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Evaluation of ber (*Ziziphus mauritiana*) germplasm for fruit setting characters

Vikalp[1]*, Mukesh Kumar[2], Mukesh Bishnoi[3], Deepak Sangwan[4], Arjoo[5]

[2]*RRS Bawal (Rewari), Chaudhary Charan Singh*
Haryana Agricultural University, Hisar, Haryana, India

ABSTRACT

The study was carried out to evaluate variability between different ber (*Ziziphus mauritiana* Lamk.) germplasm on the basis of flowering and fruit setting. Bawal Ber 12 exhibited early initiation, while BS 3 showed delayed flower initiation. The shortest flowering duration was recorded in Bawal Ber 9 (37 days), whereas longest flowering duration was recorded in Bawal Ber 1, Bawal Ber 5 and BS 1 (42 days). Different germplasm displayed notable variation in mature fruit colour, including greenish-yellow, yellow and green. Oval shaped fruits were observed in Bawal Ber 1, Bawal Ber 9 and BS 3 while Bawal Ber 2, Bawal Ber 5, Bawal Ber 6, Bawal Ber 7, Bawal Ber 8, Bawal Ber 10 and BS 2 exhibited ovate shape. Bawal Ber 3, Bawal Ber 4 and BS 1 had oblong fruits and Bawal Ber 11 displayed an oblate shape whereas Bawal Ber 12 had round fruits. The stone shape of ber germplasm varied with some exhibiting a spindle, oblong, club or oval shape. Bawal Ber 1, Bawal Ber 2, Bawal Ber 3, Bawal Ber 4, Bawal Ber 5, Bawal Ber 7, Bawal Ber 9, Bawal Ber 10 and Bawal Ber 12 had a plain fruit surface, while Bawal Ber 6, Bawal Ber 8, Bawal Ber 11, BS 1, BS 2 and BS 3 showed a ridged and wart fruit surface.

Key words: Fruit setting, Colour, Flowering, Oval, Ovate, Ridged, Variability

Clonal selection for early maturing ber (*Ziziphus mauritiana* Lamk.) clones has been a major area of focus in ber breeding. The majority of common cultivars are the outcome of selection in various geographic areas. The diverse features of ber in India exhibit a wide range of variability, indicating significant potental for further development. However, there have been limited systematic efforts to characterise the existing variability in ber germplasm across the country. In India, for plant varieties to be protected under the Protection of Plant Varieties and Farmer's Right Act, 2001 (PPV&FR Act, 2016),they must undergo distinctness, uniformity, and stability (DUS) testing . The objective of this study was to evaluate 15 different germplasm samples based on their flowering and fruit maturity characteristics to determine the distinctness of each variety compared to others.

MATERIALS AND METHODS

A total of 15 ber germplasm, Bawal Ber 1, Bawal Ber 2, Bawal Ber 3, Bawal Ber 4, Bawal Ber 5, Bawal Ber 6, Bawal Ber 7, Bawal Ber 8, Bawal Ber 9, Bawal Ber 10, Bawal Ber 11, Bawal Ber 12, BS 1, BS 2 and BS 3, were evaluated in a randomized block design with three replications at the Regional Research Station, Bawal (Rewari) of CCS HAU, Hisar (Haryana) during 2019-2020. Each plant was sampled three times from different directions. The adopted spacing between plants was 8 m x 8 m.

The parameters were recorded at specific stages following the regular DUS testing procedures of PPV&FRA. Flowering characters were observed in September, while observations on fruit parameters were recorded from ripe fruits collected from tagged branches.

Twenty branches per tree (five branches from each quarter of the tree) were randomly selected and tagged to observe the date of flowering. The dates were recorded when five per cent of the flower buds on the tagged branches had opened (Mahajan *et al.*, 2002). The nature of flowering branchlets was visually observed on the tagged branches. The presence of flowers on primary and secondary branches was noted with naked eyes. Additionally, the flower position on the tagged branches was observed at the flowering stage, categorizing them as axillary cyme, terminal or axillary clusters based on the grouping or clustering of flowers on a branch following the guidelines for

***Corresponding author :** vikalpy4@gmail.com
[1,3,4,5]Department of Horticulture, CCS HAU, Hisar, Haryana, India

DUS testing of PPV and FRA (PPV&FRA, 2016).The date of the end of flowering was also recorded on the branches tagged for the flowering date. When 85-90 per cent flower buds were opened, it was considered as the end of flowering (Mahajan *et al.*, 2002) .The flowering duration was calculated by counting the number of days from from the start of flowering to the end of flowering on the tagged branches and the average duration was calculated.

The time taken from flowering to fruit setting (in days) was calculated by counting the number of days from the date of peak flowering to the date when 50 per cent fruits on tagged branches had set. The date of 50 percent fruits maturity was noted when approximately 50 percent fruits on the tagged branches had reached maturity and the average date was calculated. The time taken from fruit setting to fruit maturity (in days) was calculated by counting the number of days from the date of 50 percent fruit setting to the date when 50 percent fruits on the tagged fruit had reached maturity .

To examine the anthocyanin blush of immature fruits, twenty immature fruits per tree were selected from the tagged branches (five fruits from each quarter of the plant). The presence or absence of anthocyanin blush in mature fruits was visually observed and marked.The bearing habit of fruits was observed visually on tagged branches of tree following the guidelines for DUS testing of PPV and FRA (PPV&FRA, 2016). The shape of mature fruits at the apex end was determined using the same fruits used for determining fruit cracking. The shape was observed and categorized as round, flat, or pointed, according to the guidelines for DUS testing of PPV and FRA. The fruit surface was determined using the fruits used for determining fruit cracking. It was observed and categorized as plain or ridged and wart, following the guidelines for DUS testing of PPV and FRA (PPV&FRA, 2016).The visual interpretation of fruit skin colour was carried out by considering the outer surface colour of matured fruits picked from tagged branches. The color was marked as yellow, greenish-yellow, chocolate brown *etc.* based on standard colour chart. The stones used for determining the stone size/ stone weight were also used to examine the stone shape. The shape was visually observed and categorized as oval, oblong, spindle, club or falcate following the guidelines for DUS testing of PPV and FRA (PPV&FRA, 2016).

RESULTS AND DISCUSSION

The data regarding the nature of flowering branchlet and flower position on branchlet did not exhibit significant variation. In all germplasm samples, the flowering position was observed on secondary branches and flowering was observed on the leaf axis (Fig. 1). These similarities in inflorescence and flowering branchlets could be attributed to a close relationship within the *Ziziphus mauritiana* species (Saran, 2005).

Flowering initiation occurred between 5th and 25th September. Bawal Ber 12 exhibited early flowering (September 5th-10th), while BS 3 showed comparatively late flowering (September 20th - 25th). The flowering period ended in the first week of October when 85-90% of the flowers had opened. Different germplasm samples completed their flowering period between the third week of October and the first week of November. The variability in flowering duration aligns with the findings reported by Nehra *et al.* (1984). The variation in flowering time in ber can be attributed to factors such as temperature, humidity, rainfall, and genetic constitution (Saran, 2005).

The duration of flowering, time taken from flowering to fruit setting, and time taken from fruit setting to fruit maturity also exhibited significant variation. Bawal Ber 9 had the shortest flowering duration (37 days), while Bawal Ber 1, Bawal Ber 5, and BS 1 had the longest flowering duration (42 days). The minimum time taken from flowering to fruit setting was observed in Bawal Ber 5, Bawal Ber 7, and Bawal Ber 12 (16 days), while the maximum time taken was observed in Bawal Ber 1, Bawal Ber 2, and BS 2 (21 days). The minimum time taken from fruit setting to fruit maturity was recorded in Bawal Ber 12 (126 days), while the maximum was observed in Bawal Ber 9 (155 days). It was noted that the flowering season in ber is prolonged, and the duration of flowering varies among different genotypes. These findings regarding flowering duration and the time taken for fruit setting and fruit maturity in ber are consistent with the results reported by Krishna *et al*. (2016).

The variability in flowering duration, time taken from flowering to fruit setting, and time taken from fruit setting to fruit maturity in ber can be influenced by various factors, including the location of the experiment (Nath and Bhargava, 2000; Raja, 2004). Temperature, humidity, nutritional status, and genetic factors are also known to contribute to the variation observed in these traits (Saran, 2005;

Sharif *et al.*, 2013; Choudhary *et al*., 2017; Choudhary *et al.*, 2020).In terms of immature fruit characteristics, anthocyanin blush was observed in Bawal Ber 4, Bawal Ber 8, Bawal Ber 9, Bawal Ber 10, and Bawal Ber 11, while it was absent in the remaining germplasm (Table 1). This variation in anthocyanin blush in immature ber fruits has been previously reported by Raja (2004) and Saran (2005). Bunching of fruits was present in Bawal Ber 2, Bawal Ber 3, Bawal Ber 4, Bawal Ber 5, Bawal Ber 8, Bawal Ber 9, Bawal Ber 11, and BS 2, while it was absent in Bawal Ber 1, Bawal Ber 6, Bawal Ber 7, Bawal Ber 10, Bawal Ber 12, BS 1, and BS 3 (Table 1). The variation in the bearing habit of ber fruits has also been documented by Godi *et al.* (2016). These variations in immature fruit color and bearing habit among different germplasm may be inherent characteristics of the specific germplasm (Krishna *et al*., 2016). The fruits of Bawal Ber 2, Bawal Ber 6, Bawal Ber 7, Bawal Ber 9 and Bawal Ber 12 were yellow incolour. The fruits of BS 3 were green in colour and remaining germplasm had a greenish-yellow color. Bawal Ber 1 to 5, Bawal Ber 7, Bawal Ber 9, Bawal Ber 10 and Bawal Ber 12 showed plain fruit surface, while other germplasm had ridged and wart fruit surface (Table 1). Ezhilarasi and Tamilmani (2009) reported that the change in fruit colour during ripening can be attributed to factors such as loss of chlorophyll, the coalescence of carotenoids and presence of pigmental phenolic compounds such as anthocyanins, β carotenes *etc*. Selection of cultivar/ germplasm by consumers depends on their appearance and other physical properties for an attractive look. Similar findings on mature fruit colour and fruit surface were also reported by Krishna *et al.*,2016; Singh and Deen, 2022.

Fruits of Bawal Ber 1, Bawal Ber 9 and BS 3 were oval in shape The fruits of Bawal Ber 3, Bawal Ber 4 and BS 1 were oblong and the fruits of Bawal Ber 11 were oblate. On the other hand, fruits of Bawal Ber 12 were roundwhile the rest of the germplasm were ovate. The fruit apex of Bawal Ber 2, Bawal Ber 8 and Bawal Ber 11 was flat in shape while the fruit apex of Bawal Ber 6, Bawal Ber 7, Bawal Ber 10 and BS 3 waspointed. The remaining germplasm had a round fruit apex (Table 2). The stones of Bawal Ber 1, Bawal Ber 2 and Bawal Ber 7 were spindle in shape; the stones of Bawal Ber 3 were oblong; stones of Bawal Ber 4, Bawal Ber 8, Bawal Ber 10 and BS 3 were a club in shape; however, the stones of Bawal Ber 5, Bawal Ber 6, Bawal Ber 9, Bawal Ber 11, Bawal Ber 12, BS 1 and BS 2 were oval (Table 2). The similar variations in the shape of fruits and stone were observed by Nehra *et al*. (1984), Kundi *et al*. (1989), Bal (1992), Raja (2004) and Torahi (2004). These variations in shape of fruits and stones may be attributed to the genetic makeup of the germplasm (Saran, 2005).

Table 1: Fruit phenotypic attributes of ber germplasm under semi-arid conditions of Haryana

Germplasm	Immature fruit: Anthocyanin blush	Bearing habit: Bunching	Mature fruit colour	Fruit surface	Mature fruit shape	Fruit shape: Apex	Stone shape
Bawal Ber 1	Absent	Absent	Greenish yellow	Plain	Oval	Round	Spindle
Bawal Ber 2	Absent	Present	Yellow	Plain	Ovate	Flat	Spindle
Bawal Ber 3	Absent	Present	Greenish yellow	Plain	Oblong	Round	Oblong
Bawal Ber 4	Present	Present	Greenish yellow	Plain	Oblong	Round	Club
Bawal Ber 5	Absent	Present	Greenish yellow	Plain	Ovate	Round	Oval
Bawal Ber 6	Absent	Absent	Yellow	Ridged and wart	Ovate	Pointed	Oval
Bawal Ber 7	Absent	Absent	Yellow	Plain	Ovate	Pointed	Spindle
Bawal Ber 8	Present	Present	Greenish yellow	Ridged and wart	Ovate	Flat	Club
Bawal Ber 9	Present	Present	Yellow	Plain	Oval	Round	Oval
Bawal Ber 10	Present	Absent	Greenish yellow	Plain	Ovate	Pointed	Club
Bawal Ber 11	Present	Present	Greenish yellow	Ridged and wart	Oblate	Flat	Oval
Bawal Ber 12	Absent	Absent	Yellow	Plain	Round	Round	Oval
BS 1	Absent	Absent	Greenish yellow	Ridged and wart	Oblong	Round	Oval
BS 2	Absent	Present	Greenish yellow	Ridged and wart	Ovate	Round	Oval
BS 3	Absent	Absent	Green	Ridged and wart	Oval	Pointed	Club

CONCLUSION

Bawal Ber 12 exhibited early initiation and completion of flowering, as well as early fruit setting and maturity. On the other hand, BS 3 showed late flowering and fruit setting, and BS 3, Bawal Ber 8, Bawal Ber 9, and Bawal Ber 11 exhibited late fruit maturity. The fruit color of the different germplasm varied significantly. This color change can be attributed to the conversion of chlorophyll to anthocyanin. The fruit surface of Bawal Ber 1, Bawal Ber 2, Bawal Ber 3, Bawal Ber 4, Bawal Ber 5, Bawal Ber 7, Bawal Ber 9, Bawal Ber 10, and Bawal Ber 12 was observed to be plain.The shape of fruits differed among the germplasm. Bawal Ber 1, Bawal Ber 9, and BS 3 had oval-shaped fruits, Bawal Ber 2, Bawal Ber 5, Bawal Ber 6, Bawal Ber 7, Bawal Ber 8, Bawal Ber 10, and BS 2 had ovate-shaped fruits, Bawal Ber 3, Bawal Ber 4, and BS 1 had oblong-shaped fruits, Bawal Ber 11 had oblate-shaped fruits, and Bawal Ber 12 had round-shaped fruits.

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