Research Article

Ekin
Journal of Crop Breeding and Genetics

11(2):68-75, 2025

www.ekinjournal.com

Ekin International biannual peer-reviewed journal

# Assessment of Ber Germplasm for Fruit Morphological Traits Under Semi-Arid Conditions

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***Citation:***
Kumar M., Kumar M., Sharma JR., Hardeep., Sangwan D., 2025. Assessment of Ber Germplasm for Fruit Morphological Traits Under Semi-Arid Conditions. Ekin J. 11(2):68-75.

***Received: 03.05.2025*** ***Accepted: 25.06.2025*** ***Published Online: 31.07.2025*** ***Printed: 31.07.2025***

## ABSTRACT

A study on fruit morphological parameters of different ber germplasm was carried out at the Experimental Orchard, CCS Haryana Agricultural University, Regional Research Station, Bawal (Rewari), Haryana during 2022-23 and 2023-24. Sixteen selected germplasm of ber planted at 8 m × 8 m in randomized block design (RBD) in three replications were characterized based on fruit morphological traits, including fruit colour, shape, fruit apex and base shape and pulp cavity at styler and stem end. Among different ber germplasm, round fruit shape was noticed in five germplasm viz. Gola, Kakrola Gola, Narendra Ber Sel-1, Narendra Ber Sel-2 and Katha Phal, while oblong fruit shape was observed in 6 germplasm viz. Umran, Kaithali, Rohtak Safeda, Bawal Sel-1, Bawal Sel-2 and Mudia Murhara. The germplasm Chhuhara and Thar Sevika had ovate fruit shape. Further, oval fruit shape was noticed in two germplasm viz. Goma Kriti and Thar Bhubraj, while oblate fruit shape was noticed in only one germplasm i.e. Illaichi. At fruit maturity, Katha Phal exhibited anthocyanin blush on fruit skin while remaining germplasm does not exhibit anthocyanin blush. The round fruit apex was noticed in 10 germplasm, while it was pointed in 4 germplasm and 2 germplasm had flat fruit apex. The varieties were systematically classified into five distinct groups based on stone shape, viz. oblong, spindle, club, oval and falcate. The significant variability observed in morphological traits among the germplasm likely represents the genetic diversity inherited from the ancestral species from which these cultivars originated.

***Keywords***: Ber (*Ziziphus mauritiana* Lamk.), germplasm, DUS, fruit morphology

## Introduction

The Indian ber (*Ziziphus mauritiana* Lamk.) is an ancient and highly significant, yet underutilized, fruit crop native to India. It belongs to the family *Rhamnaceae* and has a chromosome number 2n=48 (Srinivasan, 1952). Ber originated from India to Malaya, includes parts of south-western China (Vavilov, 1951; Hu et al., 2010). Globally, the genus *Ziziphus* has over 170 species of tiny trees and spiny shrubs that grow in warm-temperate and subtropical climates (Islam and Simmons, 2006). It is widely known by various names, including Indian jujube, Chinese fig, Chinese date and poor man's fruit (Kumari et al., 2016). It is also nominated as "King of Arid Fruits" due to the facts that it can be successfully grown in barren land and marginal soil of arid and semi-arid regions.

The ber fruit possesses a distinctive combination of sour and sweet taste, along with significant nutritional benefits. Besides consumed as fresh fruit, it is widely processed into products like dried fruits, candies, powder, pulp, jam and beverages. Nutritionally, the ripe fruit surpasses apples in protein, calcium, phosphorus and vitamin C content (Godi and Joshi, 2016), providing 20.9 kcal per 100 g pulp. It is a nutrient-rich fruit, providing 70–165 mg of ascorbic acid per 100 g of pulp and 70 IU of vitamin A.

Most of the commercially grown cultivars today were developed through selection. Farmers have also selected naturally growing seedlings based on desirable economic traits and subsequently propagated them vegetatively to preserve their genetic identity (Krishna, 2016). In ber breeding, the primary focus has been on clonal selection, especially for early-maturing clones. The majority of common germplasm results from selection practices across various regions.

India exhibits a vast diversity in ber, encompassing a wide range of variations across all key traits, providing significant potential for genetic improvement. Understanding the genetic diversity within germplasm collections is crucial for their effective utilization. While this process is complex, expensive, and time-intensive, it plays a vital role in crop improvement by guiding decisions on breeding methodologies and the management of genetic resources.

Thus, there is an urgent need to give attention to ber improvement by augmenting, characterizing, evaluating germplasm and utilizing it in breeding programme for the enhancement of productivity and development of better fruit quality. The characterization and evaluation of *Ziziphus mauritiana* germplasm are primarily based on morpho-physiological traits. Researchers use morphological descriptors such as growth habit, shoot, leaf, flower and fruit morphology to classify and distinguish different varieties of *Z. mauritiana* (Vashishtha, 2001 and Saran et al*.,* 2006). With this context, the present investigation was conducted to characterize sixteen ber germplasm based on fruit morphological traits and to establish the distinctness of the candidate germplasm from another available germplasm in India.

## Materials and Methods

The investigation was conducted at the experimental orchard of Chaudhary Charan Singh Haryana Agricultural University, Regional Research Station, Bawal. The Regional Research Station in Bawal located in the south-west part of Haryana, at an elevation of 266 meters above sea level. Its geographic coordinates are 28° 10' N latitude and 76° 50' E longitude. The region falls within an arid to semi-arid climatic zone marked by hot and dry summers and very cold winters. The experimental orchard was laid out in randomized block design (RBD) with three replications examining 16 ber germplasm (*viz*. Gola, Umran, Kaithali, Chuhhara, Goma Kriti, Thar Sevika, Thar Bhubhraj, Narendra Ber Sel-2, Narendra Ber Sel-1, Bawal Sel-1, Bawal Sel-2, Rohtak Safeda, Kakrola Gola, Mudia Murhara, Katha Phal and Illaichi). The study was comprised of 8 different fruit morphological characters, which were noticed at specified stage of crop growth when a particular character showed its full expression as per Distinctness, Uniformity and Stability (DUS) guidelines (Anonymous, 2016). Observations on the mature fruit and stone were made when the fruit reached the harvesting stage. Observations on anthocyanin blush was observed with naked eyes on immature fruit from all the directions of selected tree and expressed as anthocyanin blush present or anthocyanin blush absent. For assessment of fruit colour, the Royal Horticultural Society (RHS) colour chart shall be used.

## Results and Discussion

Significant variation was observed among sixteen selected germplasm for different fruit morphological characters. The frequency distribution of each trait along with representative germplasm examples, is presented in Table 1 & 2. In the current investigation, mature fruit shape varied significantly among different germplasm. The round fruit shape was noticed in 5 germplasm *viz*. Gola, Narendra Ber Sel-1, Narendra Ber Sel-2, Kakrola Gola and Katha Phal while oblong fruit shape was observed in 6 germplasm *viz*. Umran, Kaithali, Rohtak Safeda, Bawal Sel-1, Bawal Sel-2 and Mudia Murhara. The germplasm Chhuhara and Thar Sevika had ovate fruit shape. Further, oval fruit shape was noticed in 2 germplasm *viz*. Goma Kriti and Thar Bhubhraj, while oblate fruit shape was noticed in only one germplasm i.e. Illaichi. Similar results were also reported by Kumar et al*.,* (2021), Yadav et al*.,* (2020), Singh et al*.,* (2019), Godi et al*.,* (2016) and Krishna et al*.,* (2016) among different ber genotypes. The germplasm are typically identified based on their fruit characteristics, such as shape, the form of stylar and basal ends, pulp cavity and colour etc. These prominent characters are often reflected in their nomenclatures, such as Gola, Narma, Tikadi, Illaichi, Banarasi Karaka etc. (Vashishtha, 2001).

In relation to fruit colour, huge variability was noticed among different germplasm. Colour of fruits at maturity was noticed yellowish in Gola, Kaithali and Goma Kriti, greenish yellow in Chuhhara, Thar Bhubraj and Narendra Ber Sel-2, yellowish green in Thar Sevika, Rohtak Safeda, Kakrola Gola and Mudia Murhara and Greenish in Narendra Ber Sel-1, Bawal Sel-1 and Katha Phal. Umran had golden yellow and Bawal Sel-2 has golden green colour at maturity. In Illaichi, matured fruit was of brownish colour at horticultural maturity. Among the evaluated germplasm, only one germplasm *i.e.* Katha Phal, exhibited an anthocyanin blush on immature fruits; while remaining 15 germplasm had no anthocyanin

blush on immature fruit. Results are in accordance with the findings of Kumar et al., (2021), Yadav et al., 2020), Singh et al., (2019) and Krishna et al., (2016) among different ber genotypes. The variations in fruit colour largely depend on climatic conditions and light intensity, light quality etc. Diversity in shape and colour among different germplasm help breeders to choose genotypes according to the type of consumption (Liu et al., 2009).

The round fruit apex was noticed in 10 germplasm *viz*. Gola, Umran, Thar Bhubhraj, Narendra Ber Sel-2, Rohtak Safeda, Bawal Sel-1, Bawal Sel-2, Mudia Murhara, Katha Phal and Illaichi, while it was pointed in 4 germplasm Kaithali, Chhuhara, Goma Kriti and Thar Sevika. However, Narendra Ber Sel-1 and Kakrola Gola had flat fruit apex. Fruit base was observed round in 9 germplasm *viz*. Gola, Umran, Goma Kriti, Narendra Ber Sel-2, Rohtak Safeda, Bawal Sel-1, Bawal Sel-2, Katha Phal and Illaichi, while flat in 7 germplasm *viz*. Kaithali, Chhuhara, Thar Sevika, Thar Bhubraj, Narendra Ber Sel-1, Kakrola Gola and Mudia Murhara.

Among different ber germplasm, 11 germplasm *viz*. Gola, Kaithali, Chhuhara, Goma Kirti, Thar Sevika, Thar Bhubraj, Rohtak Safeda, Bawal Sel- 2, Mudia Murhara, Katha Phal and Illaichi had pulp cavity at stylar end, while it was absent in 5 germplasm *viz*. Umran, Narendra Ber Sel-1, Bawal Sel-1, Narendra Ber Sel-2 and Kakrola Gola germplasm. Pulp cavity at stem end was present in Gola, Umran, Kaithali, Chuhhara, Goma Kriti, Thar Sevika, Thar Bhubraj, Narendra Ber Sel-1, Narendra Ber Sel-2, Rohtak Safeda, Bawal Sel-2, Katha Phal, Kakrola Gola, Mudia Murhara and Illaichi germplasm whereas, it was absent in only one germplasm i.e., Bawal Sel-1 (Table 1 & 2). Key fruit characteristics such as apex type, stylar and stem end cavities, and fruit shape are considered the most dependable traits for classification (Bal, 1992; Azam-Ali et al., 2006).

The germplasm were further classified into five groups based on stone shape into five groups *i.e.* spindle, oblong, club, oval and falcate. The club shape stone was noticed in Umran, Chuhhara, Goma Kriti, Thar Bhubraj and Mudia Murhara while most of germplasm exhibited oval stone shape i.e., Gola, Narendra Ber Sel-1, Rohtak Safeda, Bawal Sel-1, Bawal Sel-2, Kakrola Gola, Katha Phal and Illaichi. The oblong shape stone was found in Kaithali. Further, falcate stone shape was noticed in Thar Sevika and spindle type stone were found in Narendra Ber Sel. 2. Results are in accordance with the findings of Singh et al., (2019) and Krishna et al., (2016) in ber germplasm under different growing conditions.

**Cluster Analysis**

On the basis of clustering dendrogram (ward D) sixteen ber germplasm are divided into four groups/ cluster (Table 3, Figure 1). Maximum germplasm (10) were grouped into cluster II, whereas minimum genotypes (1) were in group Cluster III and IV. The germplasm in the same group are more less similar to each other. For example, Narendra Ber Sel-1 and Kakrola Gola are clustered together at a lower height compared to Katha Phal. This indicates that the diagram is visualizing how different variables contribute to the principal components (PCs) in a Principal Component Analysis (PCA) (Figure 2). PC1 and PC2 represent 30.2% and 21.8% of the total variance in the data. In correlation metrics fruit shape is negatively correlated with stone shape, pulp cavity stem end, pup cavity styler end, and fruit apex shape (Figure 3). However, pulp cavity stem end is positively correlated with mature fruit shape. Stone shape is positively correlated with pulp cavity (stem and styler end) and fruit apex shape.

The descriptors of ber germplasm plays a vital role in identification of variation in genetic diversity among germplasm, which enable breeders/growers to select the suitable character of economic importance (Bioversity International, 2007).

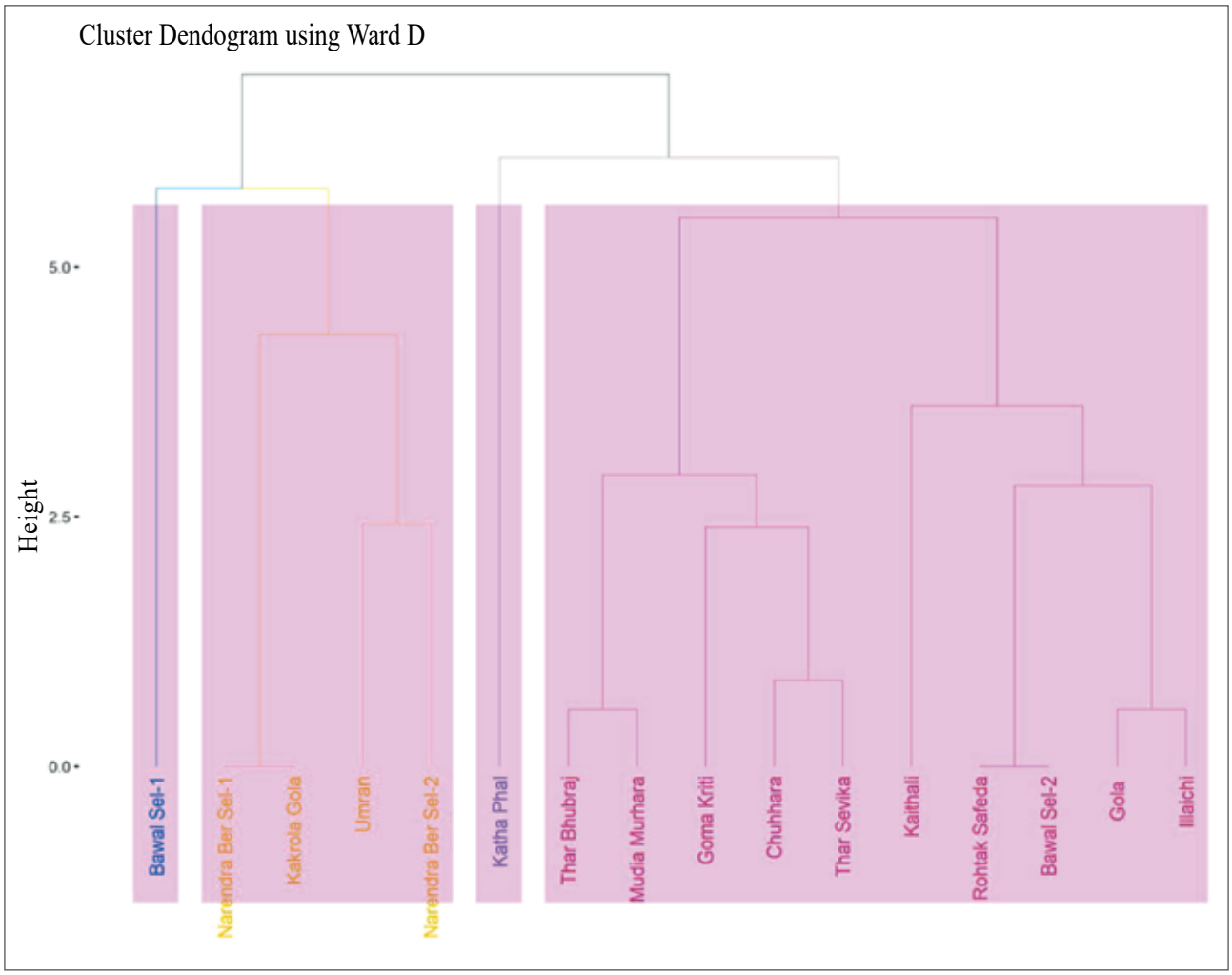


Figure 1. Cluster dendrogram (ward D) representation of ber germplasm.

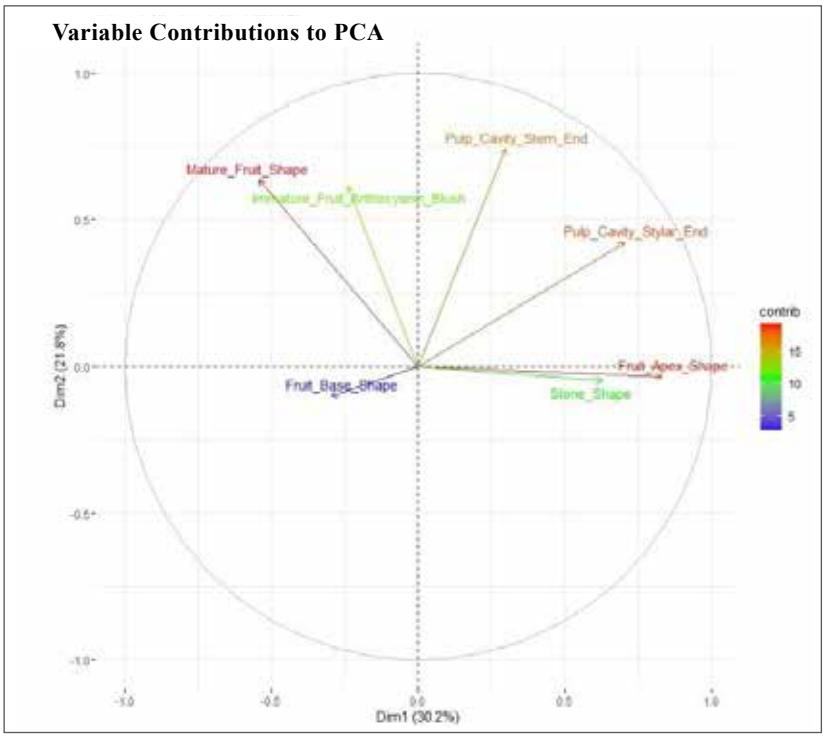


Figure 2. Different variables contribution to the principal components (PCs) in a Principal Component Analysis (PCA).

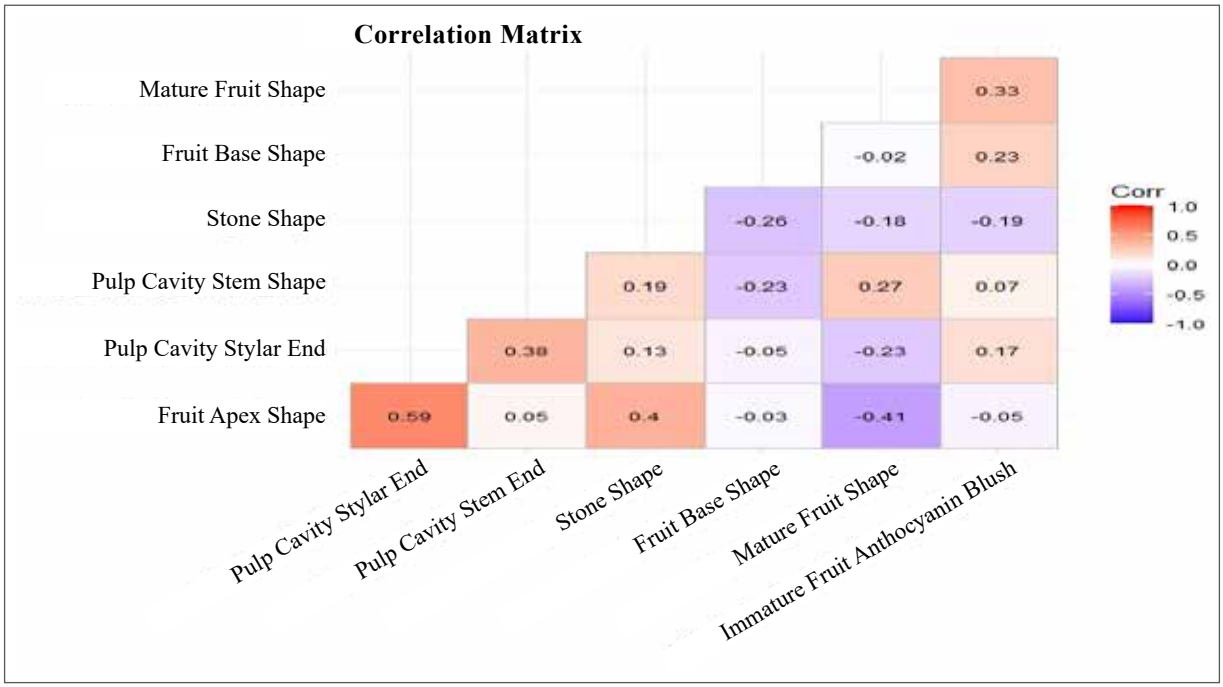


Figure 3. Correlation metrics for different characteristics of ber germplasm.

Table 1. Frequency distribution and example varieties of some important attributes of 16 ber germplasm.

| Plant Descriptor | Range in Expression | Number of Genotypes | Germplasm |
|---|---|---|---|
| **Mature fruit: Shape** | Oblate | 1 | Illaichi |
| | Oval | 2 | Goma Kriti, Thar Bhubhraj |
| | Ovate | 2 | Chhuhara, Thar Sevika |
| | Oblong | 6 | Umran, Kaithali, Rohtak Safeda, Bawal Sel-1, Bawal Sel-2, Mudia Murhara. |
| | Round | 5 | Gola, Narendra Ber Sel-1, Narendra Ber Sel-2, Kakrola Gola, Katha Phal |
| | Falcate | 0 | - |
| **Fruit shape: Apex** | Flat | 2 | Narendra Ber Sel-1, Kakrola Gola |
| | Round | 10 | Gola, Umran, Thar Bhubhraj, Narendra Ber Sel-2, Rohtak Safeda, Bawal Sel-1, Bawal Sel-2, Mudia Murhara, Katha Phal, Illaichi |
| | Pointed | 4 | Kaithali, Chhuhara, Goma Kriti, Thar Sevika |
| **Fruit shape: Base** | Round | 9 | Gola, Umran, Goma Kriti, Narendra Ber Sel-2, Rohtak Safeda, Bawal Sel-1, Bawal Sel-2, Katha Phal, Illaichi, |
| | Flat | 7 | Kaithali, Chhuhara, Thar Sevika, Thar Bhubraj, Narendra Ber Sel-1, Kakrola Gola, Mudia Murhara. |
| **Mature fruit: Colour** | Yellowish | 3 | Gola, Kaithali, Goma Kriti |
| | Greenish yellow | 3 | Chuhhara, Thar Bhubraj, Narendra Ber Sel-2 |
| | Yellowish green | 4 | Thar Sevika, Rohtak Safeda, Kakrola Gola, Mudia Murhara |
| | Greenish | 3 | Narendra Ber Sel-1, Bawal Sel-1, Katha Phal. |
| | Golden yellow | 1 | Umran |
| | Golden green | 1 | Bawal Sel-2 |
| | Brownish colour | 1 | Illaichi |
| **Immature fruit: Anthocyanin Blush** | Present | 1 | Katha Phal |
| | Absent | 15 | Gola, Umran, Kaithali, Goma Kirti, Thar Sevika, Thar Bhubharaj, Narendra Ber Sel-1, Rohtak Safeda, Narendra Ber Sel-2, Bawal Sel-1, Bawal Sel- 2, Kakrola Gola, Mudia Murhara, Illaichi |
| **Pulp cavity: Stylar end** | Present | 11 | Gola, Kaithali,Chuhhara, Goma Kirti, Thar Sevika, Thar Bhubraj, Rohtak Safeda, Bawal Sel- 2, Mudia Murhara, Katha Phal, Illaichi |
| | Absent | 5 | Umran, Narendra Ber Sel-1, Bawal Sel-1, Narendra Ber Sel-2, Kakrola Gola |
| **Pulp cavity: Stem End** | Present | 15 | Gola, Umran, Kaithali, Chuhhara, Goma Kriti, Thar Sevika, Thar Bhubharaj, Narendra Ber Sel-1, Rohtak Safeda, Bawal Sel-2, Narendra Ber Sel-2, Katha Phal, Kakrola Gola, Mudia Murhara, Illaichi |
| | Absent | 1 | Bawal Sel-1 |
| **Stone Shape** | Oblong | 1 | Kaithali. |
| | Oval | 8 | Gola, Narendra Ber Sel-1, Rohtak Safeda, Bawal Sel-1, Bawal Sel-2, Kakrola Gola, Katha Phal, Illaichi. |
| | Spindle | 1 | Narendra Ber Sel. 2. |
| | Club | 5 | Umran, Chuhhara, Goma Kriti, Thar Bhubraj, Mudia Murhara |
| | Falcate | 1 | Thar Sevika |

Table 2. Morphological characterization of ber fruits.

| Germplasm | Mature Fruit Shape | Fruit Apex Shape | Fruit Base Shape | Immature Fruit Anthocyanin Blush | Pulp Cavity Stylar End | Pulp Cavity Stem End | Stone Shape |
|---|---|---|---|---|---|---|---|
| Gola | 5 | 3 | 3 | 1 | 9 | 9 | 2 |
| Umran | 1 | 3 | 3 | 1 | 1 | 9 | 4 |
| Kaithali | 1 | 5 | 1 | 1 | 9 | 9 | 1 |
| Chuhhara | 3 | 5 | 1 | 1 | 9 | 9 | 4 |
| Goma Kriti | 2 | 5 | 3 | 1 | 9 | 9 | 4 |
| Thar Sevika | 3 | 5 | 1 | 1 | 9 | 9 | 5 |
| Thar Bhubraj | 2 | 3 | 1 | 1 | 9 | 9 | 4 |
| Narendra Ber Sel-1 | 5 | 1 | 1 | 1 | 1 | 9 | 2 |
| Narendra Ber Sel-2 | 5 | 3 | 3 | 1 | 1 | 9 | 3 |
| Rohtak Safeda | 1 | 3 | 3 | 1 | 9 | 9 | 2 |
| Bawal Sel-1 | 1 | 3 | 3 | 1 | 1 | 1 | 2 |
| Bawal Sel-2 | 1 | 3 | 3 | 1 | 9 | 9 | 2 |
| Kakrola Gola | 5 | 1 | 1 | 1 | 1 | 9 | 2 |
| Mudia Murhara | 1 | 3 | 1 | 1 | 9 | 9 | 4 |
| Katha Phal | 5 | 3 | 3 | 9 | 9 | 9 | 2 |
| Illaichi | 4 | 3 | 3 | 1 | 9 | 9 | 2 |

Table 3. Distribution of 16 germplasm into different clusters.

| Clusters | Number of Germplasm | Germplasm |
|---|---|---|
| I | 10 | Gola, Kaithali, Chhuhara, Goma Kriti, Thar Sevika, Thar Bhubhraj, Rohtak Safeda, Bawal Sel-2, Mudia Murhara and Illaichi |
| II | 4 | Umran, Narendra Ber Sel-1, Narendra Ber Sel-2, Kakrola Gola |
| III | 1 | Bawal Sel-1 |
| IV | 1 | Katha Phal |

**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).

Azam-Ali S, Bonkoungou E and Bowe C, (2006). Breeding. In: Ber and Other Jujubes, 289. deKock C, Godara A, Williams J T (Eds). International Centre for Underutilized Crops, Southampton, UK.

Bal JS, (1992). Identification of ber (*Ziziphus mauritiana* Lamk.) cultivars through vegetative and fruit characters. Acta Horticulturae, 317: 245–53.

Bioversity International, (2007). Guidelines for the development of crop descriptor lists. Bioversity Technical Bulletin Series, Bioversity International, Rome, Italy, XII 72 p.

Godi NF and Joshi VR, (2016). Studies on biochemical and organoleptic characters of different ber (*Ziziphus mauritiana* Lamk.) genotypes. Advances in Life Sciences, 5(6):2389-2393.

Godi NF, Joshi VR and Supe VS, (2016). Physical fruit characteristics assessment of selected ber (*Ziziphus mauritiana* Lamk.) genotypes. International Journal of Applied Research, 2(2):757-761.

Hu SY, Wen JB, Satar A and Tian CM, (2010). Research progress of quarantine pest *Carpomyia vesuviana*. Scientia Silvae Sinica, 46(7):147-154.

Islam MB and Simmons MP, (2006) A thorny dilemma: testing alternative intrageneric classifications within *Ziziphus* (Rhamnaceae). Systematic Botany, 31(4):826-842.

Krishna H, Bhargava R, Chauhan N and Sharma SK, (2016). Morphological descriptor for DUS testing of Indian jujube (*Ziziphus mauritiana*). Indian Journal of Agricultural Sciences, 86(6):809-814.

Kumar M, Arya RK, Kumar M, Gaur RK and Sharma S, (2021). Evaluation of Aonla varieties under semi-arid conditions of Haryana. Ekin Journal of Crop Breeding and Genetics, 7(2):139-144.

Kumari S, Bhat DJ, Wali VK, Bakshi P and Kumar R, (2016). Studies on vegetative growth and floral biology of *Ziziphus mauritiana* germplasm under rainfed conditions of Jammu, India. Ecology Environment and Conservation, *22(*2):641-646.

Liu P, Liu MJ, Zhao ZH, Liu XY, Wang JR and Yan C, (2009). Investigation on the characteristics of fruiting and seed development in Chinese jujube (*Ziziphus jujuba* Mill.). Acta Horticulturae, 840: 209-214.

Saran PL, Godara AK and Sehrawat SK, (2006). Characterization of ber (*Ziziphus mauritiana* Lamk.) genotypes. Haryana Journal of Horticultural Sciences, 35:215-18.

Singh OV, Singh K, Gowthami R and Shekhawat N, (2019). Morphological characterization of ber germplasm. Indian Journal of Horticulture, 76(2): 219-225.

Srinivasan VK, (1952). Chromosome number in the genus *Ziziphus*. Current Science, 21:224.

Vashishtha BB, (2001). Ber varieties: A monograph. Agrobios (India), Agro House, Behind Nasrani Cinema, Chopasani Road, Jodhpur, Rajasthan, India. p. 97.

Vavilov NI, (1951). The origin, variation, immunity and breeding of cultivated plants. Soil Science, 72(6): 482.

Yadav J, Gaur RK, Kumar Y, Kumari N, Yadav SS, Khan M and Yadav S, (2020). Evaluation of anti xenotic and allelochemical traits of ber (*Ziziphus mauritiana* Lamk.) fruits as a source of host plant resistance against fruit fly (*Carpomyia vesuviana* Costa) (Diptera: Tephritidae) in semi-arid region of India. Phytoparasitica, 48:607-620.