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Performance of Cactus Pear [*Opuntia ficus-indica* (L.) Mill.] Clones in Hot Arid Region of India*

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INTRODUCTION

Cactus pear [*Opuntia ficus-indica* (L.) Mill.], commonly known as prickly pear or tuna, 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 C_3 or C_4 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. Also, 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. 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). In view of these characteristics and potentials of this species, collections of different clones were made. In this paper, the performance of these cactus pear clones in the arid region of northwestern India has been discussed.

Key words: cactus pear, prickly pear

MATERIAL AND METHODS

The Central Institute for Arid Horticulture, Bikaner of the Indian Council of Agricultural Research, New Delhi, is located at lat. 28° N and long. 73.18° E at an altitude of 234.84 m above mean sea level in northwestern India. The soil of the region is sandy, poor in water-holding capacity and fertility, having pH 8.3 to 8.5, E_c 0.10 dSm^{-1} to 0.15 dSm^{-1} and 0.08% to 0.09% organic carbon. In some areas, soil salinity is common. The annual average rainfall is 240 mm, which is erratic and distributed between July and September. The mean monthly maximum temperature ranges from 42.9°C in the month of May during summer to 23.7°C in the month of January during winter, and the minimum monthly mean temperature ranges from 29.6°C to 7.1°C in summer and winter seasons, respectively. However, the summer temperature may be as high as 49°C and the winter temperature as low as -2°C . The morning relative humidity (RH) ranges from 78% in January to 45% in April, and in the evening, RH from 50% to 18% in these months. Wind velocity may be as high as 17 km/hr and as low as 3 km/hr, respectively, in June and January. As a result, evaporation during these months is, respectively, 16 mm/day and 3 mm/day.

Fifty-one cactus pear clones introduced from Texas A&M University, Kingsville, Texas, USA, in January 1997 were planted in pots for evaluating their growth performance. The planting material consisted of two cladodes or two pieces of a cladode for each clone, each weighing about 200 g to 400 g. Prior to planting, the cladodes were dried under partial shade and treated with Bavistin (0.2%). Planting was done in earthen pots which were filled with a mixture of farmyard manure, sand, and clay in 1:1:1 ratio in the month of February. Canal water was used for irrigation. Because association of the fungus *Phytophthora*

* Received 12 November 2002

nicotiana was observed (Nallathambi *et al.*, 2001), drenching with 0.2% Bavistin and 0.15% Ridomil was done. Data on survival, days taken for sprouting, and number of cladodes formed per plant were recorded. After six months, total number of newly formed cladodes, their size, weight, and total cladode yield were observed. The newly formed cladodes were harvested for planting in the field.

One hundred nine cactus clones received from Nimbkar Agricultural Research Institute, Phaltan (Maharashtra), Central Soil Salinity Research Institute, Karnal, Dehradun, and local collections (Bubaneswar, Jodhpur, Jhunjhunu, Fatehpur) from within India; and 47 clones received from Texas, 2 from Santiago del Estero, Argentina, and 3 from Beer Sheva, Israel (Table 2) were planted in the field for evaluation. Common cultural practices related to irrigation, hoeing, weeding, and plant-protection measures were followed. Observations on their establishment, flowering, and fruiting were made.

To study the direction and depth of planting of cladodes, a trial was conducted with clone 1270. The cladodes were planted in two directions, i.e., north-south (N-S) and east-west (E-W) at three depths of planting, i.e., 5 cm, 8 cm, and 10 cm so that their 1/3, 1/2, and 2/3 portions, respectively, remained underground. Data on new-cladode formation, their size, and yield were recorded six months after planting.

To study the effect of fertigation on growth of cactus pear, an experiment was carried out with clones 1118, 1279, and 1287. Four treatments [basin irrigation, basin irrigation + N application (25 g/month/plant), pitcher irrigation, and pitcher irrigation + N application (25 g/month/plant)] were used in this study.

To evaluate the acceptability of the nopalito as a vegetable in India, curry was prepared from the cladodes of clone 1308 harvested one month after sprouting. The tender cladodes were harvested in the morning. These were trimmed and chopped into small pieces, boiled for 5 minutes, then cooked in oil with the usual spices. A quality test was done for taste and acceptability of the preparation by a sensory evaluation based on scores of 10 tasters (judges). For each quality character, marking was done out of a maximum 10 marks. The cladodes of fodder/fruiting clone 1271 and vegetable clone 1308 were analysed to evaluate their nutritive contents.

RESULTS AND DISCUSSION

After planting in pots for their multiplication, 47 clones out of the 51 clones received from Texas survived under the hot arid conditions of Bikaner. Their performance was evaluated in pots with respect to sprouting, number of cladodes formed per plant, size of cladodes (cm), weight (g), and yield of cladodes.

Days Taken to Sprout

Data presented in Table 1 reveal that clone 1308 (vegetable type) took the minimum period of 24 days for sprouting while the maximum period of 135 days was taken by clone 1379. However, most of the clones (32) sprouted in 45 to 75 days after planting under the arid conditions of Bikaner. Only four clones sprouted in 24 to 40 days and 11 clones sprouted after over 76 days. Under the semiarid conditions of Karnal (India), the cladodes sprouted after 57 to 100 days after planting (Singh and Felker, 1998). Earlier sprouting at Bikaner seems to be related to the warmer conditions during the month of February.

Table 1. Multiplication of Cactus-Pear Clones Introduced from Texas, USA

Clone	Planting Material (cladodes) Received from Texas			Days Taken To Sprout	Newly Formed Cladodes					
	Length (cm)	Thickness (cm)	Weight (g)		Number per Plant (mean of 2 pots)	Length (cm)	Width (cm)	Thickness (cm)	Average Weight (g)	Yield per Plant (kg) (mean of 2 pots)
1233	15.5	0.9	221.2	55	3.0	22.3	14.9	0.7	254.2	0.763
1260	13.6	2.4	230.5	45	2.5	27.3	7.4	1.1	183.3	0.460
1277	14.3	1.9	340.5	35	3.5	20.5	10.0	1.7	178.6	0.625
1279	12.9	2.0	327.1	45	2.5	18.6	10.2	1.5	220.0	0.550
1280	13.5	1.7	218.7	75	2.0	24.6	7.5	1.4	150.0	0.300
1281	12.3	1.9	289.9	70	3.5	23.5	8.3	1.2	192.8	0.675
1282	12.7	1.7	258.5	40	3.0	17.9	9.9	1.4	187.5	0.563
1286	11.7	2.7	319.8	75	1.0	22.0	12.0	2.5	500.0	0.500
1297	10.2	1.5	192.7	45	1.5	21.6	12.3	1.0	308.3	0.488
1308	20.8	1.1	187.7	24	4.0	15.1	7.3	0.7	66.8	0.268
1320	12.9	1.8	290.6	65	3.0	23.0	11.0	1.1	266.7	0.800
1376	11.5	2.7	435.2	55	6.5	14.9	7.2	1.7	200.0	1.300
1377	11.2	2.4	338.9	70	5.0	15.5	8.1	2.2	160.0	0.800
1378	14.9	1.9	323.1	70	3.5	23.8	11.1	1.6	321.4	1.125
1379	11.9	1.8	293.0	135	3.0	20.7	7.0	1.9	166.7	0.500
1380	13.0	2.0	315.2	75	3.5	21.0	9.0	1.1	214.3	0.750
1383	17.4	2.3	574.3	75	3.0	23.0	12.4	1.3	333.3	1.000
1384	15.1	2.9	544.1	75	4.0	22.0	10.3	1.5	316.4	1.263
1385	12.0	3.1	445.7	45	3.5	21.5	7.7	2.0	107.1	0.750
1387	11.9	3.4	416.8	95	4.0	25.3	10.1	1.4	312.5	1.250
1388	10.3	2.8	293.1	40	5.5	24.4	6.2	1.3	159.1	0.875
1389	13.7	3.2	406.5	75	2.2	26.0	7.7	3.2	175.0	0.350
1390	17.8	2.3	384.5	55	6.0	23.5	6.0	1.5	141.6	0.850
1391	13.7	3.7	446.4	65	3.0	22.3	8.0	1.5	166.6	0.500
1392	14.3	3.7	425.5	65	5.0	23.6	8.4	1.3	240.0	1.200
1393	13.4	2.1	341.5	45	5.5	19.2	7.7	1.2	159.1	0.875
1398	13.8	2.3	363.3	96	5.0	23.7	6.7	1.5	125.0	0.625
1401	11.6	3.7	436.0	96	3.0	23.0	6.0	1.2	133.3	0.400
1402	13.5	2.8	330.5	70	2.0	27.7	11.5	1.4	362.5	0.750
1403	14.4	2.8	432.0	-	-	--	--	--	--	--
1404	12.1	2.9	410.5	96	4.0	21.7	6.5	1.2	200.0	0.800
1405	15.0	2.8	548.0	76	2.0	20.0	8.0	1.3	175.0	0.350
1406	15.0	3.3	444.7	86	3.5	22.1	8.1	2.6	215.7	0.755
1407	16.5	2.8	827.0	--	--	--	--	--	--	--
1408	13.9	3.1	452.5	55	2.0	22.5	7.5	1.9	225.0	0.450
1410	11.7	2.8	352.1	55	2.5	23.0	8.2	1.9	260.0	0.650
1411	12.8	3.5	658.5	45	2.0	21.0	14.0	1.5	375.0	0.750

Clone	Planting Material (cladodes) Received from Texas			Days Taken To Sprout	Newly Formed Cladodes					
	Length (cm)	Thickness (cm)	Weight (g)		Number per Plant (mean of 2 pots)	Length (cm)	Width (cm)	Thickness (cm)	Average Weight (g)	Yield per Plant (kg) (mean of 2 pots)
1422	8.2	3.0	280.0	90	4.0	21.7	8.5	2.2	212.5	0.850
1431	16.7	2.5	454.0	45	4.0	23.3	10.6	1.6	243.7	0.975
1439	16.6	2.8	591.5	70	3.0	23.3	11.0	1.7	333.3	1.000
1442	14.4	2.9	461.0	55	4.0	21.4	7.6	1.8	195.0	0.780
1449	12.5	2.8	387.0	70	4.5	18.1	6.5	1.8	133.3	0.600
1450	11.9	2.8	429.2	76	3.0	20.6	10.2	1.6	251.6	0.755
1451	13.5	3.0	380.0	95	3.0	29.0	7.0	1.4	250.0	0.750
1452	13.7	3.3	380.0	76	3.0	23.6	8.3	1.4	250.0	0.750
1454	11.1	2.8	378.7	--	--	--	--	--	--	--
1456	16.5	3.2	510.5	55	3.0	24.8	9.3	1.1	308.3	0.925
1458	12.7	2.5	400.7	45	5.5	25.1	8.0	1.0	209.0	1.150
1459	8.8	2.3	169.3	70	3.5	13.2	8.6	1.2	121.6	0.426
1461	11.3	2.3	383.9	75	4.0	17.3	8.0	2.0	206.0	0.825
1464	16.7	1.3	187.0	-	--	--	--	--	--	--

Size of Newly Formed Cladodes

The length of cladodes varied from 13.2 cm in clone 1459 to 29 cm in clone 1451 (Table 1). Six clones (1260, 1387, 1389, 1402, 1451, and 1438) produced cladodes of over 25-cm length and nine clones (1279, 1282, 1308, 1376, 1377, 1393, 1448, 1459, and 1461) of less than 20-cm length (Table 1). The width of cladodes in different clones varied from 6 cm in clone 1390 to 14.9 cm in clone 1233. Fifteen clones (1233, 1277, 1279, 1286, 1297, 1320, 1378, 1383, 1384, 1387, 1402, 1411, 1431, 1439, and 1450) had cladodes 10 cm or more in width. Seven clones (1286, 1377, 1385, 1388, 1406, 1422, and 1461) produced cladodes of 2-cm or more thickness and the remaining clones had thinner cladodes. Thus, the size and shape of cladodes in different clones varied. Clones 1233, 1402, and 1411 had very large cladodes. Such variation in size of cladodes has also been reported from Phaltan in southern India (Anon., 1993) and Agra in central India (Singh, 2000).

Yield Of Newly Formed Cladodes

Data presented in Table 1 reveal that the number and weight of newly formed cladodes varied in different clones. Six months after growth, clones 1376, 1388, 1390, 1393, and 1458 produced the maximum number of cladodes per plant (>5). The clones 1260, 1279, 1280, 1286, 1297, 1389, 1402, 1405, 1408, 1410, and 1411 produced less than 3 cladodes per plant. The remaining 31 clones developed 3 to 5 new cladodes per plant. Average weight of newly formed cladodes ranged from 66.8 g in clone 1308 to 500 g in clone 1286. Nine clones (1297, 1378, 1383, 1384, 1387, 1402, 1411, 1439, and 1456) produced large cladodes of over 300 g, whereas ten clones (1280, 1308, 1385, 1388, 1390, 1393, 1398, 1401, 1449, and 1459) produced cladodes weighing <160 g each. The remaining 28 clones produced cladodes of 160 g to 300 g. Eight clones gave higher yield of cladodes per plant (>1 kg.), two clones (1376 and 1458) owing to

larger number of cladodes per plant, and six clones (1378, 1383, 1384, 1387, 1392, and 1439) as a result of larger cladode weight.

One hundred nine cactus-pear clones, including the 47 received from Texas (Table 2), were planted in the field. The pattern in the sprouting period of these clones was similar to that observed during evaluation in the pots. Vegetable-type clones sprouted within a month, while the fodder and fruiting type clones took more than 50 days to sprout. This pattern has also been observed during both spring and monsoon seasons of planting under subtropical semiarid conditions at Agra, India, (Singh, 2000) where the fruiting-type clone 1271 took 37 and 80 days in spring and monsoon season, respectively, while 23 days were taken for sprouting in clone 1308 after planting in spring season. Spring season was found to be more suitable for planting than monsoon season at Agra.

Table 2. Cactus-Pear Clones Collection at the Central Institute for Arid Horticulture, Bikaner, India

Clone	Type	Year	Source
1118	Fruit	September 1995	NARI, Phaltan, India
1240	Fodder	September 1995	NARI, Phaltan, India
1241	Fodder	September 1995	NARI, Phaltan, India
1242	Fodder	September 1995	NARI, Phaltan, India
1248	Fodder	September 1995	NARI, Phaltan, India
1258	Fodder	September 1995	NARI, Phaltan, India
1265	Fodder	September 1995	NARI, Phaltan, India
1267	Fodder	September 1995	NARI, Phaltan, India
1269	Fodder, Vegetable	September 1995	NARI, Phaltan, India
1270	Fodder, Fruit	September 1995	NARI, Phaltan, India
1271	Fodder, Fruit	September 1995	NARI, Phaltan, India
1278	-	September 1995	NARI, Phaltan, India
1279	Fruit	September 1995	NARI, Phaltan, India
1280	Fruit	September 1995	NARI, Phaltan, India
1281	Fruit	September 1995	NARI, Phaltan, India
1282	-	September 1995	NARI, Phaltan, India
1283	Fruit	September 1995	NARI, Phaltan, India
1287	Fruit	September 1995	NARI, Phaltan, India
1288	Fruit	September 1995	NARI, Phaltan, India
1292	Fruit	September 1995	NARI, Phaltan, India
1294	-	September 1995	NARI, Phaltan, India
1296	-	September 1995	NARI, Phaltan, India
1298	-	September 1995	NARI, Phaltan, India
1299	Fruit	September 1995	NARI, Phaltan, India
1300	Fruit	September 1995	NARI, Phaltan, India
1301	-	September 1995	NARI, Phaltan, India
1308	Vegetable	August 1996	CSSRI, Karnal, India
1311	-	September 1995	NARI, Phaltan, India
1313	Fruit	September 1995	NARI, Phaltan, India
1314	-	September 1995	NARI, Phaltan, India
1315	-	September 1995	NARI, Phaltan, India
1316	Fruit	September 1995	NARI, Phaltan, India
1317	Fruit	September 1995	NARI, Phaltan, India
1319	Fruit	September 1995	NARI, Phaltan, India
1320	Fruit	September 1995	NARI, Phaltan, India
1321	Fruit	September 1995	NARI, Phaltan, India

Clone	Type	Year	Source
1324	-	September 1995	NARI, Phaltan, India
1325	Fodder	September 1995	NARI, Phaltan, India
1326	-	September 1995	NARI, Phaltan, India
1327	-	September 1995	NARI, Phaltan, India
1000	Fruit	September 1995	NARI, Phaltan, India
1100	Fruit	September 1995	NARI, Phaltan, India
AHCP-1	Fruit	December 1995	Jhunjhunu, India
AHCP-2	Fruit	February 1996	Jodhpur, India
AHCP-3	Fruit	November 1996	Fatehpur, India
BS-1	Fruit	December 1996	Beer sheva, Israel
Ofer	Fruit	December 1996	Beer sheva, Israel
Nopalea	Vegetable	December 1996	Beer sheva, Israel
1270	Fodder, Fruit	August 1996	CSSRI, Karnal, India
1271	Fodder, Fruit	August 1996	CSSRI, Karnal, India
1280	Fruit	August 1996	CSSRI, Karnal, India
1287	Fruit	August 1996	CSSRI, Karnal, India
1233	Fodder	January 1997	Texas, USA
1260	Fruit	January 1997	Texas, USA
1277	Fruit	January 1997	Texas, USA
1279	Fruit	January 1997	Texas, USA
1280	Fruit	January 1997	Texas, USA
1281	Fruit	January 1997	Texas, USA
1282	Fruit	January 1997	Texas, USA
1286	Fruit	January 1997	Texas, USA
1297	Fruit	January 1997	Texas, USA
1308	Vegetable	January 1997	Texas, USA
1320	-	January 1997	Texas, USA
1376	-	January 1997	Texas, USA
1377	-	January 1997	Texas, USA
1378	-	January 1997	Texas, USA
1379	-	January 1997	Texas, USA
1380	Fruit	January 1997	Texas, USA
1383	Fruit	January 1997	Texas, USA
1384	Fruit	January 1997	Texas, USA
1385	-	January 1997	Texas, USA
1387	-	January 1997	Texas, USA
1388	-	January 1997	Texas, USA
1389	-	January 1997	Texas, USA
1390	Fruit	January 1997	Texas, USA
1391	Fruit	January 1997	Texas, USA
1392	Fruit	January 1997	Texas, USA
1393	Fruit	January 1997	Texas, USA
1398	Fruit	January 1997	Texas, USA
1401	Fruit	January 1997	Texas, USA
1402	Fruit	January 1997	Texas, USA
1403*	-	January 1997	Texas, USA
1404	-	January 1997	Texas, USA
1405	-	January 1997	Texas, USA
1406	Fruit	January 1997	Texas, USA
1407*	-	January 1997	Texas, USA
1408*	Fruit	January 1997	Texas, USA
1410	Fruit, Fodder	January 1997	Texas, USA

Clone	Type	Year	Source
1411	Fodder, Vegetable	January 1997	Texas, USA
1422	Fruit	January 1997	Texas, USA
1431	-	January 1997	Texas, USA
1439	Fruit	January 1997	Texas, USA
1442	Fruit	January 1997	Texas, USA
1449	Fruit	January 1997	Texas, USA
1450	-	January 1997	Texas, USA
1451	-	January 1997	Texas, USA
1452	-	January 1997	Texas, USA
1454*	-	January 1997	Texas, USA
1456	Fruit	January 1997	Texas, USA
1458	Fruit	January 1997	Texas, USA
1459	Fruit	January 1997	Texas, USA
1461	Fruit	January 1997	Texas, USA
1464*	-	January 1997	Texas, USA
Rossa	Fruit	April 1997	Dehradun, India
Gialla	Fruit	April 1997	Dehradun, India
Bianca	Fruit	April 1997	Dehradun, India
AHCP-4	Fruit	July 1998	Bhubneswar, India
AHCP-5	Fruit, Fodder	October 1999	Santiago del Estero, Argentina
AHCP-6	Fruit	October 1999	Santiago del Estero, Argentina

* Did not survive

Three years after planting, cactus clones 1269, 1270, and 1271 flowered during the summer season. Fruit set was also observed but fruiting occurred only in clones 1270 and 1271. The number of fruits per pad was 4 to 5, and were yellow in colour at maturity. The fruit weight ranged from 60 g to 80 g. Flowering and fruit set was also observed in forage-type clone 1269, but all the fruits dropped. The indigenous cactus types AHCP-1 and AHCP-2 produced flowers during winter season, unlike in the exotic clones which flowered during summer. In these types, fruits matured in December, but the average fruit weight was only 30 g to 40 g. The seedy fruits were red in colour and sour-sweet in taste. This shows that fruit formation is possible in northwestern India, even under limited irrigation, if the clones mature fruits in winter when there is sufficient residual soil moisture from the monsoon of July-September. The studies also indicate that exotic clones 1269, 1270, and 1271 are hardier than the other clones and, thus, performed better under limited irrigation management.

PLANTING TECHNIQUES

The studies conducted using cladodes of clone 1270 revealed that east-west planting resulted in production of a higher number of cladodes per plant than by planting in north-south direction (Table 3). Planting the cladodes by keeping their 1/3 portion (5 cm) under the soil produced higher average length of newly formed cladodes, as well as cladodes yield per plant, six months after planting. Similar results have been obtained (Singh and Felker, 1998) under semiarid conditions at Karnal (India).

Table 3. Effect of Depth and Direction of Planting on Growth and Cladode Production in Cactus Clone 1270

Direction	No. of Cladodes/Plant				Length of Cladode (cm)			
	5 cm Depth	8 cm Depth	10 cm Depth	Mean Depth	5 cm Depth	8 cm Depth	10 cm Depth	Mean Depth
N-S	2.6	2.8	2.5	2.63	13.1	14.2	12.3	13.2
E-W	3.8	3.2	3.5	3.50	18.1	16.3	15.9	16.8
Mean	3.2	3.0	3.0	--	--	--	--	--
CD (P 0.05)								
Direction	0.87				2.08			
Depth	NS				1.53			
Direction x Depth	NS				2.11			
Direction	Weight of Cladode (g)				Cladodes Yield (kg/plant)			
	5 cm Depth	8 cm Depth	10 cm Depth	Mean Depth	5 cm Depth	8 cm Depth	10 cm Depth	Mean Depth
N-S	164.3	170.0	176.8	178.37	0.343	0.577	0.402	0.439
E-W	161.0	148.0	165.0	158.00	0.705	0.327	0.538	0.524
Mean	162.65	162.0	167.9	--	0.524	0.450	0.471	--
CD (P 0.05)								
Direction	4.85				0.057			
Depth	3.64				0.231			
Direction x Depth	5.86				0.327			

Effect of Fertigation on Growth

Cactus clones 1118, 1279, and 1287 were planted and irrigated through pitcher and by a basin irrigation system. Pitcher fertigation helped to maintain sufficient moisture (8% to 10%) for a week up to 10 cm distance from the pitcher wall (Table 4). In the basin system, however, the moisture content reduced to 3% to 4% within three days after watering. This obviously is due to slower release of moisture through the pitchers.

Table 4. Soil-Moisture Distribution

Treatment	Horizontal Distance (cm)	Soil Moisture (%)	
		3 rd Day	7 th Day
Pitcher irrigation	5	11.3	8.6
	10	8.0	7.4
	20	3.4	3.1
Basin irrigation	5	4.2	2.8
	10	3.9	3.0
	20	4.1	2.8

The pattern of sprouting and growth were almost similar in all the three clones (1118, 1279, and 1287). Sprouting in the planted cladodes took almost half the time (26 to 28 days) when irrigated through pitcher than by the basin system (49 to 50 days). The plants also produced more cladodes when fertigated through pitcher. Additive effects of N fertigation through pitcher were also observed in terms of cladodes per plant and height and spread of plant (Table 5). Thus, sustained maintenance of better moisture content in

the soil by pitcher irrigation gave better growth performance of the cactus clones. This also indicates that for satisfactory growth and production in cactus pear in arid northwestern India, judicious irrigation is essential.

Table 5. Effect of Fertigation on Growth of Cactus-Pear Clones (1118, 1279, and 1287)

Treatments	Days to Sprouting	Number of Cladodes per Plant	Plant height (cm)	Spread N-S, E-W (cm)	Length of Cladode (cm)
Basin irrigation	50.3	1.3	28.7	18.3 x 17.0	13.5
Basin irrigation + N (25g)	49.3	1.3	30.7	18.7 x 19.0	14.0
Pitcher irrigation	27.7	2.3	38.7	32.3 x 21.3	16.3
Pitcher irrigation + N (25g)	26.3	4.7	57.7	40.3 x 27.3	16.8

Indian Curry From Nopalitos

Indian curry prepared from the cladodes of clone 1308 was acceptable as judged by the sensory tasters (Table 6). However, curry from the spring crop was better than that from the monsoon crop. Thus, the nopalitos can form an important component in the diet of Indian people.

Table 6. Acceptability Score (out of 10) for Curry from Clone 1308

Characteristic	Spring-Season Cladodes	Monsoon-Season Cladodes
Appearance	7.2	7.6
Texture	6.8	6.2
Taste	8.0	8.0
Acceptability	8.2	8.0
Flavour	6.0	6.2

The cladodes, being rich in essential nutrients (Table 7), can be a vital food supplement to the Indian diet in the arid regions, which have a scarcity of fresh vegetables. High vitamin C content of 11.3 mg in clone 1308 provides hope to cope with the commonly encountered vitamin C deficiency as also suggested by Rodriguez-Felix and Cantwell (1988).

Table 7. Nutritive Contents in Cladodes of Cactus-Pear Clones

Clone	Moisture (%)	Titrable Acidity (%)	Ascorbic Acid (mg/100 g)	Total Sugar	Reducing Sugar	Nonreducing Sugar
				(mg/g fresh weight)		
1271	93.58	0.821	5.33	2.17	1.80	0.78
1308	92.78	0.450	11.33	3.08	2.33	0.75

SUMMARY

One hundred nine cactus-pear clones collected from within India and from the USA, Israel, and Argentina are being evaluated. In pot studies on 47 clones received from Texas, sprouting occurred in 24 to 135 days and produced 1 to 6.5 new cladodes per plant in different clones. The weight of cladodes varied from 66.8 g to 1300 g. Higher cladode yield was owing to more cladodes per plant in clones 1376 and 1458 and, as a result of greater cladode weight in clones 1378, 1383, 1384, 1387, 1392, and 1439. Size, shape, and thickness of cladodes also varied in different clones. Only three clones (1269, 1270, and 1271) flowered three years after planting, but fruiting was observed only in clones 1270 and 1271. Four to five fruits of 60 g to 80 g were produced per plant. The indigenous cactus pear types produced smaller fruits (30 g to 40 g), which matured during the winter (December). Clone 1308 proved to be a promising vegetable type. Curry prepared from its tender cladodes had good acceptability to the Indian palate.

Planting of cladodes in the east-west direction at 5-cm depth proved better than planting in the north-south direction. Pitcher irrigation resulted in quicker sprouting, more cladodes per plant, and better plant growth than the basin system owing to better soil moisture conditions for a longer period in the former. Additive effect of N (25 g per plant) fertigation also was observed.

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