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Characterization of Pear Accessions in Jammu Region on the Basis of Leaf Characters

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ABSTRACT: The objective of this study was to assess the diversity of soft pear germplasm in the Jammu region and identify exceptional soft pear genotypes with superior characteristics. A total of sixty soft pear genotypes were gathered from diverse locations within the Jammu region, and an extensive examination of their distinct morphological characteristics was conducted. The pear genotypes exhibited significant variation in terms of leaf characteristics. A collection of 60 pear accessions was assembled from various locations in the Jammu district, and their diverse morphological traits were thoroughly examined. The studied genotypes demonstrated diversity concerning leaf characteristics. The findings revealed a substantial variation in the following leaf parameters: leaf length ranging from 4.38 cm to 9.00 cm, leaf breadth spanning from 2.00 cm to 5.33 cm, leaf shape index varying between 1.02 cm and 3.41 cm, leaf area ranging from 13.66 cm to 40.35 cm, and petiole length varying from 1.00 cm to 4.16 cm. Pear cultivars often have a narrower genetic base due to the selection and propagation of a limited number of commercially desirable traits. This can result in reduced adaptability, susceptibility to diseases, and limited potential for future breeding improvements. The findings indicated that the observed variations in these traits could be attributed to the genotypes present or the prevailing environmental conditions in the cultivation regions, or a combination of both these factors. The observed variation in leaf characteristics indicates the presence of a diverse range of traits among the studied genotypes, which holds promising potential for future enhancement programs. This variability can be harnessed for the development and improvement of pear cultivars.

Keywords: Characterization, Genotypes, Pear, Leaf, Variability.

INTRODUCTION

Pear (*Pyrus* spp.) is a significant fruit crop extensively grown in temperate regions worldwide. Renowned for its exquisite flavor and velvety texture, pear has garnered global acclaim and widespread consumption. The unique form of this fruit has also become a source of inspiration for designers and architects, captivating their creative imaginations. Pears are primarily enjoyed fresh, in addition to being used in various culinary preparations such as pies, cakes, accompaniments to robust cheeses or carpaccio, risottos, jams, and ice creams. They are an excellent addition to diets due to their low caloric content, making them a favorable choice for those seeking a healthier eating plan. Pears boast a rich nutritional profile, containing significant amounts of vitamins A, B1, B2, B3, and C, as well as essential minerals like sodium, potassium, phosphorus, calcium, magnesium, and iron. Their high fiber content provides remarkable benefits in alleviating constipation and reducing inflammation in the intestines. Moreover, the consumption of pear fruit has been found to be effective in treating conditions such as cystitis and kidney stones, offering potential relief from these anomalies (Silva *et al.*, 2014). Originating in Western China during the Tertiary period, the pear, belonging to the genus Pyrus, underwent a dispersion from northern Italy, Switzerland, the former Yugoslavia, Germany, Greece, Moldova, and Ukraine towards the East. It reached countries including Iran, Uzbekistan, China, Japan, Korea, and Bhutan. From a commercial standpoint, pears are categorized into two primary groups: European pears and Asian pears. European pears are characterized by their elongated and full-bodied texture, while Asian pears have a sandy texture and rounded shape. As the ninth most produced fruit globally, pears are predominantly a commodity in China.

The genus *Pyrus* has two main domestication centers and primary origins. The first center is situated in China, while the second center is located in Asia Minor, extending to the Middle East, specifically in the

Caucasus mountains. Additionally, a third secondary center can be found in Central Asia.

In India, pear cultivation is predominantly concentrated in Jammu & Kashmir, Uttar Pradesh, and Himachal Pradesh, at elevations ranging from 2000 to 2400 meters above mean sea level. The total area dedicated to pear cultivation in India is approximately 42,000 hectares, with a production output of 279,000 metric tonnes (Anonymous, 2022). Specifically in the Jammu region, the pear cultivation area covers around 7,630 hectares, resulting in a production yield of approximately 24,789 metric tonnes (Anonymous, 2022).

The genetic diversity within Pyrus germplasm has been augmented over time through both hybridization techniques and natural processes, such as seed-based propagation. However, comprehensive characterization and evaluation of pear varieties are still limited in scope, particularly when it comes to selecting desired traits. Germplasm resources play a vital role in genetic breeding and the examination of intricate characteristics, while research on genetic diversity facilitates the exploration and generation of novel germplasm varieties (Zhang *et al*., 2022).

Significant genetic diversity can be observed in plant species, especially in fruit crops within the Jammu region. This geographical area is strategically positioned between two major centers of origin for temperate fruit plant species, namely the Caucasus Mountains and China. Despite this advantageous location, the cultivated pear varieties, as well as their wild relatives and naturalized forms found in the region, have not been fully explored and studied yet. There is ample scope for further research and discovery in this area.

MATERIALS AND METHODS

The current study, titled "Morphometric and Molecular Characterization of Native Soft Pear (*Pyrus communis*)," was conducted in the districts of Doda and Kishtwar in Jammu. The survey spanned two years, from 2016 to 2018, during which observations were documented according to the NBPGR descriptor (Mahajan *et al*., 2002) in various pear cultivation regions within Doda and Kishtwar. In this study, a total of sixty pear accessions sourced from the Jammu region were analyzed. Individual trees representing various pear genotypes from different locations within the Jammu region were selected, and a comprehensive examination of different characters was conducted. These characters included both qualitative and quantitative traits. The study encompassed two districts of Jammu and Kashmir, namely Doda and Kishtwar.

The Doda district is situated between 32°53´ and 34°21´N latitude and 75°1´ and 76°47 ´E longitude. It has an average elevation of 1107 meters (3361 feet) above mean sea level. On the other hand, the Kishtwar district is located in the northeastern part of the Jammu region, with coordinates of 33° 19′ 12″ N and 75° 46′ 12″ E. Kishtwar is positioned at an altitude of 1640 meters above mean sea level and is approximately 232 kilometers away from Jammu. The survey was conducted in the major pear-growing districts of Doda and Kishtwar in the Jammu province of Jammu and Kashmir state. The objective of the survey was to select promising accessions among the diverse pear genotypes and assess the variability in their tree morphological characteristics.

The site selection for this study took into consideration the presence of a diverse range of seedling pear genotypes. Based on initial field observations and discussions with orchard owners, trees that exhibited characteristics such as extremely small size, poor quality, and low yield were excluded from the study.

Ultimately, a total of sixty (60) seedling-origin pear genotypes displaying diverse tree characteristics were chosen for further analysis. Each genotype was assigned a specific code based on its location, such as SKJSPB for SKUAST-Jammu soft pear Bhaderwah, SKJSPG for SKUAST-Jammu soft pear Gandoh, SKJSPBH for SKUAST-Jammu soft pear Bhagwa, SKJSPD for SKUAST-Jammu soft pear Dachhan, SKJSPT for SKUAST-Jammu soft pear Thathri, SKJSPK for SKUAST-Jammu soft pear Kishtwar, and SKJSPN for SKUAST-Jammu soft pear Nagsani. Identification numbers were also allocated for efficient identification purposes. Additionally, the selected plants underwent geotagging to record their precise location. The leaf characteristics, including leaf length, leaf width, leaf length-to-width ratio, leaf area, and petiole length, were thoroughly examined for all the accessions. Leaf length, leaf width, and petiole length were measured using a scale for accurate measurements. On the other hand, leaf area was determined using a leaf area meter, which provides precise measurements of the surface area of the leaves.

RESULTS AND DISCUSSION

Leaves play a vital role in the growth and development of plants, as they serve as the primary source of food production through the process of photosynthesis.

The present study revealed a wide range of variation in various leaf characteristics of pear, as presented in Table 1. Significant differences were observed in leaf length, leaf breadth, leaf shape index, leaf area, and petiole length. The measured leaf length ranged from 4.38 cm to 9.00 cm, with the highest length recorded in SKJSPD-34 and the lowest length in SKJSPC-54. Similarly, the leaf breadth varied from 2.00 cm to 5.33 cm, with SKJSPD-35 exhibiting the maximum breadth of 5.33 cm and SKJSPN-60 displaying the minimum breadth of 2.00 cm. The leaf shape index ranged from 1.02 cm to 3.41 cm, and the leaf area ranged from 13.66 cm^2 to 40.35 cm^2. Additionally, the petiole length varied from 1.00 cm to 4.16 cm.

The leaf blade length-to-width ratio displayed a smaller value of 1.02 in SKJSPC-53, while a larger ratio of 3.41 was observed in SKJSPN-60. Among the genotypes, the maximum leaf area of 40.35 cm^2 was recorded in SKJSPD-32, while the minimum leaf area of 13.66 cm^2 was observed in SKJSPN-60. In terms of petiole length, the maximum measurement of 4.16 cm was recorded in SKJSPK-46, whereas the minimum length of 1.00 cm was observed in SKJSPB-03.

Table 1: Characterization of pear on the basis of leaf characters.

Sr. No.	Selection	Leaf length (cm)	Leaf breadth (cm)	Shape index (ll/lw)	Leaf Area (cm^2)	Petiole length (cm)
1.	SKJSPB-01	5.33	3.43	1.55	18.28	1.05
2.	SKJSPB-02	5.33	3.96	1.34	19.36	1.33
3.	SKJSPB-03	6.33	3.06	2.06	21.10	1.00
4.	SKJSPB-04	6.43	4.83	1.33	22.02	1.33
5.	SKJSPG-05	6.00	4.00	1.50	23.04	1.10
6.	SKJSPG-06	6.40	4.06	1.57	25.98	1.30
7.	SKJSPG-07	6.03	3.80	1.58	22.91	1.50
8.	SKJSPG-08	6.06	3.80	1.59	23.02	1.73
9.	SKJSPG-09	5.88	4.030	1.45	23.69	1.60
10.	SKJSPG-10	6.50	4.73	1.37	30.55	1.50
11.	SKJSPG-11	6.86	4.90	1.40	33.61	1.23
12.	SKJSPBH-12	6.90	4.26	1.61	29.39	2.66
13.	SKJSPBH-13	5.46	3.80	1.43	28.74	1.33
14.	SKJSPBH-14	6.50	3.23	2.01	27.99	1.66
15.	SKJSPBH-15	5.96	4.00	1.49	23.84	1.50
16.	SKJSPBH-16	5.13	3.66	1.40	28.77	1.33
17.	SKJSPBH-17	6.30	3.80	1.65	23.94	1.76
18.	SKJSPBH-18	6.56	4.13	1.58	27.09	1.80
19.	SKJSPBH-19	6.16	3.73	1.65	22.97	1.33
20.	SKJSPBH-20	4.50	3.40	1.32	15.30	1.83
21.	SKJSPBH-21	7.83	3.20	2.44	25.05	1.50
22.	SKJSPD-22	7.5	5.26	1.42	29.45	3.5
23.	SKJSPD-23	8.00	3.66	2.18	29.28	3.00
24.	SKJSPD-24	8.66	3.00	2.88	25.98	2.83
25.	SKJSPD-25	7.00	3.83	1.82	26.81	2.66
26.	SKJSPD-26	8.83	3.50	2.52	30.9	3.16
27.	SKJSPD-27	5.13	3.60	1.42	18.46	3.33
28.	SKJSPD-28	8.16	3.50	2.33	28.56	3.16
29.	SKJSPD-29	5.76	3.50	1.64	20.16	2.50
30.	SKJSPD-30	5.66	4.13	1.37	23.37	2.83
31.	SKJSPD-31	6.50	2.66	2.44	17.29	2.33
32.	SKJSPD-32	8.66	4.66	1.85	40.35	1.50
33.	SKJSPD-33	5.3	3.83	1.38	20.29	2.66
34.	SKJSPD-34	9.00	3.60	2.50	32.40	1.93
35.	SKJSPD-35	6.33	5.33	1.18	33.70	3.00
36.	SKJSPD-36	6.50	3.83	1.69	24.89	2.33
37.	SKJSPT-37	6.36	3.73	1.70	23.72	2.00
38.	SKJSPT-38	6.63	3.60	1.84	23.86	1.66
39.	SKJSPT-39	6.16	4.60	1.33	28.33	2.06
40.	SKJSPT-40	5.86	5.00	1.17	29.30	2.20
41.	SKJSPT-41	5.86	4.10	1.42	24.02	2.33
42.	SKJSPT-42	7.66	4.10	1.86	31.40	2.33
43.	SKJSPK-43	6.66	4.86	1.37	32.36	2.66
44.	SKJSPK-44	7.06	4.26	1.65	30.07	2.00
45.	SKJSPK-45	6.56	3.96	1.65	25.97	2.66
46.	SKJSPK-46	6.43	5.06	1.27	32.53	4.16
47.	SKJSPK-47	5.43	4.73	1.14	25.68	3.06
48.	SKJSPK-48	5.00	3.36	1.48	16.8	1.90
49.	SKJSPP-49	7.33	3.96	1.85	29.02	2.66
50.	SKJSPC-50	6.36	3.63	1.75	23.08	2.83
51.	SKJSPC-51	4.39	4.13	1.06	18.13	3.16
52.	SKJSPC-52	4.59	3.60	1.27	16.52	1.93
53.	SKJSPC-53	4.42	4.33	1.02	19.13	2.33
54.	SKJSPC-54	4.38	4.03	1.08	17.65	2.06
55.	SKJSPGA-55	6.40	3.53	1.81	22.59	2.83
56.	SKJSPN-56	6.56	4.06	1.61	26.63	3.66
57.	SKJSPN-57	8.00	4.76	1.68	38.08	1.33
58.	SKJSPN-58	4.50	3.43	1.31	15.43	2.50
59.	SKJSPN-59	4.83	3.60	1.34	17.38	1.66
60.	SKJSPN-60	6.83	2.00	3.41	13.66	3.16

These results are in conformity with the results obtained by Bist *et al*. (2003) where according to their findings, it was observed that the Gola cultivar of pear exhibited significantly greater leaf length compared to the Patharnakh cultivar. On the other hand, the Tumariya cultivar displayed a higher leaf breadth. The genotypes were further analyzed based on their performance, resulting in the classification of the 60 genotypes into two main clusters, each containing six subclusters.

Dhillon *et al.* (2008) found a significant variation in leaf size in different strains of pear during three years of study (Table 1). The average values of three years indicate that strain VI and strain XI produced maximum I (1.33 cm) and minimum (8.05 cm) leaf length, respectively. Nevertheless, strain × stood out with comparatively shorter leaves, measuring only 8.53 cm in length, in contrast to the majority of the other evaluated strains. Maximum (6.98 cm) leaf breadth occurred in strains III and VIII. It was statistically at par with strains V (6.97cm), IV (6.9Icm) and VII (6.83 cm). The strain XI exhibited the minimum leaf breadth, with a measurement of 6.07 cm.

According to the findings reported by Hassan *et al.* (2017), the leaf blade length of the selected wild apple genotypes varied between 6.26 and 12.06 cm. Sel-29 exhibited the highest leaf blade length, reaching a maximum of 12.06 cm, while Sel-9 displayed the lowest leaf blade length, measuring at a minimum of 6.26 cm.

The leaf blade width of the studied genotypes varied between 2.73 cm and 7.23 cm. Sel-29 displayed the maximum width of 7.23 cm, whereas Sel-25 exhibited the minimum width of 2.73 cm. In terms of petiole length, it ranged from 1.53 cm to 4.30 cm. Sel-21 had the longest petiole, measuring at a maximum of 4.30 cm, while Sel-25 had the shortest petiole, measuring at a minimum of 1.53 cm. After evaluating the performance of the genotypes, a total of 33 wild genotypes were classified into eight clusters (Table 2) using Mahalanobis D2 analysis and Tocher's method. Differences in leaf morphological parameters of pear were studied and the mean values found were 11.93, 16.79 and 14.49 cm^2 for susceptible genotypes where as on the other hand, the mean values for resistant genotypes throughout the evaluation period were 14.16, 17.42 and 15.54 cm^2. The highest value was 26.09 cm^2 for the resistant genotype whereas the lowest value was 5.12 cm^2 for the susceptible genotype (Karklina *et al*., 2021).

According to the cluster analysis conducted by Sharma *et al*. (2015), who studied assessment in variation in 23 pear genotypes on the basis of total variability were grouped into 3 clusters. Selections belonging to clusters separated by genetic distance may be used in hybridization programme to obtain a wide spectrum of variation among the seggregants. The majority of the genotypes were found in cluster I, comprising 17 genotypes. This was followed by cluster III with 8 genotypes, cluster II with 3 genotypes, cluster IV, cluster V, cluster VI, cluster VII, and cluster VIII, each with 1 genotype.

In a separate study, Rugienius *et al.* (2013) examined the morphological characteristics of pear accessions. Their research focused on parameters such as leaf length, length of the tip of the leaf blade, petiole length, and the ratio of petiole length to blade length. These traits exhibited variations across the accessions, with some displaying short, medium, and long characteristics of pear accessions.

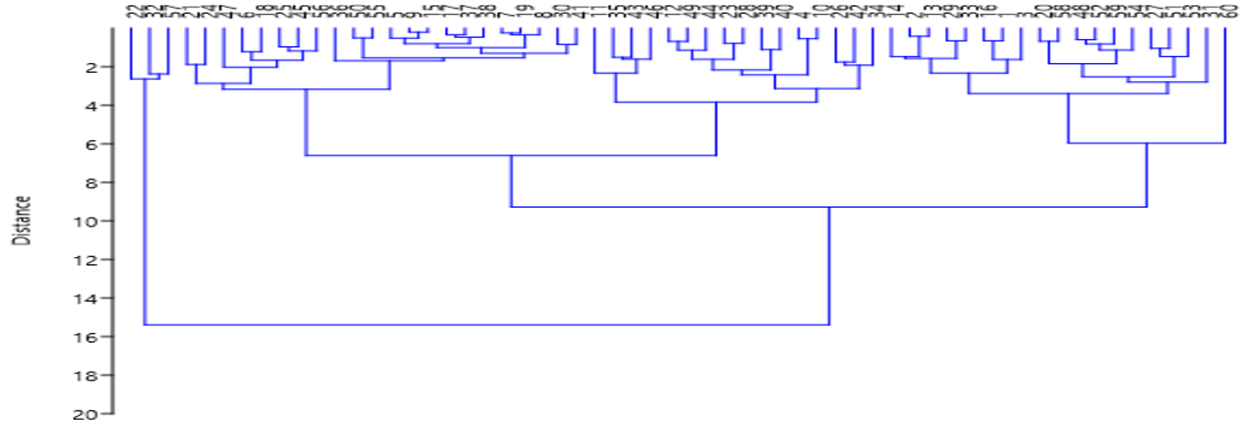
The cluster analysis revealed that the majority of genotypes were categorized into cluster I (17), with cluster III (8) being the second largest group. The remaining genotypes were distributed across cluster II (3), cluster IV (1), cluster V (1), cluster VI (1), cluster VII (1), and cluster VIII. This observation was reported by Sharma *et al*. (2015). Additionally, they found variations in leaf length, length of leaf blade tip, petiole length, and length of petiole relative to the length of the blade, which were classified as short, medium, and long.

Rugienius *et al.* (2013) conducted a study on morphological characteristics. They determined that the leaf length, width, and the ratio of leaf length to width exhibited intervals of variation. Specifically, the leaf length ranged from 2.7 mm to 5.9 mm, with an average of 3.8 mm. The width of the leaves varied between 2.9 mm and 8.6 mm, with an average of 5.1 mm. Lastly, the ratio of leaf length to width showed a range of 0.9 to 1.8 mm, with an average of 1.4 respectively. Elshihy *et al*. (2004) conducted a study on the morphological, anatomical, and biochemical characterization of Syrian pear (*Pyrus syriaca* Boiss) genotypes. One of the parameters they investigated was the leaf index, calculated as the ratio of leaf width to leaf length. The leaf index varied among the genotypes, ranging from 0.35 for W.T3 (with a leaf length of 5.5 cm and a leaf width of 2 cm) to 0.78 for Abusatel (with a leaf length of 7 cm and a leaf width of 5 cm). The genetic relationships between 33 different varieties of pear and variation found in that accessions were divided into four clusters resulted that the variation between cultivars (Bergonzoni *et al*., 2023).

Table 2: Descriptive statistics of leaf characters of pear.

Character	Minimum	Maximum	Mean	Critical difference (C.D) at 0.05%	S.D	S.E	CV
Leaf length (cm)	4.38 SKJSPC-54	9.00 SKJSPD-34	6.32	1.52	1.13	0.14	14.93
Leaf breadth (cm)	2.00 SKJSPN-60	5.33 SKJSPD-35	3.93	0.94	0.62	0.08	14.67
Leaf shape	1.02	3.41	1.65	0.66	0.45	0.05	2.23

index(ll/lw)	SKJSPC-53	SKJSPN-60					
Leaf area (cm^2)	13.66 SKJSPN-60	40.35 SKJSPD-32	24.99	2.54	5.75	0.74	15.60
Petiole length (cm)	1.00 SKJSPB-03	4.16 SKJSPK-46	2.18	14.93	0.74	0.09	15.53



CONCLUSIONS

The objective of our research was to acquire a wide range of soft pear varieties, and our investigation has substantiated the existence of a substantial diversity of soft pear in the North Western Himalayan region. Consequently, it has become imperative to safeguard these distinctive genetic resources in order to enhance morphological quality parameters. Moreover, in order to guarantee their preservation, exchange, and utilization in forthcoming breeding programs, as well as to foster the development of innovative, market-oriented cultivars through the implementation of efficient genetic methodologies, further exploration is indispensable.

FUTURE SCOPE

The future scope of addressing the challenges in the characterization of pear accessions in the Jammu region based on leaf characters involves several possibilities:

Integration of molecular techniques: Incorporating molecular markers and genetic analysis can complement leaf character-based characterization, providing a more comprehensive understanding of the genetic diversity and relationships among pear accessions in the region.

Advanced imaging and machine learning: Utilizing advanced imaging technologies, such as high-resolution imaging and hyperspectral imaging, coupled with machine learning algorithms, can enhance the accuracy and efficiency of leaf character analysis. This approach can enable automated and objective assessment of leaf traits.

Multi-dimensional characterization: Expanding the characterization beyond leaf characters to include other plant traits, such as fruit characteristics, growth habit, disease resistance, and yield parameters, can provide a broader perspective on pear accessions. Integrating multiple traits will enable a more comprehensive evaluation and selection of pear varieties suitable for the Jammu region.

Long-term monitoring and evaluation: Conducting long-term monitoring and evaluation of pear accessions will help understand the stability of leaf characters over time and under varying environmental conditions. This will provide insights into the adaptability and performance of different varieties in the region.

Collaboration and data sharing. Promoting collaboration among researchers, institutions, and germplasm repositories can facilitate the sharing of data, resources, and expertise. Establishing a centralized database for pear accessions in the Jammu region will contribute to a comprehensive understanding of the germplasm and aid in future characterization efforts.

By embracing these future possibilities, researchers can overcome the challenges in characterizing pear accessions based on leaf characters and enhance the conservation, management, and utilization of pear genetic resources in the Jammu region.

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Conflict of Interest. None.

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