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Phenotypic and Quantative Characterization of Ber (*Ziziphus mauritiana* Lamk.) Germplasm under Eastern Region of Uttar Pradesh, India

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Eastern region of Uttar Pradesh is very rich in biodiversity for ber but still less harnessed. The agro-climatic conditions of eastern region do have great potential for its commercial cultivation. Keeping these in view, fruit sample with shoot were collected from fourty genotypes of ber in diverse areas of eastern region of Uttar Pradesh and analysed for various physiological attributes and results of study shows a wide range of variability in morphological and quantitative parameters. Among the parameters leaf shape of different genotypes show a wide variation and mainly Cordate, Oval, Obovate and Elliptic shape are found. The stone shape recorded showed Obtuse, acute, oblong, showed round stone shaped. Among the quantitative variability of different genotypes stone weight (0.56 g to 1.58 g), stem girth (25.90 cm to 62.63 cm) and hight of tree (3.43 m to 5.50 m) varivility was also recorded. Therefore, on the basis of morphological and quantitative attributes, genotypes–

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7,14,15, 18, 21and 30 were screened as promising genotypes can be recommended for commercial multiplication, growing at farmer's field and conservation in the field gene bank for further evaluation and crop improvement.

Keywords: Ber Variability; fruit size; leaf shape; fruit colour and stem girth.

1. INTRODUCTION

Ber (*Zizyphus mauritiana* Lam.) an indigenous important fruit crop for arid and semi-arid regions of India belong to the family Rhamnaceae. It is mainly grown in India and other countries in central Asia, China and Taiwan and is more associated with the Indian culture since ancient times [1]. It is cultivated widely for its resistance to grow in drought and other diversified soil and climatic conditions. It is a hardy tree that tolerates extreme temperature and thrives under dry conditions. Fruit quality is best under hot, sunny and dry conditions, but there should be a rainy season to support growth and flowering, leaving enough soil moisture to carry the fruit to maturity [2]. Along with the ability to withstand drought, ber can also tolerate adverse conditions, such as salinity and water logging. In view of the recent development in production technology of this crop, the cultivation of ber is becoming increasingly popular in many parts of country. It is an ideal fruit tree for tropical and subtropical regions of the country Rajasthan, Haryana, Punjab, Uttar Pradesh, Gujarat, Madhya Pradesh, Bihar, Maharashtra, Andhra Pradesh and Tamil Nadu. Ber fruit both sour and sweet tastes and are rich in nutritive value. It is rich in vitamin 'B' complex and vitamin 'C' [3]. However, ber is richer than apple in protein, phosphorus, calcium, carotene and vitamin C and richer than oranges in phosphorus, iron, vitamin C and carbohydrates and exceeds them in calorific value [4].

Indian ber trees are small to moderate in size spreading with vine like branches. It is the hardiest fruit trees with wider adoptability to adverse soil and climate condition is an evergreen shrub or small tree up to the hight of 15 m, with 40 cm or more trunk diameter; spreading crown; stipule spines and have many drooping branching. The fruits are of variable shape and size. They are oval, obovate and round 1-2.5 inch (2.5- 6.5 cm) long. The flesh is white and crisp.The ability of *Ziziphus* species and the different varieties / types within ber to cross freely has allowed the buildup of a rich gene pool. Vegetative growth (tree form, leaf shape, apex, base and pubescence, petiole length, colour etc.), flowering and fruit characters (shape, size, style end, skin color, stone and pulp content, pulp colour and sweetness, etc.). Keeping these in view the present study was taken to study Phenotypic ccharacterization of Ber (Ziziphus mauritiana Lamk.) germplasm under eastern region of Uttar Pradesh for getting best promising genotype for commercial multipication and cultivation in the country.

2. MATERIALS AND METHODS

The present investigation was carried out at Department of Fruit Science, college of Horticulture, Chandra Shekhar Azad University of Agriculture & Technology, Kanpur (UP) during 2021-2022 and 2022 - 2023. Fruit of forty genotypes were collected from eastern region (Balrampur, Bahraich, Sidarthnagar, Shravasti, Gonda, Basti, Ayodhya Sultanpur Banaras and Allahabad district) of Utter Pradesh. Twenty fruits of ber were randomly selected from all the direction of trees from each site collected then kept into bags and tagged by the number and subjected to physico-chemical analysis in laboratory. Physical parameters like stone weight was measure by electronic weighting machine, height of tree and stem girth were estimated with the help of measuring tape data on fruit shape, fruit apex, fruit base, mature fruit colour, immature fruit colour, tree shape, leaf shape, leaf apex, leaf margin, Stone shape, stone apex, stone base, leaf colour, thorn shape, pulp colour and , pulp texture were observed using standard and recomended techniques.

3. RESULTS AND DISCUSSION

The pulp colour was recorded immediately after harvesting of fruit. The pulp colours were found creamy in colour in all fruits. The pulp texture in maximum genotype are soft in texture followed by medium soft texture. All genotypes have green leaf colour. Similar results were also reported by Ghosal and Mishra [5] Kumar et al. [6], Gupta [7], Naseem et al. [8] Khan et al. [9] Khan et al. [10], and Vikalp et al. [11].

Table 1a. Quantative parameter of ber fruits

Genotype	Stone Weight (g.)			Hight of Tree (m.)			Stem girth (cm.)		
	2021-2022	2021-2022	2021-2022	2021-2022	2022-2023	Pool Data	2021-2022	2022-2023	Pool Data
Genotype-1	1.77	1.59	1.58	4.67	4.97	4.82	61.83	63.43	62.63
Genotype-2	1.05	1.07	1.06	4.00	4.17	4.08	35.68	37.51	36.60
Genotype-3	0.75	0.76	0.75	5.00	5.53	5.27	48.39	50.59	49.49
Genotype-4	0.58	0.61	0.60	4.80	5.13	4.97	56.40	58.35	57.37
Genotype-5	1.19	1.25	1.22	3.67	3.87	3.77	55.47	58.01	56.74
Genotype-6	0.86	0.90	0.88	4.73	5.10	4.92	29.38	31.71	30.55
Genotype-7	0.75	0.80	0.78	4.10	4.50	4.30	58.61	60.87	59.74
Genotype-8	0.74	0.79	0.77	5.37	5.63	5.50	27.94	30.04	28.99
Genotype-9	0.57	0.59	0.58	5.07	5.83	5.45	34.51	36.85	35.68
Genotype-10	0.83	0.89	0.86	4.13	4.40	4.27	41.52	43.83	42.68
Genotype-11	0.77	0.79	0.78	4.90	4.90	4.90	45.60	47.60	46.60
Genotype-12	0.65	0.68	0.67	3.37	3.80	3.58	59.06	62.70	60.88
Genotype-13	0.54	0.74	0.64	3.70	4.43	4.07	54.63	57.01	55.82
Genotype-14	0.56	0.61	0.59	5.00	5.13	5.07	45.49	47.72	46.61
Genotype-15	0.64	1.04	0.84	3.80	3.47	3.63	43.68	46.35	45.01
Genotype-16	0.56	0.63	0.60	4.97	5.07	5.02	41.63	44.38	43.01
Genotype-17	0.63	0.70	0.67	3.60	3.77	3.68	24.66	27.13	25.90
Genotype-18	0.56	0.60	0.58	3.97	4.30	4.13	36.64	38.49	37.57
Genotype-19	0.73	0.75	0.74	4.23	4.33	4.28	26.66	28.43	27.54
Genotype-20	0.66	0.69	0.68	3.62	3.87	3.74	38.85	40.29	39.57
Genotype-21	0.54	0.59	0.57	3.87	3.93	3.90	47.37	48.69	48.03
Genotype-22	1.03	1.08	1.05	4.60	4.67	4.63	35.87	38.40	37.13
Genotype-23	0.61	0.68	0.64	3.22	3.63	3.43	28.12	33.46	30.79
Genotype-24	0.61	0.66	0.64	4.45	4.47	4.46	34.65	36.86	35.76
Genotype-25	0.84	0.90	0.87	4.08	4.17	4.13	54.76	57.48	56.12
Genotype-26	0.53	0.60	0.57	4.47	4.60	4.53	38.57	40.46	39.52
Genotype-27	0.59	0.66	0.62	4.13	4.30	4.22	42.61	44.08	43.35
Genotype-28	0.72	0.76	0.74	3.47	3.67	3.57	28.47	31.25	29.86
Genotype-29	0.54	0.58	0.56	3.80	3.87	3.83	38.52	41.23	39.88
Genotype-30	0.65	0.70	0.68	4.47	4.57	4.52	42.51	44.73	43.62
Genotype-31	1.58	1.44	1.51	4.07	4.17	4.12	43.58	46.49	45.04
Genotype-32	1.00	1.05	1.03	3.40	3.73	3.57	27.46	28.67	28.07
Genotype-33	1.24	1.54	1.39	4.18	4.23	4.21	57.38	61.10	59.24

Genotype-34	1.17	1.04	1.11	3.40	3.93	3.67	26.66	30.38	28.52
Genotype-35	0.81	0.89	0.85	3.97	4.03	4.00	31.53	34.25	32.89
Genotype-36	0.67	0.75	0.71	4.63	4.87	4.75	36.50	40.35	38.43
Genotype-37	0.90	0.98	0.94	4.53	2.97	3.75	41.42	44.26	42.84
Genotype-38	1.18	1.21	1.20	3.57	3.70	3.63	24.55	27.70	26.13
Genotype-39	1.24	1.06	1.15	3.93	4.03	3.98	28.64	31.73	30.19
Genotype-40	0.97	1.05	1.01	3.87	3.97	3.92	49.55	52.47	51.01
C.D.	0.18	0.09	0.15	1.00	0.95	0.55	0.50	1.56	3.76
SE(m)	0.07	0.03	0.05	0.35	0.34	0.19	0.18	0.55	1.31
Average	0.82	0.87	0.84	4.17	4.34	4.26	40.63	43.13	41.88
Range	0.53-1.77	0.58-1.59	0.56-1.58	3.22-5.37	2.97-5.83	3.43-5.50	24.55-61.83	27.13-63.43	25.90-62.63

Table 1b. Marphological parameter of ber Plants

Genotype	Leaf Shape	Leaf Apex	Leaf Margin	Stone Shape	Stone Apex	Stone Base	Leaf Colour	Thorn Shape	Pulp Colour	Pulp Texture
Genotype-1	Cordate	Acute	Serrate	Obtuse	Acute	Obtuse	Green	All curved	Creamy	Soft
Genotype-2	Oval	Acute	Serrate	Acute	Acute	Acute	Green	All curved	Creamy	Soft
Genotype-3	Oval	Acute	Serrate	Round	Obtuse	Obtuse	Green	All curved	Creamy	Soft
Genotype-4	Cordate	Acute	Serrate	Oblong	Acute	Apiculate	Green	All curved	Creamy	Soft
Genotype-5	Elliptic	Acute	Serrate	Oblong	Acute	Obtuse	Green	All curved	Creamy	Soft
Genotype-6	Elliptic	Acute	Serrate	Oblong	Acute	Obtuse	Green	All curved	Creamy	Soft
Genotype-7	Elliptic	Obtuse	Serrate	Obtuse	Obtuse	Obtuse	Green	All curved	Creamy	Soft
Genotype-8	Oval	Obtuse	Serrate	Obtuse	Obtuse	Acute	Green	All curved	Creamy	Soft
Genotype-9	Oval	Obtuse	Serrate	Acute	Obtuse	Acute	Green	All curved	Creamy	Soft
Genotype-10	Oval	Obtuse	Serrate	Acute	Acute	Obtuse	Green	All curved	Creamy	Medium
Genotype-11	Obovate	Obtuse	Serrate	Round	Obtuse	Obtuse	Green	All curved	Creamy	Medium
Genotype-12	Cordate	Obtuse	Serrate	Round	Obtuse	Obtuse	Green	All curved	Creamy	Medium
Genotype-13	Cordate	Obtuse	Serrate	Obtuse	Obtuse	Acute	Green	All curved	Creamy	Soft
Genotype-14	Obovate	Obtuse	Serrate	Spindle	Acute	Obtuse	Green	All curved	Creamy	Soft
Genotype-15	Obovate	Obtuse	Serrate	Acute	Acute	Obtuse	Green	All curved	Creamy	Soft
Genotype-16	Obovate	Obtuse	Serrate	Round	Obtuse	Apiculate	Green	All curved	Creamy	Soft
Genotype-17	Cordate	Obtuse	Serrate	Obtuse	Acute	Obtuse	Green	All curved	Creamy	Medium
Genotype-18	Elliptic	Rounded	Serrate	Obtuse	Acute	Obtuse	Green	All curved	Creamy	Medium
Genotype-19	Elliptic	Rounded	Serrate	Club	Obtuse	Obtuse	Green	All curved	Creamy	Medium
Genotype-20	Oval	Rounded	Serrate	Obtuse	Acute	Obtuse	Green	All curved	Creamy	Medium
Genotype-21	Obovate	Rounded	Serrate	Round	Obtuse	Apiculate	Green	All curved	Creamy	Medium
Genotype-22	Cordate	Rounded	Serrate	Acute	Acute	Obtuse	Green	All curved	Creamy	Soft

Genotype-23	Cordate	Rounded	Serrate	Club	Acute	Obtuse	Green	All curved	Creamy	Soft
Genotype-24	Cordate	Rounded	Serrate	Club	Acute	Acute	Green	All curved	Creamy	Soft
Genotype-25	Elliptic	Rounded	Serrate	Acute	Obtuse	Obtuse	Green	All curved	Creamy	Soft
Genotype-26	Elliptic	Obtuse	Serrate	Obtuse	Obtuse	Obtuse	Green	All curved	Creamy	Soft
Genotype-27	Obovate	Obtuse	Serrate	Round	Acute	Obtuse	Green	All curved	Creamy	Soft
Genotype-28	Oval	Obtuse	Serrate	Acute	Obtuse	Obtuse	Green	All curved	Creamy	Medium
Genotype-29	Oval	Obtuse	Serrate	Club	Obtuse	Acute	Green	All curved	Creamy	Medium
Genotype-30	Obovate	Obtuse	Serrate	Obtuse	Obtuse	Obtuse	Green	All curved	Creamy	Medium
Genotype-31	Obovate	Obtuse	Serrate	Round	Obtuse	Obtuse	Green	All curved	Creamy	Soft
Genotype-32	Cordate	Obtuse	Serrate	Acute	Acute	Acute	Green	All curved	Creamy	Soft
Genotype-33	Elliptic	Obtuse	Serrate	Club	Obtuse	Obtuse	Green	All curved	Creamy	Soft
Genotype-34	Elliptic	Obtuse	Serrate	Obtuse	Acute	Apiculate	Green	All curved	Creamy	Soft
Genotype-35	Obovate	Obtuse	Serrate	Obtuse	Obtuse	Obtuse	Green	All curved	Creamy	Medium
Genotype-36	Oval	Obtuse	Serrate	Round	Obtuse	Obtuse	Green	All curved	Creamy	Medium
Genotype-37	Oval	Obtuse	Serrate	Obtuse	Acute	Acute	Green	All curved	Creamy	Soft
Genotype-38	Oval	Obtuse	Serrate	Acute	Obtuse	Obtuse	Green	All curved	Creamy	Soft
Genotype-39	Elliptic	Obtuse	Serrate	Club	Acute	Obtuse	Green	All curved	Creamy	Soft
Genotype-40	Cordate	Obtuse	Serrate	Obtuse	Acute	Acute	Green	All curved	Creamy	Medium

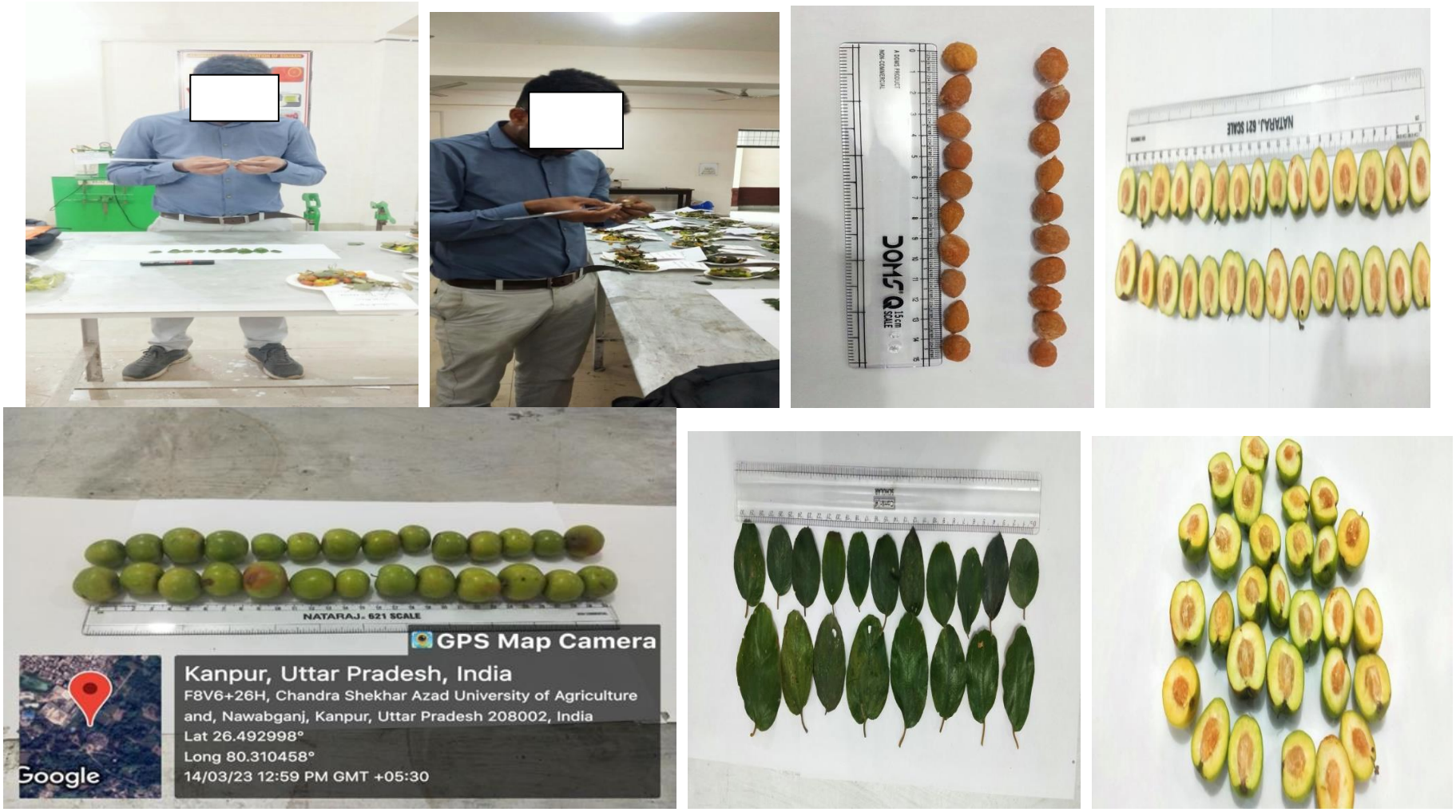

Fig. 1. Different parameter taken in fruit, leaf and stone shape size

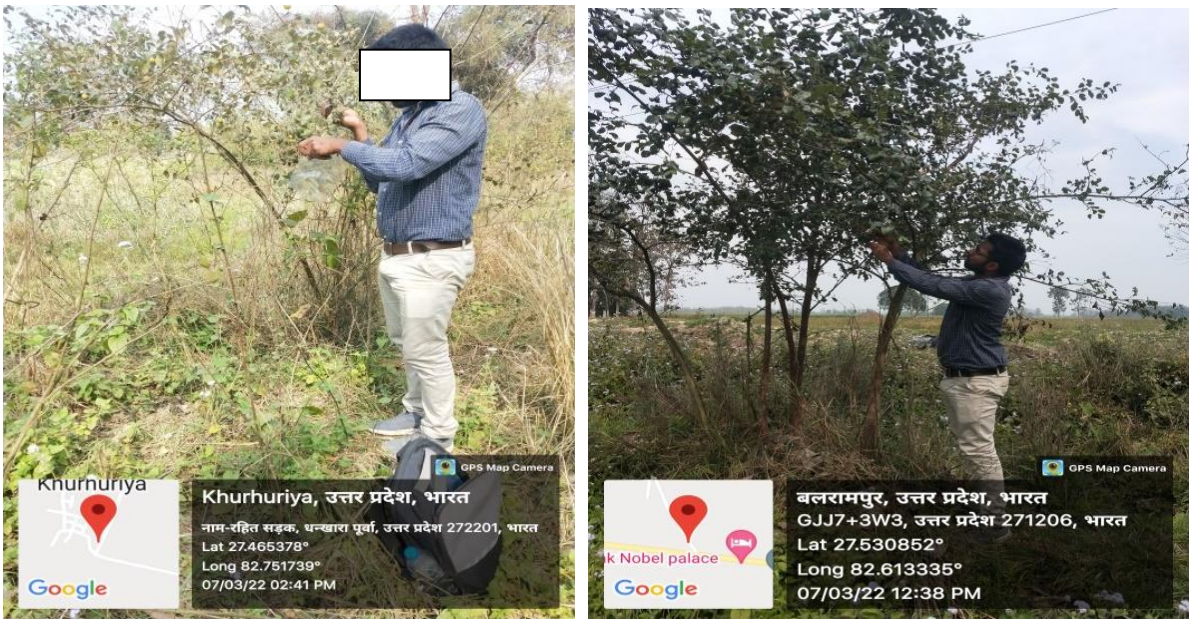

Fig. 2. Survey and collection of ber fruits germplasm

Data recorded on, leaf shape clearly revealed that all genotypes of ber sample showed four shape and variation namely: Cordate, Oval, Obovate and Elliptic. Among all genotypes, nine genotypes had a cordate shape, an elevan genotype had an oval shape, nine genotypes had an oval shape, and ten genotypes had an elliptic shape. The leaf apex was also observed in all forty different genotypes among them six genotypes have Acute leaf shape, twenty six have obtuse shaped and eight have rounded shaped. The leaf margin of ber was also observed in different genotypes is serrate leaf margin. These results in reaccord once with the earlier findings of Nissi and Joshi [4] Ghosal and Mishra [5], Kumar et al. [6] Gupta [7] Naseem et al. [8] Kumar et al. [9] in Ber fruits.

In general, fruit stone have obtuse shape, acute shape, oblong shape, round shape and club shape. Among all genotype in study 12 have obtuse shape, eight have acute shape, three have oblong shape and seven have round shape stone. Data recorded clearly revealed that apex stone are showe in twenty genotype are acute stone apex and eighteen genotype obtuse stone apex. The Data noted on stone base among genotypes are presented in stone base was twenty seven are obtuse shape, nine are Acute stone base and four are Apiculate stone base.Similar variations in the seed shape of wood apples were reported by Nissi and Joshi [4], Naseem et al., [8], Kumar et al. [9] Khan et al. [10] and Vikalp et al. [11].

The highest stone weight (1.58g) was recorded in the genotype - 1 followed by genotype -31 (1.51g) whereas lowest stone weight (0.56 g) was recorded in the genotype -29. Similar variations in stone weight of ber fruit were reported by Vikalp et al. [11], Kumar et al., [9] Ram et al. [12] Kumar at al. [9], Jan Brindza et al. [13] in ber fruits.

The highest hights of tree (5.50 m) was recorded in genotype - 8 followed in genotype -16 (5.02m). However, the lowest (3.43) hight of tree was recorded in genotype-23**.** Maximum stem girth was recorded in the genotype–1 (62.63cm.) followed by genotype - 12(60.88 cm.) while the minimum stem girth was recorded in the genotype - 17 (25.90 cm.). Height and stem girth variability in ber might be due to the cell division process and elongation of new cells formed or other genetic factors or micro-climatic conditions onthe germplasm site. These results are in accordance with the earlier findings of Kumar et al., [6] in woodapple fruits, Bairwa et al, [14] Ahmad et al, [15] Khan et al. [10] Kamble et al. [16] Kumar et al. [9] and Vikalp et a., [11] in ber fruits.

4. CONCLUSIONS

Based on the results it is reported that significant variation was observed in physical traits of

different ber genotypes by which it can be concluded that the ber genotypes showed a wide genetic diversity in the existing population of rain-fed areas in eastern region of Uttar Pradesh, in various quantitative, qualitative and morphological traits. Among these genotypes, genotypes – 7,14,15,18, 21and 30 were screened as promising genotypes. These promising genotypes can be recommended for commercial multiplication, growing at farmer's field and conservation in the field gene bank for further evaluation and release as cultivars in the future.

CONFERENCE DISCLAIMER

Some part of this manuscript was previously presented in the conference: "International Conference on Emerging Trends in Agriculture & Allied Sector for Sustainable Developments" organized by Faculty of Agricultural Sciences & Allied Industries, Rama University, Kanpur Nagar, U.P., India on 8th and 9th December, 2023. Web Link of the proceeding: https://www.ramauniversity.ac.in/news-rama-university-hosts-successful-international-conference-on-emerging-trends-in-agriculture-12-49-5706

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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