



## **Morphological Characterization of Certain Ornamental Cacti Genera Suitable for Tropical Climatic Regimes**

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### **Authors' contributions**

*This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.*

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### **ABSTRACT**

Cacti are ornamental, perennial, succulent and slow growing plants, especially known for their drought tolerant characters (xerophyte). The wide range of forms, shapes, and sizes of their stems and flowers and certain specific characters viz., areoles, spines, glochids etc. make this group of plants unique in the indoor as well as in outdoor gardens, parks and landscapes. An experiment on assessing cacti belonging to different genera for their morphological traits was conducted at the Department of Floriculture and Landscaping, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during 2017-2018. In the experiment for the morphological characterization of certain ornamental cacti genera viz., *Hylocereus triangularis*, *Myrtillocactus geometrizans*, *Mammillaria beneckeii*, *Hamatocactus setispinus*, *Ferocactus latispinus*, *Melocactus caesius* and *Gymnocalycium mihanovichii*, various morphological parameters viz., growth form, characteristic features of ribs, areoles and spines, stem colour, plant height, plant girth, number of areoles have been evaluated for their suitability to be used in tropical

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landscaping. The morphological characterization of the above said cacti has revealed that *Hylocereus triangularis* and *Myrtillocactus geometrizans* can be used as potential rootstocks whereas *Mammillaria beneckeii*, *Hamatocactus setispinus*, *Ferocactus latispinus*, and *Gymnocalycium mihanovichii* can be used as suitable scions in grafting programme.

**Keywords:** Cacti; areoles; spines; ribs; tubercles; tropical regimes.

## 1. INTRODUCTION

Ornamental horticulture has attained importance to maintain the natural environment which had been deteriorated due to rapid urbanization during the past few decades. Cacti, a xerophytic plant, have a peculiar beauty and attraction for their strange morphological characteristics for which it is widely used in ornamentalscaping. The infinite, unique variations in shape, size, colour of areoles and spines make the plants look more curious and interesting [1]. Owing to steady increase in demand of the various products, floriculture has become one of the important commercial trades in Agriculture. India has exported 20703.46 MT of floriculture products to the world for the worth of Rs. 507.31 crores in 2017-18 \*(APEDA, 2018).

The word cactus is derived from Latin word 'kaktos' meaning 'a spiny plant'. Cactus is a member of the xerophilous family Cactaceae within the order Caryophyllales with stem succulents to store water [2] which is classified into three subfamilies: Pereskioideae, Opuntioideae and Cactioideae [3]. Cacti show remarkable variation in growth form including large tree-like or columnar forms, solitary or clumped globular or globose habits, and even epiphytes and climbers. They are generally characterized by highly organized fleshy stems and branches either bearing reduced or highly modified leaves or leaves are often replaced by specialized spines, hairs, bristles or scales borne to a central swollen fleshy structure called areoles. Most cacti members are characterized by the presence of areole an important diagnostic character of the family [4]. An areole is a transformed axillary bud situated over a tubercle with spines and often with hairs and trichomes.

Cactus spines are one of the most distinctive features of the cacti biology and they consist a central, prominent spine, surrounded by many radial spines. The spines not only provide shade and collect the humidity; also they can protect the plants from predators that are seeking food or water [5].

In *Mammillaria*, areoles are carried by nipple like structures (hence the name *Mammillaria*) instead of being organized into ribs related to many other cacti. The flowers do not bloom from the areoles, but from the area at the juncture of two tubercles [6].

Cacti, a group of plants which exhibits broad diversity in their growth habits including broadleaf plants (*Pereskia*), giant arborescent plants (*Carnegiea gigantea*, *Pachycereus pringlei* and *Pachycereus schottii*), columnar species (*Neobuxbaumia polylopha*, *Cephalocereus columna-trajani*), candelabrifform species (*Myrtillocactus geometrizans*, *Pachycereus weberi*), globose forms (*Mammillaria* and *Coryphantha*) and epiphyte forms (*Hylocereus* and *Rhipsalis*) [7].

Being a unique creation found in the biodiversity, they own their own importance in the ecosystem which makes them a versatile species to be used in the various aspects of landscaping viz., rock gardens, xeriscaping etc. In order to be utilized, it should be deeply analyzed for their adaptability to the growing climatic conditions. Thus the present study was taken to assess the morphological characters of the ornamental cacti genera suitable for tropical climatic conditions.

## 2. MATERIALS AND METHODS

The experiment was conducted in the Glass house, Botanical garden, Department of Floriculture and Landscaping, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India which is located at an altitude of 426.72 m above mean sea level with 11°02' N latitude and 76°57' E longitude. During the evaluation, maximum and minimum temperature was recorded as 35.5°C and 18.7°C respectively.

Seven different species of cacti belonging to different genera viz., *Hylocereus triangularis* (L.) Britton & Rose., *Myrtillocactus geometrizans* Mart., *Mammillaria beneckeii* Ehrenb., *Hamatocactus setispinus* Engel., *Ferocactus latispinus* Haw., *Melocactus caesius* H. L. Wendl.

and *Gymnocalycium mihanovichii* Fric. utilized for the present experiment was collected from the Regional Plant Resource Centre (RPRC), Bhubaneswar, Odisha.

The plants were planted in the plastic containers filled with red earth, sand and vermicompost in the ratio of 2:2:1 to provide suitable edaphic condition for their sustained growth and development. Various morphological and vegetative parameters viz., growth form, plant height, plant girth, stem colour, hardness of the stem, number of ribs, rib height, number of areoles per plant, distance between areoles, colour of the areoles, number of spines per areoles, length of the spine, offshoots production ability and flowering behavior of the various cacti genera were observed and recorded. The data obtained from the observations were statistically analyzed by SPSS [8] with a critical difference at 5% level.

### 3. RESULTS AND DISCUSSION

The various morphological observations observed during the experimental period are tabulated in the Table 1.

The present study has revealed that, among the evaluated cacti, *Hylocereus triangularis*, *Myrtillocactus geometrizans* follow segmented and columnar form, respectively and so they can be used as rootstocks for grafting studies. The other genera like *Ferocactus latispinus*, *Melocactus caesius* and *Gymnocalycium mihanovichii* showed globular growth form whereas *Mammillaria beneckeii* and *Hamatocactus setispinus* exhibited pin cushion and barrel type respectively. Similar studies on growth form of cacti have been reported by [9], wherein it is reported that *Rebutia grandiflora* takes globular form, *Notocactus scoparia* follows barrel form in growth and *Corypantha vivipara* follows pincushion type.

Stem colour is one important criteria to select the cacti for home and office needs. From the study, it has been found that majority of selected cacti have seen with green coloured stem which ranged between bluish green to purplish green in colour.

Ribs play an important attractive feature of the cacti which are the stem modifications that was found to be varying among the species of same genera and also act as a price determining feature of certain genus like *Astrophytum*. The

number of ribs and their height found to be varying among the selected cacti genera. It has been noted that *Mammillaria beneckeii* has no ribs whereas it was noticed with tubercles which was equal to number of areoles as it belongs to pincushion type.

Areole, a unique feature of the cacti which makes them different from succulents, plays a predominant role in cacti culture and identification. The results revealed that majority of the genera evaluated have white coloured areoles except *Myrtillocactus geometrizans*, *Ferocactus latispinus* and *Melocactus caesius*, as they have gray coloured areoles. The distance between the areoles was found to be minimum (0.5 - 0.7 cm) in *Mammillaria beneckeii* which is of pin cushion type making them more attractive among others.

The spine characters like length of the spine, number of spines have been reported in the evaluation study. Among them, *Mammillaria beneckeii* have white radiating spines with one central brown hooked spine and *Ferocactus latispinus* have brown radiating spines with central curved spine. The number of spines per areole and their length was found to be varying significantly among the various genera of cacti used in the study.

The maximum plant height was observed in *Hylocereus triangularis* (26.93 cm) which is segmented in growth form followed by *Myrtillocactus geometrizans* (13.16 cm), a columnar type cactus. This may be due to accelerated cell division that occurs at the apical region of the plant which is controlled by its genetic constitution. In this experiment for the evaluation of the cacti genera, plant girth was found to be maximum in *Myrtillocactus geometrizans* (22.26 cm), columnar type followed by *Mammillaria beneckeii* (20.17 cm), a pin cushion type cacti. The minimum plant girth was recorded by *Hylocereus triangularis* (13.10 cm) owing to their reduced lateral growth and also due to its genetic constitution.

The number of areoles is important morphological parameters which has direct influence on the visual appeal of the plant. It was found to be maximum in *Mammillaria beneckeii* (118.21) and minimum in *Melocactus caesius* (31.02). This is due to the minimum distance between the areoles which provides a compact structure to the pincushion type of cacti, *Mammillaria beneckeii*.

Table 1. Morphological distinctiveness of ornamental cacti

Treatments	Growth form	Ribs		Areoles		Spines		Stem	
		Number	Height (cm)	Distance between areoles (cm)	Colour	No. of spines/ areole	Spine length (cm)	Stem colour	Hardness of the stem
C <sub>1</sub>	Epiphytic (Segmented)	3	1.50 – 2.00	2.50 – 3.00	White	10 – 12	0.20 – 0.30	Green	Non – Lignified
C <sub>2</sub>	Columnar	6 – 7	1.00 – 1.50	1.70 – 2.00	Grey	6 – 8	1.00 – 1.50	Blue green	Lignified
C <sub>3</sub>	Pin cushion type	Tubercles (Nipple like structure)		0.70 – 0.90	White	11 – 12	0.50 – 0.80	Light green	Non-Lignified
C <sub>4</sub>	Hedgehog / Barrel cacti	13	0.50 – 1.00	1.50 – 2.00	White	12 – 14	0.50 – 0.80	Green	Non-Lignified
C <sub>5</sub>	Globular	13	0.50 – 0.70	0.50 – 1.00	Grey	8 – 9	0.50 – 1.00	Blue green	Lignified
C <sub>6</sub>	Globular	10	0.80 – 1.00	1.00 – 1.50	Grey	6 – 8	0.50 – 1.00	Blue green	Lignified
C <sub>7</sub>	Globular	8 – 9	0.50 – 1.00	0.50 – 1.00	White	3 – 4	0.50 – 0.70	Purplish green	Lignified

C<sub>1</sub>: *Hylocereus triangularis*, C<sub>2</sub>: *Myrtillocactus geometrizans*, C<sub>3</sub>: *Mammillaria beneckeii*, C<sub>4</sub>: *Hamatocactus setispinus*, C<sub>5</sub>: *Ferocactus latispinus*, C<sub>6</sub>: *Melocactus caesius* and C<sub>7</sub>: *Gymnocalycium mihanovichii*

Table 2. Vegetative and flowering parameters of the evaluated cacti genera

Treatments	Growth form	Plant height (cm)	Plant girth (cm)	Number of areoles per plant	Flowering	Flower colour and retention capacity (days)	Offshoot production
C <sub>1</sub>	Epiphytic	26.93	13.10	52.15	×	-	×
C <sub>2</sub>	Columnar	13.16	22.26	52.98	×	Yellow (1)	×
C <sub>3</sub>	Pin cushion type	3.81	20.17	118.21	✓	-	×
C <sub>4</sub>	Barrel cacti	4.85	17.91	51.95	×	-	✓
C <sub>5</sub>	Globular	4.45	19.09	39.03	×	-	✓
C <sub>6</sub>	Globular	3.54	19.28	31.02	×	-	×
C <sub>7</sub>	Globular	3.18	16.91	47.62	✓	Pinkish white (5)	×
<b>Mean</b>		8.56	18.38	56.13			
<b>SE(d)</b>		0.13	0.42	1.63			
<b>CD(P=0.05)</b>		0.28	0.90	3.49			

C<sub>1</sub>: *Hylocereus triangularis*, C<sub>2</sub>: *Myrtillocactus geometrizans*, C<sub>3</sub>: *Mammillaria beneckeii*, C<sub>4</sub>: *Hamatocactus setispinus*, C<sub>5</sub>: *Ferocactus latispinus*, C<sub>6</sub>: *Melocactus caesius* and C<sub>7</sub>: *Gymnocalycium mihanovichii*

#### 4. CONCLUSIONS

Owing to their distinctiveness in the arena of exterior and interior landscaping, cacti culture has emerged presently as a multimillionaire business across the globe that includes cacti cultivation, grafting etc. They have been highly prized for their botanical oddities and beautiful flowers. Due to their minimal requirement in aftercare and cultivation aspects, they have been preferred by urban dwellers for their homes, offices and institutions.

Thus, the results of the experiment conclude that among the evaluated genera, the following cacti belonging to different genera was found to be highly suitable for landscaping in tropical climatic conditions due to their morphological distinctiveness and growth parameters: *Hylocereus triangularis*, *Myrtillocactus geometrizans*, *Mammillaria beneckeii*, *Hamatocactus setispinus*, *Ferocactus latispinus* and *Gymnocalycium mihanovichii*. Apart from their usage in tropical landscaping, *Hylocereus triangularis* and *Myrtillocactus geometrizans* can be used as rootstocks for grafting owing to their columnar growth habit and increased growth rate whereas other species viz., *Mammillaria beneckeii*, *Hamatocactus setispinus*, *Ferocactus latispinus* and *Gymnocalycium mihanovichii* can be used as scions due to their distinctive growth habits. Among the selected scions, *Mammillaria beneckeii* and *Gymnocalycium mihanovichii* possess the added advantage of flowering behavior which makes them a good choice for grafting studies and indoor landscaping.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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## APPENDIX

### View of different ornamental cacti genera



***Hylocereus triangularis***



***Myrtillocactus geometrizans***



***Mammillaria beneckeii***



***Hamatocactus setispinus***



***Ferocactus latispinus***



***Melocactus caesius***



***Gymnocalycium mihanovichii***

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