

Ripening pattern of commercial jujube (*Ziziphus mauritiana* Lamk.) cultivars in Indian arid ecosystem

Vishal Nath* and R. Bhargava

National Research Centre for Arid Horticulture, Bikaner-334 006 (Rajasthan), * Present Address: HARP, Plandu, PO-Rajaulatu, Ranchi-10, India.

Abstract

The ripening pattern of six commercial cultivars of Indian jujube (Gola, Kaithali, Banarsi Kadaka, Umran, Mundia and Seb), at six different locations (Anantapur, Sardarkrushinagar, Jobner, Jodhpur, Bikaner and Hisar) situated in the arid part of the country from south to north was studied. Inference were drawn based on pooled data on ripening period along with meteorological parameters for five years. Ripening in ber is a prolonged process which starts from first week of November in south and continues up to mid of April in north India. In general, the peak of ripening in jujube cultivars takes place between December to March at different locations. Irrespective of cultivars, the peak ripening takes place between last week of November and first week of January in southern region whereas in north part, peak starts from 10th January and continues up to 30th March. The prevailing maximum and minimum temperature of 23.3-34.4 and 6.2-19.1°C, respectively, along with a temperature difference of 11.9-18.3°C and morning relative humidity of 49.6-87.7% at least for one month induces peak of ripening in Indian jujube. Since these climatic conditions occur at different time at different locations, therefore the ripening period in ber cultivars varies with latitude and longitude.

Key words: *Ziziphus mauritiana* Lamk., ber, Indian jujube, ripening time, meteorological parameters, geographical location

Introduction

Indian jujube (*Ziziphus mauritiana* Lamk.), a member of family Rhamanaceae, is a drought hardy fruit. It is popularly known as ber or Apple of Desert. In spite of fragile environmental conditions prevailing in arid region of the country, ber plant produces high quality fruit. The jujube tree is much adopted in arid agroclimate and goes into dormancy during scarce moisture period. After pruning, plant put forth new growth before monsoon and makes use of available soil and atmospheric moisture for its floriferous growth because flowering takes place on current season's growth (Pareek, 1983). Inbuilt drought avoidance mechanisms (Pareek *et al.*, 1999) of tree enables the fruit production more remunerative under arid ecosystem.

Ber, being a non-climacteric fruit ripens on plant itself. Ripening of fruit relates with the flowering and fruit set period. In ber, flowering duration in prolong (Vishal Nath and Bhargava, 2000) which takes more than one month period from initiation to end at different location in arid region of the country. Accordingly, the ripening time is also prolonged for about one month at different sites. At national level, the ripening initiates during early November in southern India and continues up to mid of April in Northern part of the country. In order to investigate the possible reasons for such variation in ripening time in different agro climatic zones, an attempt has been made to correlate the ripening period with the prevailing meteorological parameters.

Materials and methods

Data on ripening pattern of six commercial cultivars (Gola, Banarsi Kadaka, Kathali, Umran, Mundia and Seb) of jujube have been collected from six location spread over the arid region

of the country from south to north *viz.*, Anantapur, Andhra Pradesh (14°39'N 77°42'E); Sardarkrushinagar, Gujarat (23°0'N 72°50'E); Jobner, Rajasthan (27°1'N 75°50'E); Jodhpur, Rajasthan (26°23'N 73°08'E); Bikaner, Rajasthan (29°12'N 75°45'E) and Hisar, Haryana (28° 02'N 73°18'E). Five years (1986-90 for all centres except Bikaner for which the data have been taken from 1994-98). Data on ripening duration was pooled and mean values for initiation, peak and termination of ripening were calculated. The minimum and maximum temperature (°C) and per cent morning and evening relative humidity (RH) during respective years at various locations were computed and mean values presented. The temperature difference was calculated by simple subtraction of mean minimum temperature from the mean maximum temperature.

Results and discussion

In India, availability of fruit from commercial cultivars of jujube remains in the market for about 170 days *i.e.*, from 1st week of November to mid of April. This is on account of the fact that irrespective of cultivars, the ripening initiates much earlier in southern India (7th November at Anantapur) and continues up to 15th April at Hisar in north western India. The overall scenario reveals that the ripening in different cultivars is completed within 20-50 days at each station. Sharma and Kore (1990) also made similar type of observations. However, in Rajasthan, which is the important ber growing state ripening process starts by 4th January at Jodhpur in cultivar Gola and continues up to 10th April at Bikaner in cultivar Umran. Ripening pattern of different ber cultivars have been presented and discussed.

Gola: Ripening in Gola cultivar of ber starts from 30th November at Anantapur in southern India and continues up to 5th March at

Bikaner in north western India. Peak of ripening takes place on 20th December at Anantapur, 10th January at Sardarkrushinagar, 30th January at Jobner, 10th January at Jodhpur and 20th February at Bikaner and Hisar. Pareek and Vashishtha (1986) also reported that under Jodhpur condition, Gola cultivar ripens during January. Data presented in Table 1 a and b reveal that a minimum (6.2-18.0°C) and maximum (23.3-30.1°C) temperature range (18.0 and 30.1°C at Anantapur, 9.5 and 27.8°C at Sardarkrushinagar, 6.2 and 23.3°C at Jobner, 10.7 and 26.2°C at Jodhpur, 10.8 and 27.2°C at Bikaner and 6.2 and 23.6°C at Hisar) along with respective RH favours the peak of ripening. It is apparent from Table 2 that a range of temperature difference between 12.1 to 17.1°C continuously for one month along with 49.6 to 87.7 per cent morning RH is congenial for ripening of Gola cultivar of ber in arid region.

Banarsi Kadaka: Ripening in Banarsi Kadaka cultivar of ber starts from 7th November at Anantapur in southern peninsula and continues up to 5th April at Hisar in north India. Peak of ripening occurs on 30th November at Anantapur, 23rd February at Sardarkrushinagar, 5th February at Jodhpur, 14th February at Jobner, 5th March at Bikaner and 20th March at Hisar. Data presented in Table 1 a and b reveal that a minimum (8.9-19.1°C) and maximum (25.2-30.8°C) temperature range (19.1 and 30.8°C at Anantapur, 12.0 and 29.5°C at Sardarkrushinagar, 8.9 and 25.2°C at Jobner, 11.7 and 25.4°C at Jodhpur, 10.8 and 27.2°C at Bikaner and 11.2 and 29.9°C at Hisar) along with respective RH favours the peak of ripening. It is clear from Table 2 that a range of temperature difference between 11.7 to 18.1°C for approximately one month before peak of ripening along with 52.0 to 82.2 per cent morning RH is favourable for peak of ripening in cultivar Banarsi Kadaka.

Kaithali: Ripening in Kaithali cultivar of ber starts from 20th December at Anantapur in southern India and continues up to 5th April at Hisar in northern part. Peak of ripening in Kaithali takes place on 5th January at Anantapur, 28th February at Sardarkrushinagar, 8th February at Jodhpur, 18th February at Jobner, 5th March at Bikaner and 20th March at Hisar. Perusal of data presented in Table 1 a and b reveal that a minimum (8.9-18.0°C) and maximum (25.2-30.1°C) temperature range (18.0 and 30.1°C at Anantapur, 9.5 and 27.8°C at Sardarkrushinagar, 6.2 and 23.3°C at Jobner, 11.7 and 25.4°C at Jodhpur, 10.8 and 27.2°C

and 30.1°C at Anantapur, 12.0 and 29.5°C at Sardarkrushinagar, 8.9 and 25.2°C at Jobner, 11.7 and 25.4°C at Jodhpur, 10.8 and 27.2°C at Bikaner and 16.3 and 29.9°C at Hisar) along with respective RH favours the peak of ripening. It is evident from the Table 2 that a range of temperature difference between 12.1 to 18.1°C for about one month prior to peak of ripening along with 52.0 to 84.4 per cent morning RH is congenial for peak ripening in Kaithali cultivar of ber.

Umran: Ripening in Umran cultivar of ber starts from 5th December at Anantapur in Andhra Pradesh and continues up to 15th April at Hisar in Haryana. Peak of ripening in this cultivar occurs on 30th December at Anantapur, 20th February at Sardarkrushinagar, 28th February at Jodhpur and Jobner, 20th March at Bikaner and 30th March at Hisar. Pareek and Vashishtha (1986) also noticed the ripening of Umran ber during 3rd week of February to 1st week of March under Jodhpur condition. Perusal of Table 1 a and b demonstrate that a minimum (8.9-18.0°C) and maximum (25.2-32.4°C) temperature range (18.0 to 30.1°C and Anantapur, 12.0 and 29.5°C at Sardarkrushinagar, 8.9 and 25.2°C at Jobner, 12.9 and 27.8°C at Jodhpur, 16.3 and 32.4°C at Bikaner and 11.8 and 29.9°C at Hisar) along with respective RH favours the peak of ripening. Data presented in Table 2 reveal that a range of temperature difference between 12.1 to 18.1°C along with 50.0 to 84.4 per cent morning RH for about one month prior to peak ripening is congenial to initiate maximum ripening in Umran ber.

Mundia: Ripening in Mundia cultivar starts from 20th December at Anantapur in scarce moisture region of Andhra Pradesh and continues up to 25th March at Hisar in arid part of Haryana. Peak of ripening takes place on 30th December at Anantapur, 5th February at Sardarkrushinagar, 10th February at Jobner, 25th January at Jodhpur, 20th March at Bikaner and 18th March at Hisar. Pareek and Vashishtha (1986) also observed peak ripening in Mundia during mid to end of January under Jodhpur condition. Perusal of Table 1 a and b reveal that a minimum (6.2-18.0°C) and maximum (23.3-30.1°C) temperature range (18.0 and 30.1°C at Anantapur, 9.5 and 27.8°C at Sardarkrushinagar, 6.2 and 23.3°C at Jobner, 11.7 and 25.4°C at Jodhpur, 10.8 and 27.2°C

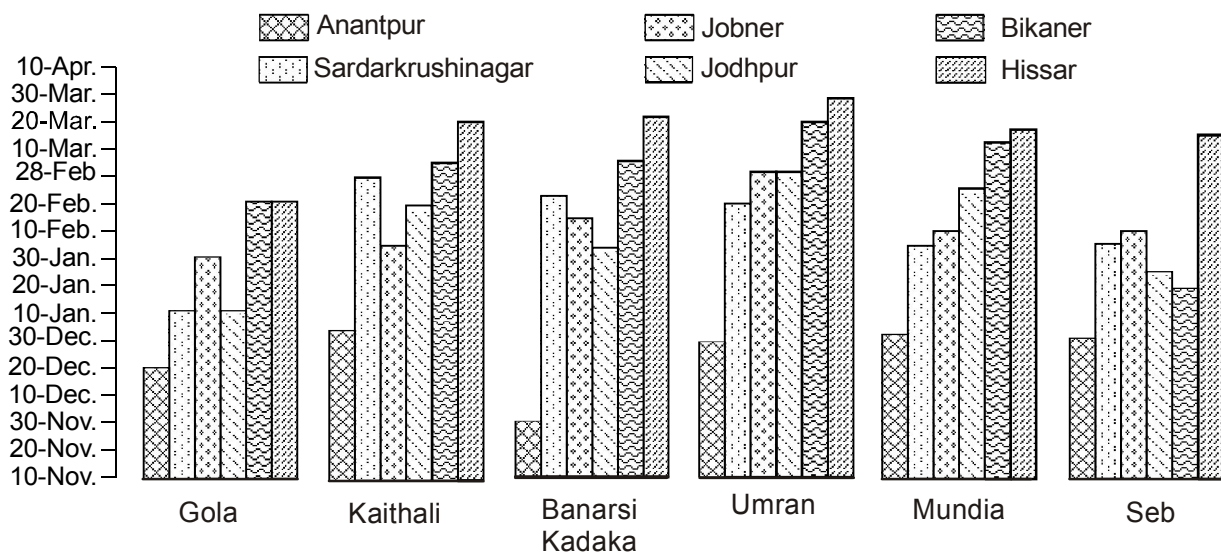


Fig. 1. Peak ripening in ber cultivars at different geographical locations

at Bikaner and 11.8 and 29.9°C at Hisar) along with respective RH favours the peak of ripening in this cultivar. Perusal of Table 2 demonstrate that a range of temperature difference between 12.1 to 18.3°C along with 52.0 to 87.7 per cent morning RH for about one month before peak of ripening is congenial for maximum ripening in Mundia cultivar of ber in arid region.

Seb: Ripening in Seb cultivar of ber starts from 5th December at Anantapur in southern India and continues up to 5th April at Bikaner in north western part. Peak of ripening takes place on 30th December at Anantapur, 5th February at Sardarkrushinagar,

10th February at Jobner, 25th January at Jodhpur, 20th March at Bikaner and 17th March at Hisar. Pareek and Vashishtha (1986) noticed that peak ripening in Seb ber takes place during mid January to mid February under Jodhpur condition. Data presented in table 1 a and b reveal that a minimum (6.2-18.0°C) and maximum (23.3-32.4°C) temperature range (18.0 and 30.1°C at Anantapur, 9.5 and 27.8°C at Sardarkrushinagar, 6.2 and 23.3°C at Jobner, 11.7 and 25.4°C at Jodhpur, 16.3 and 32.4°C at Bikaner and 11.8 and 29.9°C at Hisar) along with respective RH favours the peak of ripening. Perusal of Table 2 demonstrate that a range

Table 1(a). Minimum and maximum temperature (°C) at different locations during 1986-90

Months	Minimum temperature (°C)						Maximum temperature (°C)					
	ANP	SKN	JOB	JDP	BKN*	HIS	ANP	SKN	JOB	JDP	BKN*	HIS
January	17.7	9.5	6.2	11.7	7.3	4.5	30.5	27.8	23.3	25.4	23.2	20.4
February	19.9	12.0	8.9	12.9	10.8	6.7	33.6	29.5	25.2	27.8	27.2	23.6
March	22.4	16.5	13.1	17.1	16.3	11.8	37.4	34.5	30.3	31.9	32.4	29.9
April	25.7	21.5	18.6	24.9	21.3	17.1	39.4	37.9	37.6	37.2	37.7	35.6
May	26.2	25.1	24.7	26.7	25.5	25.5	39.7	41.4	40.3	41.2	42.5	41.2
June	24.7	27.5	26.7	27.2	27.9	27.0	35.9	38.6	39.3	39.8	40.6	39.5
July	23.8	26.1	26.0	26.9	28.2	26.5	33.7	34.5	33.5	36.2	38.1	36.2
August	23.3	25.1	23.8	25.7	27.0	26.0	33.3	32.7	32.4	34.8	36.9	35.1
September	23.3	24.2	22.2	24.9	25.3	22.6	33.5	35.4	34.0	35.9	36.8	35.3
October	21.7	18.9	16.1	20.7	21.4	16.2	32.4	36.1	33.4	36.7	35.4	34.8
November	19.1	13.4	9.6	16.0	12.2	11.6	30.8	31.7	27.8	32.0	29.8	28.7
December	18.0	11.8	5.6	10.7	7.1	5.7	30.1	28.0	21.8	26.2	24.5	23.4

Table 1(b). Morning and evening relative humidity (RH) at different locations during 1986-90

Months	Morning relative humidity (%)						Evening relative humidity (%)					
	ANP	SKN	JOB	JDP	BKN*	HIS	ANP	SKN	JOB	JDP	BKN*	HIS
January	83.8	66.5	87.7	52.0	67.9	87.0	46.0	25.9	46.9	21.8	28.0	42.8
February	73.0	61.0	80.3	50.0	63.2	83.7	35.0	29.8	36.2	16.8	23.3	35.0
March	60.2	58.4	76.2	42.0	55.9	80.1	22.8	20.1	36.8	15.8	21.1	33.0
April	58.8	49.0	50.9	31.4	44.6	66.0	23.0	17.3	28.1	11.2	16.9	29.0
May	64.6	68.1	59.6	47.0	44.8	49.6	27.0	23.6	31.1	16.8	18.9	20.5
June	70.6	73.2	66.9	60.0	49.5	56.0	39.4	39.5	34.0	28.6	29.8	33.0
July	78.2	82.0	79.8	76.0	64.4	72.6	46.8	56.4	45.5	47.8	43.1	55.8
August	81.2	86.0	82.5	82.0	71.6	80.6	49.2	60.6	58.2	54.2	43.6	57.3
September	80.2	80.3	78.9	75.0	71.9	79.6	48.6	45.7	46.7	41.6	40.5	47.8
October	81.2	61.4	70.5	49.2	63.9	77.1	49.0	22.0	33.8	18.0	39.8	32.3
November	82.2	59.2	73.8	44.8	68.9	65.8	46.2	23.3	27.9	16.6	33.6	29.8
December	84.4	63.1	76.1	49.6	72.9	82.4	51.0	24.3	33.0	21.6	38.1	37.3

Table 2. Temperature difference (°C) and morning RH (%) at different locations during 1986-90

Months	Temperature difference (°C)						Morning RH (%)					
	ANP	SKN	JOB	JDP	BKN*	HIS	ANP	SKN	JOB	JDP	BKN*	HIS
January	12.8	18.3	17.1	13.7	15.9	15.9	83.8	66.5	87.7	52.0	67.9	87.0
February	13.7	17.5	16.3	14.9	16.4	16.9	73.0	61.0	80.3	50.0	62.3	83.7
March	15.0	18.0	17.2	14.8	16.1	18.1	60.2	58.4	76.2	42.0	55.9	80.1
April	13.7	16.4	19.0	12.1	16.4	18.5	58.8	49.0	50.9	31.4	44.6	66.0
May	13.5	16.3	15.6	14.3	17.0	15.7	64.6	68.1	59.6	47.0	44.8	49.6
June	11.2	11.1	12.6	12.6	12.7	12.5	70.6	73.2	66.9	60.0	49.5	56.0
July	9.9	8.4	7.5	9.3	9.9	9.7	78.2	82.0	79.8	76.0	64.4	72.6
August	10.0	7.6	8.6	9.1	9.9	9.1	81.2	86.0	82.5	82.0	71.6	80.6
September	10.2	11.2	11.8	11.0	11.5	13.3	80.2	80.3	78.9	75.0	71.9	79.6
October	10.7	17.2	17.3	16.0	16.8	18.6	81.2	61.4	70.5	49.2	63.9	77.1
November	11.7	18.3	18.2	16.0	17.6	17.1	82.2	59.2	73.8	44.8	68.9	65.8
December	12.1	16.2	16.2	15.5	17.4	17.7	84.4	63.1	76.1	49.6	72.9	82.4

ANP-Anantapur, SKN- Sardarkrushinagar, JOB- Jobner, JDP- Jodhpur, BKN- Bikaner, HIS- Hisar

*Data of 1994-98 have been analysed.

of temperature difference between 12.1 to 18.3°C along with 52.0 to 87.7 per cent morning RH continuously for about one month before peak ripening is congenial for maximum ripening in Seb ber under arid ecosystem.

Ripening time in ber cultivars is location specific (Fig. 1) which mainly influenced by the existing climate at particular site. Pareek and Vashishtha (1986) also accepted that difference in ripening time of a ber cultivar is obviously due to climatic variation. The ber cultivars have been tentatively classified as early (Gola and Seb), mid season (Banarsi Kadaka, Kaithali and Mundia) and late (Umran) cultivars (Pareek, 1983). In present communication an attempt has been made to explain the possible reason for such variation in ripening time. From the results presented above, a summary table (Table 3) has been drawn which gives an account of the environmental parameters congenial for peak ripening of ber cultivars at different locations. Perusal of the table revealed that a minimum temperature of 6.2-19.1°C and a maximum temperature of 23.3-34.4°C coupled with morning RH of 49.6-87.7 per cent and temperature difference of 11.7-18.3°C continuously for at least one month is required for peak ripening of ber cultivars. India, being a country of diverse agroclimatic zone, the meteorological parameter differs from one place to another with the time. For instance, Anantapur (AP) has little moderate climate where the required weather parameter prevails during November-December and thus the ripening process initiates in early part of the season. Whereas, in northern part of the country, where temperature remains much lower during winters, and attain required magnitude during later part of the crop season (February-March) and thus, ripening is initiated during spring. Pareek (1983) also reported that in southern India, ripening in ber begins by November-December whereas in northern India, ripening season in different ber cultivars fall between mid February to mid April. From the above, it can be stated that temperature range, difference in minimum and maximum temperature and relative humidity have definite role to play in attaining peak ripening in ber cultivars.

Perusal of Table 3 further demonstrate that the environmental parameters required for attaining peak ripening by different cultivars are almost identical therefore, these parameters appear

to be insufficient to classify the cultivars into clear-cut groups like early, medium and late. Thus, in order to explain the variation in ripening time of different cultivars, additional derived parameters are required.

Table 3. Environmental parameters congenial for peak of ripening in jujube cultivars

Cultivars	Max. Temp. (°C)*	Min. Temp. (°C)*	Temp. Difference (°C)	Morning RH (%)
Gola	23.3-30.1	6.2-18.0	12.1-17.1	49.6-87.7
Kaithali	25.4-30.8	8.9-19.0	11.7-18.1	52.0-82.2
Banarsi Kadaka	25.2-30.1	8.9-18.0	12.1-18.1	52.0-84.4
Umran	25.2-32.4	8.9-18.0	12.1-18.1	50.0-84.4
Mundia	23.3-30.1	6.2-18.0	12.1-18.3	52.0-87.7
Seb	23.3-30.1	6.2-18.0	12.1-18.3	52.0-87.7
Range	23.3-32.4	6.2-19.1	11.7-18.3	49.6-87.7

*one month before

Acknowledgement

We thank to Project Coordinator and Principal Investigators of AICRP AZF Centers for providing required information. Thanks are also to Dr. B.B. Vashishtha for critical suggestions and Shri. G.K. Tripathi for technical help.

References

- Pareek, O.P. 1983. *The Ber*, Indian Council of Agricultural Research. New Delhi, pp 1-71.
- Pareek, O.P. and B.B. Vashishtha, 1986. Vegetative and fruit characteristics of ber (*Ziziphus mauritiana* Lamk.) cultivars of Rajasthan grown in Thar desert. *Annals of Arid Zone*, 25(3):214-211.
- Pareek, O.P., Vishal Nath and B.B. Vashishtha, 1999. In situ technique to establish ber orchards in arid region. *Agri. News*. Ministry of Agriculture and Cooperation, New Delhi.
- Sharma, V.P. and V.N. Kore, 1990. Ber. In: *Fruits- tropical and subtropical* (Eds T.K. Bose and S.K. Mitra). Naya Prokash, Calcutta, pp 592-615.
- Vishal Nath and R. Bhargava, 2000. Flowering scenario of commercial jujube cultivars in Indian Arid ecosystem. *J. Applied Horticulture*, 2(2):98-101.