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Evaluation of cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] genotypes for seed yield and quality parameters

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Abstract
The present investigation was carried out with 15 cluster bean genotypes during Kharif- 2017 following RCBD with three replications. Significant variations were recorded among genotypes for growth, yield and quality parameters. Off 15 genotypes, RGC-197 (8.36), RGM-112 (8.15) and Gourishankar-9 (8.10), showed significantly higher number of seeds per pod. The genotypes HG-365, RGC-986 and GG-1 have shown significant higher number of seeds per plant (2.98 g, 2.86 g and 2.80 g respectively) and higher dry pod yield per plant (65.07g, 64.47g and 63.33 g respectively). The genotype HG-365 gave significantly higher seed yield per plant (16.67 g) and seed yield per hectare (443.3 kg). For the quality parameters, the genotype HG-870 registered maximum percentage of gum (35.23%) which was on par with RGC 986 (34.73.%) and RGC-1002 (33.47%) whereas, the genotype RGC-1002 recorded significantly higher crude protein content (35.80%) and it was on par with RGC-1033 (35.07%), RGC-1038 (33.40%) and HG-870 (33.10%).

Keywords: *Cyamopsis tetragonoloba* (L.) genotypes

Introduction
Cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] [2n=14], is one of the important under exploited leguminous vegetables. It is commonly called by the names Guar, Chavalikayi, Gorkayi, Khutt, Govar and Kothavare in different parts of the country. Guar is a drought tolerant, hardy, deep rooted, and short day erect or bushy annual plant (Purseglove, 1981) [7], used as a multipurpose legume mainly grown for its tender vegetable and seed endospermic gum in arid and semi arid regions of India. Young pods are chief source of energy (16 Kcal), 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. India is the major guar producer accounting for 80% of the world's production. In India, guar is being grown mainly in arid and semiarid regions of North Western states of Rajasthan, Gujarat, Haryana, Punjab, parts of Uttar Pradesh, Madhya Pradesh and Tamil Nadu covering about 3.34 million hectares with a production of 0.4 million tonnes of guar seed. Rajasthan occupies the largest area under guar cultivation (82.1%), followed by Haryana (8.6%), Gujarat (8.3%) and Punjab (1%) (Pathak *et al*., 2010) [8]. Rajasthan is the largest producer accounting for 70% of total guar production followed by Gujarat, Haryana and Punjab. The productivity of cluster bean ranges from 474 kg/ha in Rajasthan to 1200 kg/ha in Haryana (Ahlawat *et al*., 2013) [1]. Thus, the total area of cluster bean in India is 4.25 million hectare and production is 2.41 million tonnes with productivity of 0.57 million tonnes/ha in 2014. Looking to the multidimensional application of cluster bean as an industrial crop which has wide adaptability under arid drought conditions, there is a prime need for its improvement. Breeding varieties suited to specific agro-ecological conditions for seed and gum purpose is need of the hour for Northern parts of Karnataka (Zone 2 and 3) in particular. Keeping the above points in mind, the present investigation was taken up to study the mean performance of the genotypes for identification of high yielding varieties.

Material and Methods
Fifteen cluster bean genotypes were collected from All India Coordinated Research Project on Dry Land Agriculture, [AICRP (DLA)], Regional Agricultural Research Station (RARS), Vijayapura, for conducting experiment at College of Agriculture, Vijayapur. They were raised during Kharif-2017 at college research block, College of Agriculture Vijayapura, in a Randomized Block Design with three replications at a spacing of 45cm x 20cm. Uniformly grown five plants under each replication were selected and tagged for recording observations on the following seed yield and quality characters *viz*., number of seeds per pod, hundred seed weight (g), dry pod yield per plant (g), seed yield per plant (g) and seed yield per hectare (kg),

crude protein (%) and gum content (%) content. Data were further subjected to analysis of variance (ANOVA) following randomized complete block design (RCBD) (Panse and Sukhatme, 1967) [7].

Seed yield parameters

The total number of seeds per pod was calculated on ten randomly sampled pods from five labelled plants and the means were calculated. The weight of hundred seeds from the pods picked at random in each experimental plot was taken and the mean hundred seed weight was worked out and expressed in grams. The dry pod yield was computed by adding the weight of dry pods (g) harvested in subsequent pickings from the tagged plants in each experimental plot after maturity. The seed yield was computed by adding the weight of seeds (g) harvested from the tagged plants in each experimental plot after maturity. The seed yield per hectare was computed by summing up all the harvested pods in each treatment, converted to seed yield per hectare and expressed in kilograms per hectare.

Quality parameters

The content of gum in seeds was estimated as per the procedure described by Das *et al.* (1977), while the nitrogen content of grains was estimated in per cent, through Microkjeldhal method (Juliano *et al*., 1973) and the value was multiplied with a factor 6.25 to arrive at the protein content expressed in per cent.

Result and Discussions

Seed yield parameters

Significant differences were observed among the genotypes with respect to number of seeds per pod, hundred seed weight, dry pod yield per plant, seed yield per plant and seed yield per hectare. The genotype RGC-197 (8.36) showed significantly higher number of seeds per pod followed by RGM-112 (8.15), Gourishankar-9 (8.10), GAUG-13 (8.05), RGC-471 (7.88), HG-100 (7.83), and HG-365 (7.83) (Table 1), which were on par with each other. However, significantly higher hundred seed weight was observed in the genotype HG-365 (2.98 g) and the genotypes RGC-986 (2.86 g), GG-1 (2.80 g) and RGC-197 (2.63 g) were on par with HG-365. Production of more number of seeds might be a genotypic character. These results are in confirmation with those of Arora *et al*. (2011) [2], and Rai *et al*. (2012) [2] in cluster bean.

The genotype HG-365 (65.07 g) recorded significant higher dry pod yield plant (fig 1). Genotypes RGC-986 (64.47 g) and GG-1 (63.33 g) were on par with HG-365. The genotype HG-365 (16.67 g) gave significantly higher seed yield per plant followed by GG-1 (14.63 g) and RGC-986 (11.60 g) while lower seed yield per plant was recorded in HG-870 (6.73 g). As anticipated genotype HG-365 (443.33 kg) recorded significant higher seed yield per hectare (fig 1). For the entire seed yield attributing characters and seed yield, genotypes HG-870 (220.00 kg) recorded the least. The genotype HG-365, RGC-986 and GG-1 showed superiority over the rest due to production of higher dry matter that leads to effective translocation and distribution of photosynt hates from source to sink in turn more pod yield per plant. Similar kind of observations made by Girish (2011) [4] and Gangadhara (2013) [3] in case of cluster bean.

Quality parameters

The gum and protein content varied significantly among the genotypes (Table 2). The genotype HG-870 recorded maximum gum content (35.23%), which was on par with RGC 986 (34.73.%) and RGC-1002 (33.47%), whereas, genotype RGC-1033 registered minimum gum content (25.23%). A close examination of the results on gum content suggested the top ranking genotypes were HG-870, RGC-986 and RGC-1002 (fig 2). Some of these genotypes were found in superior ranks in respect to vegetative characters like number of branches per plant (HG-870) and plant height (RGC-986), and also good in seed size as evident from the figures on hundred seed weight (RGC-986). However, pod yield found to have little influence on both seed weight and gum content.

The genotype RGC-1002 recorded significantly higher percentage of crude protein (35.80%), which was on par with RGC-1033 (35.07%), RGC-1038 (33.40) and HG-870 (33.10%). However minimum crude protein content was recorded in the genotypes RGC-986 (25.43%). As protein content depend on nitrogen concentration in seed which was higher in seed of genotypes RGC-1002, RGC-1003, RGC-1038 and HG-870 because of their genetic composition. Similar results on variation among the genotypes regarding protein content was also reported by Mehta *et al*. (2005) [6] in garden pea and Khatun *et al*. (2010) [5] in chick pea.

Cost economics

Benefit cost (B:C) ratio varied among the genotypes (Table 3) due to variation in yield contributing characters. Genotype HG-365 (3.39) recorded higher B: C ratio followed by RGC-986 and GG-1 (3.16 each) and least was recorded in the genotype HG-870 (1.18).

Table 1: Performance of cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] genotypes for seed yield characters

Treatments	Genotypes	No. of seeds per pod	Hundred seed weight (g)	Dry pod yield per plant (g)	Seed yield per plant (g)	Seed yield per hectare (kg)
T_1	GAUG-13	8.05	2.45	46.87	8.37	350.00
T_2	RGM-112	8.15	2.21	44.13	9.47	370.00
T_3	GG-1	7.20	2.80	63.33	14.63	420.00
T_4	RGC-1002	7.09	2.43	24.73	7.23	236.67
T_5	RGC-1033	5.93	1.97	29.53	7.50	250.00
T_6	RGC-1038	6.44	2.57	25.40	6.83	220.00
T_7	RGC-197	8.36	2.63	34.07	8.00	320.00
T_8	RGC-471	7.88	2.43	45.73	8.37	360.00
T_9	RGC-986	7.22	2.86	64.47	11.60	401.67
T_{10}	HG-100	7.83	2.42	59.27	10.00	381.67
T_{11}	HG-365	7.83	2.98	65.07	16.67	443.33
T_{12}	HG-884	7.14	1.87	33.93	8.50	308.33
T_{13}	HG-870	5.47	1.84	16.27	6.73	220.00
T_{14}	Gourishankar-9	8.10	2.58	33.93	7.77	280.00

T_{15}	Gourishankar-15	6.14	2.06	26.53	7.50	271.67
	Mean	7.26	2.41	40.88	9.28	322.22
	S. Em. ±	0.23	0.13	1.68	0.31	7.36
	C. D. at 5%	0.66	0.39	4.88	0.90	21.32

Table 2: Performance of cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] genotypes for quality parameters

Treatments	Genotypes	Gum content (%)	Crude protein (%)
T_1	GAUG-13	30.37	28.43
T_2	RGM-112	30.17	29.67
T_3	GG-1	25.90	29.17
T_4	RGC-1002	33.47	35.80
T_5	RGC-1033	25.23	35.07
T_6	RGC-1038	25.73	33.40
T_7	RGC-197	27.10	27.33
T_8	RGC-471	27.17	28.27
T_9	RGC-986	34.73	25.43
T_{10}	HG-100	27.00	30.27
T_{11}	HG-365	31.80	31.73
T_{12}	HG-884	29.90	30.27
T_{13}	HG-870	35.23	33.10
T_{14}	Gourishankar-9	30.37	31.17
T_{15}	Gourishankar-15	31.00	30.07
	Mean	29.68	30.61
	S. Em. ±	1.05	1.25
	C. D. at 5%	3.05	3.63

Table 3: Economics for different cluster bean genotypes

Treatments	Cost of cultivation (Rs. ha^{-1})	Seed yield (q/ha)	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B : C ratio
T_1	40,398.00	3.50	1,40,000.00	99,602.00	2.47
T_2	40,398.00	3.70	1,48,000.00	1,07,602.00	2.66
T_3	40,398.00	4.20	1,68,000.00	1,27,602.00	3.16
T_4	40,398.00	2.37	94,800.00	54,402.00	1.35
T_5	40,398.00	2.50	1,00,000.00	59,602.00	1.48
T_6	40,398.00	2.20	88,000.00	47,602.00	1.18
T_7	40,398.00	3.20	1,28,000.00	87,602.00	2.17
T_8	40,398.00	3.60	1,44,000.00	1,03,602.00	2.56
T_9	40,398.00	4.20	1,68,000.00	1,27,602.00	3.16
T_{10}	40,398.00	3.82	1,52,800.00	1,12,402.00	2.78
T_{11}	40,398.00	4.43	1,77,200.00	1,36,802.00	3.39
T_{12}	40,398.00	3.08	1,23,200.00	82,802.00	2.05
T_{13}	40,398.00	2.20	88,000.00	47,602.00	1.18
T_{14}	40,398.00	2.80	1,12,000.00	71,602.00	1.77
T_{15}	40,398.00	2.72	108800.00	68,402.00	1.69

Note: Seed cost: Rs. 400 / kg

Genotype HG-365 Genotype GG-1 Genotype RGC-986

Fig 1: Dry pods and seeds of elite cluster bean genotypes

Genotype HG- 870

Genotype RGC- 986

Fig 2: Dry seeds and extracted gum of elite cluster bean genotypes

Conclusion

The genotype HG-365 recorded higher seed yield per plant and seed yield per hectare that was because of more number of seeds per pod and seed weight and followed by the GG-1 and RGC-986. Quality of seed with respect to gum, genotype HG-870 recorded higher content followed by genotypes RGC-986 and RGC-1002, while more of crude protein content was recorded in the genotype RGC-1002 followed by genotypes RGC-1033 and RGC-1038.

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