Original Research Article

Evaluation of Cluster bean (*Cyamopsis tetragonoloba* L.) genotypes for vegetable pod yield and guar gum production

ABSTRACT

Cluster bean is a multipurpose legume crop grown in arid and semiarid regions for feed, fodder, and vegetable purpose. In the present study, seven genotypes of cluster bean were evaluated to estimate vegetable pod yield and guar gum properties under Coimbatore conditions. The experiment was laid out in Randomized Block Design with five replications. Observation on 14 characters *viz*., plant height (cm), days to first flowering, days to 50% flowering, number of flower cluster per plant, number of pods per cluster, number of pods per plant, pod length (cm), fresh pod weight (g), dry pod weight (g), fresh pod yield per plant (g), dry pod yield per plant (g), seed yield per plant (g), guar gum in seed (%) and protein content in seed (%) were recorded. The results of present investigation showed that CT CBE 002 outperformed all other genotypes studied in terms of plant height (156.34 cm), total number of clusters (16.44.), number of pods per cluster (6.78), number of pods per plant (99.64), seed yield per plant (29.61 g), guar gum percent (30.56 %), and seed protein content (22.13%). Pod weight was found to be the highest in MDU 1(6.62 g). CT CBE 001 was found to have the maximum pod yield per plant (343.12 g) and pod length (15.16 cm) and had the earliest days to first flowering (27.00 days) and days to 50% flowering (39.80 days).

Keywords: Cluster bean, Genotypes, Vegetable pod yield, Guar Gum

1. INTRODUCTION

Cluster bean [*Cyamopsis tetragonoloba* (L.) Taub] is a self-pollinated, diploid (2X=14) leguminous crop; which is drought hardy, deep rooted and annual in nature. It has immense potential as vegetable and industrial crop, suitable for tender pod picking and gum extraction. Its tender pods are rich source of energy (16 Kcal), moisture (81g), protein (3.2g), 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 (Kumar and Singh, 2002).

Comment [C1]: Unclear

India accounts for about 80% production of guar gum in the world, remaining 20% is produced by countries like Pakistan, USA, Australia, South Africa, Sudan and Argentina. Cluster bean is grown in an area of 2.20 million hectares in India with a production of 0.60 million tonnes (Kumar *et. al*., 2015). It is grown on a higher scale in Rajasthan (18.18 lakh ha), Gujarat (2.27 lakh ha), Haryana (1.27 lakh ha), and Punjab (0.14 lakh ha) (Balakumban *et.,al.* 2020). This crop is primarily grown in North India for guar gum, a gum found in the endosperm of the plant, while it is only minimally grown in South India for vegetable purpose. Cluster bean growing district in Tamil Nadu include Dindigul, Thirunelveli and Namakkal.

Guar seed endosperm gum is used in numerous industries, including textiles, confectioneries, medicines, cosmetics, mining, drilling and water treatment, *etc,* (Rai and Dharmatti, 2013).

To take industrial advantages of gum-type cluster beans, an experiment was conducted to evaluate the Cluster bean for accessing the suitability of varieties and genotypes for early vegetable picking

and Guar Gum and also for analysing different Cluster bean accessions for yield and quality of guar gum.

2. MATERIAL AND METHODS

The study was conducted at Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, during 2021 to 2022 using three varieties and four local genotypes, namely MDU 1, Pusa Navbahar, Sundaram 51, CT CBE 001, CT CBE 002, CT CBE 003 and CT CBE 004.

For analysing the yield parameters of the cluster bean genotypes the experiment was laid out in Randomized Block Design with five replications, where sowing of seeds was done with a spacing of 45cm between the rows and 15cm between the plants. All of the cultural practices for growing cluster beans were applied consistently to every genotype, as per the package and practices recommended for cluster bean.

Phenotyping for the genotypes was started at reproductive stage of the crop, observations were recorded on plant height, days to first flowering, days to 50% flowering, number of flower clusters per plant, number of pods per cluster, number of pods per plant, pod length (cm), pod weight (g), pod yield per plant (g), seed yield per plant (g), guar gum content in seed (%) and protein content in seed (%). The data was analysed using software SPSS version 2.1.1.

3. RESULTS AND DISCUSSION

3.1. Plant height (cm)

The measurement of plant height was done from the base of the plant at terminal growing point of the main stem, 90 days after sowing. Among the seven accessions studied, the accession CT CBE 002 recorded the maximum plant height of 156.34 cm followed by Pusa Navbahar (89.91 cm) and the minimum plant height was observed in CT CBE 003 (71.28 cm) and CT CBE 004 (74.70 cm). Variation in the plant height was also observed by Balakumbahan *et al.,*2020 during harvesting time, it was the highest in Ct - 21 (199.00 cm) followed by Ct - 14 (192.97 cm) among the selected genotypes under study, and concluded that Pusa Navbahar had the highest yield and the lowest plant height among the genotypes (101.80 cm). This variation in plant height may be due to delayed days to 50 % flowering and maturity, which resulted in increased plant height. This is in accordance with the findings of Vir and Singh, 2013.

3.2. Days to first flowering

Duration for first flowering among different genotypes ranged from 27.00 to 34.40 days. The genotype, CT CBE 001 showed the earliest flowering among all plant types at 27th day, followed by MDU 1 (28.00 days) and Pusa Navbahar (29.40 days), whereas, delayed flowering was observed in CT CBE 003 (34.40 days) followed by CT CBE 002 (33.60 days) and CT CBE 004 (32.60 days). Variation in days to first flowering may be due to highly significant and positive association with plant height at 30, 60 and 90 days after sowing, days to 50 per cent flowering and days to vegetable pod picking, which was reported by Ashwini *et al.,* 2018. Similiar observation for days to first flowering were observed by Reddy *et al.,* 2017, and observed that days to first flowering to be in the range of 28 to 38 days, and Pusa Navbahar was observed to flower at 30 days. While in a study Santhosha *et al.,* 2016, recorded days to first flowering in the range of 23 to 35 days, with 43 genotypes.

3.3. Days to 50% flowering

Days to 50 % flowering is considered as one of the important traits for studying the yield and yield contributing characters. In the present study days to 50% flowering was found to be the earliest in CT CBE 001 (39.8 days) followed by MDU 1 (41.00 days) and Sundaram 51 (42.40 days) and Pusa Navbahar (42.40 days). The most delayed 50% flowering was observed in CT CBE 003 (45.80 days) followed by CT CBE 002 (44.40 days) and CT CBE 004 (43.20 days). Vir and Singh, 2013, reported that a substantial, significant, and positive correlation for 50% blooming with days to maturity was responsed for the trait. Similar findings were reported by Reddy *et al.,* 2017, and noticed that days to 50 % flowering ranged from 38 days to 48 days, whereas twenty five genotypes were found to flower

earlier than the grand mean of 43.25 days, which was more than the best check variety Pusa Navbahar (43.00 days). Deepashree *et al.,* 2020, recorded days to 50 % flowering to be in the range of 28.00 to 32.00, in a study conducted using 74 genotypes.

3.4. Number of flower cluster per plant

The number of flower cluster per plant is an important character that influence pod yield in cluster bean. Therefore, the character was phenotyped at pod maturity stage. It was observed that CT CBE 002 had the maximum flower clusters (16.44), followed by CT CBE 001 (15.62) and Pusa Navbahar with (15.54) numbers. The least number of flower cluster was found in CTCBE003, which was 10.43 clusters. Both at the phenotypic and genotypic levels, the number of clusters per plant was positive and highly significant and correlated with the number of pods per cluster, the number of dry pods per plant, the dry pod yield per plant, and the number of seeds produced per plant, which was reported by Malaghan *et al.,* 2015. Similar data was recorded by Rai *et al.,* 2011, where 31 genotypes were compared, in which the number of flower cluster per plant ranged between 12.80 and 49.67, while the least number of clusters was observed in Varsha (12.80) and Pusa Navbahar (14.00).

3.5. Number of pods per cluster

A higher number of pods per cluster is a desirable and economically important character, that contributes to the total yield. Number of pods per cluster was the highest in CT CBE 002 bearing 6.78 pods per cluster, followed by Pusa Navbahar bearing 6.62 pods per cluster and the least number of pods per cluster was observed in MDU1 with 4.20 pods in a cluster followed by Sundaram 51 (4.64). Malaghan *et al.,* 2015, observed that variation in pods per cluster is caused at phenotypic and genotypic levels, there was a positive and highly significant correlation between the number of pods per cluster and the quantities of dry pods per plant, dry pod yield, seed yield, and clusters per plant. Comparable observation as recorded by Balakumbahan *et al.,* 2020, number of pods per cluster was found to be in the range of 5.30 to 17.43 and number of pods per cluster for Pusa Navbahar was observed as 7.53, and Rai *et al.,* 2011, in a study using 31 genotypes observed that pods per cluster was in the range of 5.40 to 14.10 and pods per cluster for Pusa Navbahar was observed as 7.97.

3.6. Number of Pods per plant

The yield of a crop is determined by the yield of its economic part, and for this crop number of pods directly contributes to higher seed yield. The number of pods ranged from 50.45 to 99.64 pods per plant. The highest number of pods was observed in CT CBE 002 with 99.64 pods per plant followed by Pusa Navbahar with 78.84 pods per plant and the least number of pods was observed by CT CB 003 bearing 50.45 pods per plant followed by CT CBE 001 (73.26 pods). Relatable observations were recorded by Balakumbahan *et al.,* 2020, where number of pods per plant was found to be in the range of 31.8 to 148.33 and Pusa Navbahar recorded a pod number of 141.83, while Santhosha *et al.* 2016, in a study using 43 genotypes recorded a range between 46.40 and 264.00. The variations in number of pods per plant may be due to number of pods per cluster, number of branches per plant, number of clusters per plant, and plant height as these characters had contributed positively to number of pods per plant, which was inferred by Vir and Singh, 2013.

Table 1. Morphological characteristics of Cluster bean genotypes.

Genotypes	Plant Height (cm)	Days to first flowering	Days to 50 % flowering	Number of flower clusters per plant	Number of pods per cluster	Number of pods per plant
CT CBE 001	80.50	27.00	39.80	15.62	5.16	73.26
CT CBE	156.34	33.60	44.40	16.44	6.78	99.64

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CT CBE 003	71.28	34.40	45.80	10.43	4.64	50.45
CT CBE 004	74.70	32.60	43.20	11.27	6.06	65.43
Sundaram 51	80.89	30.40	42.40	13.68	4.36	57.67
MDU1	83.86	28.00	41.00	13.69	4.20	55.62
Pusa Navbahar	89.91	29.40	42.40	15.54	6.42	78.84
SE(d)	**5.87**	**1.04**	**1.24**	**0.89**	**0.13**	**5.15**
CD ≤ 0.05%	**12.10**	**2.14**	**2.66**	**1.68**	**0.28**	**0.38**

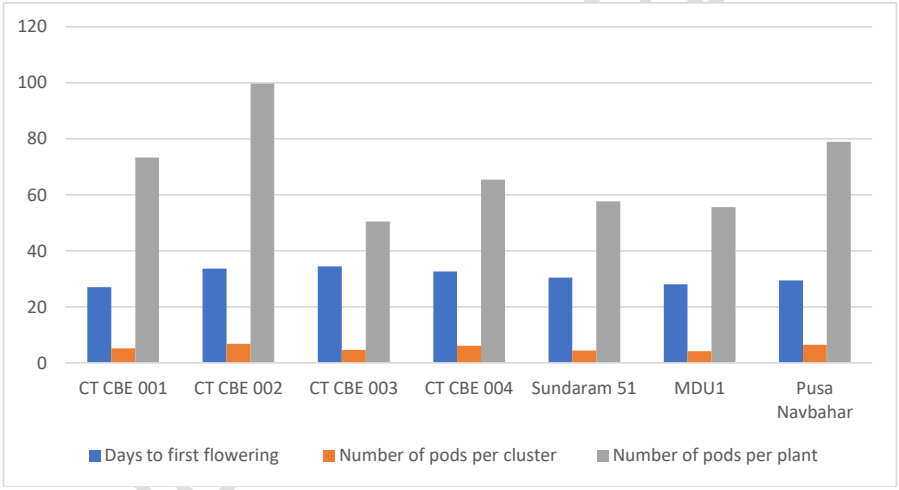

Fig. 1. Graph showing number of pods per plant, number of pods per cluster and days to first flowering.

3.7. Pod length

Pod yield is a contributing factor to economic yield, longer pod length correlates with increased pod weight. The accessions having the longest pod length was observed in CT CBE 001 (15.56 cm) followed by MDU 1 (14.52 cm), CT CBE 003 (13.69 cm) and Pusa Navbahar (9.86 cm); CT CBE 004 had the shortest pod length of 6.46 cm followed by Sundaram 51 (9.13 cm) and CT CBE 002 (9.56 cm). The differences in pod length may be due to strong positive link with pod weight and girth as well as a positive correlation with seeds per pod, that was reported by Lekshmanan and Vahab, 2016. Relatable observation was noticed by Teja *et al.,* 2021, for check variety Pusa Navbahar where its pod length was found to be 8.71 cm and related observation was recorded by Shobya *et al.,* 2019, where pod length of MDU 1 was found to be 9.46 cm.

3.8. Pod weight

It is a highly heritable character, and is of great importance when considered for economic value. Higher pod weight will influence the plant to have more fruit yield. The mean value for average pod weight ranged from 1.5 to 6.62 g and the highest pod weight was observed for MDU 1 (6.62 g), followed by CT CBE 003 (6.45 g), while the least pod weight was noticed for CT CBE 004 (1.59 g) , followed by CT CBE 002 (1.62 g) and Pusa Navbahar (1.66 g). The variation in pod weight can be attributed to increased in length, diameter and more number of seeds per pod, which was reported by Mishra *et al.,* 2019. Comparable observation were recorded by Anandhi *et al.,* 2007, in the study with 29 genotypes, fresh pod weight was recorded to be in the range of 1.47 g to 4.77, also Reddy *et al.,* 2011, in the study with 51 genotypes observed the pod weight to be in the range of 0.94 g to 2.25 g and fresh pod weight of Pusa Navbahar was found to be 1.60g.

3.9. Pod yield per plant

Pod is the economic part of this crop. Hence, increased pod yield is a desirable character for every grower. The highest pod yield per plant was observed in CT CBE 001 (343.12 g) followed by MDU 1 (291.18 g) and the least pod yield was observed in CT CBE 004 (87.64g) followed by Pusa Navbahar (109.18 g). Positive association of pod yield with pod length, pod girth, clusters per plant, pods per plant and 100 seed weight was reported by Lekshmanan and Vahab, 2016. Similar observation was recorded by Teja *et al.,* 2021 in the study consisting of 25 genotypes, which recorded yield per plant to be in the range of 47.90 to 157.06 g per plant, pod yield of 106.80 g was recorded for Pusa Navbahar, in addition Rai *et al.,* 2012, in a study recorded pod yield per plant to be in the range of 57.74 to 222.34 g and Pusa Navbahar recorded 155.59 g.

3.10. Seed yield per plant

Seed of this crop is having immense industrial importance, it can be used to extract guar gum, which has great value and used in industries. In cluster bean the guar gum is produced from its seeds. So, the highest number of seeds and seed weight are preferred to get more gum yield. The highest seed yield was obtained in CT CBE 002 (29.61g) followed by CT CBE 001 (21.40 g), Sundaram 51 (17.86 g) and Pusa Navbahar (17.34 g), the least seed yield was obtained in CT CBE 004 (13.94 g) followed by CT CBE 003 (15.55 g) and MDU 1 (17.21 g). The variation in plant height may be due to significant and positive correlation of seed yield/plant with plant height, pods/ cluster and pod yield/plant in same crop, which was determined by Patil, 2014. Comparable seed yield was observed by Deepashree *et al.,* 2021, in their study consisting of 24 genotypes seed yield was noticed to be in the range of 4.32 to 41.56 g, similar observations was also drawn by Balakumbahan *et al.,* 2020, in their study of 52 genotypes, it was observed that seed yield per plant were noticed to be in the range of 7.60 to 28.67, seed yield of 28.67 was recorded for Pusa Navbahar.

3.11. Guar gum content (%) in seed

Guar gum has an immense importance in many industries, increased gum content is highly desirable for this crop. In CT CBE 002 (30.56 %) more gum percentage was recorded than other genotypes which was followed by Sundaram 51 (28.02%), CT CBE 004 (27.86 %) and Pusa Navbahar (27.30 %), the lowest gum percentage was observed in CT CBE 001 (25.34%) followed by CT CBE 001 (25.34) and MDU 1(26.54). Three genotypes CT CBE 001(30.56%), Sundaram 51(28.02%) and CT CBE 004(27.86%) recorded higher gum content compared to Pusa Navbahar (27.30%). The variance in guar gum content may be because of positive and highly significant correlation of guar gum content with days to 50 per cent flowering and pod length, also significant and positive correlation was seen for number of seeds per pod and had positively correlated with seed yield per plot, seed yield per hectare, protein content and seed yield per plant, which was reported by Ashwini *et al.,* 2019 .These results are similar to the finding of Jitender *et al.,* (2014), in a study of 25 genotypes, guar gum content were found to be in the range of 22.44% to 29.50%. Similarly, Reddy *et al.,* 2011, in the study consisting of 51 genotypes recorded gum content to be in the range of 16.86 % to 33.10%.

3.12. Protein content in seed

In the present study, protein content ranged from 15.83 % to 22.13 %, with a mean of 18.55. The highest protein content was observed in CT CBE 002 (22.13 %) followed by Sundaram 51 (21.66 %), CT CBE 003 (20.24 %) and Pusa Navbahar (17.14 %), the lowest protein content was observed in CT

CBE 001 (15.83%) succeeded by MDU 1 (16.64 %) and CT CBE 003 (16.22 %). The difference in protein content may be due to positive correlation of protein content with plant height at 90 days after sowing, gum content and seed yield per plant, which was reported by Ashwini *et al.,* 2019. Similar results were recorded by Reddy *et al.,* 2017, protein content exhibited a range of 14.53 % to 24.50 %, protein content of Pusa Navbahar was found to be 17.76 %, also Teja *et al.,* 2021, in their study of 25 genotypes found protein content to be in the range of 15.83 to 23.86 %, Pusa Navbahar was noticed to have a protein content of 18.69 %.

Table 2. Yield and quality parameters of Cluster bean genotypes

Genotypes	Pod length (cm)	Pod weight (g)	Pod yield per plant (g)	Seed yield per plant (g)	Guar gum percent in seed (%)	Protein content in seed (%)
CT CBE 001	15.16	5.54	343.12	21.40	25.34	15.83
CT CBE 002	9.56	1.62	139.08	29.61	30.56	22.13
CT CBE 003	13.69	6.45	274.19	15.54	25.78	16.22
CTCBE 004	6.46	1.59	87.64	13.94	27.86	20.24
Sundaram 51	9.13	2.35	112.02	17.85	28.02	21.66
MDU 1	14.52	6.62	291.18	17.20	26.54	16.64
Pusa Navbahar	9.86	1.66	109.18	17.34	27.30	17.14
SE(d)	**0.36**	**0.10**	**16.61**	**1.36**	**0.26**	**0.18**
CD ≤ 0.05%	**0.74**	**0.21**	**34.21**	**2.80**	**0.53**	**0.38**

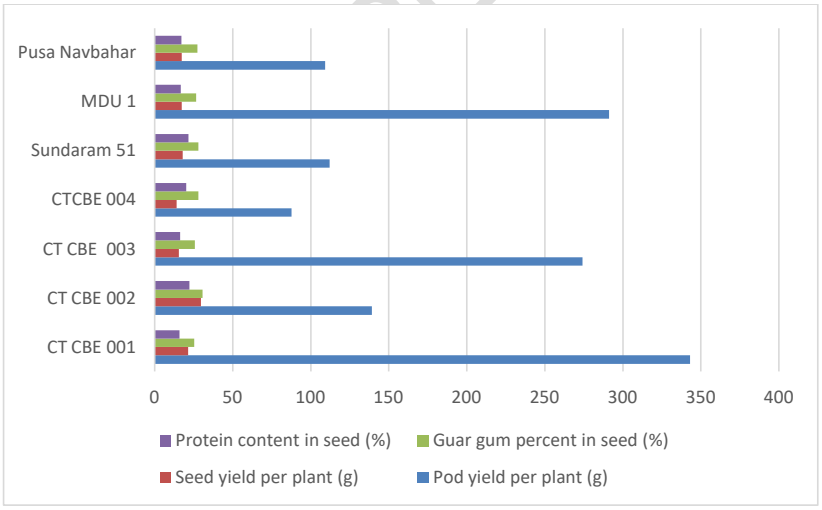

Fig. 2. Graph showing protein content in seed (%), guar gum percent in seed (%), seed yield per plant (g) and pod yield per plant (g).

4. CONCLUSION

Evaluation of seven genotypes showed variation in character for all the characters studied. Variation in biometric and quality of cluster bean genotypes varied significantly as follows for plant height (71.28 to 156.34), days to first flowering (27.00 to 34.40), days to 50% flowering (39.80 to 45.80), number of clusters per plant (10.43 to 16.44), number of pods per cluster (4.20 to 6.78), number of pods per plant (50.45 to 99.64), pod length (6.46 to 15.16), fresh pod weight (1.59 to 6.62 g), pod yield per plant (87.64 g to 343.12), seed yield per plant (13.94 to 29.61 g), guar gum percentage in seed (25.78 to 30.56 %) and protein percentage (15.83 to 22.13%). Of all the genotypes evaluated, CT CBE 002 showed superior performance in plant height, total number of clusters, pods per cluster, pods per plant, seed yield per plant, guar gum percentage and protein percentage in seed. Highest pod weight and was observed for MDU 1. Pod yield per plant, pod length was found to be highest in CT CBE 001. Earliest days to first flowering and days to 50% flowering was observed in CT CBE 001.

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