

Crown bending studies in date palm (*Phoenix dactylifera*) cv. *Barhee* in date groves of Kachchh (Gujarat), India

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Abstract

Date palm (*Phoenix dactylifera*) is one of the subsistent horticultural crops of western India, where its commercial cultivation is concentrated in Kachchh district of Gujarat. Majority, of the plantation is raised through seedlings, hence exhibit, great diversity in fruits. However, Date palm Research Station (DPRS), Mundra, has recommended cultivar *Barhee* for commercial cultivation in the region during 2002, which has brought a dramatic change in the socio-economic profile of the date growers, due to increase in area and production. Variety *Barhee* is late maturing with round yellow colored fruits, sweet at *Khalal* stage, with prolific productivity of 100-150 kg/palm for a period of 8-35 years. The roving survey under taken by the DPRS, Mundra during 2016, in various villages on *Barhee* orchards, brought the notice of a unusual and unnatural bending of the crown of *Barhee* palm in many orchards. In the present investigation, it was attempted to understand the phenomena by observing different varieties, bending direction, height of the palm, number of bunches on different direction *etc.* Our observation indicated that it is varietal character as no other varieties in the region showed bending symptoms. Majority of the palms were bended towards East, presumed to be due to phototaxis, enhanced by severe wind velocity (West to East, av. Speed 11.2 km/hr). It was also observed that, the total number of fruit bunches were more in bending direction indicating the fact that, by keeping the fruit bunches in a balanced way may help to manage this phenomena. The bending symptom was observed on palms having a height more than 5m. Hence, this phenomenon is more predominant on older palms and severe bending may leads to uprooting causing economic loss to farmers.

Key words: Date palm, crown bending, *Barhee*, physiological disorder

Introduction

Date palm, *Phoenix dactylifera* is one of the oldest cultivated crops of the world, believed to be originated from Iraq about 4000 BC. In India, it is being commercially cultivated mainly in the coastal belt of Kachchh district of Gujarat, spread over 17,000 hectares, with a production of 1.85 lakh tonnes of fresh fruits (Anon., 2018). Being dioecious and highly cross pollinated in nature and also the bulk of the plantation has been developed through seeds, there exist great variability and diversity in fruits. The cultivation of this crop in this region is very unique, as fresh fruits (*khalal* stage) are being harvested due to climatic compulsions unlike other date palm growing regions of the world, where fruits are harvest at full ripen stage (*tamar* stage) (Muralidharan *et al.*, 2008; Muralidharan and Baidiyavadara, 2013). Moreover, there are no regular varieties or spaced plantation as palm is grown in farm boundaries. Date palm Research Station, Mundra evaluated different exotic varieties for its suitability in Kachchh region and endorsed '*Barhee*' variety during 2002. Subsequently with government support a lot of Tissue culture planting materials of *Barhee* have been imported and large scale plantation has been established since 2002 which has revolutionized the date palm cultivation in the region and there are about 1.5 lakh plants of '*Barhee*' at present in the region. (Personal communication with different import agencies). '*Barhee*' is a very popular and established variety and has originated from Basrah (Iraq). It has golden yellow colour and round shaped fruits, with no astringency at *Khalal* stage with prolific yielding capacity which made it very popular among the farmers.

Survey conducted in various *Barhee* orchards spread over different villages during 2016-18, brought into the notice an unusual bending of the crown of the *Barhee* palm in many orchards. Due to severe wind velocity during summer months (May-July) which coincides the fruit maturity stage, enhance the possibility of bending further which may result in the uprooting of the palm causing severe economic loss to farmers. Hence an attempt has been made to list out possible reasons for this phenomenon and other observations are discussed in this communication

Material and methods

After initial observation of crown bending on *Barhee* palm at our Research Station, a more extensive survey was conducted in 10 villages of Bhuj, Mundra, Mandvi, Anjar and Bhachau talukas of Kachchh district to ascertain the prevalence and severity of the bending. The preliminary observation on age of the palm and percentage of palms showing bending symptoms were taken. Later, to evolve possible reasons for bending, detailed observation on age of the palms, height, bending direction, number of bunches in different direction *etc.* were taken. Eighteen varieties/clones available at Research farm was also screened and closely observed for bending symptoms. The height of the palms was measured using a marked bamboo stick and bending direction was measured using a digital magnetometer. The distribution of fruit bunches on different direction was estimated by visually counting the number of bunches in each direction. Comparison of bunch distribution were made by comparing direction-wise bunches in all directions replicating twenty times (five plant per

replication) under a randomized block design by OPSTAT by CCS HAU, Hissar (Sheoran *et al.*, 1998)

Results and discussions

The crown bending symptoms in *Barhee* was described as physiological disorder and reported by Darley *et al.* (1960) in USA later in Al Basrah (Iraq) by Hussain (1974), and from Israel (Zaid, 2002), and this unusual bending has been termed as “*Barhee disorder*” and mentioned as a physiological disorder with unknown cause and remedy. Similar symptoms were noticed in the primary survey under taken in different villages of Bhuj, Mundra, Mandvi, Anjar and Bhachau talukas (Fig. 1). Preliminary observation on crown bending, emerged from the roving survey conducted in 10 villages indicated that the crown bending ranged from 7 % in Nara village to a highest of 50 % in Guthiyali village of Mandvi taluka. In majority of the villages bending was more than 10 % (Fig. 1). At initial growth phase, the bending was less prevalent and as growth increased bending tendency also enhanced as 50 % of bended palms observed (20-30 years old) in Guthiyali village. Our preliminary survey confirmed that, the prevalence of ‘crown bending’, which otherwise known as Barhee

disorder was present in almost all *Barhee* orchards of the region. Based on the primary observation it was attempted to find out the possible reasons for bending in relation to variety, height of the palm, bending direction bunch distribution *etc* and three orchards *i.e.* from Mundra, Bhachau & Nara were selected and various observations were taken during 2016-18 at fruiting season.

Observations were taken on different varieties (*Barhee*, *Zahidi*, *Halawy*, *Khalal*, *Khadrawy*, *Khunezi*, *Bhugso*, *Medjool*, *Samaran*, *Dairy*, *Sayar*, *Tayar*, *Mejnaz*, *Ruziz* and *Yakubi*) during fruiting season in the year 2017-18 indicated that the crown bending was observed only in *Barhee* variety and no other variety has shown the bending symptom in the region (Table 1). The orchard having *Barhee* and other mixed varieties from villages Guthiyali, Ratnal, Nara, *etc.* also exhibited same observation, leading to a conclusion that it is a varietal character. However, Djerbi (1983) reported bending disorder in *Dayari*, *Jahla* and *Agnellid* varieties from Israel, indicating that this may also affect other varieties. However from our observation, no other varieties except *Barhee* have shown the bending symptoms.

Observation on height of the palm on bending indicated that, no bending was observed in palms of having less than 5 m height. The observation indicated that 87.5 % of 5-10 m high palm showed bending and it was 100 % in case of palm having 10-15 m height indicating that as height increases the chances of bending is more (Table 1). Earlier reports indicated that palms, over 3 m height showed the bending tendency, and it was severe in 10-33 year old plants (Darley *et al.*, 1964) which confirm our observation. In Nara village, the bending symptom was shown only by 7.5 % of palms, as majority of the palms height was less than 5 m.

Observations on bending direction indicated that in majority of the palms, the bending was towards East. In Mundra, 66.67 % palms were bending towards East; it was 40 % in case of Bhachau and 53.33 % in Nara village. In Mundra only 3.36 % of the palms showed bending towards west, it was 2.5 % is case

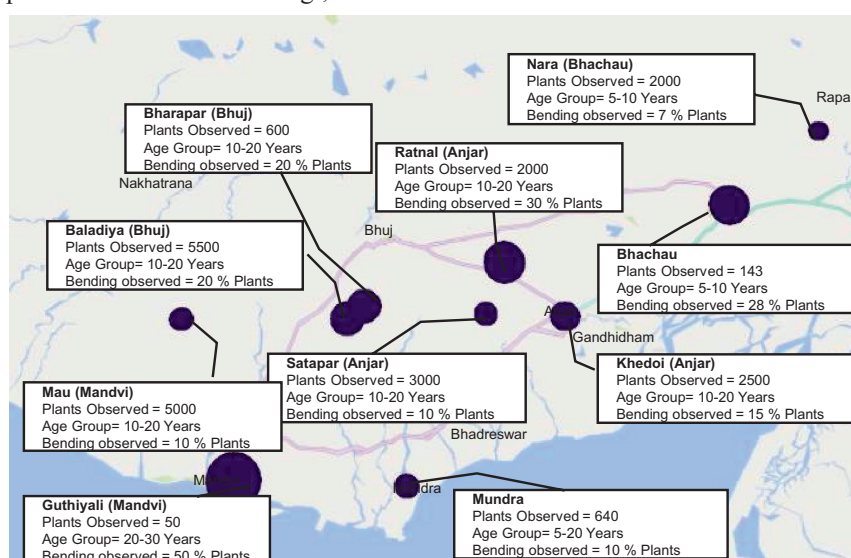


Fig. 1. Primary survey at various villages of Kachchh (Gujarat)

Table 1. Crown bending in different varieties and height

Variety	0-5 M height			5-10 M height			10-15 M height			Total		
	Total	B	N.B	Total	B	N.B	Total	B	N.B	Total	B	N.B
Barhee	46	-	46	32	28	4	41	41	-	119	69	46
Zahidi	-	-	-	4	-	4	61	-	61	65	-	65
Halawy	83	-	83	53	-	53	124	-	124	260	-	260
Khalas	-	-	-	37	-	37	-	-	-	37	-	37
Khadravi	5	-	5	25	-	25	7	-	7	37	-	37
Khuneji	12	-	12	-	-	-	-	-	-	12	-	12
Bhugasao	2	-	2	3	-	3	7	-	7	12	-	12
Medjool	-	-	-	-	-	-	6	-	6	6	-	6
Shamran	-	-	-	-	-	-	2	-	2	2	-	2
Dairy	-	-	-	-	-	-	3	-	3	3	-	3
Saidi	-	-	-	-	-	-	2	-	2	2	-	2
Zaglool	-	-	-	-	-	-	2	-	2	2	-	2
Punjab Red	-	-	-	-	-	-	1	-	1	1	-	1
Sayar	3	-	3	22	-	22	11	-	11	37	-	37
Tayar	-	-	-	1	-	1	10	-	10	11	-	11
Mejnaz	-	-	-	-	-	-	12	-	12	12	-	12
Ruziz	3	-	3	-	-	-	6	-	6	9	-	9
Yakubi	8	-	8	1	-	1	4	-	4	13	-	13

B: Bending observed; NB: No Bending observed



Fig. 2. Crown Bending in date palm cv. Barhee (a) Both leaves and bunch distribution is toward a single direction making the plant part naked in the opposite direction (b) Straight plant with equal distribution of leaves and bunches



Fig. 3. Crown bending in date palm cv. Barhee. (Primary stage- 0° - 30° Bending)



Fig. 4. Crown bending in date palm cv. Barhee. (Extreme stage: more than 90° Bending)

Table 2. Bending direction of date palm in different locations

Location	Age of the palm	Total palms	Number of bending palms	Direction			
				North	South	West	East
Mundra	5-20 years	119	69 (57.98)*	9 (13.04)	10 (14.49)	0.4 (3.36)	46 (66.67)
Bhachau	6-10 years	143	40 (27.97)	17 (42.5)	0.6 (15.0)	0.1 (2.5)	16 (40.0)
Nara	5 years	2000	150 (7.5)	10 (13.33)	10 (6.67)	40 (26.67)	30 (53.33)

*Value in parenthesis is percentage value

of Bhachau (Table 2 and Fig. 2). In the Kachchh region during summer season (May-towards West to East, which may also contributed towards bending. In California it has been reported that 50 % of the palms were bended towards South (Darley *et al.*, 1960) however in our observation the bending was least towards South in this region.

The observation on distribution the number of fruit bunches indicated that the bunches were comparatively high in the bending direction, obviously, the load of the more number of bunches towards one direction must have enhanced the possibility of bending (Table 3). The data depicted in Table 3 clearly indicated that the distribution of bunches contributed bending, as more number of bunches have been observed in bending direction except in Bhachau, where the number of average bunches were maximum in South direction even though bending was towards East. But it is also interesting to note that in no bending palm the distribution of bunches were almost uniform, which give an indication for its management. Further a comparison on distribution of bunches between bended and non bended palms (n=100 each) were made, which is presented in Table 4. The distribution clearly indicated that there is no difference on total number of bunches on bended and non-bended palms; however there is a significant difference on number of bunches with reference to bending direction. It is also interesting to note that in non-bended palms the number of fruit bunches in all different direction were almost uniform, indicating that distribution of fruit bunches play a key role in bending.

No reason and remedy has been suggested for crown bending or "Barhee disorder". Sudharsan *et al.* (2009), reported crown bending disorder due to *Arenopsis sabella* in Kuwait, wherein he reported 42 % crown bending in Succari cultivar, followed by 33 % in Anbara and 33 %

Table 3. Bunch distribution with respect to bend direction

Bending Direction	Total	A. Mundra							
		Number of bunches				Percentage			
		N	S	E	W	N	S	E	W
Towards (N=11)	7.13	2.75	0.88	2.38	1.13	38.57	12.27	33.31	15.78
Towards (N=36)	7.21	1.58	1.91	2.91	0.82	21.86	26.48	40.35	11.35
Towards (N=4)	7.25	0.50	1.75	1.25	3.75	6.90	24.14	17.24	51.72
Towards (N=12)	7.56	1.19	2.69	2.38	1.13	15.71	35.55	31.42	17.36
No bending (N=11)	8.27	1.73	2.00	2.75	1.82	20.89	24.18	32.98	21.99

Bending Direction	Total	B. Bhachau							
		Number of bunches				Percentage			
		N	S	E	W	N	S	E	W
Towards (N=17)	12.88	3.88	2.35	3.35	3.29	30.14	18.26	26.03	25.75
Towards (N=16)	13.50	2.81	4.31	3.50	2.88	20.83	31.94	25.93	21.30
Towards (N=0)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Towards (N=6)	13.17	3.17	3.83	3.00	3.17	24.05	29.11	22.78	24.05
No bending (N=106)	11.44	3.08	2.84	2.67	2.86	26.88	24.81	23.33	24.98

Table 4. Bunch distribution percentage in date palm cv. Barhee

Bending character	Total number of bunches	Number of bunches* (in different direction)				Percentage of bunches distribution**			
		North	East	West	South	North	East	West	South
Bended plants	3.59 (12.09)	1.95 (2.98)	2.09 (3.48)	1.86 (2.62)	1.95 (3.00)	29.23 (25.37)	32.97 (30.35)	26.67 (21.58)	28.89 (24.68)
Straight plants	3.63 (12.44)	2.05 (3.35)	1.97 (3.01)	1.97 (3.06)	1.96 (3.02)	31.13 (27.48)	29.77 (25.47)	28.98 (24.36)	28.94 (24.67)
SEm ±	0.05	0.04	0.04	0.04	0.04	0.92	0.78	0.83	0.87
C.D. @ 5 %	NS	NS	0.1	NS	NS	NS	2.21	NS	NS
C.V. %	13.1	18.48	16.54	20.29	19.48	28.31	23.09	27.57	27.87

*Data are square root transformed; data in parenthesis are retransformed value; ** Data are arc sine transformed value, data in parenthesis are original

in Sultana. Interestingly *Barhee* cultivar was free from crown bending, hence the crown bending normally referred to as leaning crown Syndrome (LCS) is different from *Barhee* disorder and we have not observed any insect infestation in the bended palms.

From the observation it is being inferred that, by managing the distribution of fruit bunches equally in all four directions, there is a possibility of rectifying bending. Unbalanced bunch distribution followed by heavy wind velocity in the fruiting season must have enhanced the situation. The maximum bending toward East is presumed to be due to phototaxis or the impact of wind. There are reports from California, that by rearranging the heavy fruit bunches to hang on the opposite to bending direction has rectified *Barhee* bending to a certain extent (Leland, 1968), which confirm the present hypothesis of unbalanced fruit bunch distribution. This disorder has to be rectified as severe bending leads to uproot of the plants and also the number fruit bunches have been reduced due to bending (Darley *et al.*, 1964).

References

Anonymous, 2018. Horticultural cultivation of crops, area and production. Director of Horticulture, Agriculture, Farmer's Welfare and Co-operation Department, Government of Gujarat. Available via <https://doh.gujarat.gov.in/horticulture-census.htm>. Retrieved on 25th July, 2018.

Darley E.F, R.W. Nixon and W.D. Wilbur, 1960. An unusual disorder of *Barhee* date palms. *Ann. Rep. Date growers Inst.* 37: 10-12

Darley, E.F., R.W. Nixon, W.D. Wilbur and J.B. Carpenter, 1964. Second report on the bending of tops of *Barhee* date palms. *Ann. Rep. Date Growers' Inst.*, 41: 16

Djerbi, M, 1983. Report on consultancy mission on date palm pests and diseases. FAO-Rome, pp.28.

Hussain, A.A 1974. Date palm and dates with their pests in Iraq. Uni. Of Baghdad, Ministry of Higher Education & Scientific Research, Iraq, pp166.

Leland, J., 1968. Correction of *Barhee* Bending by Bunch Handling Practices. *Date growers Institute. Ann. Report* 45:2

Muralidharan, C.M. and D.A. Baidiyavadara, 2013. Variability and diversity of elite date palm (*Phoenix dactylifera* L.) in date groves of Kachchh (Gujarat) India. *Acta Horticulturae*, 994: 263-269.

Muralidharan, C.M., S.B.S. Tikka and P. Verma, 2008. Date palm cultivation in Kachchh. *Date palm Research Station, S.D. Agricultural University, Mundra-Kachchh, Technical Bulletin* 02/2008. pp-36

Sheoran, O.P., D.S. Tonk, L.S. Kaushik, R.C. Hasija and R.S. Pannu, 1998. Statistical software package for agricultural research workers. *Department of Mathematics Statistics. CCS HAU, Hisar*: 139-143.

Sudharsan C., Y.A. Shayli and S.J. Mannel, 2009. Tree crown bending disorder in tissue culture date palm. *J. Agric. Food Envir. Sci.* 3(1): 1-4.

Zaid, A. (Ed). 2002. *Date Palm Cultivation Plant Production and Protection Paper* 156. FAO Rome.

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