FLORAL BIOLOGY OF BER - A REVIEW

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ABSTRACT

Ber is an ancient fruit of India and China. Ber fruits are very nutritious and rich in vitamins C, A and B-complex. The duration of flowering in ber is prolonged and the time of blossoming largely depends on climatic conditions. Flowering can, however, be regulated to some extent by timing the pruning operation. The flower buds in ber are borne on both mature as well as current season’s growth and the inflorescence is an axillary cyme. Most of the ber varieties are self unfruitful and fruit poorly without cross pollination. Fruits drop immature if they are set without fertilization or due to embryo abortion at later stage of fruit development. Its floral biology has been studied by many researchers, however, the self and cross-incompatibility and long juvenile period are the hindrances for the systematic hybridization programme in this crop. Therefore, an attempt has been made in this review to critically analyse the important aspects of ber flowering; flowering time, flowering duration, flowering habit, anthesis, dehiscence, stigma receptivity, pollen morphology, pollen viability, pollen germination, fruit set and fruit drop. The ber flowering literature provides a wealth of usable information for breeders.

Ber (Zizyphus mauritiana Lamk.) is one of the most ancient and common fruit indigenous to India and belongs to family Rhamnaceae. It is found growing wild as well as in cultivated forms throughout the warmer regions up to an altitude of 1500 metres above Mean Sea Level. It can be successfully cultivated even in the most marginal ecosystems of the sub-tropics and tropics (Pareek, 2001a). Ber is popular due to high economic returns, low cost of cultivation wider adaptability and ability to withstand drought (Pareek, 1983, Chadha and Pareek, 1993).

In order to undertake any programme, it becomes essential on the part of the investigator to equip himself with the knowledge of floral biology of crop. For efficient and purposeful breeding programme, it is necessary to have knowledge of the morphology and floral biology of the parents. Hence, the literature pertaining to floral biology is critically reviewed encompassing the events in flowering time and duration, phenology and transmission of buds to flowering up to fruit set and fruit drop. A proposal for the description and quantification of the floral response is presented.

Flowering time

In India, the flowering period of ber varies from early June to late November in different varieties under different agroclimatic conditions. Flowering started in September and completed in November in all the seven varieties studied (Josan et al., 1980 and Neeraja et al., 1993) under subtropics. In Delhi, the flowering in ber starts in early September and continues till mid November (Raja, 1985). Flowering continues through early winter (November) with some sporadic flow in late November and December (Godara, 1981). Sharma et al. (1990) noted that peak period of flowering was found in September. In cultivar Gola flowering started from 20th August and full bloom was observed from 15th September to 15th October under Jobner (Rajasthan) condition (Gahrwal, 1997). One flowering season (May to July) was observed by Babu and Kumar (1998) at Hyderabad. In western Rajasthan, flowering starts in July, peak being in September (Pareek, 2001a). Flowering season in Chinese jujube generally ranged from 10th June to 25th July in Korea (Cheong and Kim, 1984 and Kim and Kim, 1984). In Australia (35° 30’ S, 149° 00’ E), flowering
begins with the onset of the wet season (January-February) after initiation of growth during the spring (October) (Grice, 1998). In south China, four Indian ber cultivars planted in spring, flowered in the autumn or winter of the same year (Xue and Wang, 1999).

Flowering duration

The total duration of flowering varied from 68 to 94 days (Babu and Kumar, 1998) and 57 to 75 days (Dhaliwal and Bal, 1998) depending upon cultivar. Total flowering duration of cultivar Gola was recorded as 71 ± 5.62 days and cultivar Seb was 68 ± 4.49 days (Garhwal, 1997). Pareek (2001) also observed shortest duration of flowering in cultivar Tikadi (47 days) and longest in cultivar Umran (71 days).

Flowering habit

Flowers are borne in axil of leaves of mature as well as current season shoots (Desai et al., 1986, Garhwal, 1997). Singh and Jindal (1982) reported that cultivar Umran had highest number of hermaphrodite flowers (22.2%), followed by Gola Gurgaon with 20.1% per cent. The number of flowers per cluster has been reported to be 10 to 14 (Garhwal, 1997) and 16 to 28 (Josan et al., 1980) in different cultivars under different agro-climatic conditions.

In general, a bud passes through eight stages to develop into a flower (Josan et al., 1980, Pareek, 1983). However, Desai et al. (1986) observed that flower bud development occurred in seven stages. Initiation to opening of floral buds takes 12 to 30 days (Godara, 1980), 19 days (Desai et al., 1986), 20 to 21 days (Garhwal, 1997) and 21 days (Josan et al., 1980) in different cultivars.

Anthesis

Anthesis in ber is cultivar dependent. In some of the cultivars, it takes place in the forenoon, while in others occurs in the afternoon. Pareek (1983) reported that the anthesis occurred between 7.30 to 8.30 am in cultivars Seb, Jogiya, Ponda, Aliganj and Ilaiachi, while in cultivars Gola and Mundia it was between 12.00 noon to 1.00 pm. Anthesis in Seb and Sanaur-2 takes place in the morning between 7.30 am and 8.00 am, while in Gola, Katha and Umran at 1.0 to 2.0 pm (Vashishtha and Pareek, 1983). Desai et al. (1986) observed that anthesis was occurred between 5.30 am to 7.30 am in Chhuhara and between 12.30 pm to 2.45 pm in Sanaur. Lyrene (1983) found that Zizyphus jujube flowers opened each day between 7.00 am to 10.00 am in 10 cultivars and on the other hand it took place between 2.00 pm and 5.00 pm in 8 cultivars.

Dehiscence

In most of the cultivars, the dehiscence of anthers started just after anthesis and is completed within 4 to 5 hours (Sharma and Kore, 1990). Vashishtha and Pareek (1979) reported complete dehiscence in an hour after anthesis in cultivars Seb, Gola, Jogiya, Mundia, Aliganj, Ponda and Ilaiachi. Dehiscence followed anthesis within 0.5 h (Desai et al., 1986) to 2 to 4 h (Dhaliwal and Bal, 1998).

Stigma receptivity

At the time of anthesis the stigma appeared to be a minute protuberance. Its full development was indicated by its bi or sometimes trifurcation. This stage commenced after 16 to 18 h of anthesis. Peak receptivity of the stigma appeared to be just as the flower opened (Josan et al., 1980; Desai et al., 1986, Dhaliwal and Bal, 1998). The stigma remains receptive up to 13 h to 24 h (Desai et al., 1986) and up to 48 h (Godara, 1980).

Pollen morphology

Pollen grains are isopolar, fixiform and radiosymmetric (Hulwale et al., 1995). Each pollen had two to three germ pore. A palynological study of large fruited and local Zizyphus jujuba and Zizyphus mauritiana forms revealed that the pollen grains were triporate (McNeillide and Shekiladze, 1986). Pollen wall development of Zizyphus spinosus was initiated at the tetrad stage, the primary occurring first.
After the microspores were released from the tetrad, the exine and the intine became thick and perfect. In mature Zizyphus spinosus pollen grains, the wall consisted of ektexine, endexine, Z-layer and intine. Tectum thickness was the same as the foot layer. At the aperture, there was a break in the exine, but the intine became thick could be divided into five distinct layers (Yu et al., 1994). Cytological and morphological studies of the pollen grains of 29 varieties revealed a number of anomalies within each variety. Abnormalities included grains which were very large, very small, 2-pored, polysporous, sterile or with vegetative cells having coarsely granulated cytoplasm. A high degree of abnormality and low viability, indicating high male sterility, were found in 16 Chinese varieties (Romanova et al., 1985). Pollen grains increases in size when moistened (Hulwale et al., 1995, Dhaliwal and Bal, 1998). Pradeep and Jambhale (2000) observed significant difference for pollen diameter among the different ploidy levels (diploid, tetraploid, pentaploid and octaploid). Pollen size recorded in different cultivars of ber by different workers is presented in Table-1.

**Pollen viability**

High pollen viability has also been reported in Chhuhara, Sanaur-1, Shamber (Desai et al., 1986) and in Seedless and Darakh-1 (Hulwale et al., 1995). The viability ranging between 87.29 per cent to 90.63 per cent in different cultivars (Ojani and Desai, 1980). Pollen sterility of the five diploid accessions ranged from 4.30 per cent to 10.70 per cent and that of 33 tetraploids from 7.17 per cent to 40.35 per cent. The pentaploid Dandan had 13.25 per cent pollen sterility as against the maximum sterility observed in Illaichi (91.65%) and Seedless (81.85%), the two octaploids (Pradeep and Jambhale, 2000). High pollen sterility could be attributed to the presence of more number of multivalents and univalents (Pradeep, 1997). Yang et al. (1994) noted that pollen lost their viability if stored below –18°C temperature.

**Pollen germination**

Sucrose solution is the best media for pollen germination (Rathak and Rathak, 1993). Pollen grain germinability was also high (36.47% to 47.66%) in different cultivars (Ojani et al., 1980). Only few germinating pollen grains were observed on the stigmas of open-pollinated flowers of cultivars Moodeung, Jg10 and Sanjo (1.5, 1.2, and 1.7 grains per stigma, respectively) (Yun et al., 1994). The per cent pollen germination of Z. sativa cultivars Moodeung and Bokjo increased with increasing sucrose concentration in 1 per cent agar media up to 10 per cent then decreased at higher concentration (Park and Yu, 1989). Addition of 35 ppm boric acid increased pollen tube growth (Yun et al., 1989). The optimal medium for pollen germination in vitro was a 30 per cent sucrose solution solidified with 1 per cent agar (Romanova et al., 1985, Mchedlidze and Sheskiladze, 1986).

**Table 1:** Average size of pollen grains in different varieties of ber.

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Pollen size (mm)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chhuhara</td>
<td>29.36</td>
<td>Desai et al. (1986)</td>
</tr>
<tr>
<td>Sanaur-1</td>
<td>26.99</td>
<td>Desai et al. (1986)</td>
</tr>
<tr>
<td>Shamber</td>
<td>30.35</td>
<td>Desai et al. (1986)</td>
</tr>
<tr>
<td>Darakh-1</td>
<td>20.05</td>
<td>Hulwale et al. (1996)</td>
</tr>
<tr>
<td>Seedless</td>
<td>32.04</td>
<td>Hulwale et al. (1996)</td>
</tr>
<tr>
<td>Guli</td>
<td>19.48 ± 0.30</td>
<td>Pradeep and Jambhale (2000)</td>
</tr>
<tr>
<td>Whachi</td>
<td>21.66 ± 0.28</td>
<td>Pradeep and Jambhale (2000)</td>
</tr>
<tr>
<td>Gola</td>
<td>27.90 ± 0.46</td>
<td>Pradeep and Jambhale (2000)</td>
</tr>
<tr>
<td>Ponda</td>
<td>29.60 ± 0.76</td>
<td>Pradeep and Jambhale (2000)</td>
</tr>
<tr>
<td>Illachi</td>
<td>21.06 ± 0.48</td>
<td>Pradeep and Jambhale (2000)</td>
</tr>
</tbody>
</table>
Fruit set

Gupta and Minhas (1991) observed that under bagging a fruit set of 8 per cent was obtained in Illaichi followed by 6 per cent in Umran cultivar, whereas there was no fruit set in Sanaur - 2, Sanaur - 3, Sanaur - 4, Sanaur - 5, Kaithli and Chhuhara cultivars. Self incompatibility is found in jujube varieties (Pareek, 2001a). Self incompatibility was also found in cultivars Gola, Seb, Jogia, Aligerj, Ponda, Illaichi and Mundia (Vashishtha and Pareek, 1979); in Banaras Karaka, Illaichi, Karkkola Gola, Kaithli, Kathaphal, Mundia Murhara, Resmi, Sandhura Namaul, Safeda Selected and Umran (Godara, 1980), in ZG-2 and Sanaur-2 (Mehrotra and Gupta, 1985) and in Gola, Umran and Seb (Neeraja et al., 1995). Josan et al. (1981) also did not find any fruit set under self-pollination in different jujube varieties. However, self-fruitfulness was reported in Illaichi and Umran (Mehrotra and Gupta, 1985).

Ber cultivars also showed cross-incompatibility (Chundawat and Srivastava, 1980; Josan et al., 1981; Vashishtha and Pareek, 1983; Mehrotra and Gupta, 1985; Singh and Vashishtha, 1993; Gupta and Minhas 1991.) When ZG-4, Kala Gola and Sanaur-2 were crossed with Umran as male parent, no fruit set was recorded (Gupta and Minhas, 1991). Cultivar Umran was cross compatible as a female parent, with Umran as a male parent (Gupta and Minhas, 1991). However, Godara (1980) found that Umran showed less combining ability with other cultivars when used as a female or male parent. Mehrotra and Gupta (1985) also observed that Sanaur-2 was self-incompatible as well as cross incompatible as a female parent with Umran. Illaichi x Karkola Gola gave the highest fruit set, while Umran showed the best combining ability when used as a male or female parent (Godara, 1980).

There is also a marked variation in fruit set among the different cultivars, which ranged from 5 per cent in cultivar Illaichi to 14.9 per cent in cultivar Aligerj in arid conditions of Rajasthan (Vashishtha and Pareek, 1979). Fruit set under open pollination ranged from 3.56 per cent in ZG-2 to 18.7 per cent in Illaichi (Mehrotra and Gupta, 1985). Tikadi recorded a maximum fruit set of 27.88 per cent whereas, it was minimum in Gola (Raja, 1985). The highest number of fruits per branch (239) and fruit retention (20%) were observed in cultivar Tikadi and lowest number of fruits per branch (73), fruit set (10%) and number of fruits reaching maturity per branch (8) were observed in cultivar Gola (Shaara and Pareek, 1990). Fruit set following open pollination was highest in Umran (23.1%), followed by Seb (18.6%) and Gola (13.7%). Fruit set was higher with hand pollination (60%) in case of cross Umran x Seb than open pollination (Neeraja et al., 1995). Among Umran, Gola, Kaithli and Sukavani cultivars, Umran had the highest (24%) fruit set (Chovatia et al., 1992).

Fruit drop

A very heavy drop occurred immediately after fruit set (Singh et al., 1991). Singh et al. (1991) showed that ovule disintegration was the major cause of fruit drop immediately after fruit set. Pawar (1980) observed that Kakror Gola had considerably higher fruit drop (upto 80.6%) than Kaithli (7.2%) and Umran (12.1%). More than 50 per cent of the drop occurred when the fruits were <1.0 cm in diameter. As fruit development advanced, per cent fruit drop was reduced. A maximum fruit drop of 95.63 per cent and a minimum of 79.88 per cent was observed in the cultivars Illaichi and Tikadi, respectively (Raja, 1985). Fruit drop occurs due to lack of fertilization (Singh et al., 1991), to maintain a crop load the tree can sustain (Vashishtha and Pareek, 1979), soil moisture stress, frost, high and low temperature (Pareek, 2001a).
CONCLUSION

Due to the phenomenon of cross pollination along with the prevalence of self and cross incompatibility and pollen sterility, fruit set in the ber largely depends on timely pollination and its related factors like pollinators and environmental conditions and on the success in fertilization. The life of individual flower is very short and many flowers apparently are not pollinated during their respective period. Consequently, in spite of a very profuse flowering, fruit set in ber is very low even under open pollination. Hence, by studying the elaborated informations on various aspects breeders can overcome the bottlenecks and hindrances in ber breeding.

Shortcomings

Ber has some major problems, such as diseases like powdery mildew and sooty mould, insect pests like fruit fly and frost susceptibility. Attempts are therefore needed to develop tolerant cultivars by locating suitable sources of resistance. Further, there are two main bottlenecks in ber breeding programme; polyplody and incompatibility in its cultivars besides the typical floral morphology.

FUTURE LINE OF WORK

Earliness is desirable particularly in dry regions for growing cultivars under rainfed or limited irrigation conditions. Unfortunately early cultivars in general, have poor storage life. There is, therefore, a need to develop an early bearing cultivar having better quality of fruits with long storage life and yield consistent with the local requirements of maturity time, resistance to frost, diseases, and insect pests and suitability for post harvest uses (dehydration, candying etc.).

REFERENCES


