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Morphological and physico-chemical characterization of ber (*Ziziphus mauritiana* Lamk.) genotypes in semi-arid zone of Punjab

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Abstract

Indian jujube (*Ziziphus mauritiana* Lamk.) commonly known as ber is an important fruit crop of arid and semi-arid regions of tropical and subtropical areas. The morphological and physico-chemical characterization of twelve genotypes of jujube were studied at Punjab Agricultural University, Regional Station Bathinda. Ber genotypes characterized on the basis of tree, leaf and fruit characteristics exhibited significant variability. Leaf length ranged from 7.42 to 13.00 cm, leaf breadth from 5.60 to 8.77 cm and petiole size from 1.47 to 3.17 cm. Fruit yield (62.35 kg/tree), fruit weight (27.31 g) and pulp to stone ratio (23.60) was observed significantly higher in Umran. All the genotypes under study showed distinct variations and the genotypes with superior traits can be further used for improvement in ber crop through selection and hybridization to get desired traits.

Keywords: Ber, genotypes, fruit characteristics, morphological characters, *Ziziphus mauritiana*

Introduction

Ber (*Ziziphus spp*) belonged to the family *Rhamnaceae* that consists of 45 genera and 550 species, is widely distributed in tropical and subtropical climates in the world (Mukhtar *et al.*, 2004) [11]. Ber also called as 'the apple of arid zone' is a hardy tree of arid region which can be grown successfully in saline soil under hot, arid environment (Meena *et al.*, 2003) [10]. The fruit is very nutritious with potassium, phosphorus, calcium and manganese and also a rich source of vitamin C and vitamin B complex and anti-oxidant content of fresh fruits is higher than most of fruits (Li *et al.*, 2007) [9]. Ber demonstrates a rich genetic diversity mostly resulting from natural cross pollination and self in compatibility (Bhargava *et al.*, 2005) [2]. No serious attempt has been made for nomenclature, characterization and classification of these genotypes on the basis of vegetative as well as leaf characters. To advance economy of ber orchards, there is an urgent need to select or develop varieties from a wide variety of natural population for superior characteristics i.e., high TSS, good blend of TSS and acidity, hard flesh, good flavor and aroma besides resistance or tolerance to insect-pest like fruit fly and diseases like powdery mildew and sooty mould. A large number of ber cultivars have been developed so far but none of them possesses all the desired attributes. The present study has been conducted to characterize and classify ber genotypes based on different morphological and physico-chemical characteristics to assess diversity and to identify suitable promising accessions for quality improvement and breeding programs.

Materials and Methods

The experimental material comprising of twelve genotypes of ber viz., Gola, Muria Murhera, Sandhura Narnaul, Katha Phal, Umran, Seb, Najuk, Chhuhara, ZG-3, Kaithli, Elaichi and Walaiti planted in orchard of Punjab Agricultural University, Regional Research Station, Bathinda, Punjab. The average rainfall at the experimental site was 400 mm, the annual maximum temperature was 31.5 °C and annual minimum temperature was 16.9 °C during fruiting season. The soil was sandy loam and characterized with pH (8.31), organic carbon (0.32%), electrical conductivity (0.24 dS/m), available N (212 kg/ ha), available P (21.5 kg/ ha) and available K (357.0 kg/ ha). Observations were recorded during September- October on tree growth habit, branching habit and vigour. The data for leaf characteristics were recorded from mature leaves for leaf size, shape and petiole size and the data on fruit characteristics i.e., fruit shape, fruit surface, fruit length, fruit breadth, skin colour of unripe and ripe fruit were

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made from five fruits per tree at matured to optimum ripening stage by observing visually using descriptor's term. The fruits at each harvesting were weighed and per tree yield was recorded. Twenty representative mature fruits were picked randomly from each variety and these fruits were then analysed for physico-chemical characteristics. The TSS was measured with the digital refractometer (0-85%) and acidity was estimated by 0.1 N NaOH method (AOAC, 2005) [1]. Analysis of variance (ANOVA) and the test of mean comparison according to critical difference (CD) were applied. Significance level was accepted at $p \leq 0.05$. The data of 3 replications was analyzed statistically by randomized block design using CPCS1 software as a statistical analysis tool (Cheema and Singh, 1990) [4].

Results and Discussion

Tree characteristics

The data pertaining to vegetative characters exhibited sufficient variability. The genotypes Gola, Muria Murhera, Sandhura Narnaul, Walaiti, Elaichi and ZG-3 had spreading type growth habit; Katha Phal, Umran and Chhuhara had intermediate whereas Seb and Kaithli had upright growth habit. No variation was observed among ber genotypes with respect to stem nature (bark surface). All genotypes had rough stem nature. Bark colour was dark brown with grayish tinge in Gola and Chhuhara; light brown with grayish tinge in Muria Murhera, Seb, Najuk and Walaiti; light brown in Sandhura Narnaul, Katha Phal and Umran; blackish brown in Kaithli; dark brown in ZG-3 and light brown with blackish tinge in Elaichi. Branch thorniness was high in Gola, Katha Phal and Seb; medium in Sandhura Narnaul, Najuk, Chhuhara, Walaiti, Elaichi and ZG-3 while less in Umran and Kaithli. Thorn shape was observed all curved in all the

genotypes under study.

Leaf characteristics

Significant variation was observed in different genotypes with respect to foliage colour, leaf veins, leaf shape, leaf base, leaf apex, leaf petiole colour, leaf petiole length and leaf size. Foliage colour varied from light green to dark green in all the genotypes under study. Sandhura Narnaul and Kaithli had light green foliage while all other genotypes had dark green foliage colour. Leaf veins were observed to be more prominent on lower side and less prominent on upper side in all the genotypes. The leaf shape showed considerable variability among the genotypes (Table 2). Leaf shape was observed to be ovate in Gola, Muria Murhera and Sandhura Narnaul; oval to oblong in Katha Phal; obovate in Umran and Elaichi; oval in Najuk, Chhuhara and Walaiti; oval to obovate in Kaithli. The leaf base was acute in Muria Murhera; round in Gola, Seb, Najuk, Walaiti and ZG-3 while tapering in all other genotypes under study. The leaf apex was observed rounded in Muria Murhera, Sandhura Narnaul and Umran; acute in Seb and Kaithli; oblique in Walaiti while remaining genotypes under study possessed obtuse leaf apex. The length of leaf petiole ranged between 1.47-3.17 cm. The longest petiole length was observed in Elaichi while the shortest length was observed in Katha Phal. Leaf petiole colour did not show much variation and was observed light green in all the genotypes under study. Leaf length was significantly higher in Najuk (13.0 cm) while the minimum leaf length was recorded in Katha Phal (7.42 cm). Leaf width was recorded significantly higher in Seb (8.77 cm) and minimum leaf width was Kaithli (5.60 cm). The variation in vegetative and leaf characters was due to inherent characteristics of the genotypes.

Table 1: Tree and leaf morphological characteristics of different genotypes of ber

| Genotypes | Tree habit | Stem (bark surface) | Bark colour | Branch thorniness | Thorn shape | Foliage colour | Leaf veins | |
|------------------|--------------|---------------------|---------------------------------|-------------------|-------------|----------------|------------|----------------|
| | | | | | | | Lower side | Upper side |
| Gola | spreading | rough | dark brown with grayish tinge | High | all curved | dark green | prominent | Less prominent |
| Muria Murhera | spreading | rough | light brown with grayish tinge | medium | all curved | dark green | prominent | Less prominent |
| Sandhura Narnaul | spreading | rough | light brown | medium | all curved | light green | prominent | Less prominent |
| Katha phal | intermediate | rough | light brown | high | all curved | dark green | prominent | Less prominent |
| Umran | intermediate | rough | light brown | less | all curved | dark green | prominent | Less prominent |
| Seb | upright | rough | light brown with grayish tinge | high | all curved | dark green | prominent | Less prominent |
| Najuk | spreading | rough | light brown with grayish tinge | medium | all curved | dark green | prominent | Less prominent |
| Chhuhara | intermediate | rough | dark brown with grayish tinge | medium | all curved | dark green | prominent | Less prominent |
| Walaiti | spreading | rough | light brown with grayish tinge | medium | all curved | dark green | prominent | Less prominent |
| Kaithli | upright | rough | blackish brown | less | all curved | light green | prominent | Less prominent |
| Elaichi | spreading | rough | light brown with blackish tinge | medium | all curved | dark green | prominent | Less prominent |
| ZG-3 | spreading | rough | dark brown | medium | all curved | dark green | prominent | Less prominent |

Table 2: Leaf morphological characteristics of different genotypes of ber

| Genotypes | Leaf shape | Leaf base | Leaf apex | Leaf petiole length | Leaf petiole colour | Leaf size (cm) | |
|------------------|-----------------|-----------|-----------|---------------------|---------------------|----------------|------------|
| | | | | | | Leaf length | Leaf width |
| Gola | ovate | round | obtuse | 2.43 | light green | 10.97 | 6.13 |
| Muria Murhera | ovate | acute | rounded | 2.43 | light green | 10.40 | 7.33 |
| Sandhura Narnaul | ovate | tapering | rounded | 2.73 | light green | 11.73 | 7.33 |
| Katha Phal | oval to oblong | tapering | obtuse | 1.47 | light green | 7.42 | 5.83 |
| Umran | obovate | tapering | rounded | 3.10 | light green | 10.47 | 7.80 |
| Seb | ovate | round | acute | 2.73 | light green | 12.10 | 8.77 |
| Najuk | oval | round | obtuse | 2.53 | light green | 13.00 | 7.63 |
| Chhuhara | oval | tapering | obtuse | 2.40 | light green | 8.73 | 6.47 |
| Walaiti | oval | round | oblique | 2.27 | light green | 10.23 | 8.47 |
| kaithli | oval to obovate | tapering | acute | 1.93 | light green | 9.30 | 5.60 |
| Elaichi | abovate | tapering | obtuse | 3.17 | light green | 10.33 | 8.30 |
| ZG-3 | ovate oblong | round | obtuse | 2.13 | light green | 9.63 | 7.30 |
| CD at 5% | | | | 0.25 | | 0.80 | 0.25 |

Table 3: Fruit morphological characteristics of different genotypes of ber

| Genotypes | Fruit shape | Fruit apex | Fruit base | Colour of developing fruit | Colour of ripe fruit | Surfaces |
|-----------------|----------------|--------------------|------------------|-----------------------------------|---|-----------------|
| Gola | obovate | rounded | rounded | dark green | yellowish green | smooth |
| Muria Murhera | oval | pointed | ridged | green | light golden yellow | smooth |
| Sandura Narnaul | oval | pointed | ridged | green | light golden yellow | slightly coarse |
| Katha Phal | ovate | rounded | rounded | dark green with brown red patches | light green with brown red patches | smooth |
| Umran | oval | rounded | rounded | green | deep golden yellow with chocolate tinge | smooth |
| Seb | rounded | rounded | rounded | green | greenish yellow | smooth |
| Najuk | oval to oblong | distinctly pointed | flattened | green | light golden yellow | smooth |
| Chhuhara | ovate to oval | rounded | flattened | green | light yellow | smooth |
| Walaiti | oval | slightly pointed | distinct oblique | green | light golden yellow | smooth |
| Kaithli | oval to oblong | pointed | rounded | green | light yellow | smooth |
| Elaichi | oblate | rounded | flattened | green | light brown | ridged |
| ZG-3 | obovate | rounded | rounded | green | greenish yellow | smooth |

Table 4: Fruit yield and quality characteristics of different genotypes of ber

| Genotypes | Yield (kg) | Fruit weight (g) | Fruit length (cm) | Fruit breadth (cm) | Stone weight (g) | Pulp (%) | Pulp: stone ratio | TSS (%) | Acidity (%) |
|-----------------|------------|------------------|-------------------|--------------------|------------------|----------|-------------------|---------|-------------|
| Gola | 50.05 | 14.62 | 3.37 | 2.92 | 1.02 | 93.02 | 13.33 | 14.85 | 0.50 |
| Muria Murhera | 60.15 | 23.61 | 5.52 | 2.97 | 1.25 | 94.71 | 17.89 | 14.28 | 0.32 |
| Sandura Narnaul | 55.35 | 21.25 | 4.98 | 3.02 | 1.32 | 93.79 | 15.10 | 15.77 | 0.31 |
| Katha Phal | 56.55 | 16.85 | 3.72 | 3.06 | 1.38 | 91.81 | 11.21 | 16.62 | 0.53 |
| Umran | 62.35 | 27.31 | 4.66 | 3.17 | 1.11 | 95.94 | 23.60 | 15.35 | 0.41 |
| Seb | 50.1 | 26.16 | 3.81 | 3.62 | 1.42 | 94.57 | 17.42 | 16.47 | 0.36 |
| Najuk | 49.25 | 15.83 | 4.15 | 2.55 | 1.21 | 92.36 | 12.08 | 16.85 | 0.39 |
| Chhuhara | 59.85 | 13.15 | 3.62 | 2.25 | 0.79 | 93.99 | 15.65 | 17.26 | 0.25 |
| Walaiti | 53.7 | 20.05 | 4.89 | 2.58 | 1.21 | 93.97 | 15.57 | 17.15 | 0.44 |
| Kaithli | 60.2 | 17.76 | 4.63 | 2.91 | 1.22 | 93.13 | 13.56 | 15.17 | 0.23 |
| Elaichi | 28.5 | 5.6 | 2.2 | 1.94 | 0.39 | 93.04 | 13.36 | 16.41 | 0.25 |
| ZG-3 | 54.65 | 20.14 | 3.85 | 2.61 | 1.3 | 93.55 | 14.49 | 14.45 | 0.23 |
| CD at 5% | .25 | 1.82 | 0.21 | 0.44 | 0.23 | 1.10 | 2.88 | 1.57 | 0.08 |

Fruit characteristics

Fruit shape was observed obovate in Gola and ZG-3; round in Seb; ovate in Katha Phal; oval to oblong in Najuk and Kaithli; oblate in Elaichi and oval in remaining genotypes under study (Table 3). Fruit shape varied from round, oval, ovate, obovate, oblong to oblate in ber (Pareek, 2001) [12]. Fruit apex was pointed in Muria Murhera, Sandhura Narnaul and Kaithli; distinctly pointed in Najuk; slightly pointed in Walaiti and rounded in all other genotypes under study. Fruit base was flattened in Najuk and Chhuhara; distinctly oblique in Walaiti; ridged in Muria Murhera and Sandhura Narnaul and rounded in all other genotypes under study. The colour of the developing fruit was dark green in Gola; dark green with red patches in Katha Phal and green in other genotypes under study. The colour of the ripe fruit was yellowish green in Gola; light golden yellow in Sandhura Narnaul, Muria Murhera, Najuk and Walaiti; light green with red patches in Katha Phal; deep golden yellow with chocolate tinge in Umran; greenish yellow in Seb and ZG-3 and light brown in Elaichi. The surface of the ripened fruit was slightly coarse in Sandhura Narnaul; ridged in Elaichi while smooth in all other genotypes under study.

Fruit yield was recorded significantly higher in Umran (62.35 kg/tree) followed by Muria Murhera (60.15 kg/tree) and Kaithli (60.10 kg/tree). The maximum fruit weight (27.31 g) was recorded in Umran which was statistically at par with fruit weight of Seb (26.16 g) while the minimum weight was recorded in Elaichi (5.6 g) followed by Chhuhara (13.156 g). The average weight of the fruit was determined in the range of 0.66 to 4.68 g (Brindza *et al.*, 2011) [3] and 4.52 to 6.12 g (Ecevit, 2007) [5]. The variation in fruit weight was because of genetic behaviour of different genotypes or genotypes with

bigger or smaller sizes varying with weight (Prasad and Bankar, 2000) [13].

Fruit length was recorded highest (5.52 cm) in Muria Murhera while fruit breadth was recorded maximum in Seb (3.62 cm) followed by Umran (3.17 cm). The minimum fruit length (2.20 cm) and fruit breadth (1.94 cm) was reported in Elaichi. The variations in length and breadth may be due to characteristics of the variety. Fruit width in the range of 11.06 to 23.8 mm was observed in the evaluation of 23 varieties of Chinese jujube (Karnatovska *et al.*, 2007) [8]. The maximum fruit length was observed in Banarsi Karaka and minimum in Elaichi under Karnataka condition (Reddy *et al.*, 1998) [14]. Stone weight was recorded minimum (0.39 g) in Elaichi followed by Chhuhara (0.79 g) and maximum in Seb followed by Katha Phal. The average weight of stones in the range from 0.34 to 0.41 g was recorded in the study of 52 genetic resources (Ecevit, 2007) [5] and in the range of 0.6 to 1.9 g in the study of nine genotypes of ber (Ghosh and Mathew, 2002) [6]. The pulp percentage determines the edible portion of ber fruits. Significantly higher pulp percentage (95.94) was found in Umran followed by Muria Murhera while the minimum (91.81) was recorded in Katha Phal followed by Najuk. The flesh content in ber varieties varies from 85.46 to 94.84 per cent (Singh and Misra, 2012) [15]. Higher pulp to stone ratio is considered to be a desirable character. The highest pulp to stone ratio was observed in Umran (23.60) followed by Muria Murhera and minimum in Katha Phal. The highest pulp to stone ratio of 23.10 was reported in Umran (Godi *et al.*, 2016) [7].

The TSS content in different genotypes under study ranged from 14.28 to 17.26 ° brix. The maximum TSS (17.26° brix) was recorded in Chhuhara followed by Walaiti (17.15° brix)

and the minimum in Muria Murhera followed by ZG-3. The genotypes differed significantly from each other with respect to acidity. The acid content in different genotypes under study ranged from 0.23 to 0.53 per cent. The maximum acidity was found in Katha Phal while the minimum in Kaithli and ZG-3. The present study indicates the presence of considerable variation among the genotypes of jujube. The genotype Umran performed best in terms of fruit yield, fruit weight and pulp to stone ratio, Umran followed by Muria Murhera in terms of pulp percentage, Chuhara in terms of TSS. Thus, the genotypes with superior traits can be further used for improvement in ber crop through selection and hybridization to get desired traits.

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