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Evaluation of Elite Cluster Bean [*Cyamopsis tetragonoloba* (L.)Taub.] Genotypes for Vegetable and Gum Purpose in Northern Dry Zone of Karnataka

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Abstract: The study was conducted on evaluation of elite cluster bean [*Cyamopsis tetragonoloba* (L.)Taub.] genotypes for vegetable and gum purpose in the northern dry zone of Karnataka during *rabi* season at College of Horticulture, Bagalkot, Karnataka with twelve genotypes collected form difference sources. All genotypes showed significant difference for all the characters studied. The maximum per cent of germination was in CAZG-06-1 (94.44%), Pusa Navabahar (86.44 cm) was the tallest among the genotypes and Gujarat Local (7.44) recorded higher number of branches per plant. Rajendra Nagar Local and Jodhpur Local took least number of days (22.00 days each) for initiation of flowering. Highest pod yield (158.72 q/ha) was in CAZG-06-1 followed by IC-11704 . The dry pod yield per plant and seed yield was significantly higher in CAZG-06-1. CAZG-06-1 was also superior with respect to gum content (32.86%). The highest protein content was in Rajendra Nagar Local (38.33%). The least crude fibre content was in AVT-II- GR-4 (4.10%). Pod yield per hectare was highly significant and positively correlated with number of pods per cluster (0.933), 100 seed weight (0.792) and ten dry pod weight (0.679). Dry pod yield per plant was highly significant and positively correlated with guar gum content (0.583), number of dry pods per plant (0.830) and number of seeds per pod (0.605). Seed yield per plant was significant positive correlation with dry pod yield per plant (0.594), 100 seed weight (0.706), gum content (0.579) and number of branches per plant (0.621). All cluster bean genotypes were moderately susceptible to powdery mildew except PusaNavabahar and Rajendra Nagar Local which were susceptible to powdery mildew. Economics of different genotypes revealed that highest net profit from CAZG-06-1 genotype followed by IC-11704 and RGC-1047.

Keywords: Cluster bean, *Cyamopsis tetragonoloba* (L.) Taub, Gum content, Dry pod yield, Protein, Crude fibre

Vegetables play a vital role in nutritional security of mankind being reliable sources of necessary vitamins, minerals, amino acids and fair amount of fibres. A large number of underexploited leguminous species have a great potential in contributing nutritious food, feed and forage needs in the tropical countries even though almost half of the population are under malnourished (Maphosa and Jideani 2017). Cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] is one of the important underexploited leguminous vegetables belonging to family Fabaceae. Guar is a drought tolerant, hardy, deep rooted and multipurpose legume plant mainly grown for tender vegetable and seed endospermic gum in arid and semi-arid regions of India. Seed of cluster bean with large endosperm contains galactomannan type of gum, which forms a viscous gel even in cold water and has diversified industrial applications *viz.,* paper, food, cosmetics, mining, petroleum, well drilling, textile and jute, pharmaceuticals (Senapati et al 2006, Pathak et al 2009). Cluster bean gum has emerged as the most important agro-chemical, which is non-toxic, eco-friendly and generally recognized as safe (GRAS) by Food and Drug Administration (FDA). In India, cluster bean crop is cultivated mainly during *kharif* season. It occupied an area of 31.40 lakh hectare with a total production of 15.19 lakh tons of guar seed during 2019-20 in the country (Anonymous 2020). The country exports over 1.17 lakh tons of guar and its derivatives annually. India is the major exporter of guar gum to the world and exports various forms of Guar products to a large number of countries. The country has exported 234,872 MT of guar gum to the world for the worth of Rs. 1949 Crores during the year 2020-21 (Bajwan *et al*., 2023).

Looking to the multidimensional application of cluster bean as a vegetable and 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 vegetable and seed gum purpose is urgently needed for northern parts of Karnataka (Zone 2 and 3). Though, Central Arid Zone, Bikaner and other institutes have developed and identified certain guar genotypes for dual purpose but they have not been exploited and confirmed for their potentiality under varied agro-climatic conditions. Hence, there is a urgent need for identification of local as well as superior genotypes with respect to tenderness and dual purpose which are suited for northern dry zone of Karnataka. Therefore, the present study was undertaken to evaluate the performance of cluster bean genotypes for growth, vegetable pod yield and seed yield, to determine the association of seed yield with other contributing parameters, to analyze the seed gum, protein content and other quality parameters in cluster bean genotypes.

MATERIAL AND METHODS

Experimental site: The experiment was carried out at College of Horticulture, Bagalkot (Karnataka). The chemical properties of the soil from experimental plot are presented in Table 1. The pH of soil is 7.20 with 178.78 kg per hectare of available nitrogen, 29.00 kg per hectare of available phosphorus and 236.00 kg per hectare of available potassium.

Location and climate: Bagalkot falls under agro-climatic zone-3 northern dry zone of region-2 of Karnataka situated at 16°46' North latitude, 74°59' East longitude and at an altitude of 533.00 meters above the mean sea level. It has the benefit of both South-West and North-East monsoons. The temperature of this area ranges from 16.24^{0}C to 30.50^{0}C and relative humidity from 38.06 to 88.46 per cent with a rainfall of 147 mm during the experimental period (2021-22) as per the observation of the meteorological data recorded at meteorological observatory of the Agricultural Research Station, Bagalkot.

Experimental material: Cluster bean germplasm comprising of 12 genotypes collected from different sources formed the experimental material. The experiment was laid out in a completely randomized block design with three replications. Each genotype in each replication was represented by plot size (2.00 m X 2.70 m) of six rows of 2 m length, 60 plants per treatment per replication with spacing of 45 cm X 20cm. All other crop management practices were carried out as per the package of practices of University of Horticultural Sciences, Bagalkot (Anonymous 2018).

Observations on growth, yield and quality parameters: For recording of all the growth and yield characters, six plants in each experimental plot were randomly selected avoiding border plants. Out of them, three plants were considered for vegetable purpose and three for seed purpose and they were tagged separately for taking observations on various growth and yield parameters by picking tender green pods at weekly intervals from plants tagged for vegetable purpose. Another three plants were left for seed yield parameter purpose. The seed yield and other quantitative and qualitative parameters were recorded after harvesting the fully matured pods. The observations on all growth characters were recorded by using three randomly selected tagged plants from each experimental plot and the average of the plants was computed and recorded. The germination percentage was worked out after the final germination. Plant height (cm) was measured from ground level to the tip of the plant on 90th day after sowing and recorded. Number of branches arising from the main stem was counted on 90th day after sowing and recorded. Number of days taken from the date of sowing to first flower opening was counted and recorded as days to first flowering. The days were counted from the date of sowing to the flowering of 50 per cent of the tagged plants in each experimental plot and recorded as days to 50 per cent flowering. The days were counted and recorded from the date of sowing to days at which first vegetable pod picking. The length (cm) of each selected pod was measured from the base to tip and average over ten pods was computed and recorded. The breadth (cm) of the selected pods was measured (by calipers) at the center of the pods and average over ten pods was computed. Ten fresh green vegetable pods harvested from the tagged plants selected randomly were weighed. The weight of green vegetable pods

Table 1. Growth parameters of cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] genotypes

Genotype	Germination (%)	Plant height (cm) (90 DAS)	No. of branches per plant (90 DAS)
Pusa Navabahar	90.55	86.44	0
IC-11704	90.55	51.55	5.44
RGC-1025	90	66.32	5.77
CAZG-06-1	94.44	63.22	5.88
HGS-881	61.1	77.21	6.76
AVT-II GR-4	82.22	69.33	7.33
RGC-1047	93.88	60.99	5.44
Rajendra Nagar local	78.32	75.55	0
Gujarat local	64.99	74.99	7.44
Jodhpur local	58.32	76.55	6.6
Bikaner local	81.44	66.77	6.76
Shree ram gum-1	79.88	64.88	7.03
CD (p=0.05)	20.01	11.58	1.39

harvested from the tagged plants was recorded separately. The average of all the harvests was considered as pod yield per plant per picking and expressed in grams. After four vegetable pickings, the remaining pods were left on the plant and harvested for seed purpose after maturity. The vegetable pod yield per plot was computed.

Seed yield parameters: The number of clusters produced by the tagged plants in each experimental plot was counted and average was calculated. The number of pods from tagged plants in each experimental plot was counted and average was calculated. The weight of ten dry pods randomly selected from the tagged plants was recorded. The dry pod yield was computed by adding the weight of dry pods (g) harvested in subsequent pickings from the tagged plants after maturity. The dry pods were randomly picked from tagged plants and seeds were extracted. The number of seeds was counted. The seed yield was computed by adding the weight of seeds (g) harvested from the tagged plants after maturity. One hundred seeds from each experimental plot were counted and their weight (g) was recorded.

Seed quality parameter: Gum content of endosperm of seed was estimated by adopting the methodology suggested by Association of Official Analytical Chemists (Anonymous 1958). Total nitrogen content in dry seed powder from each genotype was estimated by Micro-Kjeldahl method (Subbaiah and Asija 1956). Crude protein was calculated by multiplying the nitrogen value by 6.25 (Oser 1965). The values obtained were expressed in percentage. Crude fiber content was estimated as per standard AOAC procedure (Anonymous 2005).

Disease incidence: The per cent powdery mildew incidence was recorded as per cent leaf area infected for the genotypes which were rated from zero to four disease scale (Girish 2011).

Economics: The benefit cost ratio was worked out by the ratio of total gross returns (Rs./ha) to total cost of cultivation (Rs/ha).

Statistical analysis: Statistical analyses of experiments were performed using Web Agri Stat Package (WASP) Version 2 (Jangam and Thali 2010).

RESULTS AND DISCUSSION

Growth parameters of cluster bean genotypes: The genotypes differed significantly with respect to the different parameters like germination per cent, plant height and number of branches per plant at 90 days after sowing. The maximum per cent of germination was in CAZG-06-1 (94.44%) followed by RGC-1047 (Table 1). Plant height in Pusa Navabahar (86.44 cm) was maximum followed by HGS-881 and Jodhpur Local).,Gujarat Local recorded significantly higher number of branches per plant (7.44) followed by AVT-II GR-4 and Shreeram Gum-1 The variation in growth parameter of the cluster bean genotypes d may be attributed to their inherent genetic makeup and response to environmental condition. These results are in accordance with the results obtained by Malaghan (2012) and Rai et al (2012) in cluster bean for germination, plant height and number of branches.

Fresh pod yield of cluster bean genotypes: Significant difference was observed for number of days to first flowering, number of days to 50 per cent flowering and number of days to first vegetable pod harvest in cluster bean. The genotype Rajendra Nagar Local and Jodhpur Local took least number of days for initiation of flowering (22.00 days each) and 50 per cent of flowering (26.66 days each). Rajendra Nagar Local also required least number of days to mature (32.52 days) whereas, the genotype Bikaner Local more number of days for initiation of first flower and fifty per cent flowering (26.83 and 32.16 days, respectively). The first vegetable pod harvesting period was delayed in the genotype RGC-1025 and Bikaner Local (44.83 days each). This may be attributed to the inheritant genetic makeup and environmental factors. Significant difference was found with respect to length of the pod, pod breadth, pod weight, pod yield per plant per picking, pod yield per plot and pod yield per hectare among the genotypes (Table 2). Highest pod length and breadth was in the genotype Pusa Navabahar (11.83 cm and 0.92 cm, respectively). Highest pod weight was r in the genotype Pusa Navabahar (31.66 g) followed by Rajendra Nagar Local , IC-11704 and Gujarat Local. Apparently vegetable pod yield of some prominent genotypes were directly proportional to pod length, pod width, number of pods and pods weight. Similar observations were also been made by Girish (2011) and Malaghan (2012).

The genotype Pusa Navabahar gave the highest vegetable pod yield of 78.70 g per plant per picking. The maximum number of dry pods per plant and seed yield per plant after vegetable pod picking was recorded in CAZG-06-1 (91.33 and 31.38 g, respectively) and the maximum dry pod yield per plant after vegetable pod picking was in CAZG-06-1 (42.59 g). The difference in pod yield per plant per picking could be attributed due to the highly significant and positive relationship with the pod length (r= 0.710), pod width (r= 0.701) and pod weight (r= 0.752). These are due to genetic makeup of the genotypes and for set of environment under which these genotypes are grown.

Highest vegetable pod yield per plot (8.72 kg) and pod yield per hectare (158.72 q) were recorded by genotype CAZG-06-1 and the least in Jodhpur Local (2.45 kg, 46.14 q, respectively). Genotypes Shreeram Gum-1 (2.94 kg/plot),

AVT-II GR-4 (2.97 kg/plot), Bikaner Local (2.72 kg/plot), Gujarat Local (2.48 kg/plot) and Jodhpur Local (2.45 kg/plot) were on par with each other with respect to pod yield per plot. This difference in pod yield per plot and per hectare could be attributed due to the highly significant and positive relationship with the increase in germination per cent (r= 0.733) results in good crop standard, number of pods per cluster (r= 0.931) apart from the genetic makeup and the influence of environment. These findings are in conformity with the results of Rai et al (2012) and Ashwini et al (2019) in cluster bean.

Dry pod and seed yield of cluster bean genotypes: Significant difference was observed among the genotypes with regard to number of clusters per plant, number of pods per cluster, number of pods per plant, ten dry pods weight, dry pods yield per plant, number of seeds per dry pod, seed yield per plant and hundred seed weight (Table 3). The genotype HGS-881 recorded significantly higher number of cluster per plant (55.66). Genotype CAZG-06-1 had highest number of pods per cluster (7.69) and genotypes HGS-881 and RGC-1025 have same number of pods per cluster (3.64 each). The highest number of pods per plant was recorded in RGC-1047 (203.88) which was on par with HGS-881 (203.11). The highest number of pods per plant in these genotypes was due

Table 2. Pod yield and yield attributes of cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] genotypes

Genotypes	Pod length (cm)	Pod width (cm)	Ten fresh pod weight (g)	Pod yield/ plant per picking (g)	Duel purpose			Pod yield per plot (kg/plot)	Pod yield per ha. (q/ha)
					No. of dry pods per plant	Dry pod yield per plant (g)	Seed yield per plant (g)		
Pusa Navabahar	11.83	0.92	31.66	78.70	17.33	8.87	5.50	4.93	91.35
IC-11704	10.63	0.86	25.66	48.24	59.00	33.97	25.31	7.55	138.82
RGC-1025	7.96	0.76	17.66	24.87	39.00	20.68	16.43	4.03	74.63
CAZG-06-1	7.90	0.76	17.50	52.99	91.33	42.59	31.38	8.72	158.72
HGS-881	7.57	0.75	14.66	50.92	41.33	25.82	18.59	3.10	56.26
AVT-II GR-4	5.61	0.72	9.83	24.04	32.66	21.84	16.27	2.97	53.51
RGC-1047	7.24	0.81	16.16	39.93	77.33	34.16	26.05	6.76	127.43
Rajendra Nagar local	10.40	0.92	26.16	63.81	12.66	5.57	3.37	4.13	78.15
Gujarat local	8.83	0.84	22.00	67.02	57.00	35.98	22.13	2.48	46.91
Jodhpur local	6.69	0.72	14.83	54.81	38.66	22.97	15.89	2.45	46.14
Bikaner local	6.79	0.72	14.16	34.04	66.00	30.83	23.04	2.72	51.35
Shree ram gum-1	6.21	0.73	13.16	43.88	68.00	32.43	25.51	2.94	55.29
CD (p=0.05)	1.49*	0.10*	4.25*	12.70*	7.17*	2.78*	2.32*	1.11*	20.82*

Table 3. Seed yield and yield attributes of cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] genotypes

Genotypes	Number of cluster/plant	Number of pods/cluster	Number of pods/plant	Ten dry pod weight (g)	Dry pod yield per plant (g)	Number of seeds per dry pod	Seed yield per plant (g)	Hundred seed weight (g)
PusaNavabahar	28.55	2.06	59.55	7.44	21.66	6.77	13.00	3.52
IC-11704	21.66	2.81	59.77	5.88	25.77	7.23	26.83	3.41
RGC-1025	26.55	3.64	96.88	3.55	24.33	6.14	41.33	3.24
CAZG-06-1	17.66	7.69	133.66	5.84	52.66	7.90	53.61	3.91
HGS-881	55.66	3.64	203.11	3.33	52.55	6.33	34.16	3.35
AVT-II GR-4	39.22	2.28	89.26	3.88	23.77	6.91	41.00	3.52
RGC-1047	34.22	5.96	203.88	6.92	51.00	8.14	41.72	3.98
Madhuri	14.88	5.55	82.11	7.10	16.33	5.69	19.83	3.39
Gujarath local	52.00	4.07	152.33	3.33	48.55	7.12	28.66	3.17
Jodhpur local	40.77	2.99	121.88	3.55	41.77	7.18	27.16	3.17
Bikenar local	30.11	3.5	85.18	3.77	40.44	7.15	26.66	3.12
Shree ram gum-1	32.00	4.42	140.88	4.00	49.21	7.08	24.33	3.18
CD (p=0.05)	9.67*	1.70*	30.15*	0.93*	9.32*	0.74*	8.50*	0.33

to higher number of cluster per plant and higher number of pods per cluster. The significant difference in these genotypes for number of cluster per plant, number of pods per cluster and number of pods per plant may be due to genetic and environmental factors. The highest number of pods per plant in the genotypes RGC-1047 and HGS-881 is due to direct inter-relationship between number of cluster per plant and number of pods per cluster. These results are in conformity with earlier works of Malaghan (2012) and Rai et al (2012) in cluster bean.

Highest ten dry pods weight was observed in the cluster bean genotype Pusa Navabahar (7.44 g) and genotypes RGC-1025 and Jodhpur Local were on par with each other with dry pods weight of 3.55 g each. The dry pod yield per plant was significantly higher in CAZG-06-1 (52.66 g). The significant differences among the genotypes may be attributed to variation in number of branches, number of pods per plant and number of seeds per pod. Similar observations were made by Girish (2011) and Malaghan (2012) in cluster bean.

The genotype RGC-1047 had the highest number of seeds per pod (8.14). This may be due to higher dry pod yield per plant in these genotypes. Significantly highest seed yield was recorded in genotype CAZG-06-1 (53.61 g). Genotypes RGC-1047, RGC-1025 and AVT-II GR-4 were on par with each other and the remaining genotypes were significant from these genotypes. Significantly higher seed yield in CAZG-06-1 may be due to more number of pods per cluster, dry pod yield per plant and more number of seeds per dry pod as observed in the present study. The genotype CAZG-06-1 recorded significantly higher seed weight (3.98 g) for 100 seed weight. Higher seed weight had also contributed for higher seed yield per plant. The superiority of CAZG-06-1 over other genotypes with respect to seed yield components *viz.*, dry pod yield, seed yield per plant and hundred seed weight may be due to its genetic potentiality to utilize the growth resources and translocate photosynthates from source to sink.

Quality parameters of cluster bean genotypes: Significant difference was observed for gum content, protein content and fibre content (Table 4). Highest gum content was recorded in genotype CAZG-06-1. THe highest protein content was noticed the genotype Rajendra Nagar Local and no significant difference was observed among these genotypes. Cluster bean genotype IC-11704 recorded highest crude fibre content, whereas the least was found in AVT-II GR-4. The significant difference in the quality parameters of the genotypes may be attributed to difference in number of seeds per plant, seed yield per plant, 100 seed weight, number of dry pods per plant and dry pod yield per plant due to specific genetical traits.

Incidence of powdery mildew disease in cluster bean genotypes: The powdery mildew disease incidence was severe in Pusa Navabahar and Rajendra Nagar Local due to larger leaf area and absence of pubescence characters which are associated with favorable environment condition while remaining genotypes were shown moderately susceptible.

Correlation studies: Correlation coefficients worked out for yield, quality and seed parameters in cluster bean (Table 5). Pod length had highly significant positive correlation with

Table 4. Quality parameters and powdery mildew disease incidence of cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] genotypes

Genotypes	Gum content (%)	Protein content (%)	Fibre content (%)	Per cent leaf area infected	Disease score (0-4 scale)	Disease reaction
Pusa Navabahar	27.46	25.08	4.66	76.41 (60.92)	4	Susceptible
IC-11704	26.73	28.00	9.90	52.14 (46.21)	3	Moderately susceptible
RGC-1025	28.56	28.58	7.43	61.23 (51.47)	3	Moderately susceptible
CAZG-06-1	32.86	32.66	5.46	53.45 (46.96)	3	Moderately susceptible
HGS-881	25.90	35.58	4.43	68.47 (55.82)	3	Moderately susceptible
AVT-II GR-4	23.20	36.75	4.10	65.32 (53.90)	3	Moderately susceptible
RGC-1047	32.33	35.58	8.10	50.67 (45.37)	3	Moderately susceptible
Rajendra Nagar local	13.20	38.33	4.13	78.57 (62.40)	4	Susceptible
Gujarath local	25.70	25.66	5.66	59.78 (50.62)	3	Moderately susceptible
Jodhpur local	22.36	25.61	9.80	67.48 (55.21)	3	Moderately susceptible
Bikenar local	24.80	30.33	8.26	60.32 (50.94)	3	Moderately susceptible
Shree ram gum-1	31.66	26.83	8.16	62.37 (52.14)	3	Moderately susceptible
CD @ 1%	8.52**	4.95**	2.68**	-	-	-

Table 5. Correlation coefficients among the different growth, yield, quality and seed components in cluster bean genotypes

@	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	1	-0.5	-0.308	0.278	0.307	0.16	0.253	0.253	0.245	-0.231	0.733**	0.737**	-0.33	0.58*	-0.724**	0.307	0.276	-0.282	0.618*	0.614*	0.444	0.120	0.043
2		1	-0.420	-0.318	-0.443	-0.443	0.222	0.233	0.263	0.570	-0.540	-0.542	-0.012	-0.283	0.368	-0.467	-0.472	-0.146	-0.017	-0.255	-0.408	-0.113	-0.569
3			1	0.324	0.387	0.453	-0.785**	-0.825**	-0.799**	-0.587*	-0.239	-0.250	0.450	-0.436	0.548	0.416	0.584*	0.621*	-0.807**	-0.209	0.411	-0.112	0.364
4				1	0.938**	0.890**	-0.341	-0.555	-0.374	-0.659*	-0.056	-0.066	-0.393	-0.296	-0.140	0.088	0.141	-0.167	-0.327	-0.218	0.247	-0.203	0.435
5					1	0.946**	-0.375	-0.594*	-0.405	-0.679*	-0.023	-0.033	-0.328	-0.274	-0.222	0.066	0.181	-0.063	-0.383	-0.280	0.357	-0.263	0.496
6						1	-0.379	-0.622*	-0.400	-0.628*	-0.040	-0.048	-0.285	-0.269	-0.183	0.098	0.218	0.006	-0.468	-0.352	0.286	-0.346	0.632*
7							1	0.928**	0.988**	0.710**	0.374	0.381	-0.454	0.598*	-0.386	-0.292	-0.519	-0.503	0.658*	0.088	-0.235	-0.204	-0.189
8								1	0.939**	0.701*	0.324	0.337	-0.326	0.555	-0.354	-0.262	-0.516	-0.493	0.755**	0.197	-0.314	-0.020	-0.288
9									1	0.752**	0.335	0.344	-0.461	0.580*	-0.389	-0.251	-0.564	-0.490	0.671*	0.070	-0.227	-0.277	-0.159
10										1	0.086	0.092	-0.058	0.442	0.006	-0.088	-0.566	-0.011	0.450	0.016	-0.210	-0.311	-0.270
11											1	0.999**	-0.040	0.931**	-0.598*	0.486	0.414	0.033	0.665*	0.791**	0.440	0.158	0.101
12												1	-0.036	0.933**	-0.604*	0.489	0.401	0.033	0.679*	0.792**	0.437	0.157	0.113
13													1	-0.053	0.595*	0.333	0.428	0.830**	-0.242	0.268	0.392	0.257	-0.041
14														1	-0.541	0.409	0.158	0.025	0.773**	0.719**	0.317	0.030	0.004
15															1	0.027	0.006	0.486	-0.640*	-0.306	0.064	-0.112	-0.112
16																1	0.621*	0.605*	0.125	0.534	0.687*	-0.160	0.422
17																	1	0.594*	-0.203	0.706*	0.579*	0.396	-0.046
18																		1	-0.345	0.151	0.583*	-0.068	0.194
19																			1	0.653*	-0.034	0.224	-0.165
20																				1	0.401	0.475	-0.228
21																					1	-0.309	0.292
22																						1	-0.497
23																							1

Critical r-1%= 0.708 5%= 0.576 * and ** indicate significance at p=0.05 and p=0.01 respectively

@:Characters; 1: Germination; 2: Plant height; 3: No. of branches; 4: Days to first flowering; 5: Days to fifty % flowering; 6: Days to first harvest; 7: Pod length; 8: Pod width; 9: Pod weight; 10: Pod yield /plant/picking; 11: Pod yield /plot; 12: Pod yield/ ha; 13: No. of dry pods/ plant; 14: No. of pods/cluster; 15: No. of cluster/plant; 16: No. of seeds /pod; 17: Seed yield/plant; 18: Dry pod yield/plant; 19: Ten dry pod weight; 20: 100 seed weight; 21: Gum content 22: Protein content; 23: Fibre content

Table 6. Economics for different cluster bean genotypes

Genotypes	Total yield (t/ha)	Total gross returns (Rs)	Net returns (Rs)	B: C ratio
Pusa Navabahar	9.13	182600	137737	4.07
IC-11704	13.88	277600	232737	6.18
RGC-1025	7.46	149200	104337	3.32
CAZG-06-1	15.87	317400	272537	7.07
HGS-881	5.62	112400	67537	2.50
AVT-II GR-1	5.35	106400	61537	2.37
RGC-1047	12.74	254800	209937	5.67
Rajendra Nagar local	7.81	156200	111337	3.48
Gujarath local	4.69	93800	48937	2.09
Jodhpur local	4.61	92200	47337	2.05
Bikenar local	5.13	102600	57737	2.28
Shree ram gum-1	5.52	110400	65637	2.46

Total cost of cultivation: Rs. 44862.25

pod width, pod weight and pod yield per plant per picking, number of pods per cluster, ten dry pods weight). Pod width was significantly and positively correlated with pod weight, ten dry pod weight and pod yield per plant per picking. Highly significant and positive relationship was observed with pod weight and pod yield per plant per picking, number of pods per cluster and ten dry pod weight. Pod yield per plot was highly significant and positive relationship with pod yield per hectare, number of pods per cluster, 100 seed weight and ten dry pods weight and had significant negative relationship with number of cluster per plant. Pod yield per hectare had highly significant and positive correlation with number of pod per cluster, 100 seed weight and ten dry pods weight and it had significant and negative correlation with number of cluster per plant. Number of dry pods per plant was highly significant and positively correlated with number of cluster per plant and dry pod yield per plant. Number of pods per cluster was highly significant and positively correlated with ten dry pod weight, 100 seed weight. Number of cluster per plant was significant and negatively correlated with ten dry pod weight. Ten dry pod weight was highly significant and positive relationship with 100 seed weight. Number of seeds per pod was significant and positively correlated with dry pod yield per plant and guar gum content. Seed yield per plant was having significant positive relationship with dry pod yield per plant, 100 seed weight and gum content.

Economics: The highest net profit was obtained from CAZG-06-1 genotype (Rs 2,72,537.75) followed by IC-11704, RGC-1047, RGC-1025 and PusaNavabahar (Table 6).

CONCLUSION

Genotypes CAZG-06-1, IC-11704 and RGC-1047 are superior prefers more with respect to gum content, vegetable pod yield, seed yield and dual purpose and these can be recommended for commercial cultivation under Northern Dry Zone of Karnataka during *Rabi* season. While Rajendra Nagar Local, AVT-II GR-4 and HGS-881 have maximum protein content and can recommended them for fodder purpose

AUTHORS CONTRIBUTION

Dr. Vasant M. Ganiger collected the germplasm from different parts of India and initiated the breeding work according to objectives. Further, continued the work intensively. Gangadhar T. C. part of the M.Sc. work carried out the experiment as per the programme of research. Dr. Bhuvaneshwari G advised with regard to quality parameters. Dr. Vijay Kumar Narayanpur and Dr. Shankrappa T.H. have given technical guidance for writing the manuscript. Dr. Shruthi P. Gondi assisted for carrying the experiment and statistical analysis.

REFERENCES

Anonymous 1958.*Official Methods of Analysis of the Association of Official Agricultural Chemists*, Washington DC, pp. 495

Anonymous 2005. *Official Methods of Analysis of the Association of Official Agricultural Chemists*, Washington DC.

Anonymous 2018. *Improved Cultivation Practices of Horticultural Crops (Kannada)*. Univ. Hort. Sci., Bagalkot pp. 97-98.

Anonymous.2020. Directorate of Economics and Statistics, DAC&FW; c2020.

Ashwini HW, Bagali AN, Babu P, Soregaon CD and Vijayalakshmi CL 2019. Evaluation of cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] genotypes for seed yield and quality parameters. *Journal of Pharmacognosy and Phytochemistry* **8**(3): 4146-4149

Bajwan A, Singh G, Walia I and Sonia 2023. Constraints in production and processing of cluster bean in Southern Haryana. *The Pharma Innovation Journal* **12**(1): 2919-2923.

Girish MH 2011. *Genetic Variability and Divergence Studies in Cluster Bean* [*Cyamopsis tetragonoloba* (L.) Taub]. M.Sc. (Hort.) Thesis, Univ. Hort. Sci., Bagalkot (India).

Jangam AK and Thali P 2010. ICAR Research Complex, Goa, Old Goa, Goa (India), pp. 402-403.

Malaghan SN 2012. *Genetic Variability and Divergence Studies In Cluster Bean [Cyamopisis tetragonoloba (L.) Taub].* M.Sc. (Hort.) Thesis, Univ. Hort. Sci., Bagalkot (India).

Maphosa Y and Jideani VA 2017. The Role of Legumes in Human Nutrition. Functional Food - Improve Health through Adequate Food. In Tech. Available at http://dx.doi.org/10.5772/intechopen.69127.

Oser BL 1965. *Hawk's Practical Physiological Chemistry*, MC Grow-Hill, NY 14th Edn. pp. 1214.

Pathak R, Singh M and Henry A 2009. Genetic divergence in cluster bean [*Cyamopsis tetragonoloba*] for seed yield and gum content under rainfed conditions. *Indian Journal of Agricultural Sciences* **79**(7): 559-561.

Rai PS, Dharmatti PR, Shashidhar TR, Patil RV and Patil BR 2012. Genetic variability studies in cluster bean [*Cyamopsis tetragonoloba* (L.) Taub]. *Karnataka Journal of Agricultural Sciences* **25**(1): 108-111.

Senapati MK, Srinatha A and Pandit JK 2006. *In vitro* release characteristics of matrix tablets: Study of Karya gum and guar gum as release modulators. *Indian Journal of Pharmaceutical Sciences* **68**(6): 824-826.

Subbaiah BV and Asija CC 1956. A rapid procedure for estimation of available nitrogen in soils. *Current Science* **25**: 259-260.

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