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Morphological characterization of traditional plant ber (*Ziziphus jujube*) genotype in Ayodhya district

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Abstract
Ber (*Ziziphus jujube*) is a significant fruit crop that grows in arid and semi-arid regions globally. It goes to the Rhamnaceae family and is generally known as Indian jujube or Chinese date or Indian plum, apple, etc. This fruit has taken a cash crop in certain areas of India, important to increased cultivation. Due to the widespread cultivation of the ber crop, it is susceptible to various factors, including, leading to serious diseases. Which is easily recognizable by the development of minor, asymmetrical brown spots on the upper surface of leaves. The consistent lower side of the leaves exhibits dark brown to black spots with distinct margins, ranging from 4 to 5 mm in diameter (near about). The, morphological characterization of 14 ber genotypes was. The leaf length ranges from (8.60 to 12.7 cm), leaf width (6.47 to 9.20 cm), and petiole length (2.17 to 4.02 cm).

Keywords: Ziziphus, Characteristics, Leaf, Morphological

Introduction
Ziziphus jujube, commonly known as ber, Chinese date, Chinese apple, or plum, is indeed a widely cultivated fruit native to an area spanning from India to China. It belongs to the Rhamnaceae family. Different names in various regions know Ber fruit and is popular for its sweet and nutritious qualities. While it is true that ber is often associated with being a fruit for the economically poor, this perception can vary from region to region. Ber is a versatile fruit and is used in a variety of culinary applications, from being eaten fresh to use in jams, jellies, and traditional medicinal practices. It has been a staple in many diets due to its nutritional value and adaptability to different growing conditions. Ber cultivation is not limited to India. As mentioned, it is grown in various other countries, including Iran, Syria, Australia, the USA, France, Italy, Spain, and various African countries. Its popularity has led to an expansion of the cultivation area in some of these regions. The specific districts in Uttar Pradesh, India, that you mentioned as having ber orchards, such as Varanasi, Mirzapur, Sonbhadra, Jaunpur, Aligarh, Ayodhya, Agra, and Raebareli, are indeed known for their ber production. The fruit is an important part of the agricultural landscape in these regions. Ber is appreciated not only for its taste but also for its potential health benefits, and it continues to be an important part of the diet in many regions around the world (Singh *et al*. 1973) [9].

It describes a genus of plants known as *Ziziphus*. *Ziziphus* is indeed a genus that consists of approximately 100 species of deciduous or evergreen trees and shrubs. These plants are primarily found in tropical and subtropical regions and are well-adapted to arid environments. One notable species, *Ziziphus mauritiana*, is found on nearly every continent and is particularly known for its exceptional drought resistance, making it a dominant component of the natural vegetation in Indian deserts. *Ziziphus* leaves are valued for their nutritional content. They are rich in minerals (Ivanova, 1982) [4] and vitamin C (Wang *et al*., 1992) [12], which makes them a significant source of nutrients. Additionally, *Ziziphus* varieties have a long history of selection and cultivation in both China and India. This tradition has led to the development of better-known and more extensively researched varieties compared to those found in other regions. These cultivated varieties are probable to have specific characteristics and benefits that have been enhanced over time through selective breeding and agricultural practices (Cherry, 1985) [3].

It provided a passage discussing the genetic diversity of ber (*Ziziphus*) genotypes and the need for characterization and classification of these genotypes based on various traits. The passage highlights the importance of developing ber varieties with desirable characteristics, such as acidity, flesh texture, flavor, aroma, and resistance or tolerance to pests and diseases like fruit flies, powdery mildew, and sooty mold.

Ber (*Ziziphus*) has a rich genetic diversity due to natural cross-fertilization and self-incompatibility (Bhargava *et al*., 2005) [1]. There hasn't been a significant effort to classify and characterize these genotypes based on vegetative and leaf traits. While many ber cultivars have been identified, none of them possess all the desired attributes. The present study aims to categorize and characterize the morphological traits of ber leaves genotypes to facilitate variety evaluation and proper identification. In essence, the underscores the importance of research and development efforts to create improved ber varieties that meet various criteria for quality and resilience.

Materials and Methods

The experimental material 14 genotypes of *ziziphus.* Genotypes are ZU, ZS-3, ZCIAH-1, ZK, ZS-5, ZNBS NEW-10, ZNBS NEW-1, ZCH, ZNBS NEW-2, ZG, ZGK, ZCHES-2, ZCHES NEW, ZNBS-9 planted in orchard of All India coordinated Research Program on Arid Zone fruits at the orchard of Department of Horticulture, its provided information about a study conducted at the College of Horticulture and Forestry, Acharya Narendra Deva University of Agriculture and Technology in Kumarganj, Ayodhya, Uttar Pradesh, India. The study involved the analysis of various soil characteristics and the collection of data on tree growth, branching habits, and leaf characteristics during September and October. This data was collected with 3 replications and was analyzed statistically.

Results and Discussion

Qualitative characteristics of leaf and tree

Studying the qualitative characteristics of leaves based on visual appearance can provide valuable information about the diversity and characteristics of different plant varieties or accessions. Qualitative characters refer to observable traits that can be categorized into distinct classes or categories, as opposed to quantitative characters, which are measured on a continuous scale.

These qualitative characteristics can vary significantly among different plant varieties or accessions, and they are often used in plant breeding, taxonomy, and ecological studies to distinguish and classify plants. Some common qualitative leaf characteristics that may exhibit significant variations include the overall shape of the leaf, such as ovate, lanceolate, elliptical, or lobed, edge of the leaf, which can be serrated, toothed, smooth, or wavy. The pattern of veins on the leaf can be palmate (radiating from a central point) or pinnate (running parallel to the midrib). The surface texture of the leaf can be smooth, hairy, leathery, or rough. The color of the leaf, which can vary from green to various shades of red, purple, or even variegated patterns. The size of the leaf can range from small and narrow too large and broad. The tip of the leaf can be pointed, rounded, or acuminate. The bottom part of the leaf can be cordate (heart-shaped), rounded, or tapering. The way leaves are arranged on the stem, such as opposite, alternate, or whorled. How the leaf is attached to the stem, including petiolate (with a leaf stalk) or sessile (without a leaf stalk).

These qualitative characteristics are useful in botanical studies, horticulture, and agriculture, as they help in the identification and classification of plant varieties. Researchers and breeders use them to select and develop plants with specific characteristics that are desirable for various purposes, such as crop improvement or landscaping. It seems like you're describing a study or observation of different plant varieties or accessions and their leaf shapes. The terms "oval," "ovate," and "oblong" are being used to classify the shapes of the leaves, and you've mentioned data related to vegetative characters showing variability. This suggests that you're documenting the diversity in leaf shapes within these plant varieties or accessions.

The genotypes, ZS-3, ZCIAH-1, ZS-5, ZNBS NEW-10, ZNBS NEW-1, ZNBS NEW-2, ZG, ZGK, ZCHES-2, ZCHES NEW, ZNBS-9 had spreading type growth habit; ZU, ZCH had intermediate whereas ZK had upright growth habit. No variation was observed among *ziziphus* genotypes concerning stem nature. All genotypes had a rough stem nature. Bark colour was with light brown ZU, ZGK, ZCHES-2, dark brown ZS-3, ZCIAH-1, ZS-5, ZNBS NEW-10, ZNBS NEW-1, ZK, ZCH, ZNBS NEW-2, ZG, ZCHES NEW, ZNBS-9. It provided some observations related to the shape of thorns, foliage color, and the prominence of leaf veins in various genotypes.

ZU	ZS-3	ZCIAH-1
		
ZK	**ZS-5**	**ZNBS NEW-10**

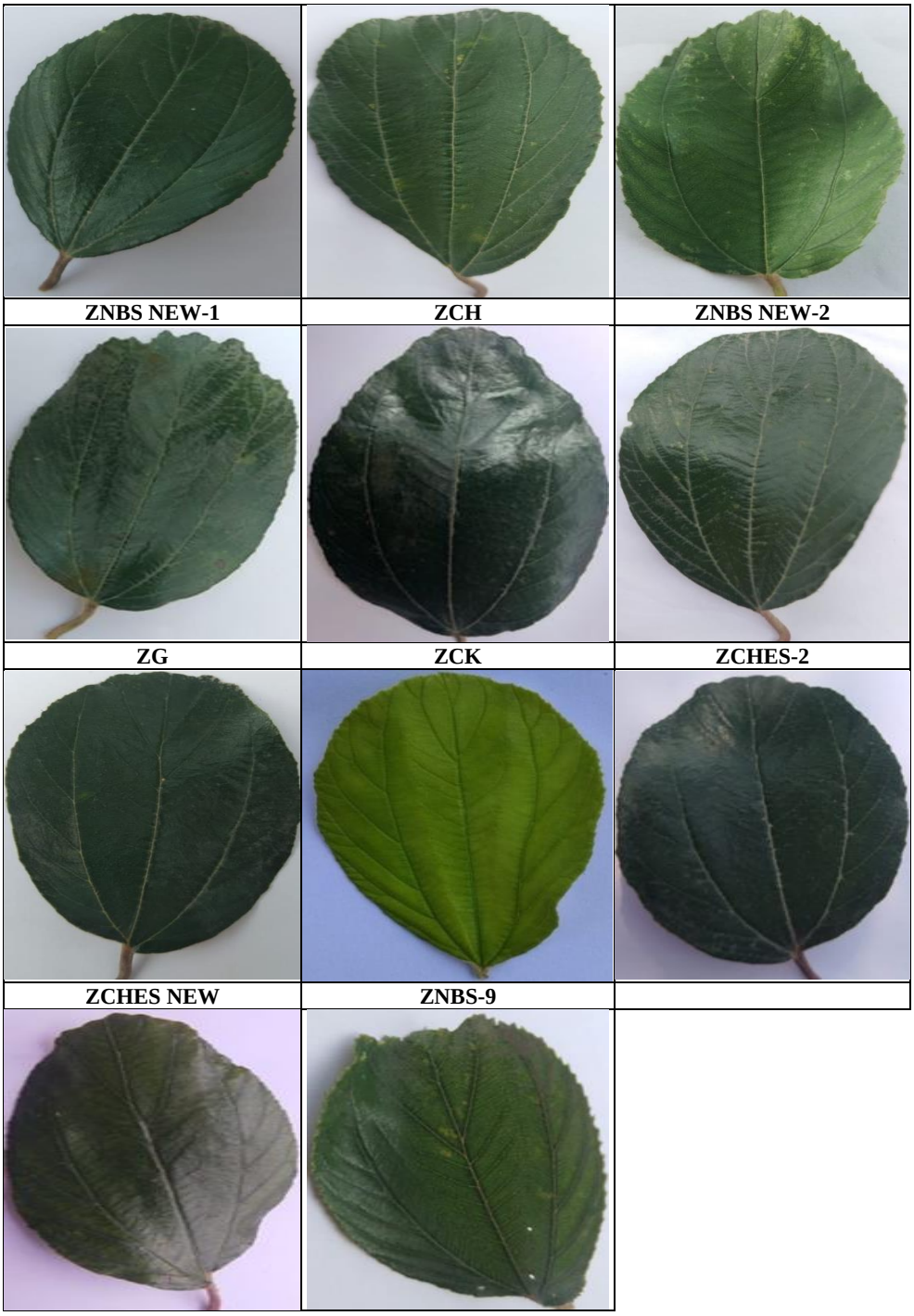

Fig 1: List of *ziziphus* leaf varieties/accessions

Table 1: Tree and leaf morphological characteristics of different genotypes of Z*iziphus.*

Genotypes	Tree habit	Stem	Bark color	Branch thorniness	Thorn shape	Foliage colour	Leaf veins upper	Leaf veins lower
ZU	Intermediate	Rough	Light brown	Less	All over curved	Dark green	Less prominent	Prominent
ZS-3	Spreading	Rough	Dark brown	High	All over curved	Dark green	Less prominent	Prominent
ZCIAH-1	Spreading	Rough	Blackish brown	Medium	All over curved	Dark green	Less prominent	Prominent
ZK	Upright	Rough	Blackish brown	Less	All over curved	Dark green	Less prominent	Prominent
ZS-5	Spreading	Rough	Dark brown	High	All over curved	Dark green	Less prominent	Prominent
ZNBS NEW-10	Spreading	Rough	Blackish brown	High	All over curved	Dark green	Less prominent	Prominent
ZNBS NEW-1	Spreading	Rough	Blackish brown	High	All over curved	Dark green	Less prominent	Prominent
ZCH	Intermediate	Rough	Dark brown	Medium	All over curved	Dark green	Less prominent	Prominent
ZNBS NEW-2	Spreading	Rough	Blackish brown	High	All over curved	Dark green	Less prominent	Prominent
ZG	Spreading	Rough	Dark brown	High	All over curved	Dark green	Less prominent	Prominent
ZGK	Spreading	Rough	Light brown	High	All over curved	Dark green	Less prominent	Prominent
ZCHES-2	Spreading	Rough	Light brown	High	All over curved	Dark green	Less prominent	Prominent
ZCHES NEW	Spreading	Rough	Blackish brown	High	All over curved	Dark green	Less prominent	Prominent
ZNBS-9	Spreading	Rough	Dark brown	High	All over curved	Dark green	Less prominent	Prominent

Table 2: Leaf morphological characteristics of different genotypes of *Ziziphus.*

Genotypes	Leaf shape	Leaf base	Leaf apex	Leaf petiole length	Leaf petiole color	Leaf size (cm) Length	Leaf size (cm) width
ZU	Obovate	Tapering	Rounded	4.02	Light green	12.07	7.90
ZS-3	Ovate		Obtuse	3.92	Light green	9.23	7.86
ZCIAH-1	Oblong with oval	Tapering	Obtuse	4.01	Light green	11.01	8.30
ZK	Ovate	Round	Rounded	4.00	Light green	10.80	9.20
ZS-5	Ovate	Round	Obtuse	2.52	Light green	9.49	6.93
ZNBS NEW-10	Oval	Tapering	Rounded	2.85	Light green	10.56	8.78
ZNBS NEW-1	Ovate	Round	Obtuse	4.00	Light green	10.00	8.65
ZCH	Oval	Tapering	Obtuse	2.70	Light green	8.73	6.47
ZNBS NEW-2	Ovate	Round	Rounded	3.21	Light green	10.52	8.10
ZG	Ovate	Round	Rounded	2.47	Light green	10.97	6.13
ZGK	Oval with Obovate	Round	Rounded	2.70	Light green	9.91	8.06
ZCHES-2	Ovate	Round	Rounded	2.46	Light green	8.60	6.50
ZCHES NEW	Ovate	Round	Rounded	3.10	Light green	10.23	8.56
ZNBS-9	Ovate	Round	Obtuse	2.17	Light green	10.00	8.50

Quantitative characteristics of Leaf

This research broadly egg-shaped leaf shapes with different genotypes in a study. Specifically, it mentions significant variations in several characteristics, with a focus on leaf shape, which was observed to be "ovate" in some genotypes (Table 2).

In scientific research, variations among genotypes are common and can provide valuable insights into the genetic diversity within a species. Different genotypes may express various traits differently, including those related to foliage color, leaf veins, leaf shape, and other characteristics.

The term "ovate" typically describes a broadly egg-shaped leaf shape, with a rounded base and a tapering apex. This information suggests that some of the genotypes being studied had leaves with an ovate shape.

ZS-3, ZS-5, ZNBS NEW-1, ZNBS NEW-2, ZG, ZGK, ZCHES-2, ZCHES NEW, ZNBS-9; oval to oblong in, ZCIAH-1, ZNBS NEW-10; obovate in ZU; oval in ZCH; oval-obate ZK in. The leaf base was round in ZS-3, ZK, ZS-5, ZNBS NEW-1, ZNBS NEW-2, ZG, ZGK, ZCHES-2, ZCHES NEW, ZNBS-9 and ZU, ZCIAH-1, ZNBS NEW-10, ZCH while tapering in all other genotypes under study" could be related to various fields, such as genetics, medicine, or research. The leaf apex was observed rounded in ZU, ZK, ZNBS NEW-10, ZNBS NEW-2, ZG, ZGK, ZCHES-2, ZCHES NEW, while ZS-3, ZCIAH-1, ZS-5, ZNBS NEW-1, ZCH, ZNBS-9 residual genetic constitution under study possessed obtuse leaf apex. about leaf petiole length and other characteristics in different genotypes. It appears that you are describing a study or observation of different plant genotypes.

Leaf Petiole Length: Range: to the longest petiole length in ZU (2.17 cm), Shortest petiole length in ZNBS-9(4.02 cm). Consistent light green color in all genotypes. Leaf Length: Highest leaf length in ZU (12.07 cm), lowest leaf length in genotype (8.60 cm). Leaf Width: Widest leaf width in ZK (9.20 cm), Narrowest leaf width in ZG (6.13 cm).

These observations provide valuable information about the variation in leaf characteristics among different genotypes. The differences in petiole length, leaf length, and leaf width suggest that these genotypes may have distinct growth patterns or genetic traits that influence these features. This information could be important for agricultural or horticultural purposes, such as selecting genotypes with desirable characteristics for further cultivation or breeding.

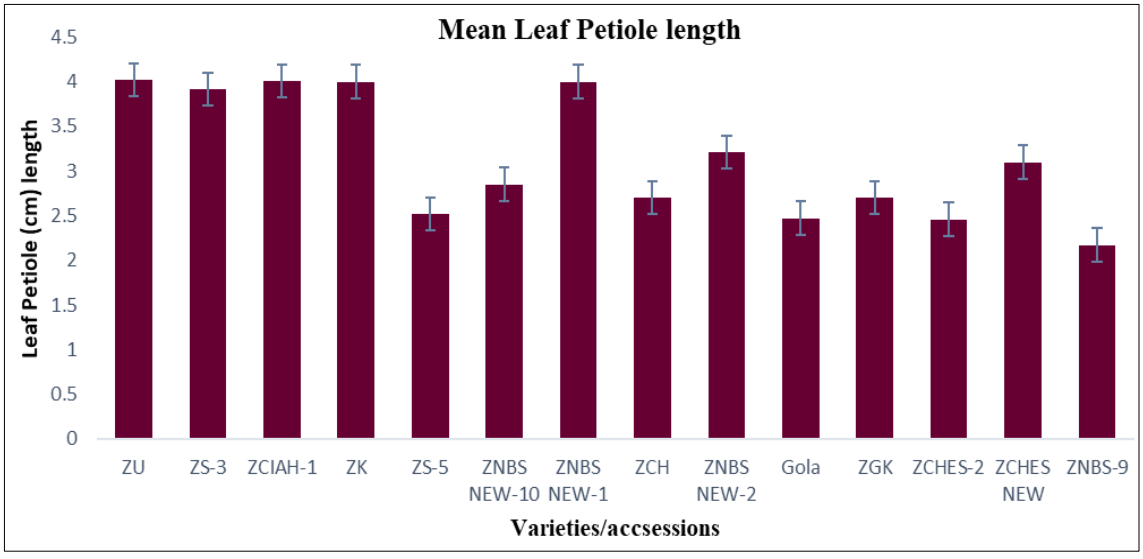

Fig 2: Mean of ziziphus leaf petiole length varieties/accession graph

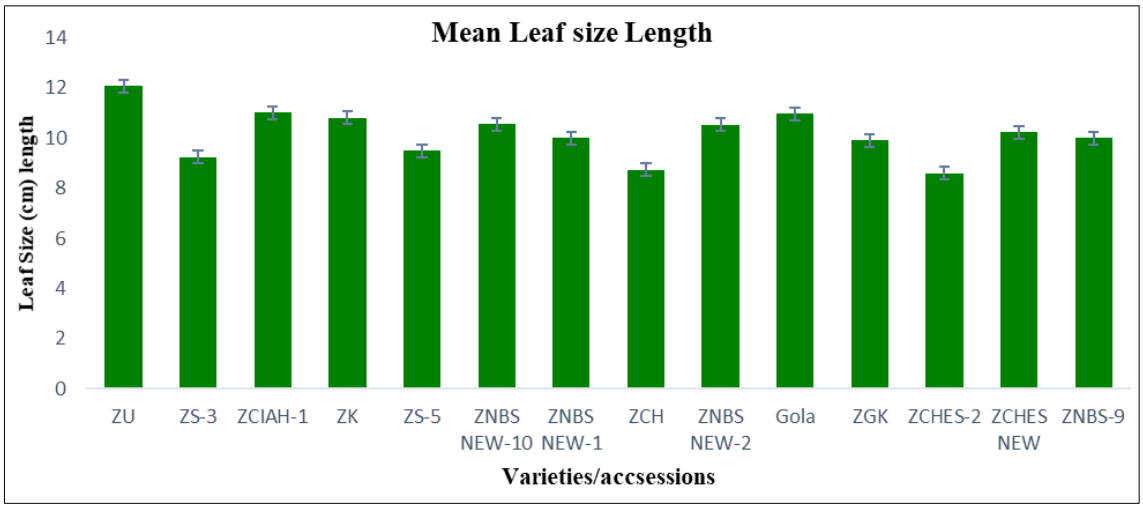

Fig 3: Mean of ziziphus leaf length varieties/accession graph.

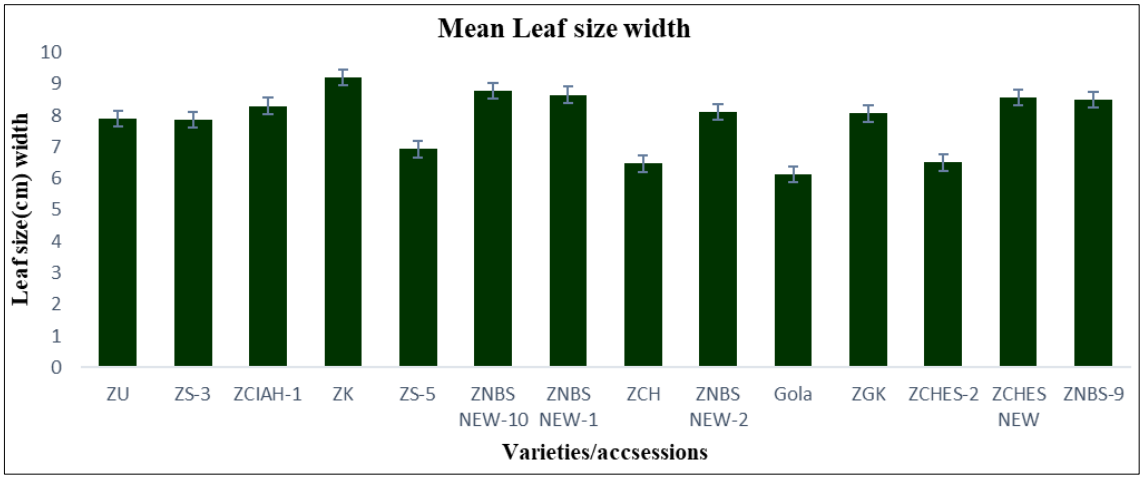

Fig 4: Mean of ziziphus leaf width varieties/accession graph.

Discussion

Ziziphus (ber) has great potential to be a major choice as a fruit crop in arid zones of the country and looks to be the most important thought for the unsophisticated. This study revealed a wide range of variations in the germplasm. This study exposed a wide range of ziziphus germplasm. The leaf morphological characters were found to be cultivar specific as well as leaf area association with petiole length, leaf size, leaf shape, and leaf quality. Although characters may change to some extent with changes in cultural practices, climatic situations, and other biotic and abiotic factors, yet they provide a dependable basis for cultivar identification in *ziziphus* jujube. The study or research findings related to Ziziphus (ber), a fruit dissimilarity promise in arid zones. The study has highlighted various aspects of *Ziziphus* germplasm and leaf morphological characteristics.

The study suggests that *Ziziphus* has significant potential as a fruit crop in arid regions of the country. This implies that it can thrive and be a valuable agricultural resource in dry and less hospitable environments. It revealed a wide range of variations within the germplasm of Ziziphus. Germplasm refers to the genetic material of a plant, which can influence its traits and characteristics. Leaf morphological characters in *Ziziphus* were specific to different cultivars. It means that different varieties or cultivars of Ziziphus may have distinct leaf characteristics. The leaf area was found to be associated with various factors, including petiole length, leaf size, leaf shape, and leaf quality. This implies that the size and quality of *Ziziphus* leaves may be influenced by these factors. Despite potential variations due to factors like cultural practices, climate, and other biotic and abiotic influences, the study suggests that leaf morphological characters can serve as a reliable basis for identifying different cultivars of Ziziphus jujube. This study is consistent with previous research findings by Bisala *et al* (1988) [2]., indicating that the variations and cultivar-specific traits observed in this study align with prior research.

It appears some information related to the characterization of different ber (*Ziziphus mauritiana*) cultivars, particularly in India and Pakistan. The references to Kumar Nantha (1991) [6] and Pareek (2001) [8] likely pertain to research or studies related to ber cultivars. it seems there are similarities and differences in the characteristics of these cultivars. For instance, the leaf base is rounded in most cases, but there are variations in the leaf apex among the different cultivars, as indicated in (Table 2) of the research. Additionally, mentioned Singh *et al*. (1971) [10], likely conducted research on ber varieties in neighboring India, where ber germplasm has been more extensively studied compared to Pakistan. This information is valuable for understanding the potential of *Ziziphus* as a fruit crop in arid regions.

Summary and Conclusion

The study mentioned focused on the analysis of various qualitative characteristics of leaves in different genotypes of *Ziziphus* jujube. The research revealed significant variations in several aspects of leaf morphology, which can be used to distinguish between different cultivars of this fruit crop. In this study found that the leaf shapes varied significantly among different genotypes. Some had ovate leaves, while others had oval to oblong or obovate leaves. The base of the leaves also showed variation, with some genotypes having round leaf bases, while others had tapering ones. The tip or apex of the leaves was not even across all genotypes. Some had rounded apexes, while others had obtuse ones. The study measured various characteristics related to leaf petioles, including color and length. Leaf petiole length ranged from 2.17 to 4.02 cm, with ZU having the longest petioles and ZNBS-9 having the shortest. Additionally, the color of the petioles likely showed variations among the genotypes. Leaf length and width were also analyzed. The research found that leaf length was significantly higher in one genotype, ZU, while leaf width was higher in another, ZK.

The findings of this study indicate that *Ziziphus* jujube has a wide range of variations in its germplasm, making it a potential fruit crop for arid regions. The leaf morphological characteristics were shown to be cultivar-specific and associated with variations in petiole length, leaf size, shape, and quality. These characteristics can serve as a reliable basis for identifying and distinguishing between different cultivars of Ziziphus jujube. This information is valuable for growers and researchers involved in the cultivation and breeding of this fruit crop.

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