***Original Research Article***

# Varietal evaluation of Ber (*Zizyphus mauritiana* Lamk.) for yield and fruits quality attributes under Bundelkhand region of Uttar Pradesh


**ABSTRACT**

The experiment ~~of Ber varieties~~ was conducted at Instruction farm, College of Horticulture, Banda University of Agriculture and Technology, Banda (U.P.) during the year ~~2021-~~2021-2022. The study aimed to ~~E~~evaluated varieties were studied yield and fruits quality attributes. The trail consisting of Ten treatments ($T_1$ -Thai Ber, $T_2$ -Umran, $T_3$ -Banarasi Karaka, $T_4$ -Seb, $T_5$ -Gola, $T_6$ -Chhuhara, $T_7$ -Kaithali, $T_8$ -Mundia, $T_9$ -Elaichi and $T_{10}$ –Rashmi).The variability was recorded in fruit shape (ovate oblong, oblong, ovate and round), fruit colour (green, yellow green, golden yellow and green) and pulp colour (creamy white and creamy).The yield attributes variability was observed in fruit length (3.40-5.72 cm), fruit width (2.13-4.20 cm), fruit weight (20.27-48.33 g), fruit volume (21.21-49.25 cc), stone length (1.59-2.80 cm), stone width (0.86-2.07 cm), stone weight (1.41-2.83 g), pulp weight (16.22-44.24 g), pulp and stone ratio (11.31-15.61) and specific gravity (0.95-0.98). The quality attributes parameter also showed wide range of variation in chemical properties i.e., TSS (10.61-16.62 $^0$Brix), ascorbic acid (80.5-115.33 mg/100g), reducing sugars (4.05-7.11 %), non-reducing sugars (3.90-4.75 %), total sugars (7.95-11.86 %), acidity (0.32-0.75 %), protein (0.40-0.70 %) and pH (3.0-5.0).Therefore, on the basis of quality attribute among the different evaluation; the variety $T_7$ (Kaithali), $T_2$ (Umran) and $T_3$ (Banarasi Karaka) found to be superior. These promising varieties can be recommended for commercial cultivation atfarmer's field.



**Keywords:** Ber, Varietal Evaluation, Yield and Fruit Quality.




## Introduction

Ber (*Zizyphus mauritiana* Lamk.) is a fruit native to India and China that belongs to the *Rhamnaceae* family. It is regarded as "King of Arid zone Fruits" and also known as "Poor man's Apple"(Nidhi~~, D., Neeraj and Vinita, B.,~~ et al., 2019). Ber fruit has also been mentioned to holly book like Ramayana and Mahabharata (Pal, 2020). According to Pareek (2001), it can be found in both wild and cultivated forms from the warmer arid and semi-arid regions up to an altitude of

1500 meters above sea level. The centre of origin of Ber is Central Asia (India & China), where it is found growing under different climatic conditions, requirement of temperatures ranges from 39-42 $^0$C and it can tolerate temperatures as high as 49-50 $^0$C (De Candolle, 1886). It is cultivated widely for its resistance to grow in drought and other diversified soil and climatic condition. It can be grown well in inferior soil with pH as high as 9.0 in arid and semi-arid regions (Kumari *et al*., 2015). The Ber leaves have also been tested by mixing in rations of goats in arid and semi-arid regions. Trees leaves and shrubs constitute about 60 % of the diet of goats and 40 % of sheep's (Shinde *et al*., 2000). Many wild Ber shrubs *i. e.*(*Zizyphus mauritiana*, *Z. rotundifolia* and *Z. nummularia*) were found growing on neglected lands, uncultivated lands in Uttar Pradesh (India). It also provides enough leaf biomass (pala) for fodder during the lean season and is suitable for hay and silage for goats due to its 11-13 % crude protein content (Tewatia and Khirwar, 2002).Ber fruits are high in ascorbic acid and high in vitamins A, B and C as well as minerals like calcium, phosphorus and iron (Shoba and Bharathi, 2007; Pareek *et al*., 2009; Choi *et al*., 2011). Ber fruit is high in proteins, fats, fibre, TSS, ascorbic acid, reducing, non-reducing and total sugars (Obeed *et al*., 2008; Koley *et al*., 2011; Krishna and Parashar, 2012; Zozio *et al*., 2011; Kumari *et al*., 2015). It is a drupe, globose to ovoid in shape, skin smooth or rough, glossy thin but tough, yellowish to reddish or blackish, flesh white, crisp and juicy, sub acid to sweet, becoming mealy in fully ripe fruit and colour of Ber fruit is changed from green to yellow to chocolate brown with the maturity and ripening (Pareek, 2013). Ber fruit is normally eaten fresh and is a rich source of ascorbic acid, necessary minerals and carbohydrates (Pareek*et al*., 2002).

Under Bundelkhand region, meagre information is available on evaluation of ber cultivars and there is no varietal recommendation. So, there is an urgent need to carry out research experiments for evaluation of ber varieties for the large-scale adoption of ber fruit crop for under Bundelkhandregion of Uttar Pradesh.

**Materials and methods**

Experiment was conducted at Instruction farm, College of Horticulture Banda, while physico-chemical evaluation in the Post-Graduate Laboratory, Department of Basic Science, College of Horticulture, Banda University of Agriculture & Technology, Banda (U.P.) during the year ~~2021-2~~2021-2022. The experimental site is situated at 24º 53'-25º 55' N latitudes and 80º 07'-

81º 34' E longitudes. Altitude? The pH obtained the range from 6.65- 8.56 (acidic and alkaline soil). Average annual rainfall is 90 cm and most of it about 88-90% received during only in three months i.e. July, August and September. The annual temperature is comparatively high and it ranges in between 32-49.5$^0$C, 23-35$^0$C and 10-22$^0$C for summer, rainy and winters respectively. The experiment was carried out in randomized block design with three replications.The details of ten treatments were $T_1$ -Thai Ber, $T_2$ -Umran, $T_3$ -Banarasi Karaka, $T_4$ -Seb, $T_5$ -Gola, $T_6$ -Chhuhara, $T_7$ -Kaithali, $T_8$ -Mundia, $T_9$ -Elaichi and $T_{10}$ -Rashmi. Statistical analysis of the data for physical parameters observation were recorded on Initialfruit set,Fruit drop, Fruit retention, Fruit shape, Fruit colour, Fruit length, Fruit width, Fruit weight, Fruit volume, Stone width, Stone length, Stone weight, Pulp colour, Pulp weight, Pulp and Stone ratio, Specific gravity andYield. Chemical parametersobservations were recorded on TSS,Ascorbic acid, Reducing sugars, Non-reducing sugars, Total Sugars, Acidity, Protein and Determination of pH. The physical parameters like: Fruit weight, Stone weight and Pulp weight measure by electronic weighting machine and Fruit length, Fruit width, Stone width, Stone length was calculated with the help of Vernier Callipers.The total soluble solids were measured using an Erma hand refracto meter (0-32 $^0$Brix). Ascorbic acid was determined by using 2, 6-Dichlorophenol-indophenols visual titration method (Johnson and Dana, 1948). Reducing sugars was determined by Nelson method (1944). The percentage of non-reducing sugars was obtained by subtracting the values of reducing sugar from total sugars and multiplying by 0.95 (Somogyi, 1952). Total sugars were determined by Dubois *et al*. (1956) method. The titrable acidity of the pulp was determined by titrating 10 ml juice against 0.1 N NaOH using phenolphthalein as an indicator as per the produce suggested by Sadashivam (1991). Lowry *et al.* (1951) used the Folin Ciocalreau's Phenol reagent to calculate protein content. A pH paper is piece of paper used to find out if a solution is basic, acidic or neutral. The data obtained during experimentation was statistically analysed as per method given by Panse and Sukhatme (1985) and results were evaluated at 5% level of significance.

**Results and discussion**

The different varieties of Ber differed significantly in Initial fruit set, fruit drop and fruit retention. Significantly maximum initial fruit set 64.36 % was recorded by ($T_7$-Kaithali) and minimum fruit set 36.70 % was recorded in ($T_9$-Elaichi). The similar fruits set variability in ber were reported by Singh *et al.*, (2016). The minimum percentage of fruit set refers to natural

tendency of trees to shed their immature fruits. Highest fruit drop 71.10 % was recorded by ($T_7$ -Kaithali) and the lowest fruit drop 57.00 % was recorded by ($T_1$ -Thai Ber). Similar fruit drop variabilitywasalso reported by Tarai and Ghosh (2010) and Singh *et al*. (2016). Mostly fruit drop during early stage of fruit development may be quality to unsuccessful fertilization ovule degeneration. Maximum fruit retention 43.00 % was observed by ($T_1$ -Thai Ber) and the minimum fruit retention 28.90 % was observed by ($T_7$ -Kaithali). Similar fruit retention variability was reported by Tarai and Ghosh (2010). The maximum fruit length, fruit width, fruit weight, fruit volume,stone length, stone width, stone weight, Pulp weight and Pulp and Stone ratio was recorded in ($T_1$ -Thai Ber) were resulting 5.72cm, 4.20cm, 48.33g, 49.25cc, 2.80cm, 2.07cm, 2.83g, 44.24g and 15. 61 respectively.The minimum fruit length, fruit width, fruit weight, fruit volume, stone length, stone width, stone weight, pulp weight and pulp and stone ratio was recorded in ($T_9$-Elaichi)were resulting 3.40cm, 2.13cm, 20.27g, 21.21cc, 1.59cm, 0.87cm, 1.41g, 16.22g and 11.31 respectively. The similar results of fruits length, fruit width, fruit weight and fruit volume variability in ber were reported by Obeed *et al*. (2008), Shukla *et al*. (2012), Kumar *et al*. (2016) and Kumar *et al*. (2021).Stone length, stone width,stone weight, pulp weight and pulp & stone ratio these results are in conformity with the previous to Shukla *et al*. (2012) and Kumar *et al*. (2021).The maximum specific gravity 0.98 was observed in treatment ($T_1$ -Thai Ber) and ($T_3$ -Banarasi karaka). The lowest value 0.95 was observed ($T_2$ -Umran) and($T_9$ -Elaichi). However, treatment ($T_4$ -Seb) was found statistically at par with ($T_5$ -Gola) and ($T_7$ -Kaithali).The similar variations in specific gravity of ber studies were earlier Ghosh and Mathew (2002), Obeed *et al*. (2008), Shukla *et al*. (2012). The similar results of yield reported by Ghosh and Mathew (2002), Rao and Subramaniyam (2010), Tarai and Ghosh (2010) and Singh*et al*. (2016).Out of ten treatments, 5 are ovate oblong ($T_1$ -Thai Ber, $T_2$ -Umran, $T_4$ -Seb, $T_6$ -Chhuhara and $T_7$ -Kaithali), two are oblong ($T_3$ -Banarasi Karaka and $T_{10}$ -Rashmi), two are round ($T_5$ -Gola and $T_9$ -Elaichi) and one is ovate ($T_8$ -Mundia). Among these, three treatments had light green ($T_1$-Thai Ber), ($T_3$-Banarasi karaka) and ($T_7$-Kaithali), three had yellow green ($T_2$-Umran), ($T_8$-Mundia) and ($T_9$-Elaichi), two had golden yellow ($T_5$-Gola) and ($T_{10}$-Rashmi) and two had green ($T_4$-Seb) and ($T_6$-Chhuhara). Among them, seven treatments had creamy white ($T_1$-Thai Ber), ($T_3$ -Banarasi karaka), ($T_4$-Seb), ($T_6$-Chhuhara), ($T_8$-Mundia), ($T_9$-Elaichi) and ($T_{10}$-Rashmi) and three treatmentshad creamy ($T_2$-Umran), ($T_5$-Gola) and ($T_7$-Kaithali).

The fruits quality attributeswere recorded the significantly maximum total soluble solid 16.62 $^{0}$Brix was noticed in treatment ($T_7$ -Kaithali) followed by treatment16.22 $^{0}$Brix ($T_2$ -Umran) and 16.13 $^{0}$Brix ($T_3$ -Banarasi Karaka), while the minimum TSS value 10.61$^{0}$Brix was noted by treatment ($T_1$ -Thai Ber). However, treatment ($T_2$ -Umran) was found statistically at par with ($T_3$ -Banarasi Karaka). Similar trend of total soluble solid was reported by Ghosh and Mathew (2002), Ibrahim *et al*. (2009), Rao and Subramaniyam (2010) and Gupta *et al*. (2012). The significantly highest ascorbic acid (115.33 mg/100g) was recorded by the treatment ($T_1$ -Thai Ber) followed by 113.17 mg/100g ($T_{10}$ -Rashmi) and112.50 mg/100g ($T_8$ -Mundia). While minimum ascorbic acid value recorded in (80.50 mg/100g) was noted by the variety ($T_7$ -Kaithali). Similar variation was observed Ghosh and Mathew (2002), Obeed *et al*. (2008) and Gupta *et al*. (2012). The significantly highest reducing sugar 7.11 % was observed in ($T_7$ -Kaithali). However, followed by treatment 6.82 % ($T_2$ -Umran) and6.55 % ($T_3$ -Banarasi Karaka). The minimum reducing sugars value 4.05 % was noted by the treatment ($T_1$ -Thai Ber). The significantly maximum non-reducing sugars 4.75 % content was observed in ($T_7$ -Kaithali), followed by treatment 4.62 % ($T_2$ -Umran) and 4.43 % ($T_3$ -Banarasi Karaka). The minimum value 3.90 % was observed by the treatment ($T_1$ -Thai Ber). However, treatment ($T_2$ -Umran) was found statistically at par. The significantly maximum total sugars 11.86 % was recorded in treatment ($T_7$ -Kaithali), followed by treatment 11.43 % ($T_2$ -Umran) and10.98 % ($T_3$ -Banarasi Karaka). The minimum total sugars value 7.95 % was noted by the treatment ($T_1$ -Thai Ber). The different treatment, significantly highest acidity 0.75 % was recorded in ($T_1$ -Thai Ber) and followed by 0.70 % ($T_{10}$ -Rashmi) and 0.60 % ($T_8$ -Mundia). However, lowest acidity 0.32 % was recorded in ($T_7$ -Kaithali). While treatment ($T_{10}$ -Rashmi) statistically was recorded at par within ($T_8$ -Mundia) and ($T_6$ -Chhuhara). Similar variation in terms of reducing sugars, non-reducing sugars, total sugars and acidity were reported by Obeed *et al*. (2008), Ibrahim *et al*. (2009), Singh *et al*. (2015), Kumar *et al*. (2016) and Anjum *et al*. (2018). Significantly maximum protein 0.70 % was observed in treatment ($T_1$ -Thai Ber), followed by treatment 0.67 % ($T_{10}$ -Rashmi) and 0.64 % ($T_8$ -Mundia). In contrast, minimum protein 0.40 % among the treatment was observed in ($T_7$ -Kaithali). However, treatment ($T_{10}$ -Rashmi) statistically was observed at par within ($T_8$ -Mundia), ($T_5$ -Gola) and ($T_4$ -Seb). Similar variation of ber was reported by Kumar *et al*. (2016). The significantly highest (5.00) pH was recorded in Treatment ($T_7$ -

Kaithali) followed by4.80 ($T_8$ -Mundia)and 4.50 ($T_3$ -Banarasi Karaka). The lowest pH value 3.00 was noted by ($T_1$ -Thai Ber). Similar variation of ber was reported by Para (2014).

**Table No.-1: Effect of different varietal evaluation substance on Initial fruit set, Fruit drop, Fruit retention, Fruit length, Fruitwidth, fruit weight and fruit volume**

| Treatments | Physical parameters | | | | | | |
|---|---|---|---|---|---|---|---|
| | Initial fruit set (%) | Fruit drop(%) | Fruitretention (%) | Fruit length(cm) | Fruit width (cm) | Fruit weight (cm) | Fruit volume (cc) |
| $T_1$: Thai Ber | 44.50 | 57.00 | 43.00 | 5.72 | 4.20 | 48.33 | 49.25 |
| $T_2$:Umran | 61.87 | 69.87 | 32.83 | 4.80 | 3.37 | 32.29 | 33.27 |
| $T_3$: Banarasi Karaka | 58.00 | 67.17 | 30.13 | 4.70 | 3.22 | 31.40 | 32.75 |
| $T_4$: Seb | 54.70 | 62.77 | 37.23 | 5.20 | 3.73 | 35.92 | 36.95 |
| $T_5$: Gola | 51.67 | 61.63 | 38.37 | 4.58 | 3.10 | 30.75 | 31.40 |
| $T_6$: Chhuhara | 38.97 | 64.67 | 35.33 | 4.50 | 3.00 | 28.72 | 29.74 |
| $T_7$: Kaithali | 64.36 | 71.10 | 28.90 | 5.01 | 3.53 | 33.42 | 34.45 |
| $T_8$: Mundia | 47.43 | 59.67 | 40.33 | 4.30 | 2.80 | 26.25 | 27.20 |
| $T_9$: Elaichi | 36.70 | 65.63 | 34.37 | 3.40 | 2.13 | 20.27 | 21.21 |
| $T_{10}$: Rashmi | 40.97 | 58.70 | 41.30 | 3.70 | 2.25 | 23.60 | 24.60 |
| Mean(T) | 49.92 | 63.82 | 36.18 | 4.59 | 3.13 | 31.09 | 32.08 |
| Range?? | 36.70-64.36 | 57.00-71.10 | 28.90-43.00 | 3.40-5.72 | 2.13-4.20 | 20.27-48.33 | 21.21-49.25 |
| SE(m)± | 0.29 | 0.22 | 0.23 | 0.12 | 0.05 | 0.36 | 0.36 |
| C.D. at 5% | 0.87 | 0.67 | 0.67 | 0.36 | 0.15 | 1.10 | 1.07 |

**Table No.-2: Effect of different varietal evaluation substance on Stone length, Stone width, Stone weight, Pulp weight, Pulp and stone ratio, Specific gravity and Yield**

| Treatments | Physical parameters | | | | | | |
|---|---|---|---|---|---|---|---|
| | Stone length (cm) | Stone width (cm) | Stone weight(g) | Pulp weight (g) | Pulp and stone ratio | Specific gravity | Yield (Kg/plant) |
| $T_1$: Thai Ber | 2.80 | 2.07 | 2.83 | 44.25 | 15.61 | 0.98 | 41.38 |
| $T_2$:Umran | 2.44 | 1.60 | 2.50 | 28.32 | 11.31 | 0.95 | 56.46 |
| $T_3$: Banarasi Karaka | 2.34 | 1.52 | 2.42 | 27.88 | 11.50 | 0.98 | 53.23 |
| $T_4$: Seb | 2.60 | 1.81 | 2.63 | 31.25 | 11.88 | 0.97 | 50.17 |
| $T_5$: Gola | 2.25 | 1.45 | 2.36 | 27.88 | 11.15 | 0.97 | 47.22 |
| $T_6$: Chhuhara | 2.15 | 1.21 | 2.21 | 24.14 | 10.90 | 0.96 | 39.17 |
| $T_7$: Kaithali | 2.50 | 1.70 | 2.53 | 29.10 | 12.18 | 0.97 | 58.77 |
| $T_8$: Mundia | 2.00 | 1.11 | 1.92 | 21.13 | 10.98 | 0.96 | 44.80 |
| $T_9$: Elaichi | 1.59 | 0.86 | 1.41 | 16.22 | 11.47 | 0.95 | 34.77 |
| $T_{10}$: Rashmi | 1.84 | 1.02 | 1.83 | 19.12 | 10.47 | 0.96 | 37.21 |
| Mean(T) | 2.251 | 1.430 | 2.27 | 26.78 | 11.75 | 0.96 | 46.32 |
| Range?? | 1.59-2.80 | 0.86-2.07 | 1.41-2.83 | 16.22-44.24 | 11.31-15.61 | 0.95-0.98 | 34.77-58.77 |
| SE(m)± | 0.028 | 0.019 | 0.01 | 0.09 | 0.22 | 0.006 | 0.26 |
| C.D. at 5% | 0.085 | 0.058 | 0.04 | 0.27 | 0.67 | 0.017 | 0.79 |

**Table No.-3: Effect of different varietal evaluation substance on fruit shape, fruit color and pulp color. If you can convert to values**

| Treatments | Yield attributes | | |
|---|---|---|---|
| | Fruit shape | Fruit color | Pulp color |
| $T_1$: Thai Ber | Ovate Oblong | Light green | Creamy white |
| $T_2$:Umran | Ovate Oblong | Yellow green | Creamy |

| | | | |
|---|---|---|---|
| $T_3$: Banarasi Karaka | Oblong | Light green | Creamy white |
| $T_4$: Seb | Ovate Oblong | Green | Creamy white |
| $T_5$: Gola | Round | Golden yellow | Creamy |
| $T_6$: Chhuhara | Ovate Oblong | Green | Creamy white |
| $T_7$: Kaithali | Ovate Oblong | Light green | Creamy |
| $T_8$: Mundia | Ovate | Greenish yellow | Creamy white |
| $T_9$: Elaichi | Round | Yellow green | Creamy white |
| $T_{10}$: Rashmi | Oblong | Golden yellow | Creamy white |

**Table No.-4: Variability in Chemical Characteristics of Ber Varieties Under Bundelkhand region Uttar Pradesh.**

| **Treatments** | **Chemical Characteristics** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **(TSS) $^0$Brix** | **Ascorbic acid (mg/100pulp)** | **Reducing sugars (%)** | **Non reducing sugars (%)** | **Total sugars (%)** | **Acidity (%)** | **Protein (%)** | **pH** |
| $T_1$: Thai Ber | 10.61 | 115.33 | 4.05 | 3.90 | 7.95 | 0.75 | 0.70 | 3.00 |
| $T_2$:Umran | 16.22 | 87.37 | 6.82 | 4.62 | 11.43 | 0.38 | 0.43 | 4.80 |
| $T_3$: Banarasi Karaka | 16.13 | 83.83 | 6.55 | 4.43 | 10.98 | 0.40 | 0.47 | 4.50 |
| $T_4$: Seb | 13.30 | 101.77 | 5.50 | 4.22 | 9.73 | 0.49 | 0.57 | 3.80 |
| $T_5$: Gola | 13.00 | 104.87 | 5.10 | 4.21 | 9.31 | 0.54 | 0.60 | 3.60 |
| $T_6$: Chhuhara | 14.07 | 95.17 | 5.85 | 4.06 | 9.91 | 0.44 | 0.54 | 4.00 |
| $T_7$: Kaithali | 16.62 | 80.50 | 7.11 | 4.75 | 11.86 | 0.32 | 0.40 | 5.00 |
| $T_8$: Mundia | 12.50 | 112.50 | 4.80 | 4.09 | 8.89 | 0.60 | 0.64 | 3.40 |
| $T_9$: Elaichi | 15.60 | 91.00 | 6.21 | 4.38 | 10.59 | 0.42 | 0.50 | 4.20 |
| $T_{10}$: Rashmi | 11.72 | 113.17 | 4.35 | 4.12 | 8.47 | 0.70 | 0.67 | 3.20 |
| Mean(T) | 13.98 | 98.55 | 5.63 | 4.28 | 9.91 | 0.50 | 0.55 | 4.06 |
| Range?? | 10.61-16.62 | 80.5-115.33 | 4.05-7.11 | 3.90-4.75 | 7.95-11.86 | 0.32-0.75 | 0.40-0.70 | 3.00-5.00 |
| SE(m)± | 0.16 | 0.48 | 0.02 | 0.092 | 0.09 | 0.08 | 0.05 | 0.04 |
| C.D. at 5% | 0.49 | 1.45 | 0.05 | 0.276 | 0.27 | 0.23 | 0.15 | 0.11 |

**CONCLUSION-**

On the basis of the fruit quality attributes, the varieties ($T_7$ -Kaithali), ($T_2$ -Banarasi Karaka) and ($T_3$ -Umran) were screened as promising. These varieties can be further used for processing purpose and preparation of ber based products. These promising varieties can be recommended to the farmers for commercial cultivation. Significant variation was noted in all varieties of ber. The ber varieties are classified as early, mid and late on the basis of days taken to maturity. The following varieties of ber may be recommended for cultivation in Bundelkhand region of Uttar Pradesh. ($T_4$ -Seb and $T_5$ –Gola) as early season varieties, ($T_7$ -Kaithali and $T_8$ – Mundia) as mid-season varieties and ($T_2$ -Umran and $T_9$ –Elaichi) as late season varieties.

Data Availability: All relevant data are within the paper and its supporting information files.c

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