was dominant and inherited in a monogenic way.

Table 2. Chi-square analysis of F_2 segregating population of a cross IDB-29-2 × BSL

IDB-29-2 × BSL	O_i	E_i	$O_i - E_i$	$(O_i - E_i)^2$	$(O_i - E_i)^2 / E_i$
Single stem	130	127.5	2.5	6.25	0.049
Basal	40	42.5	-2.5	6.25	0.147
Total	170			χ^2	0.196
				P	0.5-0.7

#Expected ratio 3:1 Allelic gene interaction, monogenic

Cross F5 × RGC-1066

An F_2 population was raised involving parents $F_5 \times$ RGC-1066 where, parent F_5 is having branched trait and parent RGC-1066 is single stem intermittent. In a segregating population of this cross total of 85 plants were

detected as branched, while 32 plants detected as single stem and 46 plants were exhibited basal. A ratio of 9:3:4 for branched, single stem and basal revealed by chi-square test (Table 3). This suggested that two pairs of gene interact with supplementary gene effect.

Table 3. Chi-square analysis of F_2 segregating population of a cross $F_5 \times$ RGC-1066

$F_5 \times$ RGC-1066	O_i	E_i	$O_i - E_i$	$(O_i - E_i)^2$	$(O_i - E_i)^2 / E_i$
Branched	85	91.68	-6.68	44.62	0.48
Single stem	32	30.56	1.44	2.07	0.067
Basal	46	40.75	5.25	27.56	0.67
	163			χ^2	1.217
				P	0.5-0.7

#Expected ratio 9:3:4, supplementary gene effect

Conclusion

The inheritance of two characters namely branching behavior and bearing habit was studied in clusterbean for F_2 population. These traits were controlled by two pairs of genes in three segregating F_2 population viz., PNB × CAZG-16-10-3 (9:6:1), $F_5 \times$ RGC-1066 (9:3:4), while IDB-29-2 × BSL branching

pattern controlled by one pair of gene which exhibited monogenic inheritance. These traits controlled by major gene and showed complex pattern of inheritance. Furthermore, should be confirming in next segregation generation and additional cross involving different parent.

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