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RESEARCH ARTICLE

Morphological description of spine gourd collections in Bundelkhand region of Central India

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Abstract

This study investigates the qualitative morphological and seed-related characteristics of 31 spine gourd (*Momordica dioica*) genotypes to assess their genetic diversity. The research focused on 17 distinct traits, observing significant variations that can be used for genotype identification and classification. Among the characteristics analysed, notable variations were observed in leaf margin, shape, and colour, as well as in fruit characteristics such as colour, shape, and spine density. Seed traits, such as colour, shape, and seediness, also showed notable diversity. Shannon's Diversity Index for 17 morphological traits ranged from 0 to 1.250, with leaf margin showing the highest diversity (H'=1.25) and node colour at the attachment of the leaves showing the least (H'=0.239). A qualitative cluster analysis using the UPGMA algorithm grouped the 31 genotypes into two main clusters: Cluster A (5 genotypes) and Cluster B (26 genotypes). Cluster B was further divided into two subgroups, 'b1' and 'b2'. Subgroup 'b1' contained one genotype (RLBKD-16), and 'b2' contained the remaining 25 genotypes, which were further subdivided into a cluster of one genotype (RLBKD-32) and another of 24 genotypes. The dendrogram effectively illustrates the genetic relationships and diversity among the genotypes, underscoring the value of these traits for selection in breeding programs. These stable, non-environmentally influenced traits are valuable for effective selection in breeding programs aimed at crop improvement, providing a strong basis for future genetic enhancement efforts in spine gourd.

Keywords: Spine gourd, Genetic diversity, Qualitative traits, Shannon's Diversity Index, Cluster analysis, Seed traits.

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Introduction

Spine gourd (*Momordica dioica Roxb.*) is a perennial, dioecious ($2n = 28$) climber belonging to the Cucurbitaceae family, cultivated globally for its edible fruits, leaves, shoots, and seeds (Muronga et al., 2021). The *Momordica* genus contains about 80 species (Bharathi et al., 2011). It is commonly known as spine gourd or small bitter gourd worldwide; in Bangladesh, it is also known as kakrol, and in India as kankro, kartoli, kantoli, kantola, ban karola, orjangle karela (Rai et al., 2012). Spine gourd is native to the Indian subcontinent and is widely distributed across Asia. In India, farmers cultivate them extensively in West Bengal, Bihar, Odisha, Uttar Pradesh and Madhya Pradesh. Spine gourd's toughness and ability to withstand different climates have led to its recent introduction and cultivation in the Americas and Australia as well. It is a perennial climbing vine with tuberous roots and dioecious flowers. Characterised by its elongated, slender stem capable of reaching several meters in length, the plant displays a glabrous stem and broadly ovate leaves. Solitary, yellow flowers that precede the development of fruits are densely covered with short spines, culminating in a stubby, beaked avoid or ellipsoid shape (Gupta & Sood, 2020). Botanically classified as a 'pepo',

the fruit undergoes a striking colour transformation from green immaturity to a mature hue of sunny yellow or vibrant orange (Asna et al., 2020). These seeds vary in shape from round to oval and range in colour from yellow to brown. Per 100 g of edible fruit, the nutritional value is reported to contain 84.1% moisture, 45 g carbohydrate, 18 g protein, 6 g ash, 22 g fibre, and 1.1 g minerals, along with small quantities of essential vitamins like carotene, thiamine, riboflavin, and niacin (Tiwari et al., 2022). This versatile vegetable finds its way into numerous dishes worldwide. The young shoots, leaves, and tender fruits are commonly enjoyed stir-fried, curried, pickled, or incorporated into soups. The leaves of the spine gourd are a culinary delight. It has been growing as part of the wild vegetation in the Western Ghats and the coasts of India and offers a unique flavour profile when cooked as a leafy green (Joseph et al., 2020). Its young, prickly fruits are a popular ingredient in many curries, and the cooked fruit can serve as a versatile vegetable replacement in meals. Beyond the fruit, the plant's young shoots and leaves, known as greens, are edible. Additionally, the tuberous root can be used to make a vegetable dish. The gourd's seed oil has semi-drying properties, adding another dimension to its culinary potential. This popular vegetable has high market demand due to its good nutritional and medicinal value, high keeping quality, ability to withstand long-distance transportation, high market price, and strong export potential (Rasul, 2004). Despite many advantages, there was no research thrust paid to Spine gourd improvement, genetic diversity, or genetic relatedness, and its utilisation in breeding programmes based on morphological and physiological variation has been studied in many crops (Fatima, 2013; Bhagat et al., 2017). Understanding the nature and magnitude of genetic variability in Spine Gourd will provide the foundation for designing a breeding programme. The present investigation aimed to examine morphological descriptors from different local collections of spine gourd genotypes in the Bundelkhand region of India and to analyse their consistency over multiple years using various qualitative parameters. By employing these tools, we can assess the stability of morphological traits and their usefulness as indicators of varietal purity and genetic relationships among different spine gourd genotypes. The present study specifically concentrates on the unique characteristics of spine gourd plants, providing valuable insights into their genetic diversity and potential applications in crop improvement.

Materials and Methods

The present investigation was carried out at B-Block, Vegetable Research Farm, Department of Vegetable Science, College of Horticulture and Forestry, RLBCAU, Jhansi, during the *kharif* seasons of 2024 and 2025. The experimental site is located at 25.31° North and 78.33° East, at an altitude of 227 meters above mean sea level. The university falls under the sub-tropical climatic zone. The crop was sown in the experimental field in June, 2024. The experimental material used in the current study comprised 31 spine gourd genotypes, including three standard checks, each replicated four times in an RBD to yield four blocks, and the remaining 28 new genotypes to be tested against the checks were planted in an augmented block design (ABD). The soil is sandy in texture (inceptisol) and acidic in reaction (5.4 pH). The sprouted root tubers were planted in pits measuring 30×30×30 cm, with a spacing of 2.0×2.0 m between plants and rows, respectively, in an augmented block design with four blocks. To raise the crop, 15–20 t/ha of well-rotted FYM was applied at land preparation, along with inorganic fertilisers at the rate of NPK @ 100:70:40 kg/ha. The pits were filled with a 2:1:1 mixture of soil, sand, and decomposed cow dung. Roots began to sprout 20 to 25 days after planting. The female-to-male ratio was maintained at 8:1, and the plants were stacked with bamboo sticks. When the plants reached 2.5 m in height, they were allowed to climb rope nets hung vertically to a height of 2.5 m above the soil surface. Ten plants were maintained in each replication for recording observations.

Details of experimental material

The experimental plant material comprised 31 spine gourd genotypes, including three released varieties —*Indira Kakoda 1*, *Indira Kakoda 2,* and *Chhattisgarh Kakoda 2* — which served as checks. These 28 local accessions originated from different locations of the Bundelkhand region of India (Table 1; Fig. 1).

Data about 17 different morphological descriptors *i.e.,* leaf margin, leaf pubescence, days of first flowering, number of first flowering node, number of ridge on stem, stem colour, node colour at the attachment of the leaves, leaf shape, leaf colour, fruit colour, fruit shape, conical spine density, conical spine strength, pedicel attachment with the fruit, seediness, seed colour, seed shape. The observations were recorded on 10 randomly selected plants for each character in each replication at different crop growth stages. Data were collected on 17 qualitative traits, including morphological and seed characters. To estimate diversity within the genotypes, the phenotypic frequencies of these traits were used, and the Shannon-Weaver diversity index was calculated. The index (H) was computed according to the methodology presented by Negassa M. (1985) to assess the current level of diversity using the following formula:

$$H = -\sum [pi \times \log pi]$$

Where pi is the portion of the total number of entries belonging to the i^{th} class, the clustering of genotypes based on their morphology was performed using the algorithm UPGMA (unweighted paired group method using arithmetic

Table 1: List of the genotypes of spine gourd used for the investigation, along with their source of collection

S. No.	*Genotype*	*Source/Site of collection*
1	Indira Kakoda 2 (Check-I)	IGKV, Raipur, Chhattisgarh
2	Indira Kakoda 1 (Check-II)	IGKV, Raipur, Chhattisgarh
3	Chhattisgarh Kakoda 2 (Check-III)	IGKV, Raipur, Chhattisgarh
4	RLBKD-1	Kathgaon village, Panna district, Madhya Pradesh
5	RLBKD-3	Makari village, Panna district, Madhya Pradesh
6	RLBKD-4	Pahuj village, Jhansi district, Uttar Pradesh
7	RLBKD-5	Kalinzar village, Banda district, Uttar Pradesh
8	RLBKD-7	Khohi village, Banda district, Uttar Pradesh
9	RLBKD-8	Manipur village, Panna district, Madhya Pradesh
10	RLBKD-9	Khamri village, Chattarpur district, Madhya Pradesh
11	RLBKD-11	Harrai village, Chattarpur district, Madhya Pradesh
12	RLBKD-12	Banjari village, Chattarpur district, Madhya Pradesh
13	RLBKD-13	Chandlavillage, Chattarpur district, Madhya Pradesh
14	RLBKD-14	Deori village, Chattarpur district, Madhya Pradesh
15	RLBKD-15	Bhitari village, Datia district, Madhya Pradesh
16	RLBKD-16	Godab village, Datia district, Madhya Pradesh
17	RLBKD-17	Seondha village, Datia district, Madhya Pradesh
18	RLBKD-21	Lamiyari village, Chitrakoot district, Uttar Pradesh
19	RLBKD-22	Haripur village, Banda district, Uttar Pradesh
20	RLBKD-23	Karatal village, Banda district, Uttar Pradesh
21	RLBKD-24	Nahari village, Banda district, Uttar Pradesh
22	RLBKD-25	Rajapur village, Chitrakoot district, Uttar Pradesh
23	RLBKD-26	Karari village, Jhansi district, Uttar Pradesh
24	RLBKD-27	Simardha village, Jhansi district, Uttar Pradesh
25	RLBKD-32	Baveru village, Panna district, Madhya Pradesh
26	RLBKD-33	Bigari village, Lalitpur District, Uttar Pradesh
27	RLBKD-34	Baswaha village, Lalitpur District, Uttar Pradesh
28	RLBKD-36	Mau village, Lalitpur District, Uttar Pradesh
29	RLBKD-38	Aheta village, Lalitpur District, Uttar Pradesh
30	RLBKD-39	Basova village, Niwari District, Uttar Pradesh
31	RLBKD-40	Kumarra village, Niwari District, Uttar Pradesh

averages) using NTSYS-pc (numerical taxonomy and multivariate analysis system) 2.02i (Rohlf F.J., 2002).

Results and Discussion

Phenotypic expression of morphological characters in spine gourd genotypes showed a wide range of variation. The morphological traits of all cucurbitaceous species were reported by Thakur et al. 2018. In the present study, only the characters showing variation are explained. Above all, the described characters are stable and unaffected by the environment. Thus, selection based on these traits will be effective. Analysing genetic diversity based on qualitative traits is an important approach for identifying and enhancing crop varieties (Makwana et al., 2023; Mishra et al., 2022; Sharma et al., 2023). In this investigation, an attempt was made to group and distinguish spine gourd genotypes based on variations present in their morphological and seed-related characteristics. These traits were carefully examined to unravel the genetic diversity within the spine gourd genotypes under investigation. Using descriptors, each genotype was identified and characterised. The present investigation focused on various qualitative traits and observed that although some lines shared standard qualitative features, they could still be differentiated from

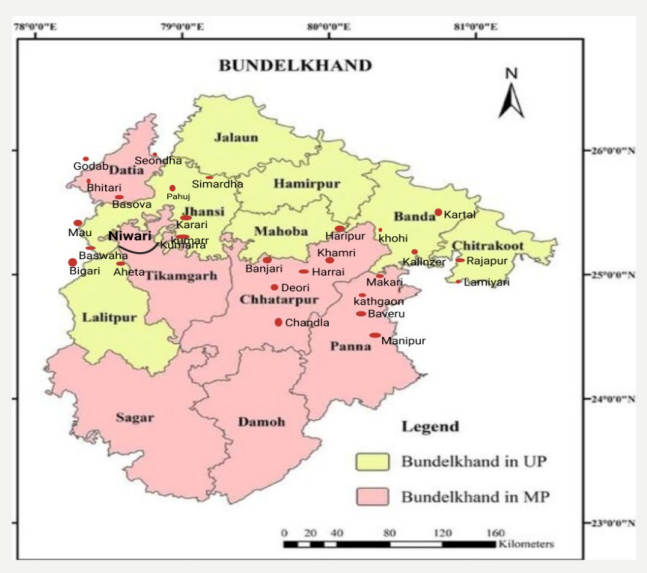

Fig 1: Site of germplasm collection of the spine gourd from the Bundelkhand region of India, created using https://BioRender.com.

one another based on their monomorphic traits. This highlights distinct genetic variation among the lines, even when only a few characteristics differ. Notably, the genetic base has been narrowed due to selective breeding for yield improvement (Tiwari et al., 2021).

Qualitative Characterisation

The qualitative characterisation of 31 spine gourd accessions across all 17 traits is illustrated in Tables 2 and 3, and the details are given in Figures 2, 3 & 4. Leaf margin, an important trait observed in the vegetative stage, was recorded in four categories: absent, slightly dented, dented, and serrated. Out of 31 genotypes, two showed absent or no margin, 11 genotypes had slightly dented leaves, 11 had dented leaves, and seven genotypes had serrated leaf margins. The genotypes were further classified based on leaf pubescence: 19 had absent pubescence, 8 had slight pubescence, and 4 had medium pubescence. The leaf's colour is a prominent visual trait. Out of 31 genotypes, 20 had green leaf colour, and the remaining 11 had dark green leaf colour. The leaf shape also exhibited notable variations. They were categorised into three groups: bi-lobed observed in 22 lines, tri-lobed observed in 5 lines and penta-lobed observed in 4 lines. Among the analysed genotypes, 29 exhibited green node colour at the attachment of the leaves, and the remaining two exhibited blackish green node colour at the attachment of the leaves. A total of 31 genotypes are present; 26 have ridges on the stem (5 ridges), and the remaining 5 have ridges absent. Nineteen genotypes had light-green stems, eleven had green stems, and one had dark-green stems. Various other reports are available on the morphological characterisation of the Bitter gourd (Rahman et al., 2021& Bhagat et al., 2017), and snake gourd by Islam et al. (2020).

Among the 31 genotypes, 18 were classified as early flowering (less than 30 days), nine as medium flowering (30–40 days), and the remaining four as late flowering

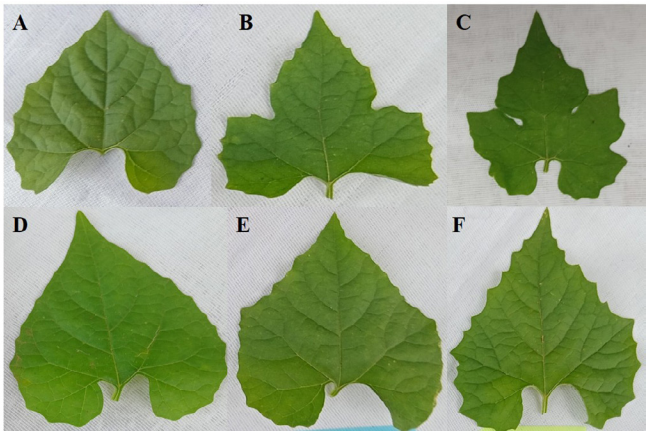

Fig. 2: Variation in Leaf Shape (A - C) A; Bi-lobed, B; Tri-lobed, C; Penta-lobed (D) and Leaf Margin (D-F) Dented, (E) Slightly Dented, (F) Serrated

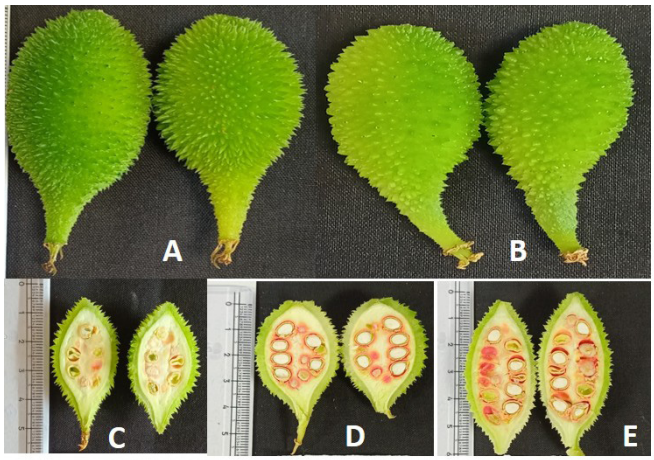

Fig. 3: Conical spine density and strength: (A) Thin and Soft, (B) Thick and Hard and Seediness at edible maturity: (C) Few Seeded, (D) Medium Seeded, (E) More Seeded

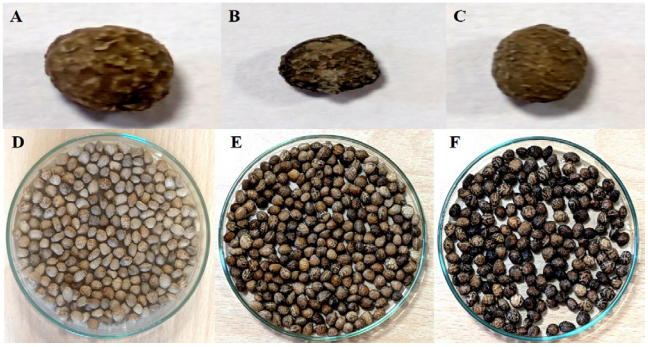

Fig. 4: Variability in seed shape: (A) round, (B) flat, (C) oval and seed Colour: (A) yellow, (B) yellowish brown, (C) black

Table 2: Qualitative characterisation of spine gourd based on descriptors

Characteristics \ Genotypes	Check-I	Check-II	Check-III	RLBKD-1	RLBKD-3	RLBKD-4	RLBKD-5	RLBKD-7	RLBKD-8	RLBKD-9	RLBKD-11	RLBKD-12	RLBKD-13	RLBKD-14	RLBKD-15	RLBKD-16	RLBKD-17	RLBKD-21	RLBKD-22	RLBKD-23	RLBKD-24	RLBKD-25	RLBKD-26	RLBKD-27	RLBKD-32	RLBKD-33	RLBKD-34	RLBKD-36	RLBKD-38	RLBKD-39	RLBKD-40
Leaf colour	1	1	1	1	1	1	3	1	1	1	1	1	1	1	3	3	1	1	3	3	3	3	1	3	3	3	1	1	1	1	3
Leaf shape	1	1	1	1	2	2	1	1	2	1	1	1	1	1	1	1	1	1	5	1	1	1	1	1	5	2	1	3	5	5	1
Leaf Margin	1	1	3	9	7	7	7	9	3	7	7	3	7	3	3	3	3	7	3	9	7	3	7	3	9	9	3	7	9	9	7
Leaf pubescence	3	1	1	1	3	1	3	1	1	1	5	1	1	1	3	1	3	3	1	1	3	1	5	1	5	5	1	1	1	1	3
Days of Ist flowering	1	1	1	3	1	1	1	3	1	1	3	3	3	5	1	1	1	3	5	1	1	3	1	3	5	1	1	1	1	3	5
No. of Ist flowering node	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	2	3	1	1	1	1	1	2	2	1	1	1	2	3	3	3
No. of ridges on stem	1	1	9	1	1	1	9	1	1	1	1	1	1	1	9	1	1	1	1	1	1	1	9	1	1	1	1	1	1	9	1
Stem colour	1	3	3	3	5	1	1	1	1	1	1	1	1	1	3	3	3	3	3	1	1	1	1	1	1	1	3	3	1	1	3
Node colour attachment of leaves	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Fruit colour	5	5	5	7	9	9	9	7	5	5	5	5	5	5	5	5	5	5	7	5	7	5	5	5	5	7	5	5	5	5	5
Fruit shape	1	1	3	3	3	3	5	3	3	1	5	5	3	3	5	9	1	3	1	3	3	1	3	1	1	5	1	5	3	3	3
Conical spine density	3	3	1	3	3	1	3	3	3	3	1	3	3	3	3	1	1	1	3	1	3	1	3	1	3	1	3	3	3	3	1
Conical spine strength	3	3	1	3	3	1	3	3	1	3	3	1	3	3	3	3	3	3	1	1	1	3	1	1	3	3	1	1	3	3	3
Pedicel attached fruit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Seediness	3	1	3	3	3	3	3	3	3	3	3	1	3	1	3	3	1	3	3	3	3	3	3	3	3	3	1	1	3	1	1
Seed colour	1	3	3	1	3	3	1	1	1	5	1	5	3	3	3	3	3	3	3	1	5	3	5	3	5	3	1	1	1	3	5
Seed shape	3	3	3	3	3	5	5	5	1	3	3	1	5	5	1	3	3	3	3	5	1	3	3	3	3	3	3	3	5	3	3

*RLBKD-Rani Lakshmibai Kakoda, Check-I (Indira Kakoda-2), Check-II (Indira Kakoda-1), Check-III (Chhattisgarh Kakoda-2)

Table 3: A compilation of 17 qualitative characteristics of spine gourd genotypes

S. No.	*Characteristics*	*States*	*Stage of Observation*
1	Leaf margin	Absent (1), Slightly dented (3), Dented (5), Serrated: 5 lobes (7)	Vegetative
2	Leaf pubescence	Absence (1), Few (3), Medium (5), More (7)	Vegetative
3	Days of first flowering	Early (less than 30 days) (1), Medium (30-40 days) (3), Late (40-60 days) (5)	Flowering
4	Number of first flowering node	1-10 nodes (1), 11-20 nodes (2),21-30 nodes (3)	Flowering
5	No. of ridges on stem	Present (5 ridge) (1), Absence no ridge (5)	Vegetative
6	Stem colour	Light green (1), Green (3), Dark green (5)	Vegetative
7	Node colour at the attachment of the leaves	Green (1), Blackish green (5)	Vegetative
8	Leaf shape	Bi-lobed (1), Tri-lobed (3), Penta-lobed (5)	Vegetative
9	Leaf colour	Green (1), Dark green (3)	Vegetative
10	Fruit colour	Green (1), Dark green (3), Light green orange (5)	Fruiting
11	Fruit shape	Round (1), Oval (3), Cylindrical (5), Spindle (7)	Fruiting
12	Conical spine density	Thin (1), Thick (3)	Fruiting
13	Conical spine strength	Soft (1), Hard (3)	Fruiting
14	Pedicel attachment to the fruit	Depressed (1), Slightly depressed (3), Pointed (5)	Fruiting
15	Seediness	Few (1), Medium (3), High (5)	Fruiting
16	Seed colour	Yellow (1), yellowish-black (3), Black (5)	Fruiting
17	Seed shape	Flat (1), Round (3), Oval (5)	Fruiting

(40–60 days). Furthermore, the genotypes were categorised into three groups based on the number of first flowering nodes. About 22 genotypes had their first flower at nodes 1 to 10, five at nodes 11 to 20, and the remaining four at nodes 21 to 30. Limited variation was observed among the genotypes in fruit colour. About 23 genotypes displayed green-coloured fruits, the remaining five dark green, and three light green-orange. Another observed parameter was the fruit shape. Among the analysed genotypes, nine had round fruit shape, 15 had oval-shaped fruits, six had cylindrical fruit shape, and only one had spindle-shaped fruits. Out of 31 genotypes, 20 genotypes have fruits with thin conical spine density and soft spine strength, and the remaining 11 genotypes have fruits with thick spine density and complex spine strength. Pedicel attachment with the fruit categorised in tree groups, i.e., depressed, slightly depressed and pointed. Twenty-six genotypes showed a pointed pedicel attached to the fruit, two genotypes had a depressed pedicel attached, and three genotypes had a pedicel attached to the fruit in a slightly depressed position. The findings of this study are consistent with previous research by Yadav et al. (2024) in *Coccinia grandis*, Yadav et al. (2024) in *Momordica dioca*, and Asna et al. (2020) in bitter gourd.

Seed-related traits were assessed after harvesting to determine their significance in categorising spine gourd genotypes and their relevance in consumer preference and marketing. Among these traits, based on variation in seediness, the genotypes were classified into three distinct groups: few-seeded (8), medium-seeded (21) and more-seeded (2). Seed colour was divided into three main groups: yellow (10 genotypes), yellowish black (15 genotypes), and black (6 genotypes). Seed shape showed three significant variations, with pictures taken at 2x magnification showing flat shape in 4 genotypes, round shape in 20 genotypes, and oval shape in 7 genotypes. Genotype identification based on discernible qualitative characteristics was conducted and reported by various researchers: Behera et al. (2012) in Asian bitter gourd, Karaman et al. (2018) in Turkish bitter melon, and Verma & Joshi (2025) in bitter gourd. These studies contributed to the comprehensive understanding of spine gourd genotypes and their morphological variations.

Shannon's Diversity Indices

Diverse parents are a key requirement for any hybridisation programme. Frequency distribution of the diversity index was estimated using the 'H' index for 17 qualitative traits (Table 4). Shannon's diversity indices for 17 morphological traits ranged from 0 to 1.250, with a mean value. The ' H 'index of the trait leaf margin was observed to be higher (1.25) among all the traits, while node colour at the attachment of the leaves had a minimum value (0.239). These findings align with similar observations reported by previous studies (Bhagat et al. 2017). The studies also support the notion that leaf margin is a highly diverse trait, whereas node colour at the leaf attachment site exhibits minimal diversity.

Table 4: Frequency distribution and Shannon-Weaver diversity index for various qualitative traits of spine gourd genotypes

S. No.	*Descriptors*	*Score*	*Genotype frequency*	*Percentage contribution (%)*	*Shannon's diversity index*
1.	Leaf Margin				1.25
	Absent(no attachment)	1	2	6.45	
	Slightly dented (SD)	3	11	35.5	
	Dented (D)	5	11	35.5	
	Serrated (5 lobes)	7	7	22.6	
2.	Leaf pubescence				0.914
	Absence (Ab)	1	19	61.3	
	Few (F)	3	8	25.8	
	Medium (M)	5	4	12.9	
	More (Mo)	7	0	0	
3.	Days of first flowering				0.939
	Early (less than 30 days)	1	18	58	
	Medium (30-40 days)	3	9	29	
	Late (40-60 days)	5	4	12.9	
4.	Number of first flowering node				0.802
	1-10 nodes	1	22	71	
	11-20 nodes	2	5	16.1	
	21-30 nodes	3	4	12.9	
5.	No. of ridges on stem				0.442
	Present (5 ridge)	1	26	83.9	
	Absence no ridge	5	5	16.1	
6.	Stem colour				0.778
	Light green (L.G)	1	19	61.3	
	Green (G)	3	11	35.5	
	Dark green (D.G)	5	1	4	
7.	Node colour at the attachment of the leaves				0.239
	Green (G)	1	29	93.5	
	Blackish green (B.G)	5	2	6.45	
8.	Leaf shape				0.802
	Bi-lobed (BL)	1	22	71	
	Tri-lobed (TL)	3	5	16.1	
	Penta-lobed (PL)	5	4	12.9	
9.	Leaf colour				0.650
	Green (G.)	1	20	65	
	Dark green (D.G.)	3	11	35	
10.	Fruit colour				0.742
	Green (G)	1	23	74	
	Dark green (DG)	3	5	16	
	Light green orange (LG)	5	3	10	
11.	Fruit shape				1.140
	Round (R)	1	9	29	
	Oval (OV)	3	15	48	
	Cylindrical (C)	5	6	19	
	Spindle (S)	7	1	4	
12.	Conical spine density				0.65
	Thin (T)	1	20	65	
	Thick (TK)	3	11	35	
13.	Conical spine strength				0.65
	Soft (S)	1	20	65	
	Hard (H)	3	11	35	
14.	Pedicel attachment with the fruit				0.550
	Depressed (D)	1	2	6	
	Slightly depressed (SD)	3	3	10	
	Pointed (P)	5	26	84	

Cont...

15.	Seediness				0.790
	Few (F)	1	8	26	
	Medium (M)	3	21	68	
	High (H)	5	2	6	
16.	Seed colour				1.030
	Yellow (Y)	1	10	32	
	yellowish-black (YB)	3	15	48	
	Black (B)	5	6	20	
17.	Seed shape				0.883
	Flat (F)	1	4	13	
	Round (R)	3	20	65	
	Oval (O)	5	7	22	

Qualitative Cluster Analysis

A qualitative cluster analysis was conducted on 31 spine gourd genotypes using the UPGMA algorithm in NTSYS pc 2.02i, considering 17 qualitative traits. The resulting dendrogram, as shown in Fig. 5, illustrates the similarities among the genotypes based on the measured qualitative variables. This dendrogram highlights the effectiveness of the methodology in this study for classifying spine gourd genotypes. The dendrogram revealed two distinct clusters: cluster A and cluster B. Cluster A comprised five genotypes, while cluster B comprised 26 genotypes. Within cluster B, further subdivision occurred into two subgroups denoted as 'b_1' and 'b_2'. Subgroup b_1 contained one genotype (RLBKD-16), whereas subgroup 'b_2' encompassed 25 genotypes. Furthermore, these 25 genotypes were segregated into two clusters: one consisting of a single genotype (RLBKD-32) and the other comprising 24 genotypes (Bhagat et al., 2017).

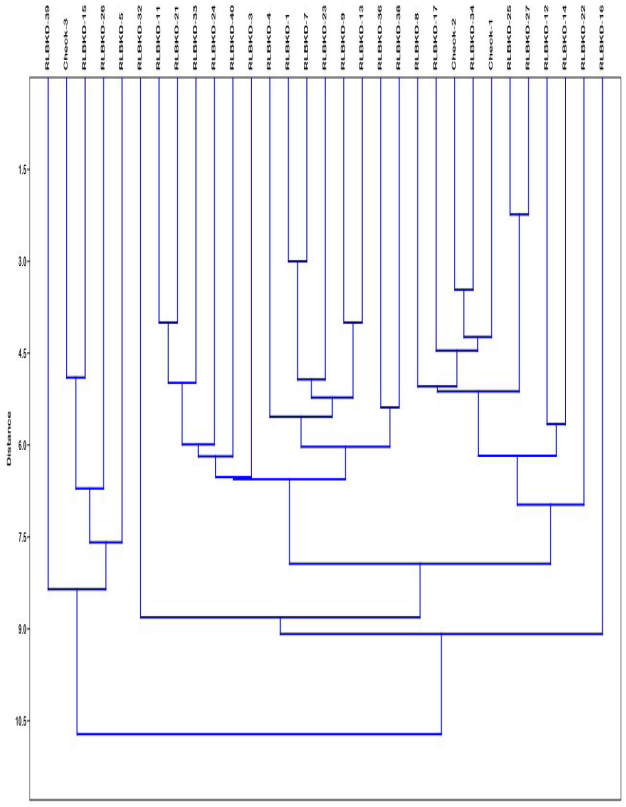

Fig. 5: UPGMA dendrogram based on morphological variability in qualitative traits of 31 spine gourd genotypes

Conclusion

The morphological characterisation of *Momordica dioica* genotypes, along with the assessment of diversity using Shannon's diversity index (H), facilitated the accurate classification of the genotypes. Systematic characterisation of germplasm enables more efficient utilisation of the genetic material, offering advantages over traditional selection methods. Studies have revealed substantial diversity within the spine gourd genotype, particularly in traits such as days to first flowering, fruit colour, fruit size, and seediness. These traits play an important role in determining market and consumer preferences, making them desirable targets for improvement. The presence of diverse morphological characteristics in spine gourd germplasm lines offers plant breeders a wide range of options for selecting and developing improved varieties. This profile served as a valuable resource for the identification, characterisation, and evaluation of elite spine gourd genotypes. Plant breeders can utilise this information to make informed decisions while selecting suitable genotypes for field trials and seed production.

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सारांश

यह अध्ययन 31 स्पाइन गॉर्ड (*Momordica dioica*) जीनोटाइप्स की गुणात्मक रूपात्मक एवं बीज-संबंधी विशेषताओं का मूल्यांकन कर उनकी आनुवंशिक विविधता का आकलन करता है। इस शोध में 17 विशिष्ट लक्षणों का अध्ययन किया गया तथा ऐसी महत्वपूर्ण विविधताओं का अवलोकन किया गया जिनका उपयोग जीनोटाइप्स की पहचान एवं वर्गीकरण में किया जा सकता है। विश्लेषित लक्षणों में पत्ती के किनारे, आकार एवं रंग, साथ ही फल की विशेषताओं जैसे रंग, आकृति एवं स्पाइन घनत्व में उल्लेखनीय विविधता पाई गई। इसी प्रकार, बीज के रंग, आकृति एवं बीज-आकार जैसे लक्षणों में भी पर्याप्त विविधता देखी गई। 17 रूपात्मक लक्षणों के लिए शैनन का विविधता सूचकांक 0.239 से 1.250 के मध्य पाया गया, जिसमें पत्ती के किनारे में सर्वाधिक विविधता (H' = 1.250) तथा पत्तियों के जुड़ने पर नोड के रंग में न्यूनतम विविधता (H' = 0.239) दर्ज की गई। NTSYS एल्गोरिद्म का उपयोग कर किए गए गुणात्मक क्लस्टर विश्लेषण के आधार पर 31 जीनोटाइप्स को दो मुख्य क्लस्टरों में वर्गीकृत किया गया: क्लस्टर A (5 जीनोटाइप्स) एवं क्लस्टर B (26 जीनोटाइप्स)। क्लस्टर B को आगे दो उपसमूहों (IIa और IIb) में विभाजित किया गया। उपसमूह IIa में एक जीनोटाइप (RLBKD-16) शामिल था, जबकि उपसमूह IIb में शेष 25 जीनोटाइप्स पाए गए, जिन्हें आगे एक जीनोटाइप (RLBKD-32) तथा 24 जीनोटाइप्स वाले एक अन्य समूह में विभाजित किया गया। डेंड्रोग्राम जीनोटाइप्स के बीच आनुवंशिक संबंधों एवं विविधता को प्रभावी रूप से प्रदर्शित करता है तथा प्रजनन कार्यक्रमों में चयन के लिए इन लक्षणों के महत्व को रेखांकित करता है। ये स्थिर एवं पर्यावरण से अपेक्षाकृत अप्रभावित लक्षण फसल सुधार हेतु प्रजनन कार्यक्रमों में प्रभावी चयन के लिए अत्यंत उपयोगी सिद्ध हो सकते हैं तथा स्पाइन गॉर्ड में भविष्य के आनुवंशिक सुधार प्रयासों के लिए एक सुदृढ़ आधार प्रदान करते हैं।