RESEARCH ARTICLE

# Assessment of Cactus (*Opuntia Ficus-indica* L. Mill) Accessions for Growth, Yield and Nutritional Parameters under Pot Culture

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## Abstract

A pot experiment was conducted at BAIF Development Research Foundation, Urulikanchan, Pune, India during 2014–2016 to study the biomass production performance of four cactus accessions as a source of fodder for livestock. Single matured cladodes of individual accessions were planted in plastic pots during August 2014 and were harvested 18 months after planting. The growth and yield observations were recorded during harvesting and fresh cladodes were analyzed for nutritional parameters in the laboratory. The study revealed that the highest green biomass yield per plant was recorded in accession 1270 (1.74 kg) followed by 1271 (1.45 kg), 1280 (1.39 kg) and the lowest was in accession 1308 (1.36 kg). The maximum fresh weight per cladode was observed in accession 1280 (448.84 g) followed by 1270 (436.75 g), 1271 (394.73 g) and the minimum was in accession 1308 (150.69 g). The more number of cladodes (9.0) were found in accession 1308 followed by 1270 (4.0), 1271 (3.69) and the least (3.10) was in accession 1280. The maximum cladodes area of 333.14 $cm^2$ was recorded in accession 1270 followed by 1280 (310.84 $cm^2$), and the lowest was in accession 1308 (95.61 $cm^2$). The nutritional evaluation of fresh cladodes revealed dry matter in the range of 8.24–11.15%, crude protein 4.00–6.03% and crude fiber 7.06–8.15%.


**Keywords:** Biomass yield, Cactus accessions, Growth, Nutritional parameters.

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## Introduction

There are approximately 130 genera and 1500 species available under the family of Cactaceae (Khalafalla *et al*., 2007). Among them, the *Opuntia* and *Nopalea* genera are the most important due to their usefulness to man. Cactus (*Opuntia Ficus-indica)* is a long-domesticated crop that has emerged as one of the most suitable species for arid and semi-arid climate not only for its better water use efficiency (WUE) and rain use efficiency (RUE) but also a source to meet the requirements of food, forage and host of other benefits along with ecological advantages (De Kock, 2001). Cactus represents the best choice since it shows great adaptability to various soil conditions and prevents environmental destruction caused by erosion. Cactus has severalfold greater water to dry matter conversion efficiency than C3 and C4 plants (Peter *et al*., 2006). The dry matter content of *Opuntia* is less than 15%, and it has low protein content (about 4%), low phosphorus and fiber content (about 10.0%) on dry matter basis, however, it is rich in energy, calcium, and ash. Since paddles are highly succulent (85% water), animals can survive for a long time without water in areas having water scarcity (Nefzaoui and Ben Salem, 2001).

*Opuntia Ficus-indica* is commercially grown in countries like Mexico, Malta, Spain, Sicily, Italy, Greece, Libya, Tunisia, Morocco, Algeria, Lebanon, Syria, Egypt, Saudi Arabia, Yemen, Israel, Chile, Brazil, Turkey, France, Bulgaria, Portugal, Albania, Cyprus, United States (FAO, 2002). Though Cactus is being cultivated in many countries of the world for quite some time, its commercial cultivation in India is yet to start. During the last two decades, the research was conducted by many public sector research Institutes in India, especially those who are working in arid agricultural crops. Cactus has the capacity to produce good biomass throughout the year using minimum water. It is a multipurpose plant, drought tolerant, easy to establish, has the potential for rangeland and pastureland management, and helps in soil and water conservation. It is a source of a variety of agri-foods available in more than 50 products like marmalades, juices, nectars, candies, frozen pulp, alcoholic beverages, pickles, sauces, shampoos, soaps, and lotions. It has medicinal uses such as antacid, arteriosclerosis, anti-cholesterol, and hyperglycemia. Cactus is a good species for climate change. Considering the multiple uses of the cactus an attempt was undertaken to evaluate the growth and yield performance of various cactus accessions at BAIF Development Research Foundation, Pune

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## Materials and Methods

The pot experiment was conducted at BAIF Development Research Foundation, Central Research Station, Urulikanchan, Pune, Maharashtra, India. This place receives an average annual rainfall of 500 mm with a minimum of 8°C and maximum of 42°C temperature. Fully matured 1-year-old cladodes of four accessions namely 1270, 1271, 1280 and 1308 were obtained from the existing mother plants available at BAIF campus which was originally collected from Central

Agroforestry Research Institute, Jhansi, India. After cutting of cladodes from the mother plant, they were kept for curing under room temperature for 20 days to reduce moisture content and to avoid rotting after plantation. Single matured cladodes of individual accessions were planted during the month of August 2014 in plastic pots having 28 cm diameter and 24 cm height and filled with soil, sand and farmyard manure in 40:40:20 proportions. No chemical fertilizers were applied. Eight pots of each accession were replicated three times in randomized block design. The pots were kept under the open condition in the field and were watered ten days after planting with 1 liter of water per pot at 10 days interval. After one month of planting 2 liter water was applied per pot at 15 days interval. The plants were allowed to grow till January 2016 and the growth parameters were recorded on plant height, number of cladodes, cladode length, width, thickness, cladode area, number of areoles, fresh biomass yield per plant. The leaf area was worked out by using digital image capture method. The collected data were tabulated and further analyzed to draw the conclusion.

## Results and Discussion

The data collected on various growth, yield and nutritional parameters are depicted in Tables 1 and 2.

### Plant Height

Plant height among the four accessions was found highly significant. The maximum plant height of 73.89 cm was recorded in 1280 accession and lowest (63.10 cm) was in accession 1308.

### Cladode Size

The cladode length, width, and thickness were recorded to estimate the cladode size, which plays an important role in biomass production. The cladodes act as a water reserve system for the plants and accessions with higher reserve could have better adaptation potential to water stress. Significant variations were observed in cladode length among the accessions. The accession 1280 produced longest (31.85 cm) and 1308 produced shortest (21.16 cm) cladode length (Table 1), cladode length of 28.20 cm and 23.24 cm were recorded in accessions 1271 and 1270, respectively.

Similarly, the cladode width was also found significantly different among the accessions. Accession 1270 recorded the highest cladode width of 16.70 cm, and the lowest of 8.39 cm was recorded in accession 1308. Significant variation was observed in cladodes thickness among the accessions and the maximum thickness of 1.62 cm was noticed in accession 1270, followed by 1.59 cm in accession 1271, 1.49 cm in accession 1280 and the least (0.86 cm) was in accession 1308. Soni *et al.* (2015) reported 24.72 cm cladode length and 8.20 cm width in 1271, 19.41 cm length, and 10.79 cm width in 1270 accession in 9 months old plants.

### Cladode Area

The cladode area plays an important role in biomass production. The maximum leaf area of 333.14 $cm^2$ was observed in accession 1270, followed by 1280 (310.84 $cm^2$) and minimum leaf area (95.61 $cm^2$) was found in accession 1308. Half piece cladode area of 158 $cm^2$ was reported by Tewari and Bajpai (2002).

### 2 No. of areoles per cladode

Significant differences were observed in a number of areoles per cladode among different accessions. A maximum number of areoles (92.30) were measured in accession 1271, followed by 1270 (91.28) and less number of areoles (40.94) was recorded in accession 1308. Soni *et al.* (2015) reported 105 and 101 areoles in accession 1270 and 1271, respectively.

### Number of Cladode Per Plant

The significant differences were observed in the number of cladodes per plant. Accession 1308 recorded maximum number of cladodes (9.0), followed by 1270 (4.0), 1271 (3.69) and a minimum number of cladodes (3.10) were found in accession 1280. Soni *et al.* (2015) reported the highest number of cladodes (14.4) in accession CAZRI Botanical garden, which is similar to accession 1308.

### Green Biomass Production

The fresh cladode biomass weight significantly differed among the accessions (Table 1). The maximum weight per

**Table 1:** Growth and yield performance of different cactus accessions at BAIF, Urulikanchan

| *Accessions* | *Plant height (cm)* | *Cladode length (cm)* | *Cladode width (cm)* | *Cladode thickness (cm)* | *Cladode area (cm2)* | *No. of Areoles* | *Fresh weight/ cladode (g)* | *No. of cladodes/ plant* | *Biomass yield/plant (Kg)* |
|---|---|---|---|---|---|---|---|---|---|
| 1270 | 56.36 (+2.95) | 23.24 (+0.47) | 16.70 (+0.31) | 1.62 (+0.04) | 333.14 | 91.28 (+1.57) | 436.75 (+19.36) | 4.00 (+0.35) | 1.74 (+0.16) |
| 1271 | 63.69 (+3.00) | 28.20 (+0.47) | 12.37 (+0.21) | 1.59 (+0.04) | 231.31 | 92.30 (+1.45) | 394.73 (+16.45) | 3.69 (+0.35) | 1.45 (+0.17) |
| 1280 | 73.89 (+4.85) | 31.85 (+0.95) | 13.16 (+0.41) | 1.49 (+0.09) | 310.84 | 88.03 (+2.41) | 448.84 (+32.49) | 3.10 (+0.56) | 1.39 (+0.27) |
| 1308 | 63.10 (+7.67) | 21.16 (+0.52) | 8.39 (+0.20) | 0.86 (+0.07) | 95.61 | 40.94 (+1.05) | 150.69 (+12.89) | 9.00 (+0.90) | 1.36 (+0.43) |
| *$p$ <(0.05) | * | ** | ** | ** | - | ** | ** | ** | NS |
| **$p$ <(0.01) | | | | | | | | | |

(Figures in the parenthesis are standard error)

**Table 2:** Nutritional evaluation of different cactus accessions

| *Accessions* | *Dry matter (%)* | *Crude protein (%)* | *Crude fibre (%)* | *Ether extract (%)* | *Ash (%)* | *Silica (%)* |
|---|---|---|---|---|---|---|
| 1270 | 8.95 | 4.00 | 7.26 | 1.70 | 15.57 | 0.28 |
| 1271 | 11.15 | 4.20 | 7.47 | 1.56 | 13.24 | 0.95 |
| 1280 | 9.28 | 6.03 | 8.15 | 1.05 | 16.30 | 0.64 |
| 1308 | 8.24 | 5.45 | 7.06 | 1.09 | 12.25 | 0.34 |

cladode (448.84 g) was observed in accession 1280, followed by accession 1270 (436.75 g), 1271 (394.73 g) and the lowest weight per cladode (150.69 g) was in accession 1308. Soni *et al.* (2015) reported 200.9 g and 182.4 g cladode weight in 1270 and 1271 accessions at the age of 9 months, respectively. Pareek *et al.* (2003) reported 66.8 to 1300 g weight of cladodes in his pot experiment conducted at CIAH, Bikaner. The fresh green biomass yield per plant was at par with each other. The highest biomass yield of 1.74 kg/plant was recorded in accession 1270, followed by 1.45 kg in accession 1271, 1.39 kg in 1280 and the least (1.36 kg) was in accession 1308. Soni *et al*. (2015) reported better performance of accession 1270 and 1271 in his study at Bikaner. ShamsudheenMangalasseryet *al.* (2017) reported biomass yield of 0.17–3.48 kg per plant after one year of growth.

### Nutritional Evaluation

The harvested cladodes were tested for its nutritional parameters in the laboratory, and results are given in Table 2. The results revealed that the dry matter content was ranged from 8.24% (1308) to 11.15% (1271). The crude protein content is a very important quality parameter in any feed and fodder. The highest crude protein of 6.03% was recorded in accession 1280, followed by 5.45% in accession 1308. The crude protein content in accession 1270 and 1271 was at par with each other which was 4.0 and 4.20%, respectively. The other parameters like crude fiber, ether extract, ash, and silica were in the range of 7.06–8.15%, 1.05–1.70%, 12.25–15.57% and 0.28–0.95%, respectively. Roy *et al.* (2014) reported the dry matter and crude protein in the range of 7.78–10.80% and 5.80–9.26%, respectively in studied accessions of 1270, 1271, 1287 and 1308.

### Regeneration of new cladodes

After three months of harvesting of the cladodes in the pots, the basal cladode showed regeneration and development of new cladodes ranging from 1.5–4.75. Accession 1308 put out a number of cladodes within three months from harvest.

## Conclusion

The study indicated that all four cactus accessions were grown nicely under a semi-arid climate of Pune district in Western Maharashtra. The growth and yield of various accessions under the study showed different performance; however, accession 1270 performed better, followed by accession 1271. It could be concluded that thornless cactus can be established and grown under Western Maharashtra climatic conditions which could serve as an alternate source for green fodder for livestock.

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