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Status and strategic approaches of date palm (*Phoenix dactylifera*) production in India— a review

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Abstract

Date palm (*Phoenix dactylifera* L.) is emerging as an important fruit crop in the arid and semi-arid regions of India, particularly in Gujarat, Rajasthan, and to a lesser extent in Maharashtra and Tamil Nadu. Its cultivation offers considerable potential for agricultural diversification, driven by the adoption of tissue culture technology and introduction of high-yielding varieties. Prominent varieties include Barhee, Khunezi, Khalas, and Halawy for fresh fruit consumption; Zahidi, Shamran, Khadrawy, and Nagal for soft fruit purposes; and Medjool, which is primarily cultivated for dry dates (*Chuhhara*). Despite these advancements, India continues to depend heavily on imports to meet rising domestic demand, emphasizing the need to expand cultivation in other suitable agro climatic regions. Research progress in varietal improvement, disease management, and post-harvest processing has provided a strong foundation for sustainable growth. However, challenges such as limited technical expertise, inadequate irrigation, and somaclonal variation in tissue-cultured plants remain significant bottlenecks. Future strategies should focus on expanding cultivation in potential regions, strengthening post-harvest infrastructure, and enhancing both domestic and export markets. Through strategic innovation, farmer training, and supportive policy incentives, India can reduce import dependency, achieve self-sufficiency in date production, and establish itself as a competitive player in the global date market.

Key words: Date palm, Varieties, Tissue culture, Offshoot, Irrigation, Climate, Challenges

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Date palm (*Phoenix dactylifera* L.; Family: Arecaceae), also known as khajoor or kharek, is an ancient fruit tree native to semi-arid and arid regions of the world. It thrives in poor, desert soils due to its hardy nature having deep root system. This fruit tree is particularly suited for cultivation under saline water irrigation. The date palm prefers its "feet" in water and its "head" in fire/sun, as it requires a dry, hot climate for proper growth and development of fruits. Its successful cultivation is possible in areas with adequate irrigation facilities and dry, hot climatic conditions.

Its fruit is highly nutritious and favoured worldwide. Varieties such as Halawy, Khalas, Khuneizi, Chipchap, Braim, Barhee, and Anand DP-1 are consumed fresh (doka stage) due to their sweet taste and flavour. Besides fresh consumption, several value-added products such as dry dates, pind, beverages, jams, paste, chutney, pickles, vegetables, and biscuits are made from dates. Fresh dates are often used in processed products, and date mouth fresheners are another product with diverse uses (Rathore, 2012). Fresh date fruit can be used to make ready-to-serve (RTS) drinks, although, temperature plays a role in its storage (Godara and Pareek, 1985). The RTS drinks or juices cannot be stored for long due to rapid fermentation. Medjool cultivar is highly suitable for making dry dates (*Chhuhara*) because of its late maturity, high yield, and large berry size, which contribute to a high recovery percentage (Rakesh *et al.*, 2023). Fruit yield varies among cultivars depending on location, tree age, and cultural practices employed (Chandra *et al.*, 1992; Singh *et al.*, 2006). Dates can supplement the dietary needs of desert communities where nutritious food options are scarce. Both dry dates (*Chhuhara)* and soft dates (*Pind Khajoor*) are in high demand and have significant market potential (Meena *et. al.,* 2025). Due to the presence of tannins, many date varieties are astringent at the green doka stage. However, some varieties, such as 'Halawy' and 'Barhee,' are not astringent even when light green or yellow and are palatable at the fresh doka stage (Singh, 2018). After a lengthy evaluation of date palm varieties under the hot, arid conditions of Bikaner, the following varieties are recommended for cultivation (Table 1) in Rajasthan.

Studies are ongoing to assess the germplasm value of seedling date palm and to establish tissue culture protocols for propagating improved varieties and ensuring the availability of quality planting material. Since India is the world's largest importer of dates, local production has significant potential to supply domestic markets and create job opportunities in the horticulture sector. The constraints faced by date growers in its cultivation, post-harvest management, and marketing have also been discussed.

Origin and distribution

The exact geographic origin of the date palm has not

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Table1: Suitable varieties of date palm and uses

Variety	Maturity period	Uses
Halawy, Khuneizi, Nagal, Muscat, Anand DP-1,	Early (Mid of June to Ist week of July)	Fresh eaten ,processed products,
Khalas, Zahidi, Shamran, Khadrawy, Braim, Chip-chap, Sayer,	Mid-season (July)	Fresh, eaten, processed products, pickle,
Barhee, Medjool, Sewi, Dayari,	Late (Last week of July to first week of August)	Fresh eaten, processed products dry dates beverages,bakery products, jam, chutney, fruit drinks,

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yet been definitively established. It has been cultivated since at least 4,000 BC in Mesopotamia, but there are various theories about its origins. This discussion will examine these theories with a specific focus on India, considering observations that have not been adequately addressed. Sanskrit literature highlights the widespread presence of *P. sylvestris* in the Indian subcontinent and the absence of *P. dactylifera*.

Zaid and de Wet (2002) suggested that the date palm (*Phoenix dactylifera*) may have evolved from *P. reclinata* of tropical Africa, *P. sylvestris* of India, or as a hybrid between the two. Globally, twelve *Phoenix* species have been identified. Sanderson (2001) notes that the date palm appears in ancient records across a broad area from the Indus Valley (now Pakistan) to Mesopotamia (now Iraq), the Nile Valley, Southern Persia, the Eastern Mediterranean, and the Horn of Africa. He suggests that this wide distribution implies the palm originated in a more restricted area and was later spread by human activity to regions with favourable geographic, soil, and climatic conditions. Sanderson (2001) supports the theory that the date palm originated in the Indus Valley, where *P. dactylifera* may have existed as a natural hybrid with *P. sylvestris* from at least the 6th millennium BC. Barreveld (1993) reports that the earliest evidence of date palms has been found in Ancient Egypt, where cultivation seems to have coincided with the rise of the oldest civilization in Northeast Africa.

Jaikrishna Thakar served as a curator of forests and gardens in Porbandar State (now Gujarat) from 1886 to 1904. During his tenure, he studied the flora of the Baroda Hills and authored a comprehensive flora on the subject. In his work, he includes only *P. sylvestris*, describing it as a tree mostly without offshoots, with flower clusters measuring 2.54-3.76 cm and fruits that are yellow or orange. Thakar (1926) noted the cultivation of Egyptian date palms and mentioned that in the Kutch-Bhuj and Abadasa regions, date palms known as *kharakadi* or *khalela* (*P. sylvestris*) produced very sweet and tasty yellow and red fruits. In his 1926 book, Thakar states that *P. sylvestris* grows wild and is cultivated in Kutch-Bhuj, while *P. dactylifera* (referred to as *khajuriarabi*) was observed in the Bhuj King's Sarad garden. Fruits from *P. sylvestris* in the Bhuj and Abadasa regions were popular. Old date palm seedlings exist in the coastal belt of the Kachchh region (Pareek and Sodagar, 1985; Muralidharan *et al.*, 2008).

The introduction of Arabian date palms into India likely began with the first Mohammedan invasion of Sind (in undivided India) in the early eighth century when dates were believed to have been brought to Western India for cultivation (Blatter, 1926). The presence of *P. dactylifera* in the Indus Valley is attributed to either Alexander the Great's army (4th century BC), Arab conquerors (7th century), or pilgrims from Mecca (Newton *et al.*, 2013). Hooker (1894), in the *Flora of British India*, mentions *P. sylvestris* as wild and grown throughout the plains of India, Burma, and the Indus Basin, while *P. dactylifera* was introduced into Sindh and Northwest India. Cooke (1908), in the *Flora of Bombay Presidency*, mentions only *P. sylvestris*.

Wild *khajoor* trees are found naturally in the Aravali Hills in Udaipur and Mount Abu. The local *desi khajoor* tree is found throughout the country but produces inferior quality fruit with a large stone and less pulp. From its crown, a liquid called "neera" or *taddi* is extracted, used as a fresh drink and for making jaggery. It is also found in the Bundelkhand region and is a suitable component for agroforestry systems (Tewari *et al.*, 2001). Variations in seedling growth and development in *Phoenix* species under nursery conditions were recorded by Singh and Bhargava (2009). In addition to *Phoenix dactylifera*, another fruiting species at HAU farm, which produces small fruits (2-3g) with very small stones, may be *P. reclinata*. A small, bushy type of *Phoenix* species found in the coastal belt of Odisha, with large seed kernels and low pulp content, may be *P. canariensis*. Basu and Chakraverty (1994) reported that *P. dactylifera* was cultivated in the Indian Botanical Garden, Calcutta, in the early nineteenth century.

Newton *et al.* (2013) explored the complex relationship between *P. dactylifera* and *P. sylvestris* in India. They observed that *P. dactylifera* is characterized by an erect trunk, large stones, less pulp, but a sweet taste. Their travels in Kutch, Saurashtra (Kathiawad), and the Aravalli Hills revealed that *P. dactylifera* was exclusively cultivated in Kutch and not observed in the wild, whereas *P. sylvestris* was found both wild and cultivated in the Kathiawar

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Region. Gros-Balthazard (2013), through phylogenetic analysis of *Phoenix* based on chloroplast sequences and genetic diversity, identified closely related populations of wild date palms for the first time.

The study of hybridization in *Phoenix* highlighted difficulties in identifying species within the genus. Experimental data suggested that *P. sylvestris* is not the progenitor of *P. dactylifera*. All commercial date cultivars have been developed through the selection of chance seedlings based on local needs. Many varieties have been introduced from date-growing countries to India, with over 1,000 varieties available globally. *Medjool* is recognized as the top variety in the world. In Pakistan, which ranks 6th in production, cultivars such as *Begam Jangi*, *Dhakki*, *Aseel*, *Kharbalion*, *Fasli*, and *Mozawati* are grown on a large scale for processing and export. In Gulf countries, famous cultivars include *Ajwa*, *Barhi*, *Deglet Noor*, *Medjool*, and *Sukkary*. In the 18th century, some crossbreeding work in *Phoenix* species was done in the USA to develop a promising male variety, resulting in the identification of the *Fard-4* male palm (Nixon and Carpenter, 1972)

Research and technologies development

Research and development on date palms in India commenced in 1955, when the Indian Council of Agricultural Research (ICAR) sanctioned the Coordinated Scheme for Date Palm Improvement. The main center was established in Abohar, located in the Ferozepur district of Punjab, an area deemed highly suitable for date palm cultivation due to its dry, arid climate and the availability of canal water for irrigation (Kalra, 1976). The primary objective of the scheme was to expand date palm cultivation in appropriate regions across the country. This ought to be achieved through the selection, propagation, and distribution of cultivars/varieties that could be grown successfully, as well as by identifying optimal cultural management practices, such as pruning, pollination, and methods for achieving optimum fruit bearing and proper ripening.

In 1956, JC Bhakshi, the scheme's in-charge, was sent to the USA to select and procure different date palm varieties. He successfully obtained a significant number of suckers from fifteen cultivated varieties. By 1964, 19 varieties were procured from Egypt, Aden, West Pakistan *etc.* within India. In 1959, an improvement initiative for the date palm scheme was launched in Khedoi-Kachchh, Gujarat, by the Bombay Presidency (now part of Gujarat and Maharashtra). This was to address the date palm resources in Kachchh. Later, the initiative was relocated to Mundra based on ICAR's recommendations. Suckers and planting material were distributed across various parts of the country and to ICAR and state government centers for further evaluation.

The major date palm growing areas in India include Kachchh (Gujarat), Rajasthan, parts of Punjab, and to a lesser extent, Tamil Nadu. In the Kachchh region, there are over 2 million date palms, mostly propagated from seeds and offshoots, which provide a rich biodiversity for experimentation and improvement. Recent efforts by the Indian government have led to an increase in date palm cultivation from 8,973 hectares to 16,000 ha, with notable advancements in Rajasthan through the introduction of tissue culture planting materials. Currently, date palms are cultivated in approximately 23,071 ha across the country (Table 3). Significant work remains to be done in improving cultivars, employing hybridization techniques, screening local varieties, training farmers, establishing regional cultivation norms, and enhancing grading, packaging, marketing, and fruit shelf life (Abbas, 2014a).

Date palm research in Gujarat began in 1959 when state government established the Date Palm Research Centre in Khedoi, Anjar taluka, Kachchh district. The Centre aimed to evaluate various date palm offshoots procured from around the world. Subsequently, in 1978, ICAR established another Date Palm Research Centre under Gujarat Agricultural University in Mundra, Kachchh district. The coastal belt of the Kachchh region harbors rich genetic diversity in date palms, which should be further exploited. Elsewhere in the country, date palm populations are less abundant. At ICAR-CIAH, Bikaner, 65 genotypes/cultivars have been conserved in the National Field Gene Bank, collected from various sources (Singh *et al.*, 2006; CIAH, Bikaner 2016-17) and evaluated for growth performance and fruiting characteristics, including three germplasm varieties introduced from ICARDA, Amman, Jordan in 2015. In 1998, offshoots of the varieties *Braim, Chipchap,* and *Sukkar* were introduced from Iraq. However, *Sukkar* did not survive due to the small sized of suckers and lack of roots. Conversely, *Braim* and *Chipchap* are performing well under hot, arid conditions and yielding good fruit (Singh *et al.*, 2005). In January 2009, offshoots of two germplasm varieties, *Siwi* and *Ahmat,* were introduced from Egypt through NBPGR, New Delhi and both are thriving under Bikaner conditions. A late-maturing, rain-tolerant, red berry-coloured genotype has been identified at CIAH, Bikaner (CIAH, Bikaner; 2016-17; Singh *et al.,* 2023).

The institutions such as SDAU, DRS, Mundra (Gujarat); CAZRI, Jodhpur; SKRAU, Bikaner; PAU, RFRS, Abohar (Punjab); Central State Farm, Jaitsar, Sri Ganganagar; Suratgarh Farm (Table 2); and COE Date Palm, Bhojka, Jaisalmer (Rajasthan) maintain tissue culture plants of nine varieties and evaluate their performance.

Table 2: Status of date palm germplasm in India

Centre/place	Nos.	Suitable varieties/genotypes
ICAR-CIAH, Bikaner	68	Halawy, Khalas, Zahidi, Khuneizi, Chip-chap
DRS,SKRAU, Bikaner	35	Halawy, Barhee, Khalas, Zahidi, Khuneizi, Medjool,
RFRS, PAU, Abohar, Punjab	34	Halawy, Barhee, Medjool, Zahidi,
DRS,SDAU, Mundra, (Gujarat)	18	Halawy, Barhee and Local red type
CAZRI, Jodhpur	19	Halawy and Anand DP -1(TC plant early maturity)
Centre of Excellence Date palm, Bhojka, Jaisalmer,	09	Barhee, Khadrawi, Khalas, Jamli, Saggai, Khuneizi, Medjool and 02 male cultivars.

A substantial number of date palm varieties and some promising selections, Sel.-9, Sel.-13, Yaqubi, Kotho, Trofo, Bhukso, Gulchati, Madhepura, Khedoi-7, Sopari, and Saidy, have been identified from natural populations in the Kachchh region. The farmers in Kachchh have made some selections themselves (Pareek and Sodagar, 1986). These yellow and red berry varieties are particularly suited for producing various processed products (Singh *et al.*, 2009). An elite green-coloured, sweet berry type at the doka stage has also been identified in Kachchh at farmer fields. M/s Kachchh Crop Service (KCS) has recognized several elite red and yellow fruit varieties at farmers' fields and is producing tissue culture plants from these elite materials for large-scale planting. Tissue culture-raised plants have shown a higher survival rate compared to traditional sucker or offshoot plantations due to better root development (Fig.1).

In Kachchh region of Gujarat, maximum date palms are natural and as grove in depressions, on riverbank, *nala* and boundary of the farms. In natural date grove populations maximum seedlings are male. In Gujarat major area of date palm cultivation is in the coastal area of Bhuj, Anjar, Khedoi, Mundra, Mandvi, Gandhidham, etc.

During 2020-21, area of date palm cultivation has increased to 19,980 ha with production of 18,5346 tonnes fresh fruits with productivity of 9.27 ton/ha (Table 3). The tissue culture plants of cultivar Barhee imported from UK through UAE have been planted at farmers' field in Kachchh district. They started fruiting 3-4 years after of planting. In these plantations, suckers productions are not allowed by growers for better growth and early fruiting. Mr. Rahul Gala Shah founded a Society in 2006 for date palm farming. The spell out an association of farmers, has become largest organization of Barhee date growers in India. A total of 25,000 offshoots/ tissue culture plants were procured from Israel, Jordan and United Arab Emirates (UAE). Now, date palm cv. Barhee plantation has spread over throughout Kachchh and is started production of fruits. Further, date palm planting material is also spread over Gujarat. The area and production of date palm is increasing in Gujarat (Fig.2).

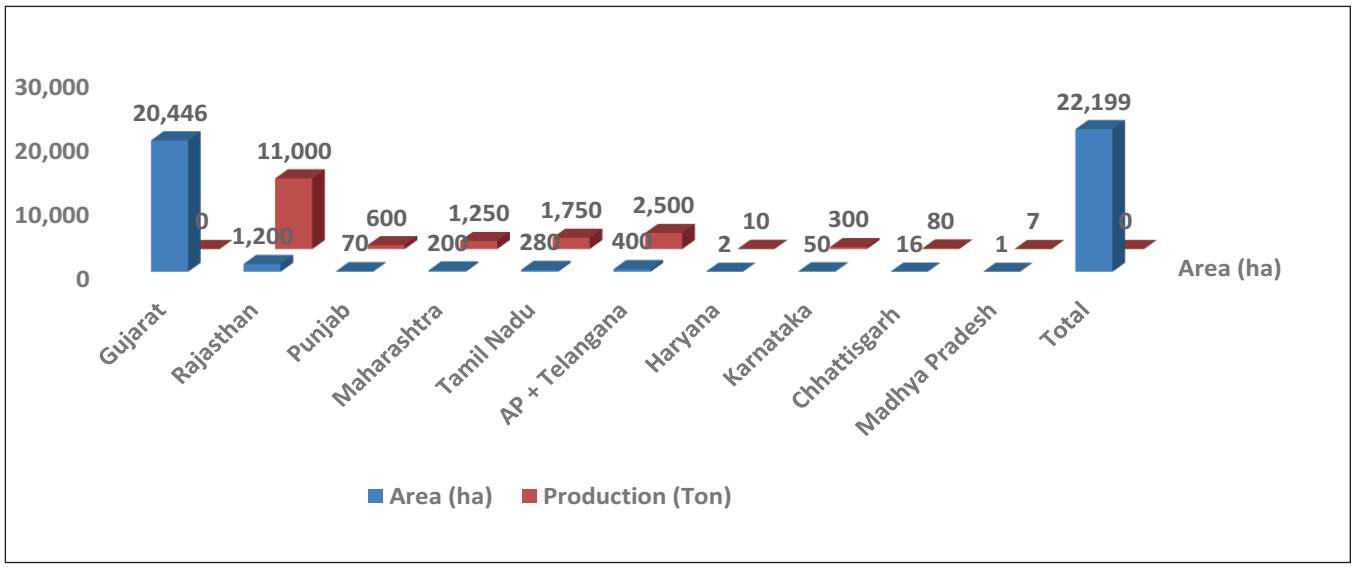

Fig. 1. Area and production of date palm in India

Source: Government's Department of Horticulture and through Personal Communication

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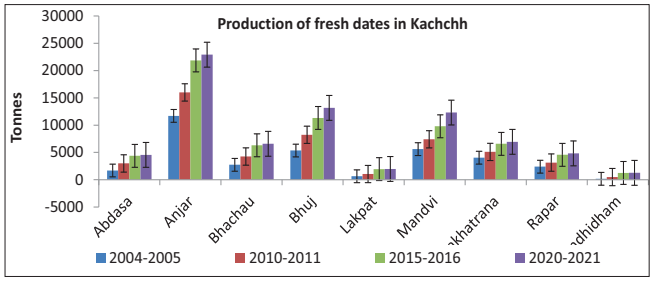

Fig.2. Area and production of date palm in Kuchh district of Gujarat

In India date palm production is not meeting our domestic demand and maximum dates are imported from date-growing countries of the world. During 2013, India imported 311575 tonnes date from UAE, Pakistan, Egypt, etc, of worth 183169,000 US $ and it was increasing pattern, during 2021 as 450356 tonnes. Egypt and Saudi Arab are largest dates producing countries in the world.

According to FAO stat, India is one of the largest importers (No1 position) of dates in the world. Under National scenario, import of dates can be reduced up to some extent by expansion in area and quality production by planting of date palm in Rajasthan, Gujarat, Punjab, Haryana and Tamil Nadu (Fig 3 and 4).

However, 2021, India's position as an exporting country for product dates, fresh/dried is37th in the world. The export quantity 766 tonnes for costing 1287 US$ and share per centage of 0.07 on the world.

Further, India also exports a small quantity of dates and processed products to neighbouring countries like Nepal, Myanmar, Bhutan, Singapore, Maldives and Sri Lanka, amounting 6,35,000 US $. This may increase in the future.

Date palm cultivation

The very best dates known can be grown at Montgomery, Multan, Khushab, Sirsa and Lahore (now in Pakistan) and Ludhiana (in India), but that Delhi and Ambala (India) fall somewhat short of the required climatic standards. Milne stated that minimum and maximum temperatures are suitable for the fruiting season at all stations, he observed that if first class dates ripen under 3,277 heat units then finest dates should ripen in Punjab. In the fruiting season, excess rainfall and normal high humidity cause the most damage during ripening period. For offshoot propagation, if the fruits are ripe on mother tree, at that time offshoot is cut, there can be no doubt of the type of fruits that offshoots will bear. Before being removed, offshoots should be pruned of mature leaves, preserving the tender young opened leaves in central bud.

To prevent excessive water loss from transpiration, offshoots should weigh at least 2.7 kg; those of lesser weight will likely die. Trimmed offshoots ready to be planted should weigh 5.4-6.8 kg and be 3-4 years old. Some 6-12 month before offshoot is to be removed; earth should be heaped around base of the mother palm and kept moist to stimulate root growth and thereafter planting is done in field at 5 to 6 m. distance. Raising of seedlings and selection work was initiated and improvement work on date palm was done by Jawanda and Kalra (1972) at Abohar, Punjab.

Water management is crucial for offshoot plantations, as date palms yield best under well-drained, aerated soils. Roots extend 2–3 m deep, so aeration must

Table. 3 Area and production of fresh dates in Gujarat during 2005-2021

Districts	2005-06		2010-11		2015-16		2020-21	
	Area ha	Production (Tonnes)	Area ha	Production (Tonnes)	Area ha	Production (Tonnes)	Area ha	Production (Tonnes)
Ahmadabad	6	51	2	10	2	17	8	56
Banaskantha	85	357	100	500	152	770	210	1,449
Bharuch	0	0	0	0	18	62	13	60
Dwarka	-	-	-	-	11	56	25	150
Gandhinagar	1	5	1	5	2	0	2	14
Jamnagar	0	0	8	31	85	425	148	651
Kachchh	13,171	92,197	16,693	1,23,995	17,658	1,65,632	18,920	1,79,362
Morbi	-	-	-	-	57	303	131	786
Patan	16	160	30	264	89	462	204	1,440
Porbandar	0	0	2	8	2	10	9	46
Rajkot	0	0	3	21	68	382	94	773
Surendranagar	11	110	13	130	59	354	130	410
Others	0	0	0	0	23	11	86	149
Total Area	**13,290**	**92,880**	**16,852**	**1,24,964**	**18,226**	**1,68,474**	**19,980**	**1,85,346**

Source: Director of Horticulture, Government of Gujarat

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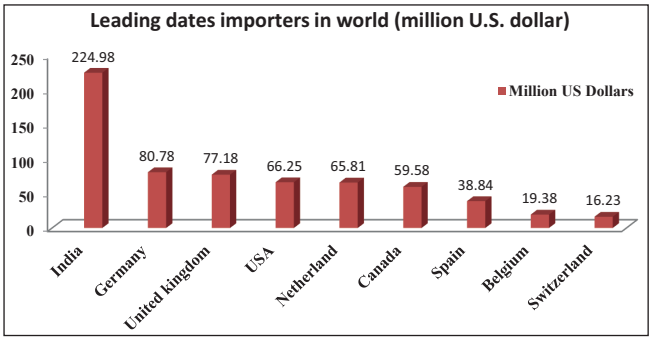

Fig.3. Imports of date palm worldwide
Source: Food and Agricultural Organisation (FAO), 2021

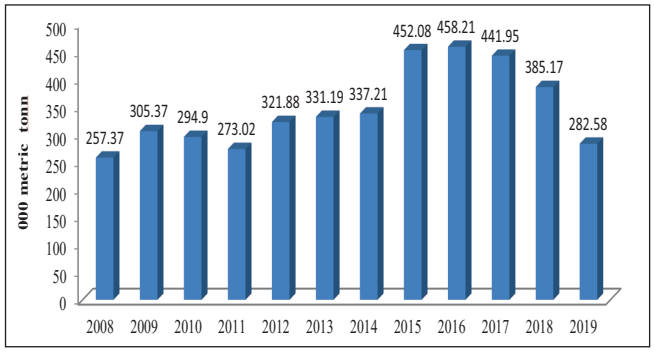

Fig.4. Export volume of date palm neighbouring countries
***Source*:** FAO Stat database

be maintained to this depth, with the water table kept between 2.7 and 4.9 m. Manure should be applied after growth begins. In Punjab, coal ash serves as an effective mulch, conserving moisture and preventing termite attack. Intercropping can be practiced during the early years; legumes or other fruits such as pomegranates or figs are recommended. The soil should be kept moist for the first month after date palm planting and until they are fully established. Offshoots in well-drained medium loamy soil in September require daily watering for the first 40 days, every-other-day watering for the next 40 day and thereafter watering every 6 day until growth begins. In spring, watering should be every 4 or 5 days until the rains commence. An annual application of 25 kg of well-seasoned manure per adult plant is needed. In arid region, oil seeds crop like *Brassica juncea*, and *Eruca sativa* can be grown in newly establishing orchards. As taramira is a rainfed crop grown during *rabi* season in arid region.

The timing of hand pollination varies; if weather is warmer, flowering is earlier. Pollination is appropriate when the female spathe bursts and the stigma is receptive. The low temperature in preceding year affects fruit setting in date palm (Shabana and Al-Sunbol, 2007). The receptivity time of stigma in date variety varied. It has been observed that pollination and fruit setting in cv. Medjool is highly receptive. The pollination and stigma receptivity in date palm cv. Shamran was studied by Gupta and Thatai (1980) at Abohar. The male flower cluster with its enclosing spathe is cut when it is about to open. Waxy scales cover the stamens. One or two small branches are cut from the male cluster and placed among the small branches of the female cluster. One male tree may sufficient to pollinate 100 female trees; however, it is safer to have 3-5 male palms per 100 female palms. Netting to protect the ripening fruits is necessary to protect against birds damage. In hot arid conditions, it is experienced that many bunches/berries are damaged due to high wind velocity, dust storm/ hot sand. Protection measures/ covering of bunches should be followed.

The research work on date palm was conducted on establishment of suckers, rooting, and to screen better varieties at Abohar, Punjab (Kalra, 1976, Katyal and Dutta, 1976). The performance of various cultivars was monitored in Abohar area to assess their performance (Vij *et al.*, 2005). Different hormonal treatments were applied in aerial suckers for root development. Mounding/earthing is also practised for rooting in high offshoots and results were encouraging (Vij *et al*, 1977). Under varietal evaluation, maximum number of fruits (15-21) per strand in cv. Deglet Noor; maximum fruit (23-68 g) and seed weight (2-3.5 g) in cv. Medjool were observed. Total soluble solids recorded were (27.6%) in cv. Halawy. Halawy and Barhee fruits were good for fresh eating at *doka* stage and cv. Medjool for *chuhhara* (dry date) making, whereas cv. Zahidifruits were good for processing as soft dates. The old seedling palms (50-60 year.) are growing well on farm road side and some of them producing good quality fruits. Some farmers of border areas in Punjab maintain seedling palms. There is a better scope for chance seedling selection and identification of elite material.

Table 4: Import of dates products in India

Units	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2021
Quantity (MT)	193467	256295	247300	311575							450356
Value 000US $	95043	141713	112649	183169							240350

Source: FAO Stat database

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Gujarat

Along the western border of Gujarat, Kutch, Saurashtra and North Gujarat are considered the best regions for date palm cultivation. Thakor (1926) observed the Arabian date palm in the private garden of King of Kutch. Old records show that date palm groves on north-western border of India were developed from seeds discarded by army encampments and in part from seeds and offshoots planted by settlers, returning from the Haj pilgrimage. It is said that 400 years ago Mundra in Kutch was the only (Tables 3 and 4).

Sea route through which pilgrims went for Haj from India and on return brought the dates. In the course of time, date plantations increased. Previously Kutch, the largest district of Gujarat, was almost isolated from the mainland. Only after 1947 with the improvement of road and railroad connections were the trade channels opened and the marketing of dates improved. There was considerable increase in date palm plantations; in 2004-05 the total area increased from 8,973 ha to 16,000 ha during last decade (Abbas, 2014a). Under the National Horticulture Mission, Government of India, Gujarat has received grants to promote date palm cultivation and research. Date cultivation suffered heavy losses in 1998 from a major hurricane and hundreds of plants were destroyed and also during severe storm / earthquake in Kachchh region. In general, seedlings are growing on Farm boundary, roadside, and foothills. A rich diversity in date plants is available near Kera, Khedoi village and male palms spathes are used for collection of pollen grains.

Date palm seedling plantation has done at Research farm, SK Nagar, Gujarat for evaluation. A few plants are in fruiting stage. The growth in male palms is vigorous and fast than female and male plants ratio is 40-50%. Male palms are used for pollination purpose.

Date palm Research Station, SDAU, Mundra, is working on date palm research since 1978 and has made the following recommendations for Gujarat region:

- Cultivars Halawy and Barhee are recommended for commercial plantation. The Khalal stage of Halawy cultivar is the best quality for making chuhhara, which is prepared by immersing the fruits in boiling water for 20 minutes and then drying them on trays in an air circulation oven at 45°C for 60–65 hours.
- The Barhee cultivar is the best for making pind khajoor.
- Medium-quality fruits are useful for preparing good-quality beverages. The Local Red variety is well-suited for making jam.
- Cultivars Medjool, Hatemi, Ruziz, Selection-3, and Tayar are resistant to white scale, Parlatoria blanchardi.
- Using 600-gauge low-density polythene at the color break stage of the fruit (ICBR of 1.1.73) protects against rain damage in late-maturing cultivars.

Kachchh region

About 70-80% of date palm cultivation in coastal belt of Kutch, from Anjar to Mandvi, originated from seeds, and majority of fruits are of inferior quality (Ramdevputra *et al.*, 2009). During 2019 survey in the Kachchh area, rich genetic diversity was observed in fruits of date palms at doka stage, with variation in fruit colour, weight, size, taste, total soluble solids and acidity (Singh *et al.*, 2020). As a result, offshoots of date palm cultivars were obtained from different date-growing countries through the United Nations Development Program (UNDP) and their evaluation was undertaken at Date Palm Research Station (DRS), Mundra. Five introduced date palm cultivars—Zahidi, Halawy, Barhee, Khadrawy, and Sayar and one Local Red variety as the control were evaluated from 1999 to 2001 DPRS, Mundra, Kutch. During 2000-2001, the Barhee cultivar produced the maximum yield of 66.17 kg / palm over three years. The Sayer and Khadrawy cultivars recorded lowest yields.

The highest number of strands (62.08) and longest strand length (44.92 cm) were recorded in the Barhee cultivar, although Halawy was also statistically comparable to Barhee. The maximum fruit weight was recorded in Halawy in 1999, while during 2000-2001, the Barhee cultivar had highest average fruit weight of 15.40 g, 12.63 g, and 12.74 g, respectively. Fruits of Barhee, Zahidi, Khadrawy, and Sayar cultivars had poor taste quality and were astringent at khalal stage, whereas Halawy, Barhee and Local Red varieties were superior, with a market price of INR 15/kg. Barhee yielded highest return of INR 992.70 / palm / year due to its sweet taste and softness at khalal stage (Ramdevputra *et al.*, 2009).

The Kutch Date Palm Development Consortium, an association of farmers registered under the Society Act (1960) and based in Bhuj, Gujarat, is the largest organization of Barhee date palm growers in India. The organization addresses all the needs of its members, including the import of date palms, Post Entry Quarantine (PEQ) facilities, fertilizers, manure, pesticides, technical knowledge, and development of marketing channels and buyback guarantee. A total of 25,000 offshoots and tissue-cultured plants were procured from Israel, Jordan, and the United Arab Emirates for the development of date orchards (KDDC, 2009).

Rajasthan

The northern arid regions in India consist largely of the Rajasthan Desert, the Rann of Kutch and semiarid

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regions of Punjab and Gujarat. Rajasthan occupies almost 60% of the total of these regions. The region has sandy saline soil of 8-10 pH, with very low rainfall, cold winters and very hot summers. Furthermore, it has salty ground water, strong winds and low soil fertility. Maharaja Shri Ganga Singh ji brought date palm plants and was planted in the Garden, Sri Ganga nagar and other places in Rajasthan. The Rajasthan canal system represents the major irrigation scheme. With construction of the Indira Gandhi Canal, Jaiselmer District has an area of 677,000 ha and Barmer District 3,100 ha of irrigation facilities. This facility has led to making this region a garden of date palms as it grows well under extreme temperatures and saline soil, although requiring a proper water supply.

The commercial varieties of date palm were introduced from the USA, Pakistan and Middle East countries during 1955-1962. The performance of some of the cultivars was found more beneficial under arid irrigated conditions at Abohar, Punjab. The success opened up the possibilities of commercial date palm cultivation in India. Therefore, new thrust was given to date palm research since 1978 under the All India Coordinated Fruit Improvement Project of the ICAR at (now AICRP on Arid Zone Fruits), Bikaner and Jodhpur in Rajasthan, Abohar in Punjab, Hisar in Haryana and Mundra in Kachchh, Gujarat. The area under cultivated type date palm (*Phoenix. dactylifera*) is less in India and now it is being increase after introduction of tissue culture planting material especially in Gujarat, Rajasthan, Tamil Nadu and other place.

M/s. Atul Pvt. Ltd., a prominent industrial chemical company located in South Gujarat, has undertaken a massive effort to make the Rajasthan Desert green with date palms. The company and the Rajasthan Government have formed a joint venture company, M/s. Atul Date Palm Ltd., a publicprivate-cooperative venture. A memorandum of understanding (MOU) was signed between UAE University, Al-Ain and M/s. Atul Ltd., to transfer tissue culture technology of date palm. M/s Atul Pvt.Ltd., in 2011 acquired a majority holding in DPD Ltd., London, which produces tissue culture date palm plantlets for distribution worldwide.

The Atul date palm project is very ambitious and when fully implemented will represent an outstanding private/public program effort for date palm cultivation in Rajasthan. However; there are many scientific, social, climatic conditions to overcome. (Rajmohan *et al.,* 2010**,** report for date palm in Rajasthan) in two phases: first, import of secondary hardened plantlets and establishment of demonstration farms and second, the establishment of nurseries and import of primary hardened plants with secondary hardening in India. Activities included: (a) About 47,000 primary tissue culture palms of Barhee, Khalas, Khunezi and Medjool cvs. (female and male) were imported from Arab nations and secondary hardening is in process at a new nursery at Jodhpur, Rajasthan.

After one year plant showed satisfactory growth; (b) In an area of 104 ha at Jaisalmer, Rajasthan, tissue culture female palms of cvs. Barhee, Medjool, Saggai and Zamli have been planted along with male cv. Madsari and Ghanami for pollination. Growth of all cultivars after 10-12years of planting has been evaluated and it was found Barhee, Khuneizi, Medjool are suitable in respect of better yield and quality of fruits. However, stunted growth, morphological variation in plants were noticed during farmer's fields in tissue culture date palm orchards.

The Rajasthan Date Palm Project, supported by the state government, established 140 ha of plantations using tissue-cultured plants of several cultivars at Khara Farm, Bikaner, and Sagra–Bhojka Farm, Jaisalmer. This farm has developed as Centre of Excellence for date palm in Rajasthan. Date palm orchard development work in Thar desert is appreciable. Drip irrigation is practiced moreover; during visit of farm maintenance of the irrigation system through contract was inadequate. A large number of plants exhibit a phenotype that is not typical of the cultivar. Problems during production in the laboratory stage may be the cause for this presumed somaclonal variation (Table 5).

Table 5: Area of date palm cultivation in different districts of Rajasthan.

District	Area (ha)	Varieties planted
Sri Ganaganagar	170.00	Barhee, Khuneizi, Khalas, ,Medjool,
Hanumangarh	130.00	Barhee and Medjool,
Churu,	25.5	Barhee,
Bikaner	300.00	Barhee, Khadrawy, Khuneizi, Khalas, Medjool, Zamali, Saggai and male plants
Jaisalmer	500.00	Barhee, Khadrawy, Khuneizi, Khalas, Medjool, Zamali, Saggai and male plants
Barmer	205.00	Barhee, Khuneizi, ,Medjool,
Jhunjhunu	12.00	Barhee, Khuneizi, Khalas, ,
Nagaur	42.00	Barhee, Khuneizi, Khalas, ,
Jodhpur	37.00	Barhee, Khuneizi, Khalas, ,
Pali	22.00	Barhee, Khuneizi,
Sirohi	13.80	Barhee,
Jalore	40.00	Barhee, Khuneizi, Khalas,

The average fruit yield / palm at full *doka* stage was, in Barhee (66.0 kg), Halawy (59.7 kg), Khalas (43.7 kg) and Medjool (35.0 kg). The date palm are planted at 8mx8m spacing and common cultural practices were adopted. The cultivar Medjool is goodfor high yield and preparing dry dates (*chuhhara)*; Halawy, Barhee, Khalas, Khunezi, Sewi,

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Braim,Chip-chap, are best for fresh eating and processing (Singh *et al,* 2006). Spray of Ethephon 1000ppm at colour turning stage hasfound usefulfor earlyripening and improvement of berries in date palm (Meena *et al,* 2009). In a morphological characterization study of stone, variability in stone/seed characters in date palm was observedand accordingly, varieties may be groupedin small, medium and large/ big sized (Singh *et al*,2020).

One genotype (CIAH/DP/Sel.-1) late maturing, rain tolerant of red colour berry has identified by ICAR-CIAH, Bikaner. The fruits were harvested (45-50kg/tree) at *doka* stage at the end of August and first week of September. The length of bunch is bigger in size (90-105cm.), bunch weight 6-8kg.,number of bunch 9-12; number of berries/strand 25-29,fruit size 3.20 cm x 2.20 cm. Average fruit weight 10-12g, TSS 34-38^0 brix, obtained IC number 0624544 for specific rain tolerant late maturity characters, Fruits are sweet in taste, edible at *doka* stage. Besides fresh consumption, it can alsobe used for making value added products (Singh*et al,*. 2023).

Tamil Nadu

Seed propagation is not useful due to dioecious nature. The common method of date palm propagation is sucker/offshoots of an appropriate size and weight (Mohammad, 1978). At present, tissue culture technique is more common for large scale plant multiplication. Saliah nursery (Dates India, 2011b) in Tamil nadu imports tissue culture plants of Meznaz, Chayar, Jaglool, Barhee, Jagidar, Khadravi and Khalas. According to Mr. S. Nizamudeen, these plants have grown to 1.5-3.0 m tall. They are all female trees and bear fruits from the second year of planting and recommended practices are as follows:

- *Planting and irrigation:* planting in a pit 60 cm x 60 cm x 60 cm. Biofertilizers like vermi-compost, sheep manure or farm yard manure (any one of them) can be used with plant spacing of 6 x 6 m. Irrigation of 30 litre per tree once a week up to 1 year. For the next 2 years, 50 litre per tree once a fortnight. For the subsequent 2 years, 100 litre/ tree once a month under drip irrigation, then the drip system should be converted into basins.
- *Intercropping:* during the early years intercropping can be done to generate additional income and to provide protection to young palm trees against heat. Plants like *Aonla* (Phyllanthus emblica), fig (Ficus carica) *badhal* (monkey fruit, lakoocha), *seetha phal* (custard apple), Cajanus cajan, Vigna radiata, Macrotyloma uniflorum, sesame, Helianthus annuus, Zea mays, Sorghum bicolor and finger millet can be grown. For such plantings additional irrigation must be provided.
- *Pollination:* Pollination is done by hand for better pollination honey bee rearing should be introduced.

Date-palm flowering take place during January to February. Fruit harvest is done in June or July. After 5 years of planting the fruit is harvested at three stages. The fruiting begins from the fifth year of planting. Under drip irrigation the yield in 5th years is 50 kg, year 6 is 60 kg, years 7 and 8 is 100 kg and in year 9 reaches150 kg. The average of 150 kg fruits/year for a tree assumes that it is healthy. The date palms yield well for up to 50 years but for following 50 year the yields decrease. For better pollination and fruit yield 10 males are necessary for 100 female plants (Dates India, 2011b).

Organic date palm

Mr. K. G. Murugavel is first southern India to successfully cultivate organic Barhee dates. About 30 km from Coimbatore, he has a 1 ha farm in Vanjipalayam where he has 3.1 m tall palms of Barhee. A total of 200 plants grow in neat rows; each boxed in by thin sprinkler pipes and 8 m apart. Each tree was laden with 50-80 kg of shiny yellow dates, nicknamed *honeyballs*. They are crunchy and sweet. In Feb. 2009 he imported 200 plantlets from the UAE and planted them on his farm. Holes were filled with organic manure, ash and sand, 148 plants / ha, watered every 3 day. Neem cake and organic manures are applied once every 3 month. He harvested fruit within 28 months very fast time period for Barhee.

In the first year the plant height was 2.4 m tall with 20 kg of fruit and in the second year 40 kg /plant. When in full maturity each tree will be 20 m tall and estimated to yield 200-300 kg of organic dates which are harvested annually in July and September. This year each kilogram of dates fetched @ 300- per kg. The dates do not require any processing and are plucked at three stages.

In Hanumangarh, Rajasthan, a progressive farmer (M/s Laxmi Farm) is cultivated fruit crop and medicinal plants by adopting organic practices.

Tissue culture in date palm

Tissue culture plants of date palm were introduced in Kachchh region. Many importing agencies are engaged for this work.With a survey of date palm cultivation in Punjab, Kachchh and Tamil Nadu and recent attempts of covering vast arid and semi-arid regions of Rajasthan and its adjacent regions with date palm presents great challenges to improve cultivating practices, find local elite cultivars and import cultivars for better uniform acceptability and improved better date products. Over

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decades of cultivation practices followed in different regions, regenerating dates either by seeds or offshoots and trying different imported cultivars, there are present date fruits of great variations in size, shape, colour, weight, taste and astringency.

One way was to import tissue culture plants from abroad where such technologies have been developed either it was necessary to develop such technologies in India using either local elite cultivars and/or develop select cultivars found suitable for the conditions of India's different regions. The attempt of tissue culture was done in India by Kutch Crop Services Ltd., Mundra after setting a tissue culture lab. The lab has developed tissue culture plants of Barhee and local elite type. (KCSL, 2014). At CIAH, Bikaner a few of tissue culture plants of date palm supplied by M/s AV Thomas &Co., Kerala were evaluated under hot arid condition. More number of sucker productions was observed in comparison to suckers raised plants under field condition (Bhargava *et al*., 2014). Physiological variation in tissue cultured plants was noted. Somaclonal variation has been observed in tissue culture raised plants.

Kutch Crop Services Ltd (KCSL), Mundra, Gujarat

The KCS, Mundra has been involved in socio-economic development since more than three decades in the Kachchh region. The need for evaluating date palm as a source of income for farmers of Kutch was established at Vivekananda Research and Training Institute (VRTI), Mandvi in 1994; in 1995 a study was initiated in consultation with Israeli scientists to identify elite date palm cultivars. The activities of KCSL are (a) improve the socio-economic conditions of local farmers in Kutch and other regions; (b) provide knowledge about scientific cultivation practices in a cost effective manner; (c) provide quality planting material at an affordable cost and (d) conserve the natural heritage of elite date palm.

During 2000, a tissue culture laboratory for date palm was started it was sponsored by Rural Agricultural Research and Development Society (RARDS) to set up a date palm tissue culture lab in Mundra, Kutch. With the scientific team , KCSL has succeeded in motivating entire team to develop the protocol for elite cultivars of date palm and laboratory is producing about 5-10 thousands plants. Cv. Barhee and KCS-143 plants were procured from KCS Ltd, Gajod, Bhuj to see their performance under arid condition and the performance was good. The KCSL has also supplied tissue culture plants to farmers for orchard development in Kachchh region.

Anand Agricultural University, Anand

The AAU Plant Tissue Culture Laboratory claims to have developed, for the first time in India, a protocol of micropropagation of indigenous genotypes of date palm. Field evaluations of tissue culture grown plants at Anand and Dantiwada (university fields) have shown total field establishment (no mortality), early flowering and profuse suckering. On flowering they were true to type DNA based molecular markers (viz. Random Amplified Polymorphic DNA (RAPD), Intersimple Sequence Repeat (ISSR) and Simple Sequence Repeat (SSR) have been employed to verify variant plants and proved their superiority and clonal fidelity. According to Dr. Subash, responsible for developing this technology, around 1,500 plants are under hardening process in different stages. The fruits from local genotypes and elite varieties have huge potential to capture local and global markets. The technology involves raising shoot apices (apical and auxiliary buds) of selected offshoots of elite cultivars. The stages involved are callus initiation, somatic embryo induction, development, maturation, germination and finally in-vitro plantlet development. The tissue culture plants (Anand -1, red type) have supplied to different organizations and farmers for planting and are performing well with respect growth and fruits yield. The protocol developed by AAU have ready for large scale development of plants.

Tissue culture and protocol development

In our country, many tissue culture lab are working for production of tissue culture plants of different fruit crops, but only a few of them are producing date palm plants. At Jodhpur, tissue culture lab is also established and working on date palm crop. At CCSHAU, Hisar, date palm tissue culture work has also been started a long year back for protocol development. Tissue culture technique has been followed to develop plantlets in the lab.Tissue culture protocol development varied from variety to variety in case of date palm plants. This fruit crop is differed from others. Single or same protocol cannot be implemented to other variety. Protocol development research work in date palm has also been carried out at Biotechnology lab, ICAR-CIAH, Bikaner and some successful results have been found for mass multiplication of tissue culture plantlets. Auxiliary apical meristem tissues were taken for callus formation. The different hormones media were tried for rooting after callus formation. Hardening process has also been developed for tissue culture raised plants (Anon., 2017-18).Evaluation of tissue culture plants have been carried out at Institutes farm. ICAR-CIAH is recognised centre for the evaluation of imported plantlets/ quarantine for date palm crop.

Spathe emergence, flowering and pollination

It is a dioecious fruit tree and male and female

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spathes are borne on separate palms. In date palm, flowering entirely differs from other fruit trees as emergence of spathe, opening and then flowering, which takes about a month period. It also depends on genetic character and climatic conditions of the region. The atmospheric temperature plays an important role in spathe emergence, opening and flowering process. The spathe emergence, opening and flowering is governed by climatic data recorded in different year in Thar Desert, Jaisalmer (Singh and Uchoi, 2016). The good orchard management practices can improve spathe emergence, flowering and fruiting in date palm as it is continuous process and depends on growth and development of the plants (More *et al.*,2014). The age factor in date palm plants is also responsible for flowering. In case of date palm, number of leaves also important factor for spathe emergence, opening and number of bunches plant.

In general, hand pollination is done in dates at the time of spathes opening in female plants. About 5% male plants are necessary for pollination purpose. Earlier there was no known male in the world. There is no hybrids and hybridization work has not been done so far in date palm (Nixon and Carpentor, 1984). Now, several male varieties of date palm *viz.* Al-in-city, Madsari, Fard-4, Charmis and Local, are available for pollen grain production.

To see the effect, the hybridization work should be tried. The male date palm genotype (CIAH/DP/M-01) has been identified for more pollen grain production 600-700g pollen/tree (Singh *et al.*, 2018).

Fresh collected pollen grain has found more effective than stored pollen grain for fruit setting and yield in cv. Halawy (Singh *et al*, 2019). Pollens can be stored for long time at suitable temperature in freez. The opening of spathes depends upon environmental temperature. Effect of pollination and different type covering of bunches are found suitable for quality fruit production (Kumawat, 2020). Under Bikaner conditions, spathe emergence starts from last week of January and completed at the end of February and sometime up to first week of March. It has been observed that prolonged winter delays the spathe emergence. Spathe emergence continues physiological process along with growth of trees. It has been observed that occasionally, spathes are emerged out during winter months.

The spathe emergence/opening is started during February month. At Abohar, flowering takes place by the middle of March. Spathe opening starts by the fourth week of February and continues up to third week of April. Similar observations have also been reported by Jawanda and Kalra (1972) at Abohar. Mertia and Vashishatha (1985) have observed variation in spathe emergence in different years in cultivar Halawy under hot arid condition of Jaiselmer.

Harvesting, post-harvesting handling and marketing

Harvesting, post-harvest management and marketing of dates is an important set of neglected agricultural practices in Kachchh region (Muralidharan *et al,* 2008). Kutch produces only khalal dates; rutab and tamar stage of dates are not produced because of unfavourable climatic conditions during June-July which are the months for further ripening of the dates. Kutch produces the largest share of dates in India and different processed products have been developed (Ramdevputra, 2003).

Dates produced from these three major sources in Kutch also have sub cultivars (varieties) developed from many years of cultivations, long life of trees and possibility of random, natural or human (inter varietal) pollination resulting in a complex heterogeneous population of genetic diversity producing mostly poor-quality dates and a few elite ones. Problems associated with harvesting and grading of fruits are not scientifically resolved or taken care of with appropriate awareness of the farmers. Hence date cultivars undergo monetary loss and frustration.

In Kachchh there are local varieties, tissue cultured selected local varieties and imported Barhee cv. Pre-harvest practices that determine fruit quality and appropriate covering of fruit bunches and thinning fruit strands or bunches require standardization. Postharvest grading of fruits depends on size, colour, flavour, weight, shape, sweetness and astringency at khalal stage. Quality of date cv. Medjool was assessed after giving hot water treatment and drying efficiency and found cv. Medjool is good for dry date (Rakesh Reddy *et al.*,2023).

Marketing involves establishing prices based on grading by an organized independent agency, growers association to avoid middle man interference. In Anjar, Bhuj there is lack of an open market where farmers bring their dates to sell; but in the absence of a grading and price setting agency it is unorganized and date growers depend upon the middleman who decides the quality and price.

Plant protection

The problem of diseases, insects, in date palm crop is low due to hardy nature of plant. However, main disease and insects attack have observed in date palm orchards *viz.* suckers rot, Graphiola, palm weevil, termites, mites, etc The executive summary of the report of the committee which visited Gujarat and Rajasthan states stated that in Rajasthan symptoms resembling those of trunk rot (*Thielaviopsis paradoxa*) pathogen are

present on a few trees. The presence of this pathogen is difficult to determine and laboratory tests should be repeated. Due to this reason, plant is broken and fall down in dust storm.In Gujarat presence of red palm weevil is the main problem, which is considered to be a major threat to production and should be given priority. Another problem is the high levels of infection with *Graphiola*, a leaf fungus. Protocols for monitoring the red palm weevil are also present (Muralidharan *et al.*, 2019). It may be desirable to treat *Graphiola* chemically; control measures consist of: (a) leaf pruning, coupled with treatment with any wide spectrum fungicide and (b) planting of resistant cultivars. Control measure for red palm weevil involve: (a) pheromone based RPW-IPM strategy; (b) set monitoring traps; (c) check palms around traps and (d) treat infested plants.

The damage of immature fruits by birds in Rajasthan is common, the management practices and use of different type covering material should be recommended. To control of termites, chemical insecticides as well as organic methods should be followed.

Future thrusts area of research

Kachchh region has a high genetic diversity in date palms; not only due to the complex relationship of natural hybridization with sugar date palm but the present populations of date palms consist of a majority grown from seed, offshoots and more recently from tissue culture. A few recent attempts (Srivastava *et al.*, 2013, 2014) at molecular characterization to find the best genotypes and identify sexual differentiation have been made for date palms in Kutch. But more systematic and concentrated investigations are required to identify genetic markers for the best cultivar identification and characterization of fruit qualities, such as shape, weight, colour, taste and sweetness.

The mapping the genomes of cultivars of date palms will be a great step towards improving the date palm cultivars and throwing light on the origin and domestication of the date palm. For the date palms in Kutch it is necessary to have morphometric and cellular markings for different cultivars and especially of elite cultivars with superior date qualities recognized for global market. India has main four regions of date palm cultivation, Punjab, Gujarat, Rajasthan and the south-eastern coastal region (mostly Andhra Pradesh and Tamil Nadu); with advancing climatic changes and preference for date palm cultivars, the best cultivation practices and disease preventive measures should be standardized. The pollination is a skilled practice apart from selecting appropriate varieties having metaxenia pollen effects. If a pollen bank is established on a cooperative basis having necessary storing facilities and appropriate grading of varieties, it would be a boon to farmers.

Looking to the frequency of earthquakes and hurricanes in Kachchh region, it is necessary that germplasm of elite cultivars of Kachchh should be conserved to other growing site for future use. The present tissue culture technology developed in India to produce date palm plantlets requires fine tuning and appropriate changes to produce true-to-type plants. At present tissue cultured palms pose some problems of somatic clonal variations. Moreover, it is necessary to have tissue culture plantlets of elite cultivars suitable to different regions and satisfying local tastes and demand as well as export requirements.

The development of various technologies and the requirement for date-palm research, conservation of germplasm and exploitation of genetic diversity, crop improvement, utilization of fruits in India, at least two-three suitable locations at Bikaner, Jaiselmer and Mundra should be strengthen. The date palm has its own unique place in agro-Horticulture system. Its usefulness in many ways and means and ability to endure unfavourable climate with long life satisfy the objectives of agri-horticulture development in arid and semiarid regions for the benefit of the farmer's community. The various processed products made from date fruits have an economic and social benefits for creating jobs. By reducing import of date palm, foreign exchange can be also saved. Date processing industries should be established in date palm growing areas. As well as development of orchards of date palm in arid and semi-arid regions would be an asset for ecological development, crop diversification and eco-tourism. There are vast potential of eco-tourism in Rajasthan and Gujarat, which can be helpful in many ways for social and economic development.

Conclusion

Date palm cultivation in India has made significant strides, particularly in the arid regions of Rajasthan and Gujarat. Research efforts, including varietal improvement, disease control, and post-harvest processing, have laid the foundation for sustainable growth. However, challenges such as limited local expertise, inconsistent irrigation, and somaclonal variations in tissue-cultured plants need to be addressed to enhance productivity and marketability. Looking forward, the focus should be on expanding cultivation into other suitable regions, improving post-harvest handling and processing, and developing domestic and export markets. By fostering innovation and farmer education, India can become self-sufficient in date palm production and even emerge as a key exporter in global market.

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