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CATEGORIZATION OF BER VARIETIES IN RELATION TO BLOOMING PERIOD, FRUIT SETTING AND HARVESTING TIME

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Thirty four local Ber varieties were evaluated at Horticultural Research Institute AARI, Faisalabad, Horticultural Research Station Bahawalpur (Punjab) and Jujube Research Station, Tandojam (Sindh). Traits viz. total period of blooming (dates), peak period of blooming (dates), total period of fruit set (dates), peak period of fruit set (dates), total period of fruit harvest (dates), peak period of fruit harvest (dates), total flowering days, peak flowering days, total fruit setting days, peak fruit setting days, total harvesting days and peak harvesting days were studied. The results revealed significant differences in parameters studied except total period of blooming under Tandojam, Sindh conditions. Varieties were classified as early, mid and late season for both provinces. Local varieties had potential for further manipulation in terms of variety improvement to attract growers for extensive ber cultivations under changing global climatic scenario.
Keywords: Jujube, germplasm, flowering behavior, fruit set, harvest time

INTRODUCTION

Jujube (*Zyzyphus mauritiana* Lamk.) locally called Ber belongs to family Rhamnaceae (Buckthorn), which is indigenous to China and Indo Pak subcontinent. It is called "apple of desert" and fits well into the marginal ecosystem of semiarid and arid zones. Xerophytic properties of ber i.e. tap root system, presence of scales on buds and deciduous behavior in extreme summer has made its cultivation successful where no other fruit crops do well (Pareek *et al*., 2007). Jujubes are predominantly cultivated in several Asian countries, including India, China, Pakistan, Korea, Thailand, and Vietnam. There are minor acreages in Russia, the Middle East, southern Europe, Australia, and the USA (Reich, 1991; William, 2002). Ber can provide constant production even in drought and can yield between 80 Kg to 200 Kg fruit per tree depending on the age and climatic conditions. Ber trees can give extras income to farmers if incorporated into their agricultural system or grown on marginal lands. Nutritionally ripe fruits are richer than apple in protein, phosphorus, calcium, carotene and vitamin C contents (Mukhtar *et al*., 2004). It contains many types of bio-active substances such as, triterpenic acid, volatile oil, glycosides, saponins and flavonoids that have wide pharmacological effects on humans (Al Zhao *et al*., 2008). Immature jujube is usually of green color, after ripening changes to yellowish-green and turns to fully brown or red when mature and starts to wrinkle when over ripe.

In Pakistan, Ber is produced over an area of 5425 hectares with an annual production of 27950 tones (Anonymous, 2011). Primary Ber producing areas in Pakistan are Bhawalpur, Faisalabad, Multan, Jhang, Sargodha (Punjab province) and Tandojam, Hyderabad, Mirpurkhas, Nawabshah, Gadop and Malir Area of Karachi (Sindh Province). Ber demonstrates a rich genetic diversity mostly resulting from natural cross pollination and self incompatibility (Bhargava *et al*., 2005).

In Pakistan a number of Ber varieties are grown but still no serious attempt has been made to classify these available varieties on the basis of blooming, fruit setting and harvesting criteria. Jujube need to exploit widely due to their value in human nutrition and added benefits to rural people of various by products from this multipurpose tree. The intention of this study was to provide information to growers and extension workers about selection of Ber varieties with respect to their blooming, fruit setting and harvest time. On the basis of gathered information the varieties can be classified as early, mid or late maturing, which will be important regarding availability of fruit for a longer period of time and stabilize prices in the market.

MATERIALS AND METHODS

Thirty four genotypes selected in this study were 15-20 year old, T-grafted on Desi Ber (*Zyzyphus rotundifolia*) in experimental fruit garden of Horticultural Research Institute AARI, Faisalabad, Punjab (71°34' 11.68 E & 13°14' 17.08 N, 343ft altitude), Horticultural Research Station Bahawalpur, Punjab (71°38.665' E & 29°22.725' N, 329ft altitude) and Jujube Research Station, Tandojam, Sindh

(68°32.130' E & 25°24.749' N, 67ft altitude). Metrological information of germplasm sites is given in Table 1. Different varieties selected from Punjab were Karela, Umran, Khobani, Fauladi,Suffon, Anokhi, Mehmood Wali, Ajooba, Yazman local, Saddqia, Pakwhite, Gorh, Dilbhar, Dehli Sufaid, Bahwalpur Selection 1, Allu Bukhara and Bahwalpur Selection 2. The varieties from Sindh included Gola early, Gola Late, Gola saffina, Gola kararri, Gola grape, Soofi umran, Soofi gilli, Soofi sanghar, Soofi sialkoti, Soofi local, White chambeli, Khirol Mukhri, Khirol Desi, Khirol Ratam, Soghat, Naayab and Goba.

For recording data three trees of each variety were randomly selected. Each variety was considered as individual treatment hence making total number of experimental units 102. The observations were recorded on total period of blooming (dates), peak period of blooming (dates), total period of fruit set (dates), peak period of fruit set (dates), total period of fruit harvest (dates), peak period of fruit harvest (dates), total flowering days, peak flowering days, total fruit setting days, peak fruit setting days, total harvesting days, peak harvesting days. Experiment was laid out according to Randomized Complete Block Design. Data was analyzed statistically and treatments were compared by using Least Significant Difference (LSD) test at 5% probability level.

RESULTS AND DISCUSSION

Punjab germplasm (Faisalabad and Bahawalpur): Flowering period in *Zyzyphus mauritiana* cultivars ranges from August to October. Inflorescence is cyme and number of flowers per branch is very high. Flowering period ranged from 40 to 70 days, depending on cultivar (Dhaliwal and Bal, 1998). Statistical analysis depicted that period of onset of flowering ranged from 17th August to 30th October in various Ber varieties under Faisalabad conditions. Total time period taken for flowering was found the longest in "Khobani" i.e., 69 days (Fig. 1) which ranged from 17th August to 26th October (Table 2). Minimum total time period taken for flowering was recorded in "Saddqia i.e., 40 days (Fig. 1) which lasted from 14th September to 26th October (Table 2). Similar observations have also been recorded in various Indian Ber cultivars (Sharma *et al.,* 1990). It was observed that flowering season is long and duration of flowering varied in different ber genotypes (Gupta, 2001). Peak time period taken for flowering was the longest in

Table 1. Metrological data of germplasm sites in in Punjab and Sindh province

	Faisalabad		Bahawalpur		Tandojam	
	2010	**2011**	**2010**	**2011**	**2010**	**2011**
Average annual maximum temperature (°C)	31.0	31.2	33.3	32.6	32.6	33.5
Average annual minimum temperature (°C)	11.7	17.2	19.0	19.2	21.3	22.8
Average annual humidity (%)	58.2	61.3	57.7	58.4	59.5	58.3
Annual total precipitation (mm)	761.3	506.5	307.59	156.72	277.37	713.7

Source: Observatory of plant physiology AARI, Faisalabad; Weather Station Bahawalpur; Regional Agro Met Centre Tandojam, Sindh, Pakistan.

Table 2. Flowering times of different Ber varieties in Punjab (Faisalabad and Bahawalpur)

Varieties	**Total period of blooming (days)**	**Peak period of blooming (days)**
Karela	29th Aug. to 25th Oct.	18th Sept. to 10th Oct.
Umran	25th Aug. to 10th Oct.	22nd Sept. to 4th Oct.
Khobani	17th Aug. to 26th Oct.	28th Sept. to 18th Oct.
Fauladi	25th Aug. to 20th Oct.	15th Sept. to 12th Oct.
Suffon	6th Sept. to 26th Oct.	1st Oct. to 15th Oct.
Anokhi	25th Aug. to15th Oct.	26th Sept. to 20th Oct.
Mehmood Wali	29th Aug. to 26th Oct.	27th Sept. to 16th Oct.
Ajooba	30th Aug. to 15th Oct.	26th Sept. to 16th Oct.
Yazman local	28th Aug. to 20th Oct.	26th Sept. to 15th Oct.
Saddqia	14th Sept. to 26th Oct.	11th Oct. to 20th Oct.
Pakwhite	27th Aug. to 28th Oct.	25th Sept. to 18th Oct.
Gorh	30th Aug. to 30th Oct.	30th Sept. to 26th Oct.
Dilbhar	28th Aug. to 18th Oct.	15th Sept. to 12th Oct.
Dehli Sufaid	1st Sept. to 29th Oct.	8th Oct. to 18th Oct.
Bhawalpur Selection 1	30thAug. to 22nd Oct.	27th Sept. to 16th Oct.
Allu Bukhara	4th Sept. to 29th Oct.	8th Oct. to 28th Oct.
Bhawalpur Selection 2	26th Aug. to 27th Oct.	12th Oct. to 30th Oct.

"Dilbhar" and Fauladi i.e., 27 days (Fig. 1) which ranged from 15th September to 12th October (Table 2) followed by "Gorh" i.e., 26 days (Fig. 1) ranged from 30th September to 26th October (Table 2). The shortest peak time period taken for flowering was recorded in "Dehli Sufaid" i.e., 10 days (Fig.1) which started from 8th to 18th October (Table 2). Flowering time and duration in Ber varieties relates to climatic conditions like temperature, rainfall and genetic factors (Pareek, 2001).

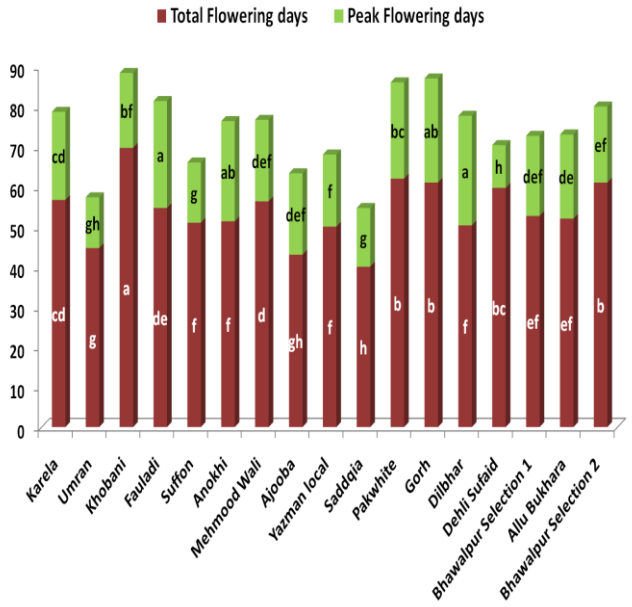

Figure 1. Number days for blooming in different Ber varieties under climatic conditions of Punjab (Faisalabad and Bahawalpur)

Total time period taken for fruit setting was the longest in "Pakwhite" i.e., 66 days (Fig. 2) ranging from 4th September to 12th November (Table 3) while the shortest total time period for fruit setting of 36 days (Fig. 2) was recorded in "Allu Bukhara" which ranged from 11th September to 17th October (Table 3) and "Ajooba" 13th September to 19th October (Table 3). Such variations in fruit setting time among different Ber cultivars have also been recorded by Neeraja *et al*. (1995). Peak time period taken for fruit setting was maximum in Gorh i.e., 24 days (Fig. 2), from 14th October to 6th November (Table 3). The minimum peak time period taken for fruit setting of 11 days (Fig. 2) which ranged from 16th October to 27th October and was recorded in "Yazman local" followed by "Karela", "Anokhi", "Ajooba" and "Saddiqia" (12 days) (Fig. 2). Studies in India have indicated that *Z. mauritiana* cultivars have cross incompatibility (Teaotia and Chauhan, 1964). Ackerman (1961) found that many jujube cultivars set fruit poorly without cross pollination.

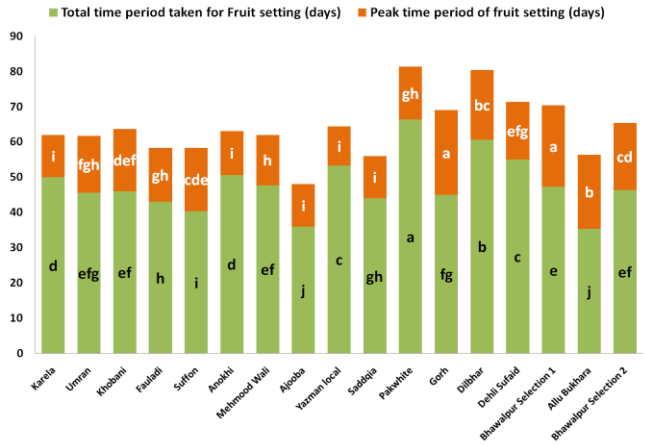

Figure 2. Number of days for fruit setting in different Ber varieties under climatic conditions of Punjab (Faisalabad and Bahawalpur)

Total time period taken for fruit harvesting ranged from 20th February to 10th April. The longest total time period taken for fruit harvesting was observed in "Bahawalpur Selection 2" i.e., 27days (Fig. 3) which ranged from 25th February to 23rd March (Table 3). The shortest total time period for harvesting was recorded in "Ajooba" i.e., 8 days (Fig. 3) ranging from 11th March to 19th March (Table 3). The longest peak time period taken for fruit harvesting was observed in "Gorh" i.e., 13 days which ranged from 20th March to 3rd April. The minimum peak time period taken for fruit harvesting was recorded in "Anokhi" i.e., 2 days (Fig. 3) which ranged from 10th March to 12th March (Table 3).

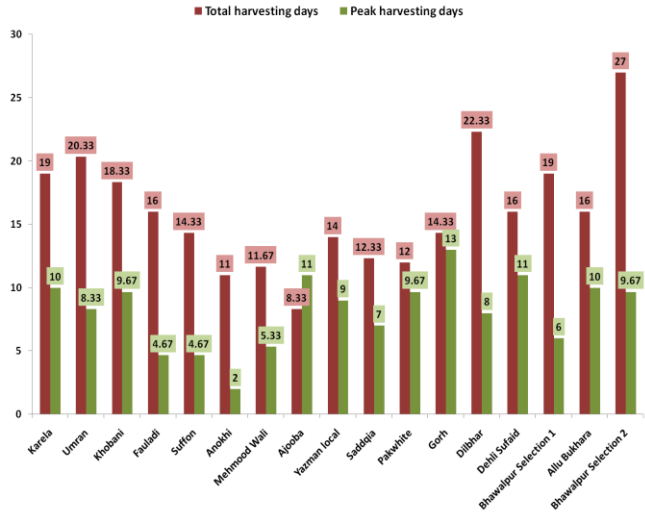

Figure 3. Number of days for fruit harvesting in different Ber varieties under climatic conditions of Punjab (Faisalabad and Bahawalpur)

Table 3. Fruit set and harvest times of different Ber varieties in Punjab (Faisalabad and Bahawalpur)

Varieties	Total period of Fruit set (days)	Peak period of fruit set (days)	Time period of fruit harvest (days)	Peak period fruit of harvest (days)
Karela	6th Sept. to 24th Oct.	25th Sept. to 8th Oct.	20th Feb. to 10th Mar.	2nd Mar. to 13th Mar.
Umran	2nd Sept. to 20th Oct.	28th Sept. to 15th Oct.	22nd Feb. to 13th Mar.	5th Mar. to 15th Mar.
Khobani	29th Aug. to 16th Oct.	20th Sept. to 8th Oct.	23rd Feb. to 13th Mar.	2nd Mar. to 13th Mar.
Fauladi	9th Sept. to 22nd Oct.	5th Oct. to 20th Oct.	28th Feb. to 15th Mar.	6th Mar. to 10th Mar.
Suffon	12 Sept. to 20th Oct.	1st Oct. to 19th Oct.	6th Mar. to 20th Mar.	10th Mar. to 16th Mar.
Anokhi	8th Sept. to 30th Oct.	10th Oct. to 22nd Oct.	5th Mar. to 16th Mar.	10th Mar. to 12th Mar.
Mehmood wali	7th Sept. to 25th Oct.	26th Sept. to 10th Oct.	8th Mar. to 20th Mar.	15th Mar. to 20th Mar.
Ajooba	13th Sept. to 19th Oct.	10th Oct. to 22nd Oct.	11th Mar. to 19th Mar.	13th Mar. to 23rd Mar.
Yazman local	14th Sept. to 7th Nov.	16th Oct. to 27th Oct.	10th Mar. to 24th Mar.	12th Mar. to 20th Mar.
Saddqia	20th Sept. to 5th Nov.	11th Oct. to 24th Oct.	8th Mar. to 21st Mar.	14th Mar. to 20th Mar.
Pakwhite	4thSept. to 12th Nov.	16th Oct. to 30th Oct.	10th Mar. to 25th Mar.	25th Mar. to 3rdApril.
Gorh	7th Sept. to 23rd Oct.	14th Oct. to 6th Nov.	12th Mar. to 5th April	20th Mar. to 3rd April.
Dilbhar	2nd Sept. to 3rd Nov.	10th Oct. to 28th Oct.	15th Mar. to 30th Mar.	18th Mar. to 25th Mar.
Dehli Sufaid	10th Sept. to 5th Nov.	16th Oct. to 1st Nov.	10th Mar. to 28th Mar.	15th Mar. to 25th Mar.
Bhawalpur selection 1	4th Sept. to 22nd Oct.	23rd Sept. to 17th Oct.	24th Feb. to 12th Mar.	6th Mar. to 11th Mar.
Allu Bukhara	11th Sept. to 17th Oct.	19th Oct. to 10th Nov.	20th Mar. 10th April.	30th Mar. to 6th April.
Bhawalpur Selection 2	5th Sept. to 21st Oct.	30th Sept. to 18th Oct.	25th Feb. to 23rd Mar.	11th Mar. to 20th Mar.

As a result of the millennia of local selection, many Ber cultivars have arisen, some of which have become commercially recognized. Nevertheless, virtually nothing is known about the patterns of genetic variation of this existing germpalsm. No particular research has been made on identifying reproductive traits of *Ziziphus* cultivars. Bearing and associated characters provide useful information on proper times of flowering, fruit setting and harvesting for the classification of Ber varieties (Singh *et al.*, 1974).

***Sindh germplasm (Tandojam)*:** Blooming period under Tandojam, Sindh conditions prevailed from 8th August to 30th October. Flowering and fruit setting under Tandojam condition was somewhat earlier than Faisalabad due to climatic differences (Table 1). Non significant results were recorded in case of total time period taken for flowering among seventeen local Ber cultivars, while significant results were recorded for peak time period taken for flowering. The lengthiest peak time period taken for flowering was recorded in "Khirol Mukhri" i.e., 25 days (Fig. 4) which ranged from 14th September to 9th October (Table 4) while the shortest peak time period taken for flowering was recorded in "Gola Early" i.e., 10 days (Fig. 4) ranging from 9th September to 19th September (Table 4).

Fruit setting time ranged from 25th August to 3rd November under Tandojam Sindh conditions. Maximum total time period taken for fruit setting was in "Soofi Umran" (46 days) (Fig. 5) starting from 14th September to 30th October (Table 5). The minimum total time period for fruit setting was recorded in "Gola Early" and "Gola Kararri" (32 days) followed by Soofi Sialkoti (31 days) (Fig. 5) which ranged from 28th September to 29th October (Table 5). Such variation in period of peak fruit set in ber varieties was recorded by Raja (2004). Peak time period taken for fruit setting was the longest in 'Gola Late" i.e., 23 days (Fig. 5) ranging from 28th September to 21st October (Table 5) while the shortest peak time period taken for fruit setting was recorded in "Soofi Local" (7 days) which ranged from 9th October to 16th October (Table 5)**.** Fruit set depends on physiological and environmental conditions. Time of anthesis also varies with cultivar (Dhaliwal and Bal, 1998).

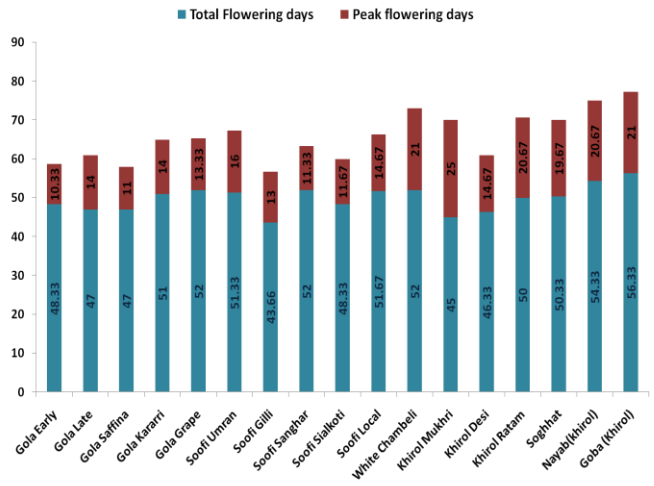

Figure 4. Nimber days for blooming in different Ber varieties under climatic conditions of Sindh (Tandojam)

Table 4. Flowering times of different Ber varieties in Sindh (Tandojam)

Varieties	Total period of blooming (days)	Peak period of blooming (days)
Gola Early	20th Aug. to 25th Sept.	9th Sept. to 19th Sept.
Gola Late	30th Aug. to 14th Oct.	27th Sept. to 12th Oct.
Gola Saffina	30th Aug. to 18th Oct.	8th Sept. to 20th Sept.
Gola Kararri	28th Aug. to 10th Oct.	10th Sept. to 25th Sept.
Gola Grape	4th Sept. to 17th Oct.	20th Sept. to 4th Oct.
Soofi Umran	8th Aug. to 12th Oct.	29th Sept. to 16th Oct.
Soofi Gilli	4th Sept. to 27th Oct.	10th Oct. to 24th Oct.
Soofi Sanghar	5th Sept. to 25th Oct.	10th Oct. to 23rd Oct.
Soofi Sialkoti	12th Sept. to 30th Oct.	15th Oct. to 27th Oct.
Soofi Local	26th Aug. to 22nd Oct.	29th Sept. to 16th Oct.
White Chambeli	27th Aug. to 15th Oct.	14th Sept. to 6th Oct.
Khirol Mukhri	1st Sept. to 28th Oct.	14th Sept. to 9th Oct.
Khirol Desi	30th Aug. to 18th Oct.	28th Sept. to 16th Oct.
Khirol Ratam	7th Sept. to 29th Oct.	30th Sept. to 22nd Oct.
Soghhat (Gola group)	2nd Sept. to 26th Oct.	26th Sept. to 16th Oct.
Nayab (Khirol)	3rd Sept. to 23rd Oct.	24th Sept. to 16th Oct.
Goba (Khirol)	30th Aug. to 28th Oct.	19th Sept. to 22nd Oct.

Table 5. Fruit set and harvest times of different Ber varieties in Sindh (Tandojam)

Varieties	Total period of Fruit set (days)	Peak period of fruit set (days)	Time period of fruit harvest (days)	Peak period fruit of harvest (days)
Gola Early	1st Sept to 3rd Oct	20th Sep to 1st Oct.	16th Jan. to 2nd Feb.	26thJan. to 2nd Feb.
Gola Late	8th Sept to 28th Oct	28 Sept. to21 st Oct.	30th Jan. to 15th Feb.	9th Feb. to 18th Feb.
Gola Saffina	5th Sept. to 13th Oct.	18th Sept to 25th Sept.	1st Feb. to 16th Feb.	6th Feb. to 12th Feb.
Gola Kararri	2nd Sept to 4th Oct.	18th Sept to 26th Sept.	1st Feb. to 16th Feb.	10th Feb. to 14th Feb.
Gola Grape	10th Sept to 25th Oct.	25th Sept. to 9th Oct.	26th Jan. to 7th Feb.	1st Feb. to 6th Feb.
Soofi Umran	14th Sept.. to 30th Oct.	18th Oct to 26th Oct.	28th Jan. to 12th Feb.	2nd Feb. to 8th Feb
Soofi Gilli	26th Sept. to 28th Oct.	11th Oct. 22nd Oct.	13th Feb. to 25th Feb.	12th to 16th Feb.
Soofi Sanghar	10th Sept. to 30th Oct.	17th Oct. to 28th Oct.	5th Feb. to 16th Feb.	10th Feb. to 14th Feb.
Soofi Sialkoti	28th Sept. to 29th Oct.	27th Oct. to 7th Nov.	26th Jan. to 4th Feb.	27th Jan. to 5th Feb.
Soofi Local	1st Sept. to 24th Oct.	9th Oct. to 16th Oct.	6th Feb. to 20th Feb.	12th Feb. to 16th Feb.
White Chambeli	4th Sept. to 21st Oct.	7th Oct to 20th Oct.	15th Feb. to 28th Feb.	20th Feb. to 26th Feb
Khirol Mukhri	3rd Sept to 27th Oct	26th Sept. to 19th Oct.	16th Feb. to 27th Feb.	20th Feb. to 25th Feb.
Khirol Desi	4th Sept. to 3rd Nov.	16th Oct. to 2nd Nov.	15th Feb. 27th Feb.	23rd Feb. to 26th Feb.
Khirol Ratam	7 Sept. to 29th Oct.	26th Sept. to 11th Oct.	16th Feb. to 5th Mar.	25th Feb. to 4th Mar.
Soghhat (Gola group)	5th Sept. to 26th Oct.	25th Sept. to 10th Oct.	10th Feb. to 3rd Mar.	22nd Feb. to 24th Feb.
Nayab(khirol)	8th Sept. to 28th Oct.	1st Oct. to 20th Oct.	13th Feb. to 7th Mar.	20th Feb. to 23rd Feb.
Goba (Khirol)	6th Sept. to 24th Oct.	29th Sept. to 13th Oct.	20th Feb. to 15th Mar.	26th Feb. to 7th Mar.

Table 6. Categorization of ber cultivars according to harvest time

Germplasm site	Harvest season	Varieties
Punjab	Early	Karela, Umran, Khobani, Bahawalpur1
(Faisalabad and Bahawalpur)	Mid	Fauladi, Suffon, Anokhi, Mehmood wali, Ajooba, Yazman local, Saddqia, Bahawalpur 2
	Late	Pakwhite, Gohr, Dilbhar, Allu Bukhara, Dehli Sufaid
Sindh	Early	Gola early, Gola, Grape, Soofi umran, Soofi Sialkoti
(Tandojam)	Mid	Gola late, Gola, Saffina, Gola kararri, Soofi Gilli, Soofi sanghar, Soofi local
	Late	White chambeli, Khirol mukhri, Khirol, Desi, Ratm, Soghat, Nayab, Goba

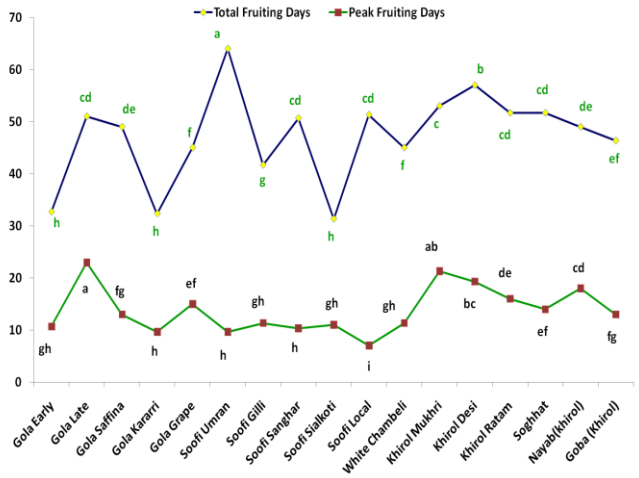

Figure 5. Number of days for fruit setting in different Ber varieties under climatic conditions of Sindh (Tandojam)

Maturity started in Ber (*Z. mauritiana*) from first week of November and continues up to end of February under Tandojam, Sindh conditions. Total time period taken for fruit harvesting ranged from 26th January to 13th March. The longest total time period for fruit harvesting was observed in "Goba Khirol" i.e., 23 days (Fig. 6) and ranged from 20th Feburary to 15th March (Table 5).

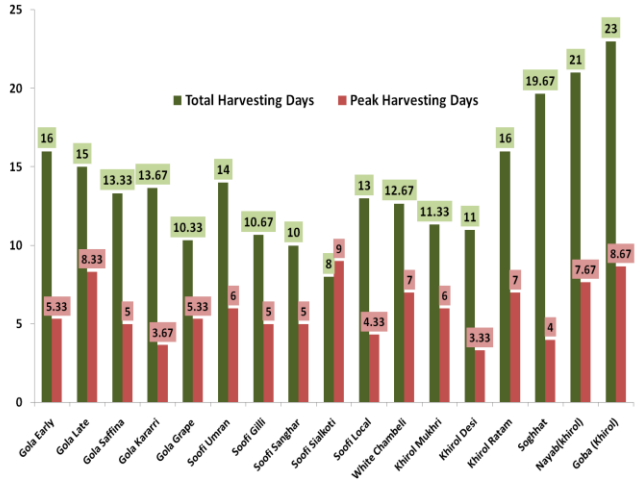

Figure 6. Number of days for fruit harvesting in different Ber varieties under climatic conditions of Tandojam, Sindh

However, the shortest total time period for harvesting was recorded in "Soofi Sialkoti" i.e., 8 days ranging from 26th Jan to 4th Feb (Table 5). Fruit maturity in different cultivars of Z. mauritiana was obtained in 180 to 200 days (Kumar *et al*., 1986). Variation in harvesting periods of different Ber cultivars has also been indicated by Vishal *et al.* (2002). The longest peak time period taken for fruit harvesting was observed in "Soofi Sialkoti" i.e., 9 days (Fig. 6) which ranged from 27th January to 5th February, while the shortest peak time period taken for fruit harvesting was recorded in "Khirol Desi" i.e., 3 days (Fig. 6) and ranged from 23rd February to 26th February (Table 5). Such variations in harvesting time and period have also been observed by Singh and Jindal (1980). There may be involvement of some genetic and climatic factors too. Variation in maturity period of ber varieties might be attributed to temperature difference and morning relative humidity. Cultivars of *Z. mauritiana* also differed in the time of flowering (on set, duration and peak) in Maharastra, India (Desai *et al.*, 1986). Flowering season was observed in Hyderabad (India) from May to July and its total duration varied from 68-94 days. Cultivars Gola, Mundia and Akola flowered early; Umran and Seb in midseason; Banarsi and Kaki were late flowering (Babu and Kumar, 1988).

This study has generated knowledge about potential Ber cultivars, both in point view of yield and harvesting time, which in turn would be helping to avoid glut problems in markets and improve economic strength of the growers. Commercial Ber varieties existing in Punjab and Sindh were categorized as early, mid and late (Table 6). This information will be supportive for trade and industry as by knowing proper time of fruit maturity of various cultivars, planning could be made for domestic and export markets.

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