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Evaluation of cluster bean [*Cymopsis tetragonoloba* (L.) Taub.] genotypes for vegetable pod yield

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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 and yield parameters. Among the fifteen genotypes, the genotype RGC-197, RGC-1033 and RGC-1002 have shown significantly higher plant height at 30, 60 and 90 days after sowing and least of it was recorded in the genotype RGC-1038 at 30 and 90 DAS and in Gourishankar-9 at 60 DAS. Off the branching habit genotypes, HG-870, HG-870 and RGC-986 recorded significantly higher plant height. The genotypes RGC-986 and HG-100 have shown least number of days for all the earliness parameters like days to first flowering, days to 50 per cent and days to first vegetable pod picking. The number of cluster per plant was higher in the genotype RGC-197 but the number of pods per cluster was significantly higher in the genotype RGC-471, thus this genotype has recorded the significantly higher number of pods per plant. Similarly pod length was higher in the genotype RGC-197 but the pod width was recorded significantly higher in the genotype RGC-471 and also this genotype RGC-471 had higher ten pod weight significantly thus this genotype has maintained higher green pod yield per plant, per plot and per hectare.

Keywords: Cluster bean, mean performance, yield, yield parameters

Introduction
Cluster bean [*Cyamopsis tetragonoloba* (L.) Taub] is an important leguminous crop, highly adopted to arid and semi-arid parts of the requiring low inputs and care. It is cultivated mainly in rainy season as rain fed crop in arid zones. In India, the crop is mainly grown in the dry habitats of Rajasthan, Haryana, Gujarat and Punjab. In Karnataka, it is being grown in limited area of 2746 hectare with a production of 19,804 metric tonnes and it has been cultivated for tender vegetable pods purpose around the year in Northern part of Karnataka *viz*., Dharwad, Belagum, Vijayapura, Bagalkot and Haveri. In year 2014-15 the area of Haryana under guar cultivation was 406000 hectares with an average yield of 832 kg/ha and total production of 338000 tonnes of guar grain (Anonymus, 2016). Since it is relatively tolerant to salt and drought and performs better under adverse climatic conditions and needs less fertilization, thus suitable for small and marginal farmers to cultivate, even under problematic soils. The crop is known for its exceptional adaptation towards poor and erratic rains, different cropping systems and in industrial applications in many ways besides other social and dietary uses. These qualities have made it most favoured crop of marginal farmers in arid areas. However, there are no improved varieties available and farmers used to cultivate the local types. Collection of genotypes from wide geographical area would serve as a gene pool not only for selection but it would also serve as a basic breeding material for hybridization and selection of progenies with better recombination of desirable traits. Breeding and selection programmes often encompass several characters simultaneously (Hill *et al.*, 1998) [4]. Therefore, a study was undertaken to evaluate availbale cluster bean gentypes to develop short durated, determinate and high yielding with vegetable pod traits like tenderness, fibreless, attractive green color with seasonal adoptability to northern parts of Karnataka.

Materials and Methods
Fifteen cluster bean genotypes collected from All India Coordinated Research Project on Dryland Agriculture, [AICRP (DLA)], Regional Agricultural Research Station (RARS), Vijayapura, for conducting experiment at College of Agriculture, Vijayapur, and were raised during Kharif-2017 at college research field, Department of Horticulture, College of Agriculture Vijayapur, in a Randomized Block Design with three replication at a spacing of 45cm x 20cm.

Uniformly grown five plants under each replication were selected and tagged for recording observations for the following characters *viz*., Plant height (cm), number of branches, days to first flowering, days to 50% flowering, days to vegetable pod yield, number of cluster per cluster, number of pods per plant, pod length (cm), pod width (mm), pod yield/plant (g), pod yield/hector (tones) and ten pod weight (g). Data were subjected to analysis of variance (ANOVA) following randomized complete block design (RCBD) (Panse and Sukhatme, 1967) [6].

Morphological characterisation

Growth parameters

The plant height was measured at 30, 60 and 90 days after sowing (DAS) from the cotyledonary node up to the growing tip in randomly sampled five plants and the mean was worked out and expressed in centimetres. Number of branches arising from the main stem was counted on 90th day after sowing and recorded.

Earliness parameters

The number of days required for initiation of first flower was recorded from five randomly selected plants in different treatmental plots and the average value for each treatment was calculated and recorded as days to first flowering, while the days to 50 per cent flowering was counted from the date of sowing to the flowering of 50 per cent of the tagged plants in each experimental plot and the days to first vegetable pod picking was counted from the date of sowing to days at which first vegetable pod picking was done.

Yield parameters

The number of clusters per plant in five randomly selected plants was counted in each plot and their means were calculated and expressed as number of clusters per plant. The number of pods per plant was counted from five randomly selected plants and the mean number of pods per plant was worked out. Pod length was measured individually from tip to the base of the pod using one foot scale and mean values were expressed in centimetres, while pod width of the selected pods was measured by digital vernier caliper at the centre of the pod and average of five pods was computed and recorded in millimetres.

The weight of green vegetable pods 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. The vegetable pod yield per plot was computed by summing up all the harvested pods of each treatment and expressed in kilograms, while the vegetable pod yield per hectare was computed by summing up all the harvested pods of each treatment, converted to pod yield per hectare and expressed in quintal per hectare.

Result and discussion

Morphological characters

The genotypes RGC-471 and RGC-197 registered low fibrousness and had no stringiness followed by the genotypes HG-100 and HG-884, which were also with low fibrousness but presence of stringiness was noticed. However, the genotypes RGC-1033 and RGC-1038 were having high fibrousness and stringiness (Table 3).

Growth parameters

The genotype RGC-197 (Fig. 1) recorded significantly higher plant height (15.27 cm) followed by RGC-1033 (15.20 cm) and RGC-1002 (13.93 cm) and they were on par with each other while, the genotype RGC-1038 (11.33 cm) registered lower plant height at 30 DAS while, for 60 DAS the genotype RGC-197 registered significantly higher plant height (107.00 cm) and Gourishanker-9 (45.77 cm) recorded least plant height among the genotypes. For plant height at 90 DAS the genotype RGC-197 (119.00 cm) and RGC-1033 (111.67 cm) recorded significantly maximum plant height and the genotype RGC-1038 (70.67 cm) recorded minimum plant height (Table 1). The number of branches per plant also showed significant differences among the cluster bean genotypes. Genotype HG-870 (Fig 2) recorded significantly higher number of branches per plant (8.67) which was on par with HG 884 (7.80) and RGC 986 (7.80) while, least number of branches per plant was recorded in the genotype RGC-197 (0.67).

Significant differences were observed among the genotypes with respect to plant height at all stages of plant growth. The mean value of plant height increased from 13.05 cm at 30 days after sowing (DAS) to 88.49 cm at 90 DAS. Similar results were noticed with respect to plant height by Maria *et al*. (2012) [9] among different varieties of cluster bean.

Earliness parameters

For days to first flowering, genotypes RGC-986 and HG-100 took (18.00 each) (Table 1) significantly least number of days for initiation of flowering and days to first flowering and for days to 50 per cent flowering (21.00 days each), whereas, genotype RGC-1033 (24.33 days) took significantly more number of days to initiate first flowering. The genotype RGC-986 (45.6 days) took significantly least number of days for first vegetable pod picking which was on par with genotype HG-100 (49.00 days). Whereas, the genotypes RGC-197 (56.00 days), RGC-1002 (54.33 days), RGC-1038 (54.00 days), RGC-471 (53.00 days), GAUG-13 (52.00 days) and GG-1 (51.00 days) took significantly maximum days to first vegetable pod picking. These results are in conformity with the earlier works Malaghan (2012) [8] in cluser bean.

Vegetable pod yield parameters

Number of clusters per plant was recorded significantly higher in the genotypes HG-870 (21.00) and HG-100 (19.00) whose values ranged from 7.00 to 21.00 (Table 2). The data for number of pods per cluster (Fig. 3) ranged from 3.07 to 6.93, the genotype RGC-471 (6.93) had highest number of pods per cluster. Number of pods per plant was ranged from 28.73 to 92.93 and higher number of pods per plant recorded in the genotype RGC-471 (92.93) and was on par with genotypes HG-100 (89.53), RGC-197 (88.47) and HG-365 (82.93). Undoubtedly, if number of pods per cluster and number of cluster per plant increases the yield per plot also increses. These results are in conformity with the earlier works of Arora *et al*. (2011) [2] and Girish (2011) [3] with respect to number of pods per plant.

The data for pod length ranged from 5.08 cm to 6.50 cm, the higher pod length was recorded in the genotype RGC-197 (6.50 cm) which was on par with genotypes RGC-471 (6.45 cm), HG-100 (6.19 cm), HG-365 (6.07 cm) and HG-884 (6.05 cm). The data for pod width ranged from 5.15 to 7.20 mm, all the genotypes recorded significantly higher pod width except RGC-1002 (5.15 mm). Ten pod weight ranged from 7.60 to 22.27 g. The genotypes RGC-471 (22.27 g) and RGC-197 (21.33 g) recorded significantly higher ten pod weight. The data for pod yield per plant per picking ranged from 21.00 to 64. g. The genotypes RGC-471 (64.07 g) and RGC-197

(63.40 g) gave significantly higher pod yield per plant per picking.

The data for pod yield per plot ranged from 4.83 to 7.87 kg, the higher pod yield per plot was recorded in the genotype RGC-471 (7.87 kg) and genotypes RGC-197 (7.60 kg), HG-100 (7.40 kg) and HG-365 (7.20 kg) were on par with RGC-471. The data for pod yield per hectare ranged from 5.16 to 8.41 ha^{-1}. The significantly higher pod yield per hectare was observed in the genotypes RGC-471 (8.41 ha^{-1}) which was on par with the genotypes RGC-197 (8.12 ha^{-1}), HG-100 (7.91 ha^{-1}) and HG-365 (7.69 ha^{-1}). It has shown maximum number of pods per plant, pod width, ten pod weight that making it to be in an advantageous position in the race of higher ranking genotypes with respect to green pod yield. These findings are in conformity with the results of Girish (2011) [3] and Rai *et al*. (2012) [10] in cluster bean and and Khokhar *et al*. (1988) [6] in garden pea.

Cost economics

Benefit cost (B:C) ratio varied among the genotypes due to variation in yield contributing characters. The genotype RGC-471 (3.16) recorded higher gross returns followed by RGC-197 (3.02) and HG-100 (2.92) and least B:C ratio was recorded in RGC-1002 (1.55) for vegetable pod yield (Table 4).

Table 1: Evaluation of cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] genotypes for growth parameters.

SI. No.	Genotypes	Plant height (cm)			No. of branches per plant	Days to first flowering	Days to 50 % flowering	Days to first vegetable pod picking
		30 DAS	60 DAS	90 DAS				
1	GAUG-13	12.67	79.50	90.80	7.13	20.00	23.00	52.00
2	RGM-112	12.33	83.43	94.80	7.40	20.00	25.00	52.00
3	GG-1	13.27	61.20	72.33	6.00	19.33	22.00	51.00
4	RGC-1002	13.93	62.90	86.33	5.13	20.00	24.00	54.33
5	RGC-1033	15.20	94.33	111.67	1.33	24.33	28.33	51.00
6	RGC-1038	11.33	56.10	70.67	6.33	20.00	24.00	54.00
7	RGC-197	15.27	107.00	119.00	0.67	22.00	26.00	56.00
8	RGC-471	12.40	86.20	92.97	7.07	20.00	25.67	53.00
9	RGC-986	12.33	83.87	89.33	7.80	18.00	21.00	45.60
10	HG-100	12.67	76.97	83.40	7.27	18.00	21.00	49.00
11	HG-365	12.67	86.10	92.17	7.73	21.33	24.00	53.00
12	HG-884	13.20	60.40	83.03	7.80	19.67	23.00	51.00
13	HG-870	12.53	64.80	72.83	8.67	18.33	23.00	50.00
14	Gourishankar-9	12.67	45.77	85.00	5.53	18.33	22.00	50.33
15	GouriShankar-15	13.27	65.33	83.00	6.93	18.00	22.00	50.00
	Mean	13.05	74.26	88.49	6.94	19.82	23.60	51.49
	S. Em ±	0.61	2.33	2.67	0.34	0.81	0.70	1.49
	C.D at 5%	1.78	6.75	7.74	1.118	2.35	2.05	4.33

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

SI. No.	Genotypes	No. of cluster per plant	No. of pods per cluster	No. of pods per plant	Pod length (cm)	Pod width (mm)	Pod yield per plant per picking (g)	Pod yield per plot (kg)	Pod yield per hectare (t)	Ten pod weight (g)
1	GAUG-13	12.00	5.73	64.93	5.60	6.87	40.73	6.85	7.32	9.53
2	RGM-112	15.00	5.07	74.27	5.08	6.61	34.33	6.50	6.94	10.60
3	GG-1	15.00	5.53	73.53	5.87	7.08	36.00	6.22	6.64	13.33
4	RGC-1002	14.00	3.93	43.40	5.34	5.15	21.00	4.83	5.16	7.60
5	RGC-1033	11.00	3.07	35.40	5.98	7.19	23.93	4.97	5.31	15.07
6	RGC-1038	7.00	4.20	28.73	5.75	6.37	32.20	5.77	6.16	12.73
7	RGC-197	18.33	5.33	88.47	6.50	6.92	63.40	7.60	8.12	21.33
8	RGC-471	15.33	6.93	92.93	6.45	7.20	64.07	7.87	8.41	22.27
9	RGC-986	11.33	3.40	34.67	5.46	6.54	38.87	6.55	7.00	12.53
10	HG-100	19.00	4.73	89.53	6.19	6.62	56.13	7.40	7.91	13.33
11	HG-365	14.67	5.73	82.93	6.07	7.08	44.00	7.20	7.69	18.60
12	HG-884	15.00	5.47	63.40	6.05	6.26	41.20	6.22	6.64	18.40
13	HG-870	21.00	4.37	79.80	5.77	7.18	33.27	6.10	6.52	14.00
14	Gourishankar-9	13.00	4.67	70.87	5.83	6.20	39.60	6.65	7.10	13.53
15	Gourishankar-15	10.67	4.40	44.60	5.78	6.67	33.33	6.50	6.94	12.67
	Mean	14.16	4.84	64.50	5.88	6.66	40.14	6.48	6.92	14.37
	S. Em ±	0.59	0.23	3.06	019	0.35	1.31	0.19	0.29	0.49
	C.D at 5%	2.33	0.68	8.86	0.56	1.02	3.80	0.55	0.80	1.44

Table 3: Performance of cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.] genotypes for morphological characters

Treatments	Genotypes	Flower colour	Fibrousness	Stringiness
T_1	GAUG-13	Whitish purple	Average	Present
T_2	RGM-112	Whitish purple	Average	Present
T_3	GG-1	Whitish purple	Average	Present
T_4	RGC-1002	White	High	Present
T_5	RGC-1033	White	High	Present
T_6	RGC-1038	Whitish purple	High	Present

T_7	RGC-197	Whitish purple	Low	Absent
T_8	RGC-471	Whitish purple	Low	Absent
T_9	RGC-986	Whitish purple	Absent	Present
T_{10}	HG-100	Whitish purple	Low	Present
T_{11}	HG-365	Purple	Absent	Present
T_{12}	HG-884	Whitish purple	Low	Present
T_{13}	HG-870	Whitish purple	Average	Present
T_{14}	Gourishankar-9	Whitish purple	Average	Present
T_{15}	Gourishankar-15	White	Average	Present

Table 4: Economics for different cluster bean genotypes

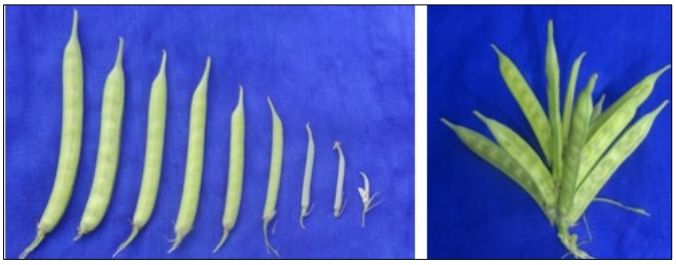
Treatments	Cost of cultivation (Rs. ha^{-1})	Pod yield (t/ha)	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B: C ratio
T_1	40,398.00	7.32	1,46,400.00	1,06,002.00	2.62
T_2	40,398.00	6.94	1,38,800.00	98,402.00	2.44
T_3	40,398.00	6.64	1,32,800.00	92,402.00	2.29
T_4	40,398.00	5.16	1,03,200.00	62,802.00	1.55
T_5	40,398.00	5.31	1,06,200.00	65,802.00	1.63
T_6	40,398.00	6.16	1,23,200.00	82,802.00	2.05
T_7	40,398.00	8.12	1,62,400.00	1,22,002.00	3.02
T_8	40,398.00	8.41	1,68,200.00	1,27,802.00	3.16
T_9	40,398.00	7.00	1,40,000.00	99,602.00	2.47
T_{10}	40,398.00	7.91	1,58,200.00	1,17,802.00	2.92
T_{11}	40,398.00	6.94	1,38,800.00	98,402.00	2.44
T_{12}	40,398.00	6.64	1,32,800.00	92,402.00	2.29
T_{13}	40,398.00	6.52	1,30,400.00	90,002.00	2.23
T_{14}	40,398.00	7.10	1,42,000.00	1,01,602.00	2.52
T_{15}	40,398.00	7.69	1,53,800.00	1,13,402.00	2.81

Note: vegetable pod cost: Rs. 20 / kg

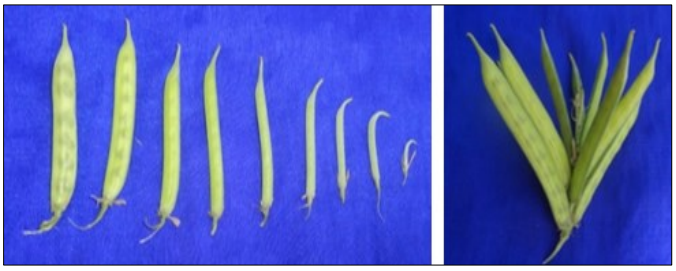
Fig 1: RGC-197, a taller and non branching genotype

Fig 2: HG-870, a highly branching genotype

T_8: Genotype RGC-471



T_7: Genotype RGC-197



T_{10}: Genotype HG-100

Fig 3: Growth stages from pod setting to days to first harvest of green pods of elite cluster bean genotypes

Conclusion

The genotype RGC-471 found superior for vegetable pod yield which recorded more number of pods per plant, pod width and ten pod weight thus maintained more pod yield per plant per picking and yield per plot and it is followed by the genotypes RGC-197 and HG-100.

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