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Cactus Pear (*Opuntia ficus-indica*) in India

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Establishment and Performance of Cactus (*Opuntia ficus-indica*) Accessions at Initial Stages under Shade net in Semi-Arid Region of Rajasthan

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Opuntia ficus-indica (Cactus), commonly known as prickly pear belongs to the order Caryophyllales and the family Cactaceae. Locally cactus is called nagphani or danda thor. *Chapathi kalli* is the common name of plant used in Tamil Nadu. It is reported to contain about 130 genera and nearly 1500 species, which is a new crop in India although its spiny type, bearing very small fruits (locally called nagphani) is found wild in arid and semiarid plateau regions. Owing to its xerophytic characteristics and capability for greater conversion of water to dry matter than by either C3 or C4 plants through a specialized photosynthetic mechanism called Crassulacean acid metabolism (Felker *et al*, 1997; Mizrahi *et al.*, 1997), it was considered as a potential crop species for the water-scarce arid parts of India.

It has a marked capacity to withstand prolonged drought (Nobel, 1995; Felker *et al.*, 1997), extreme heat, highly efficient in water use (Nobel, 1995; Snyman, 2004; Snyman, 2005), moderately tolerant to salinity (Gajender *et al.*, 2014) and are considered as an important potential source of food and fodder (Mathur *et al.*, 2009) in many desert areas of the world. It is considered as a natural reservoir of water and may reduce the water requirement of cattle (Flores- Hernandez *et al.*, 2004). Many species of cactus are found growing as wild plants in arid (less than 250 mm annual rainfall) and semi-arid (250-450 mm annual rainfall) regions of India. In addition to its remarkable value as cattle and human food, it can act as biological barrier to prevent and control top-soil loss (Nefzaoui and El Mourid, 2009) and increase fodder availability for animals (Alary *et al.*, 2007). Opuntias are also important as cover in arid and semi-arid areas because they can survive and spread under conditions of scarce and erratic rainfall and high temperatures and can play important role in the protection of local fauna.

Cactus pear has multiple uses. It produces sweet, nutritionally rich edible fruits, its tender cladodes are used as fresh green vegetable and salad, mature cladodes or cactus stems are used as nutritive fodder for milch animals (Vishal Nath *et al.*, 1999). The fruit, as well as cactus stem are used to prepare value-added products, such as jam, squash, wine, pickle, body lotions, shampoo, creams, etc. It also has several medicinal and industrial uses (Singh and Felker, 1998). The fruit is a fleshy berry, varying in shape, size, and colour and has a consistent number of hard seeds. The fairly high sugar content and low acidity of the fruit make it very sweet and delicious. Cacti, and specifically *Opuntia* spp., have been extremely useful livestock forage in times of drought, primarily by providing digestible energy, water and vitamins. Although mainly used for cattle, opuntia has also been used as forage for pigs.

Owing to these uses, it may be considered as a potential crop species for the water-scarce arid parts of India. In recent years, an attention of growing spineless cactus pear in the drier areas of India in terms of fruit, fodder and vegetable production is increasing (Singh and Singh, 2003; Pareek *et al.*, 2003; Singh, 2006). Therefore, present investigation has been carried out to estimate survival rate and initial establishment of cactus populations (before and after rainfall) which is collected from different region of arid zone of India under semi-arid condition of Rajasthan.

The study was conducted on fifteen accessions of cactus in shade net house condition in Central Arid Zone Research Institute (CAZRI), Regional Research Station, Pali-Marwar, Rajasthan situated at 25°46'N longitude and 73°50'E latitude at 225 msl during the year 2016. The soil is fine sandy clay loam with high silica content in texture and alkaline with pH 8.5. Fifteen accessions of cactus imported through ICARDA office New Delhi were used in the study. The planting material consists of two cladodes or two pieces of a cladode from each clone and it was weighed prior to planting (200 g to 400 g). The cladodes were dried under partial shade and treated with Bavistin (0.2%). Planting was done in cement pots which were filled with a mixture of farmyard manure and soil in the month of March. The planting was done at the depth of 5 cm ($^1/_{3^{rd}}$ portion of cladode) in pots as suggested by Pareek *et al.* (2003). Survival rate and growth of cladodes were measured before (March to May, 2016) and after rain fall (July to August, 2016). Survival Percentage (%) (before and after rainfall), number of cladodes, days to sprouting were measured and observations were recorded.

Survival percentage before and after rainfall: Differences among the accessions were observed in survival rate of cladodes before and after rainfall (Table 1). The survival rate of cladodes before rainfall ranged between 40 to 100%. The highest survival percentage of cladodes before rainfall was recorded in Trunzara Red San Cono, ARL Spineless, Roso Castle Sardo and Algerian (100%). This was followed by accessions 1271 (40%)), Bianca Macromer (40%) and Piantra-25 (67%), and Trunzara Red Bronte (67%) had lowest survival percentage before rainfall. But after rainfall the survival percentage was decreased and it ranged from 31.4 to 80%. The highest survival rate of the cladodes was observed in ARL Spineless (80%), Roso San Cono (80%) and Algerian (80%) whereas lowest was 1271(31.4%) followed by Bianca Macromer (37) and 1308 (50%) after rainfall (Table 1).

Survival rate before rainfall (March to June-2016) was better as compared to after commencement of rainfall (from July-2016). The decrease of survival rate after rainfall was mainly due to rotting and decay of plants caused by water logging condition in pots. The infestation of fungus *Phytophthora nicotiana* may be more because of favourable climatic condition. Nallathambi *et al.* (2005) also reported that foot rot caused by *Phytophthora nicotiana* has been observed as a major disease in the establishment of cactus pear (*Opunita* spp.) under arid conditions. Foot rot incidence was prevalent in 23.5% of the germplasm collections during the months of August and November. Guvera (2001) suggested that the cactus and other drought-tolerant and water-efficient fodder shrubs are better growing in deep sandy soils under low rainfall condition (100-150 mm). Gajender *et al.*(2014) also reported that cactus has lower tolerance to salinity at establishment and survival stage.

Table 1. Survival percentage and days for sprouting of different cactus accessions

S. No.	Cactus Accessions	Survival percentage (%) (before rain)	Survival percentage (%) (after rain)	Days for sprouting
1.	1270	80	60	45
2.	1271	40	31.4	45
3.	CAZRI Botanical Garden	80	55	46
4.	1308	80	50	66
5.	Bianca Macromer	40	37	30
6.	Trunzara Red San Cono	100	60	28
7.	Piantra-25	67	55	72
8.	ARL Spineless	100	80	69
9.	Red San Cono	85.8	57.1	50
10.	Roso Castle Sardo	100	75	70

11.	Roso San Cono	80	80	48
12.	Algerian	100	80	69
13.	Trunzara Red Bronte	67	55	66
14.	Yellow Rocca Palumba	80	66	66
15.	White San Cono	80	66	49

Growth parameters of cactus accessions: Days to sprouting was higher in Piantra-25 (72 days) followed by Roso Castle Sardo (70 days), ARL Spineless and Algerian (69 days) lower in Trunzara Red San Cono (28 days) followed by Bianca Macromer (30 days). Seven accessions sprouted in 28 to 49 days and others sprouted after over 50 days (Table 1). Under the semiarid conditions of Karnal (India), the cladodes sprouted after 57 to 100 days after planting (Singh and Felker, 1998). But, earlier sprouting was occurred at RRS, Pali-Marwar seems to be related to the warmer conditions during the month of March. Number of cladodes per plants ranged between 6 to 2. Maximum number of cladodes per plant was observed in 1270 and 1308 (6) followed by Trunzara Red San Cono (5) whereas minimum was in White San Cono (2). Singh (2003) and Soni *et al.* (2015) also reported higher number of cladodes in accessions 1270 and 1271. Maximum plant height was recorded in 1308 (71.8 cm) followed by 1271 (64.0 cm) and Trunzara Red San Cono (59.0cm) whereas minimum was in Bianca Macromer (20.5 cm) (Table 2). The cladodes length varied in different accessions. The accession Piantra-25 recorded the maximum (26.0 cm) length followed by the accession CAZRI Botanical Garden (25.60 cm). The Length of cladodes was minimum in accession Algerian (13.0 cm) followed by Roso Castle Sardo (13.25 cm) (Table 2).

Table 2. Growth parameters of different cactus accessions

S. No.	Cactus Accessions	Number of cladodes per plant	Plant height (cm)	Cladode length (cm)	Cladode width (cm)	Cladode thickness (cm)
1.	1270	6	39.5	22.20	17.0	1.32
2.	1271	3	64.0	22.80	6.25	0.65
3.	CAZRI Botanical Garden	3	39.5	25.60	8.85	0.90
4.	1308	6	71.8	19.06	4.03	0.90
5.	Bianca Macromer	3	20.5	17.50	5.20	0.50
6.	Trunzara Red San Cono	5	59.0	18.70	6.76	0.56
7.	Piantra-25	3	54.5	26.00	7.36	0.86
8.	ARL Spineless	3	40.0	20.20	6.13	0.60
9.	Red San Cono	4	46.0	18.40	5.10	0.40
10.	Roso Castle Sardo	4	36.0	13.25	6.65	0.40
11.	Roso San Cono	3	53.3	23.15	4.85	0.55
12.	Algerian	3	51.0	13.00	4.63	0.63
13.	Trunzara Red Bronte	3	51.0	20.00	6.25	0.65
14.	Yellow Rocca Palumba	3	31.0	20.25	5.40	0.55
15.	White San Cono	2	47.0	16.50	4.70	0.50

Maximum width of cladode (17.0 cm) was attained by the accession 1270 followed by CAZRI Botanical Garden (8.85 cm). Minimum cladode width (4.03 cm) was recorded in accession 1308 (Table 2). Regarding cladodes thickness, it was observed that the accession

1270, CAZRI Botanical Garden and 1270 had the largest cladode thickness of 1.32 cm, 0.90 cm and 0.90 cm, respectively (Table 2). The lowest cladode thickness (4.9 cm) was observed in the accession Red San Cono (0.40 cm) followed by Roso Castle Sardo (0.40 cm). Such variation in size of cladodes has also been reported from Phaltan in southern India (Anon., 1993), CAZRI, RRS, Bikaner (Soni *et al.*, 2015) and Agra in central India (Singh, 2000).

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