



Identification of early maturing and leaf determinate growth habit type accessions of cluster bean (*Cyamopsis tetragonoloba* L. Taub.)

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Summary

Cluster bean (*Cyamopsis tetragonoloba* L. Taub.), commonly known as guar, is a member of the family Papilionaceae, cultivated in the Indian Sub-continent since time immemorial. It is a drought-hardy leguminous annual crop used variously for vegetables, forage and green manure. There is tremendous variability available in Indian cluster bean germplasm. Genetic resources with their enormous variability for different characters provide the base for the improvement of crop plants. Within genetic resources, genetic stocks are expected to play a major role in future crop improvement programmes. One promising unbranched, single-stemmed and flower determinate growth habit bearing accession IC-140784P1, developed through single plant selection at ICAR-NBPGR Regional Station Jodhpur starts flowering at 23 days after sowing and flowers 50% at 32 days after sowing. This accession does mature only 82 days after sowing. These accessions mature about 10-15 days early compared to normal existing improved cultivars, which take 90-95 days for maturity. Another accession IC 569315 has been characterized as leaf determinate (in which the stem terminates into the leaf) with alternate cluster-bearing habit. The majority of the cluster bean crop is grown under rainfed conditions in the drier parts of the country. Therefore, maturity is an important trait, especially for cluster bean.

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INTRODUCTION

Cluster bean (*Cyamopsis tetragonoloba* L.) is a self-pollinated crop with $2n = 14$ chromosomes.¹ Cluster bean is an arid legume usually grown under resource-constrained situations mostly in arid and semi-arid regions. Cluster bean is a drought-tolerant annual legume grown on marginal and sub-marginal soils receiving low rainfall. Cluster bean cultivation is mostly in India, Pakistan, the USA, Italy, Morocco, Germany, and Spain.² It is an important arid crop with tremendous potential for vegetable purposes (tender pods) and more specifically for its industrial usage (gum). The gum obtained from seeds is of great industrial value. India, being the chief

guar-growing country is the largest exporter of guar gum.³ The discovery of the galactomannan gum in the endosperm of this crop in 1948, led to the crop gaining importance as one of the major crops of industrial significance. Accordingly, the use of guar gum has been diversified for its use in textile, paper, petroleum, mining, cosmetics, etc. The potential value of a crop can be realized through genetic improvement, which is where the availability of genetic diversity in the species plays an important role. With respect to cluster bean, much of the variability in their genetic resource is found to be distributed in the drier regions of the country. The ultimate objective of all the activities in the management of plant genetic resources is to provide for its use in crop improvement programmes. With increasing constrain in crop production, breeders continually need new and diverse germplasm to find specific traits to maintain or improve yields.⁴ Among different types of crop genetic resources, released varieties and breeding lines contribute more to crop breeding. Wild relatives and genetic stocks, however, are expected to play a greater role in the future.⁵ Genetic stocks are defined as

^aICAR-National Bureau of Plant Genetic Resources Regional Station, Jodhpur Rajasthan-342005, India

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accessions in a collection that typically possess one or more genetic anomalies or aberrations, that may be used by plant breeders, often for sophisticated breeding and basic research. The majority of the cluster bean crop is grown under rain-fed conditions in the drier parts of the country therefore it faces harsh conditions due to moisture stress. Therefore, maturity is an important trait, especially for cluster bean. Most of the improved cultivars popular in the region is having a maturity time of 90-95 days after sowing. Due to this, there is always a very high chance of crop getting failure due to water scarcity. Therefore, any germplasm line having a short maturity duration will be a useful source of donors in a breeding programme.

Materials and Methods

Cluster bean germplasm characterization and evaluation have been a continuous programme at ICAR-NBPGR Regional Station, Jodhpur. A total of 50 accessions of cluster bean collected from Rajasthan, Gujarat and Maharashtra were evaluated during *kharif* 2020, *kharif* 2021, *summer* 2022 and *kharif* 2022 at ICAR-NBPGR Regional Station Jodhpur. The soil of the experiment site was sandy loam with a pH of 7.86 having 0.19 % organic carbon and 125.0, 13.5 and 255 kg/ha available N, P₂O₅ and K₂O, respectively. The experiments were laid out under augmented Block Design (ABD) with national checks during summer and *kharif* seasons keeping line to line distance of 50 cm. and plant to plant distance of 10 cm. The plot size consists of three rows of 2 meters in length each. In the summer four irrigations were given uniformly at the interval of 20 days including pre-sowing irrigation. Only pre-sowing irrigation was given to *kharif* experiment as rains were sufficient after the sowing of the experiments during the *kharif* season. Five plants were selected randomly from each plot and tagged for data collection. The data of selected plants were recorded on the date of flower initiation, the number of days to 50% flowering and the number of days to maturity. The mean values of these observations were statistically analyzed separately for each season.

Results and Discussion

During *kharif* 2020, two promising accessions were identified as important traits. Accession IC-140784P1 was identified as single-stemmed, unbranched with flower-determinate growth habit type and all node pod-bearing nature. It was identified through single plant selection to be matured uniformly in 82 days after sowing. It starts flowering 23 days after sowing and flowers 50% at 32 days after sowing. This accession does

mature only 82 days after sowing. This accession matures about 10-15 days early compared to existing improved cultivars, which take 90-95 days. The early maturity of this accession has been verified during subsequent years, *kharif* 2021, *summer* 2022 and *kharif* 2022 with national check varieties RGC-936 and RGC-1066 (Table 1 & Figure 1). This is the accession of cluster bean reported from ICAR-NBPGR Regional Station, Jodhpur to mature as early as 82 or below days after sowing (Figure 2). The early and uniform maturity of determinate guar accession will be highly valuable in crop rotation thereby expanding the crop niche. The single-stemmed determinate types are more uniform in maturity and thereby help in reducing the problem of black seeds, which reduces the quality of seeds.⁶ Another accession IC 569315 has been characterized as leaf determinate (in which the stem terminates into the leaf) with the alternate cluster-bearing habit (Figure 3). The leaf determinate accession IC 569315 is single-stemmed accession with broad leaves and a pinkish colour seed coat. It produces longer clusters and possesses 100 seed weights of 2.74 g. with a sturdy stem. The majority of the cluster bean crop is grown under rainfed conditions in the drier parts of the country. For the highest seed yield, the guar plant should have early maturity, determinate growth type, optimum plant height, all node pod bearing, branching number and a high number of cluster per plant with each cluster having the maximum number of pods.⁷ ⁹ The unbranched types with lesser ground spread have the potential advantage over the branched type in that they can accommodate higher per-hectare plant populations and are more synchronous in maturity. The unbranched types may also find their use in mixed cropping with pearl millet under rainfed farming. The single-stemmed determinate types are more uniform in maturity and thereby help in reducing the problem of black seeds, which reduces the quality of the seeds. The determinate types will suit the growing conditions in southern India where assured irrigation supply is available.^{6, 8} The utilization of the genetic stocks in the breeding program has been proven of high value in various crops such as wheat¹⁰, rice, maize, soybean and tomato. Therefore, the utilization of the genetic stocks identified will not only help in increasing the productivity of cluster bean in the dry areas of the country but also help in sustaining the production.

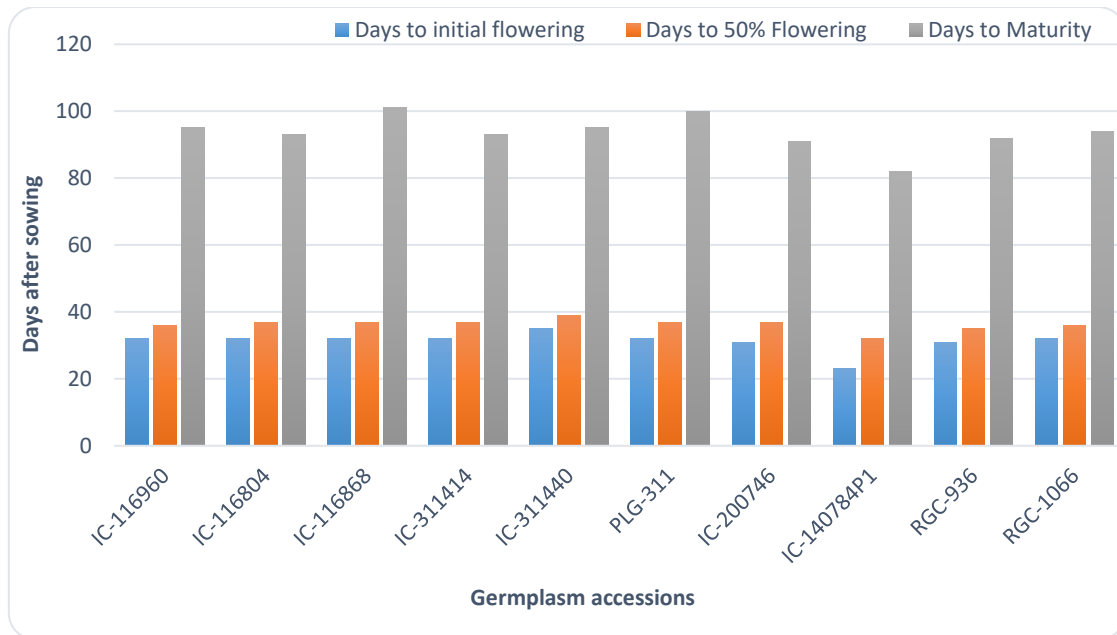


Figure 1: Performance of cluster bean germplasm accessions



Figure 2: Identified early maturity accession IC-140784P1



Figure 3: Identified Leaf determinate accession IC 569315 with pink seed coat colour

Table 1: Performance of cluster bean germplasm for days to flower initiation, days to 50% flowering and days to maturity during kharif 2020 to 2022 and summer 2022

Germplasm accessions	Days to Flower Initiation					Days to 50% Flowering					Days to Maturity				
	2020	2021	2022	2022 Summer	Average	2020	2021	2022	2022 Summer	Average	2020	2021	2022	2022 Summer	Average
IC-116960	32	32	33	31	32	37	36	37	35	36	94	96	95	96	95
IC-116804	31	31	32	32	32	37	37	38	36	37	93	92	94	93	93
IC-116868	31	30	31	30	32	36	38	37	35	37	102	98	103	101	101
IC-311414	29	31	32	30	32	36	37	38	36	37	92	94	93	94	93
IC-311440	35	35	36	34	35	38	39	40	37	39	96	94	95	96	95
PLG-311	32	33	32	31	32	37	39	37	36	37	98	102	98	100	100
IC-200746	31	30	31	31	31	36	37	38	36	37	88	90	91	93	91
IC-140784P1	23	24	22	23	23	33	34	30	31	32	81	82	83	82	82
RGC-936	30	31	31	30	31	34	36	36	34	35	90	92	91	93	92
RGC-1066	31	32	32	31	32	35	37	35	35	36	94	92	93	95	94
C.D. (0.05)	1.706	1.072	1.45	1.024	1.545	1.463	1.507	1.065	1.505	1.889	4.314	4.564	4.316	2.554	2.974
SE(m)	0.57	0.358	0.484	0.342	0.516	0.489	0.503	0.356	0.503	0.631	1.441	1.524	1.441	0.853	0.993
SE(d)	0.806	0.506	0.685	0.484	0.73	0.691	0.712	0.503	0.711	0.892	2.038	2.156	2.038	1.206	1.405
C.V.	3.236	2.006	2.689	1.956	2.865	2.537	2.357	1.683	2.481	3.011	2.689	2.833	2.667	1.567	1.841

Conclusion

Accession IC-140784P1 was identified as early maturity within 80-82 days after sowing. It also showed the traits as determinate growth habit, all node pod bearing, single-stemmed and uniform in maturity. Thus, identified early maturing accession could be used in a breeding programme of cluster beans to shorten the crop duration. The leaf determinate accession IC 569315 is single-stemmed with a study stem and has a pinkish colour seed coat. The determinate growth habit in guar provides several advantages over its indeterminate counterpart. Identifying new germplasm possessing unbranched, erect, all-not cluster-bearing ability, photo insensitiveness and determinate growth habit will allow guar to be developed as a modern crop that is well suited to intensive agronomic management conditions. In the near future, the new plant types of guar described here are expected to play a major role in enhancing the productivity as well as the quality of the grain produced.

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Declaration of interests

The authors have no conflict of interest to declare.

Data sharing

All relevant data are within the manuscript.

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