

FLORAL BIOLOGY OF BER (*ZIZIPHUS MAURITIANA* LAMK.) CULTIVARS UNDER SEMI-ARID CONDITIONS OF HARYANA

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Abstract– A field experiment was carried out at experimental orchard, CCS Haryana Agricultural University, RRS, Bawal (Rewari), Haryana to study the floral biology of ber. Nine cultivars of ber planted during 2007 (13 years old plants) at 7 m × 7 m in randomized block design were selected for evaluation. The plants were tagged in the month of April. These cultivars were observed to study the variability in floral biological parameters. The floral parameter such as flowering habit in the selected cultivars was recorded on the leaf axis of secondary branches. The ovary was observed superior to half-inferior among the cultivars. Anthesis occurred in forenoon in some cultivars whereas, in afternoon in others. Dehiscence time was observed from 1 to 3 hours in different cultivars. Date of initiation of flowering to end of flowering, flowering duration, time taken from flowering to fruit setting, time taken from fruit setting to fruit maturity varied as 16 August to 31 October, 49-62 days, 16-21 days and 128-151 days, respectively.

INTRODUCTION

Ber (*Ziziphus mauritiana* Lamk.) is a major fruit crop of arid and semi-arid regions. It belongs to the Rhamnaceae family, which has 600 species and about 50 genera. India has a area of ber about 50000 hectares (ha) and produced about 539000 metric tonnes (MT) during 2018-2019 (Anonymous, 2019). China is the leading ber producing country in the world followed by India, Pakistan and Malaysia. Haryana, Punjab, Madhya Pradesh, Uttar Pradesh, Bihar and Maharashtra are the commercial ber-growing states in India. It covered an area of 4288 ha in Haryana and produced 48428 MT during 2018-19 (Anonymous, 2019). Gola, Seb, Sandhura Narnaul, Kaithli, Mudia, Banarsi Karaka, Chhuhara and Umran are popular commercial ber cultivars.

Ziziphus mauritiana is a thorny plant with a trunk diameter of 40 cm or more, a spreading crown, stipular spines and many drooping branches. In the months of March and April, seeds are sown in well-

prepared nursery beds at 30 cm × 30 cm spacing and at a depth of 2 cm. These seedlings are either transferred in the field for *in-situ* budding or can be budded in the nursery beds throughout July and August. It is a cross pollinated crop; honey bees, yellow wasps and other hymenopterous species are its major pollinators. It is a drought-resistant plant that can tolerate temperatures as high as 50°C. Ber fruits can be consumed fresh or processed into canned, sweets, pulp, jam and juices. Its fruits are nutrient-rich, high in ascorbic acid (vitamin -C), vitamins (A and B) and minerals like calcium, phosphorus and iron. The majority of the ber orchards in the area are seedling raised and knowledge of the variation in physico-chemical composition is critical in assessing the best varieties, thus research was conducted to identify the elite types of variety for future development. An innovative farmer needs to choose cultivars that are higher in quality, have a longer shelf life and yield more from the same land area.

MATERIAL AND METHODS

The experimental location, Bawal, is located in Haryana's southern area. The climate of Bawal is semi-arid, with hot and dry summers and freezing winters. During the monsoon season, around 80-85 percent of total annual rainfall is received, with minimal rains from December to February. A field study was done on 13-year-old ber plants that were planted in a randomised block design at a spacing of 7 m x 7 m. In the experiment, three plants from each cultivar were selected and maintained under regular agronomic procedures according to the package of practices. The growth and morphological characteristics were evaluated in accordance with the NBPGR descriptor (Mahajan *et al.*, 2002) and standards for DUS testing of PPV & FRA at recommended growth stages, i.e., three months after pruning (Anonymous, 2016).

Twenty branches were randomly selected and tagged per plant (five branches from each quarter of the plant) to determine the start of flowering. Five per cent opening of flower buds on the tagged branches was considered as flowering initiation and the average date of initiation was noted. The flower position on the tagged branches was observed visually with the naked eyes at the flowering stage during regular visit in the orchard as axillary cyme, terminal and axillary clusters based on group or cluster of flowers arranged on a branch. A day before opening, 50 buds that were supposed to open the next day were marked to monitor the time of anthesis. The number of completely opened flowers were counted every half-hour interval starting from 5 a.m. in the next morning. To stop recounting, fully opened flowers were labelled with delible ink. The observations on anthesis were carried out before 50 flower buds had fully opened each cultivar during the flowering season. The findings were made in each cultivar on three successive days when the plants were in full bloom.

The rate of anther dehiscence was measured using 50 freshly opened flowers from each cultivar. The dehiscence was assumed complete when 25 to 50 per cent of the anthers had dehisced. The time, when the most flowers dehisced was noted, during the flowering season, three days observations were made in each cultivar. It was assumed that a flower had dehisced when the anthers were turned yellow. Dehiscence was observed using a convex lens. Type of ovary was described as position of ovary relative to position and behavior of sepals, petals and

stamens in a flower. This was observed by using convex lens, during the blooming period in the different cultivars. The date of the end of flowering was also noted on the same branches that were tagged for the date of initiation of flowering; when 85-90 per cent of flower buds were opened was considered the end of flowering. The flowering duration was calculated by adding the number of days from the start of flowering to the end of flowering on the same tagged branches and calculated for the average no. of days. Time taken from flowering to fruit setting (days) was determined by calculating the number of days between the peak flowering date and the 50 per cent fruit set date. Time taken from fruit setting to fruit maturity (days) was determined by adding up the number of days from the date of 50 per cent fruit set to the date of 50 per cent fruit maturity on the tagged branches and calculated the average number of days.

The per cent fruit set was determined as the number of fruits that reached grain size on the basis of the total number of flowers. The fruits that reached grain size were counted from the tagged branches. The formula for calculation of fruit set per cent is:

$$\text{Fruit set (\%)} = \frac{\text{total number of grain sized fruits}}{\text{total number of flowers}} \times 100$$

RESULTS AND DISCUSSION

The data on the nature of flowering branches and flowering behaviour revealed no significant differences. In each cultivar all the flowers were borne on the leaf axis of secondary branches *viz.* Gola, Umran, Kaithli, Chhuhara, Goma Kirti, Thar Sevika, Thar Bhuhraj, Narendra Ber Selection 1 and Narendra Ber Selection 2 (Table 1). Teatota and Chauhan (1963) also recorded flowering on secondary branches. The strong genetic connection between its inflorescence and flowering branches might have similarities (Saran, 2005). Different cultivars showed considerable variation in the date of flowering initiation. The flowering initiation was observed from 16 to 31 August (Table 1). Early flower initiation was recorded in Gola (16-21 August) whereas, comparatively delayed in Umran (24-31 August). In the last week of September, the flowering was ended (85-90% flower open). The different cultivars of ber recorded completion of flowering from the second week of October to the

last week of October. Yamdagni *et al.* (1967) at Kanpur recorded that flowering in ber varied from the third week of September to the second week of November. Nehra *et al.* (1984) at Hisar recorded the variation in flowering duration. Flowering time variations in ber may be connected to environmental factors like temperature, humidity, and rainfall, as well as the genetic composition of the variety/germplasm (Saran, 2005). In ber, time of anthesis differed from cultivar to cultivar. It happened in the morning in some cultivars while in the afternoon in others (Table 1). The anthesis started during forenoon or morning hours in Chhuhara (5:30 am to 7:30 am), in between 6:00 am to 8:00 am in Thar Sevika, Thar Bhubhraj, Narendra Ber Selection 1 and Narendra Ber Selection 2, whereas it started during afternoon in Gola (12:00 pm to 1:00 pm), Goma Kirti (12:00 noon to 2:00 pm), Kaithli (12:30 pm to 2:00 pm) and Umran (1:00 pm to 2:30 pm). The similar observations of anthesis of ber are in agreement with those obtained by Pareek (1983) and Desai *et al.* (1986). The dehiscence of anthers starts immediately after anthesis and completed within 1 to 3 hours in different cultivars of ber. Dehiscence time (about 2-3 hr) was recorded higher in Umran, Kaithli, Chhuhara and Narendra Ber Selection 1, while in rest of cultivars (Gola, Goma Kirti, Thar Sevika, Thar Bhubhraj and Narendra Ber Selection 2) ranges

between 1-2 hr (Table 1). These observations of dehiscence of anthers in different ber cultivars are in accordance with the results of Sharma and Kore (1990) and Dhaliwal and Bal (1998). No variations were recorded in types of ovary in all the cultivars studied. Superior to half-inferior ovary was recorded among the cultivars *viz.* Gola, Umran, Kaithli, Chhuhara, Goma Kirti, Thar Sevika, Thar Bhubhraj, Narendra Ber Selection 1 and Narendra Ber Selection 2 (Table 1). It may be characteristics of the specific variety/germplasm. Different cultivars showed considerable variation in the date of end of flowering, it ranged from 5th to 31st of October (Table 2). The end of flowering was recorded earlier in Gola (5-9 October), while delayed in Umran (28-31 October). The fruit set per cent of cultivars varied substantially and it ranged from 10.70 to 19.35 per cent (Table 2). The maximum fruit set percentage (19.35%) was recorded in Umran, followed by Kaithli (17.20%), while the minimum fruit set percentage (10.70%) was recorded in Chhuhara. The flowering duration varied significantly between cultivars, ranging from 49 to 62 days (Table 2). Flowering duration, time taken from flowering to fruit setting and time taken from fruit setting to fruit maturity recorded were significantly varied in the selected cultivars. The minimum flowering duration was recorded in Gola (49 days) while, the maximum

Table 1. Table on flowering habit, flowering initiation time, time of anthesis, dehiscence time and type of ovary of different ber cultivars under semi-arid conditions of Haryana.

Cultivars	Flowering habit	Flowering initiation time	Time of anthesis	Dehiscence time	Type of ovary
Gola	Leaf axis	16-21 Aug	12:00 pm-1:00 pm	1-2 hr	Superior to half-inferior
Umran	Leaf axis	24-31 Aug	1:00 pm-2:30 pm	2-2.30 hr	Superior to half-inferior
Kaithli	Leaf axis	21-26 Aug	12:30 pm-2:00 pm	2 hr	Superior to half-inferior
Chhuhara	Leaf axis	19-23 Aug	5:30 am-7:30 am	2-2.30 hr	Superior to half-inferior
Goma Kirti	Leaf axis	20-26 Aug	12:00 pm-2:00 pm	2 hr	Superior to half-inferior
Thar Sevika	Leaf axis	20-25 Aug	6:00 am-8:00 am	2 hr	Superior to half-inferior
Thar Bhubhraj	Leaf axis	19-23 Aug	6:00 am-8:00 am	2 hr	Superior to half-inferior
Narendra Ber Selection 1	Leaf axis	18-22 Aug	6:00 am-8:00 am	2-3 hr	Superior to half-inferior
Narendra Ber Selection 2	Leaf axis	17-22 Aug	6:00 am-8:00 am	2 hr	Superior to half-inferior
Range	—	16-31 Aug	5:30 am-2:30 pm	1-3 hr	—
CD (p=0.05)	—	—	—	—	—

Table 2. Table on end of flowering, fruit set (%), flowering duration (days), time taken from flowering to fruit setting (days) and time taken from fruit setting to fruit maturity (days) of different ber cultivars under semi-arid conditions of Haryana.

Cultivars	End of flowering	Fruit set (%)	Flowering duration (days)	Time taken from flowering to fruit setting (days)	Time taken from fruit setting to fruit maturity (days)
Gola	5-9 Oct	11.80	49	18	139
Umran	28-31 Oct	19.35	62	21	151
Kaithli	17-22 Oct	17.20	57	17	142
Chhuhara	15-18 Oct	10.70	56	18	132
Goma Kirti	11-16 Oct	11.85	51	16	128
Thar Sevika	14-18 Oct	13.00	54	19	136
Thar Bhubhraj	13-19 Oct	13.65	53	20	135
Narendra Ber Selection 1	13-18 Oct	14.10	55	18	139
Narendra Ber Selection 2	11-16 Oct	13.70	54	18	142
Range	5-31 Oct	10.70-19.35	49-62	16-21	128-151
CD (p=0.05)	—	0.58	2.20	0.95	5.84

flowering duration was recorded in Umran (62 days), followed by Kaithli (57 days). In different cultivars, time taken from flowering to fruit setting ranged from 16 to 21 days (Table 2). Minimum time taken from flowering to fruit set was recorded in Goma Kirti (16 days), while the maximum time taken from flowering to fruit set was recorded in Umran (21 days), followed by Thar Bhubhraj (20 days). The time taken from fruit setting to fruit maturity varied significantly between cultivars and it ranged from 128 to 151 days (Table 2). Minimum time taken from fruit setting to fruit maturity was recorded in Goma Kirti (128 days) while maximum in Umran (151 days). The flowering season in ber was extended and the duration of flowering differs across genotypes. These results of flowering duration, time taken for fruit setting and fruit maturity of ber are in accordance with the findings

**Fig. 1.** Anthesis in Gola cultivar.

of Raja (2004) and Sharif *et al.* (2013). Nath and Bhargava, (2000) observed that the fruiting of ber may varied with the location of the experiment. Saran, (2005) reported that environmental factors like temperature, humidity, nutritional status and genetic variability are responsible for variation in flowering duration, time from flowering to fruit setting and fruit setting to fruit maturity among different cultivars.

**Fig. 2.** Fruit setting in Umran cultivar.

CONCLUSION

On the basis of results obtained from the experiment it may be concluded that early flowering initiation (16-21 August), end of flowering (5-9 October), early fruit setting (18 days) and early fruit maturity (139 days) were recorded in Gola whereas, late fruit setting (21 days) and late fruit maturity (151 days) was observed in Umran. Maximum flowering duration (62 days) and maximum fruit set

percentage (19.35 %) was found in Umran whereas minimum flowering duration (49 days) was recorded in Gola and minimum fruit set percentage (10.70 %) was recorded in Chhuhara.

REFERENCES

- Anonymous, 2016. Guidelines of PPV&FRA for the conduct of test for distinctiveness, uniformity and stability on Indian jujube (ber) (*Ziziphus mauritiana* Lamk.). *Plant Variety Journal of India*, **10**(2).
- Anonymous, 2019. National Horticulture Board, Gurugram, India.
- Desai, U. T., Randhawa, D. B. and Wavhal, K. N. 1986. Floral biology of ber. *Journal of Maharashtra Agricultural Universities*. **11**: 76-78.
- Dhaliwal, J. S. and Bal, J.S. 1998. Floral biology of ber-A review. *Journal of Research, Punjab Agricultural University*. **35**: 36-40.
- Mahajan, R. K., Gangopadhyay, K. K., Kumar, D. V. G., Srivastava, U. and Gupta, P. N. 2002. Minimal descriptors of Agri-horticultural crops. *Part III: fruit crops* (No. C042. 018). NBPGR, New Delhi.
- Nath, V. and Bhargava, R. 2000. Flowering scenario in commercial cultivars of jujube (*Ziziphus mauritiana* Lamk.) under Indian arid ecosystem. *Journal of Applied Horticulture*. **2**(2): 98-101.
- Nehra, N. S., Chitkara, S. D. and Singh, K. (1984). Studies of morphological characters of some wild forms and cultivated varieties of ber. *Punjab Horticultural Journal*, **24**(1-4): 49-59.
- Pareek, O.P. 1983. The Ber. ICAR, New Delhi, India.
- Raja, S. 2004. Morphological and molecular characterization of ber germplasm. M.Sc. Thesis, CCS HAU, Hisar.
- Saran, P. L. 2005. Studies on genetic divergence in ber (*Ziziphus mauritiana* Lamk.) germplasm. Ph.D. Thesis, CCS HAU, Hisar.
- Sharif, N., Jaskani, M. J., Alwi, M., Bloch, D. M., Abbas, M. M. and Ishfaq, M. 2013. Categorization of Ber varieties in relation to blooming period, fruit setting and harvesting time. *Pakistan Journal of Agricultural Sciences*. **50**(3): 407-413.
- Sharma, V. P. and Kore, V. N. 1990. In Fruits- Tropical and Subtropical. (Bose, T.K. and Mitra, S.K.) Naya Prokash, Kolkata. Pp. 592-615.
- Teaotia, S. S. and Chauhan, R. S. 1963. Flowering, pollination, fruit set and fruit drop studies in ber (*Ziziphus mauritiana* Lamk.). *Punjab Horticultural Journal*. **3**: 60-70.
- Yamdagni, R., Bajpai, P. N. and Misra, R. S. 1967. Studies on floral biology of ber. *Labdeb Journal of Science and Technology*. **13**(5): 240-248.