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RESEARCH ARTICLE

Morphological diversity and high-yielding potential of foxtail millet (*Setaria italica*): Insights from germplasm characterization

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Abstract

The morphological diversity of 50 foxtail millet accessions was assessed by evaluating ten morphological traits. Phenotypic scores for the 50 genotypes were provided based on the descriptor of *Setaria italica.* Based on the percentage of phenotypic variants, 84 % of the genotypes were not pigmented (green), 66 % were medium lodging, 88 % were essentially glabrous, 98 % with green leaf, 86 % were actively growing, 74 % with short inflorescence lobes, 42 % with medium inflorescence bristles, 54 % with medium inflorescence compactness and 86 % had ovate inflorescence shape. Only 2 % of the genotypes were pigmented with anthocyanin pigments on theleaf and none were found to have obovate inflorescence. The dendrogram generated indicated that the genotypes were grouped into 11 clusters at 0.74 co-efficient level. Maximum number of genotypes (13) was grouped in cluster XI. The genotypes in this cluster had similar morphological characters. The maximum number of 4 high yielding genotypes Kangani (22.25 g), Bhedi (19.54 g), SE 201 (10.38 g) and Navn (9.20 g) were found to be grouped under cluster X. All of these were non-pigmented, medium compact and ovate inflorescence with short inflorescence lobes. The findings provide crucial insights into the morphological traits that can be utilized in foxtail millet breeding programs. The identified high-yielding genotypes with favourable characteristics, such as compact and ovate inflorescence, can be valuable resources for developing superior varieties and hybrids, enhancing productivity and adaptability in diverse agro-climatic conditions.

Keywords: cluster; foxtail millet; germplasm; morphological diversity; yield

Introduction

Foxtail millet is an important grain crop in temperate, subtropical and tropical Asia and southern Europe. China, India and Japan are the major foxtail millet-growing countries in the world. With the rapid development of maize and other crops, foxtail millet has gradually become a minor crop in the last 80 years. However, it is still widely cultivated in Asia, Europe, North America, Australia and North Africa as grain food or forage (1). In India, the crop is grown on a minimal area of around 0.1 million ha in sporadic patches in the states of Andhra Pradesh, Karnataka, Tamil Nadu, Maharashtra, Madhya Pradesh, Uttar Pradesh and North Eastern states, with an annual production of 0.29 mt and productivity of 600 kg /ha. Tamil Nadu is grown in an average area of about 3000 ha and covers western zones, particularly in Coimbatore, Madurai, Dindugal, Erode, Salem and Tirunelveli districts (2, 3). Foxtail millet is an underutilized, drought-tolerant crop that stands to become much more critical in a potentially much warmer and drier future environment (4).

Foxtail millet holds immense potential in addressing food security and climate resilience. As a highly nutritious and drought-tolerant crop, it plays a crucial role in regions with erratic rainfall and poor soil fertility (5). The grain is rich in protein, fibre and micronutrients, making it a valuable alternative for combating malnutrition. Moreover, foxtail millet has a short growth cycle and requires minimal inputs, making it an economically viable option for smallholder farmers in resource-limited areas (6). Given the increasing frequency of extreme weather events and the growing need for sustainable agriculture, foxtail millet stands to gain renewed significance as an adaptable crop for future food systems.

Wide genetic diversity is available in foxtail millet and characterizing these resources is a prerequisite for the genetic improvement of its landraces, cultivars and cultures. Variational variability in crop plants is beneficial for selecting parents for the hybridization programme. Plant selection based on phenotype or morphology is valid and can directly serve in selecting source material in breeding for biotic and abiotic stresses. Phenotypic traits are frequently affected by environmental conditions and development stages of the

plant and are hence considered to be of limited importance (7). However, phenotypically superior parents with good phenotypic or morphological expression led to better expression in future generations. The present study aimed to assess the extent of morphological divergence and yield potential among 49 foxtail millet accessions obtained from ICRISAT germplasm collection and the local check CO 7. The study aims to morphologically characterize the foxtail millet genotypes available in the national germplasm repository and better utilization in further breeding programmes.

Materials and Methods

The present study comprised 49 foxtail millet germplasm accessions collected from ICRISAT, Hyderabad and a ruling local check variety, CO7. The experiment was carried out at the Department of Plant Breeding and Genetics, Agricultural College and Research Institute, Madurai, India, during the *rabi* and summer 2019 seasons with varied environmental conditions (Table 1) in Randomized Block Design (RBD) with three replications. Each entry was sown in a single row with a spacing of 60 cm between rows and 15 cm between plants. The package of practices recommended by Tamil Nadu Agricultural University for foxtail millet was followed throughout the cropping period. In concern with the yield of millet crops, the following 13 yield correlated quantitative characters *viz*., days to 50% flowering, plant height, number of tillers per plant, number of productive tillers per plant, flag leaf length, flag leaf width, panicle exertion, length of inflorescence, panicle length, panicle width, single panicle weight, straw yield per plant and grain yield per plant were considered predominantly in diversity studies. Ten morphological traits such as plant pigmentation, blade pubescence, sheath pubescence, leaf colour, degree of lodging at maturity, senescence, inflorescence lobes, inflorescence bristles, inflorescence compactness and inflorescence shape were recorded as per the descriptor of *Setaria italic* (IBPGR 1985) based on the PPV & FRA guidelines. All observations were recorded on five randomly selected plants for each genotype at various crop growth stages. The data obtained was then subjected to standard statistical procedures using TNAU-Stat software. The phenotypic scores were converted to binary data and subjected to cluster analysis based on NTSYS (Numerical Taxonomy and Multivariate Analysis System), a widely used software for analyzing genetic diversity, phylogenetic relationships and clustering patterns among individuals or populations based on molecular, morphological, or other types of data - PC similarity co-efficient and Unweighted Paired Group Method with Arithmetic Mean (UPGMA) clustering method.

Results and Discussion

Analysis of variance revealed significant differences among the 49 genotypes along with one check. All genotypes were scored for ten morphological traits; the scores are presented in Table 1.

The frequency distributions for different phenotypic classes of the morphological characters were calculated and the details of phenotypic variants observed for ten morphological characters are listed in Table 3.

Plant pigmentation was observed under three categories: not pigmented, pigmented and deep purple. Eight genotypes *viz.*, Hirlla navne, Koni dhan, Kuruvai kepai, SAR 2 (F × M), A 109/1-1, SE 480, SE 2482 and CO 7 had pigmentation on plants (16 %) and the remaining 84 % genotypes were not pigmented and green in colour. None of the plants showed deep purple. Blade pubescence was observed during the flowering stage of the crop. Most of the genotypes were essentially glabrous 88 % (44 genotypes), while the remaining 6 genotypes *viz*., Kupam, Mobbu navne, Kangni, Kuurvai kepai, SAR 1718 and SE 480 had medium pubescence 12 %.

For the character sheath pubescence, the majority of 43 genotypes were categorized as essentially glabrous (86 %) and the remaining 7 genotypes *viz.*, Kaon, Kupam, Mobhu navne, Kangni, Kuruvai kepai, SAR 1718 and SE 105/1-1 were medium pubescent (14 %). Observation on leaf colour was made during the vegetative stage of the crop. Most 49 genotypes (98 %) showed green leaf colour and only a check variety of CO 7 noticed anthocyanin pigments on the leaf (2 %). The genotypes were grouped into two categories to observe the degree of lodging at maturity. The majority of 33 genotypes showed medium lodging with a phenotypic score of 5 (66 %) while the remaining 17 genotypes *viz.*, Bhedi, Kangani, Mosu tenai, Vellai tenai, Hirlla navne, Mobbu navni, Navne, Kangni, Kawni, Tangun, Kangni, KEP 16 (F × M), JNSE 9 A, SE 201, SE 7261/2-1, DT 46888 and CO 7 had very slight lodging with the phenotypic score of one (34 %).

Based on the field performance of the genotypes, the senescence characters were classified into two types, of which the majority of 43 genotypes were growing well in the field condition and scored as actively increasing (86 %). In contrast, the remaining 7 genotypes (14 %) viz., Kangni, SAR 2 (F × M), A 109/1-1, SE 703, SE 21741, SE 7230/3-1 and DT 4696 showed poor field performance and scored as dead with the phenotypic score of 9. Inflorescence lobes were classified into four types, short inflorescence lobe was the most predominant class with 37 genotypes (74 %) followed by long inflorescence lobe 8 genotypes (16 %) and only two genotypes KEP 51 (F × M) and ISe 249 A; Navne exhibited large and thick inflorescence lobes (4 %), while in 3 genotypes *viz*., Kaoni, Vellai tenai and SE

Table 1. Characterization of the growing environment based on location, growing season and meteorological parameters.

S. No	Particulars	Rabi (2019)	Summer (2019)
1	Environment name	Madurai	Madurai
2	Location	AC&RI, TNAU, Madurai	AC&RI, TNAU, Madurai
6	Latitude/Longitude/Altitude	10.0701°N, 78.2041°E,	10.0701°N, 78.2041°E,
7	Soil texture	Sandy loam	Sandy loam
8	pH	7.5	7.7
9	Mean maximum temperature (°C)	29.6 ° C	36 ° C
10	Mean minimum temperature (°C)	18 ° C	22.3 ° C
11	Total rainfall (mm)	918 mm	840 mm

Table 2. Phenotypic scores of ten morphological traits for 50 foxtail millet genotypes

Genotype	Plant pigmentation	Blade pubescence	Sheath pubescence	Leaf colour	Degree of Lodging at maturity	Senescence	Inflorescence lobes	Inflorescence bristles	Inflorescence compactness	Inflorescence shape
Korra	0	1	1	1	5	1	3	5	5	3
Kaon	0	1	5	1	5	1	3	5	5	3
Kaoni	0	1	1	1	5	1	0	7	9	3
Bhedi	0	1	1	1	1	1	3	5	5	3
Kangani	0	1	1	1	1	1	3	5	5	3
Kupam	0	5	5	1	5	1	7	7	5	3
Mosu tenai	0	1	1	1	1	1	3	5	5	3
Vellai tenai	0	1	1	1	1	1	0	3	9	1
Hirlla navne	3	1	1	1	1	1	7	1	7	3
Mobbu navne	0	5	5	1	1	1	7	1	5	3
Navne	0	1	1	1	1	1	3	5	5	3
Bili navne	0	1	1	1	5	1	3	3	5	3
Kangni	0	5	5	1	1	1	3	7	5	3
Kawni	0	1	1	1	1	1	3	3	5	3
Koni dhan	3	1	1	1	5	1	7	7	5	3
Tangun	0	1	1	1	1	1	3	5	7	3
Kangni	0	1	1	1	1	1	3	5	5	1
Kuruvai kepai	3	5	5	1	5	9	3	5	5	3
KEP 8 (F × M)	0	1	1	1	5	1	3	5	7	3
KEP 51(F × M)	0	1	1	1	5	1	9	7	3	3
KEP 6 (F × M)	0	1	1	1	5	1	3	1	7	3
KEP 16(F × M)	0	1	1	1	1	1	3	5	3	3
SAR 2 (F × M)	3	1	1	1	5	9	3	5	3	3
SAR 1659-1	0	1	1	1	5	1	3	1	7	3
SAR 1706	0	1	1	1	5	1	3	1	7	3
SAR 1718	0	5	5	1	5	1	3	3	7	5
SAR 1903	0	1	1	1	5	1	3	5	3	3
A 107/1	0	1	1	1	5	1	3	5	3	3
A 109/1-1	3	1	1	1	5	9	3	5	5	5
JNSE 9A	0	1	1	1	1	1	3	3	5	5
SE 105/1-1	0	1	5	1	5	1	3	5	3	3
SE 201	0	1	1	1	1	1	3	5	3	3
SE 480	3	5	1	1	5	1	0	7	7	3
SE 703	0	1	1	1	5	9	3	1	5	3
SE 21741	0	1	1	1	5	9	3	1	5	3
SE 2482	3	1	1	1	5	1	3	5	3	3
SE 2994	0	1	1	1	5	1	7	1	5	5
SE 3045	0	1	1	1	5	1	3	3	3	3
SE 4929	0	1	1	1	5	1	7	1	5	3
SE 7230/3-1	0	1	1	1	5	9	3	1	5	3
SE 7261/2-1	0	1	1	1	1	1	3	3	5	3
PR 4722	0	1	1	1	5	1	7	5	7	3
DT 4675	0	1	1	1	5	1	3	1	7	5
DT 4682	0	1	1	1	5	1	3	3	5	3
DT 4688	0	1	1	1	1	1	3	3	3	3
DT 4696	0	1	1	1	5	9	7	5	5	3
ISe 249A; Navne	0	1	1	1	5	1	9	5	5	3
ISe 277 F; Bahadur	0	1	1	1	5	1	3	3	3	3
ISe 397 A; Kangni	0	1	1	1	5	1	3	3	5	3
Co 7 Check	3	1	1	3	1	1	3	7	5	0

Table 3. Phenotypic variants observed for ten morphological traits

S.No	Character	Phenotypic variation	Phenotypic score	Number of variants	Percentage of variants
1.	**Plant pigmentation**	Not pigmented (green)	0	42	84.00
		Pigmented	3	8	16.00
		Deep purple	7	0	0.00
2.	**Blade pubescence**	Essentially glabrous	1	44	88.00
		Medium pubescent	5	6	12.00
		Strongly pubescent	9	0	0.00
3.	**Sheath pubescence**	Essentially glabrous	1	43	86.00
		Medium pubescent	5	7	14.00
		Strongly pubescent	9	0	0.00
4.	**Leaf colour**	Green	1	49	98.00
		Yellow	2	0	0.00
		Pigmented	3	1	2.00
		Deep purple	4	0	0.00
5.	**Degree of lodging at maturity**	Very slight	1	17	34.00
		Medium	5	33	66.00
		Extensive	9	0	0.00
6.	**Senescence**	Actively growing	1	43	86.00
		Dead	9	7	14.00
7.	**Inflorescence lobes**	Absent	0	3	6.00
		Short	3	37	74.00
		Long	7	8	16.00
		Large and thick	9	2	4.00
8.	**Inflorescence bristles**	Very short	1	11	22.00
		Short but obvious	3	11	22.00
		Medium	5	21	42.00
		Long	7	7	14.00
		Carrying a spikelet	9	0	0.00
9.	**Inflorescence compactness**	Loose	3	11	22.00
		Medium	5	27	54.00
		Compact	7	10	20.00
		Spongy	9	2	4.00
10.	**Inflorescence shape**	Oblong	1	2	4.00
		Ovate	3	43	86.00
		Elliptic	5	5	10.00
		Obovate	7	0	0.00

480 (6 %) inflorescence lobes were absent. Inflorescence bristles characters were classified into five types: the majority of 21 genotypes had medium (42 %), followed by each 11 genotypes for very short (22 %) and short but obvious (22 %), 7 genotypes viz., Kaoni, Kupam, Kangni, Koni dhan, KEP 51 (F × M), SE 480 and CO 7 exhibited with long inflorescence bristles (14 %) and none of the genotypes was found with a character inflorescence bristle carrying a spikelet.

The trait of inflorescence compactness (Fig. 1) is classified into four types. The majority of 27 genotypes in this study had medium inflorescence compactness (54 %), followed by loose inflorescence 11 genotypes (22 %), compact inflorescence 10 genotypes (20 %) and only 2 genotypes (4 %) Kaoni and Vellai tenai produced spongy inflorescence compactness. Regarding inflorescence shape (Fig. 2) majority of 43 genotypes had ovate shape inflorescence (86 %) followed by elliptic 5 genotypes (10 %) and only two genotypes Vellai tenai and Kangni showed oblong shape inflorescence (4 %). None of the genotypes were found to have obovate inflorescence (Table 3). Research indicates similar results in earlier workers (8-11).

The phenotypic score observed for fifty genotypes for ten morphological traits were further converted to binary data and were subjected to cluster analysis based on NTSYS - PC (Rholfs') (1998) similarity co-efficient and UPGMA clustering method. The dendrogram generated indicated that the genotypes were grouped into 11 clusters at 0.74 co-efficient level and is represented in Fig. 3. From the cluster diagram, it is evident that cluster XI included maximum genotypes (13), while clusters I, II, VI and IX had only one genotype each. The distribution of 50 genotypes into different clusters is presented in Table 4.

Grouping of genotypes into different clusters based on NTSYS method for morphological traits revealed that the genotypes were grouped into 11 different clusters. Maximum number of genotypes (13) was grouped in cluster XI (Table 4). The genotypes of this cluster had similar plant pigmentation, blade pubescence, sheath pubescence, leaf colour, degree of lodging at maturity, senescence, inflorescence lobes, inflorescence bristles, inflorescence compactness and inflorescence shape are contributed towards more yield. These findings are consistent with previous studies, such as those by (9) and (11), which also highlighted the significant role of agronomic traits in distinguishing genotypic variation and their relationship to yield. Specifically, similar clustering patterns when studying foxtail millet germplasm, noting the impact of these traits on genetic diversity and performance (9). Likewise, research indicates that morphological traits are key differentiators in the DUS (Distinctness, Uniformity and Stability) characterization of foxtail millet accessions, reinforcing the importance of such traits in agronomic selection and yield improvement (11). These results, thus, confirm earlier findings while highlighting the specific morphological characteristics contributing to enhanced productivity in foxtail millet.

Fig. 1. Variation in inflorescence compactness.

Fig. 2. Variation in inflorescence shape.

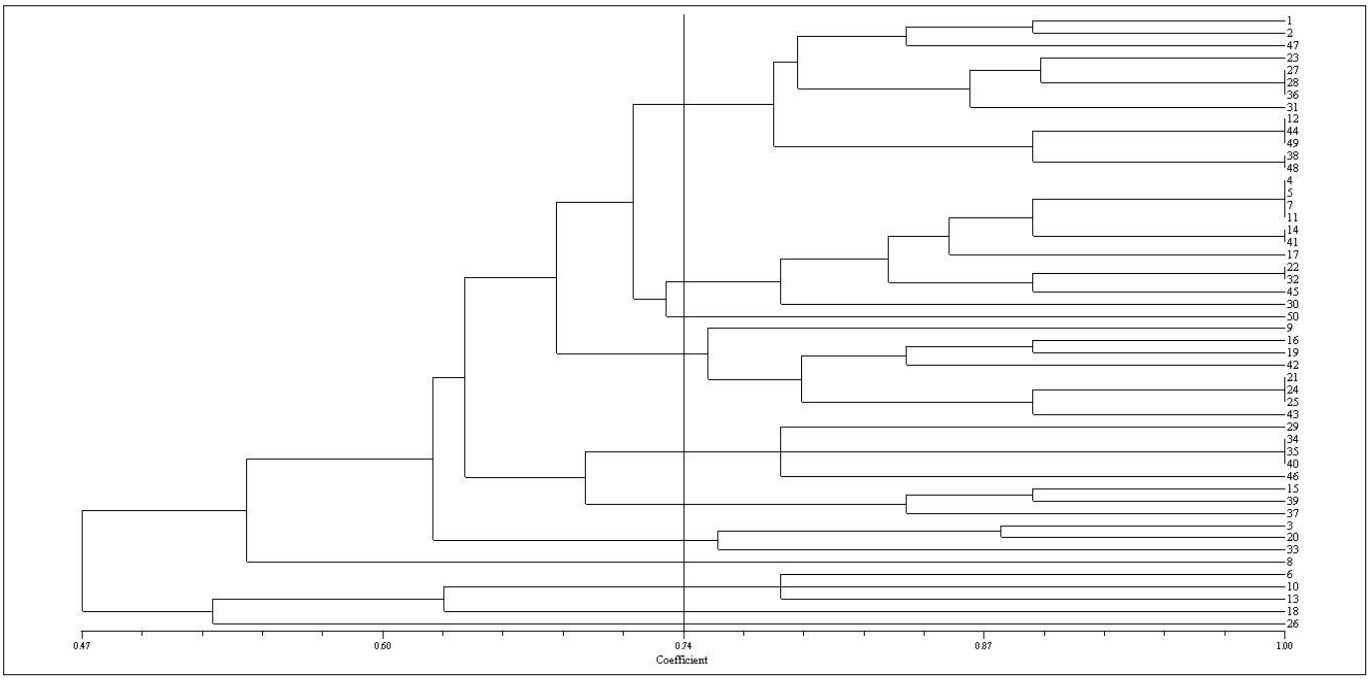

Fig. 3. UPGMA dendrogram developed for ten morphological traits of 50 foxtail millet genotypes.

Table 4. Distribution of 50 foxtail millet genotypes into different clusters for ten morphological traits

Cluster	Number of genotypes	List of genotypes
C I	1	SAR 1718
C II	1	Kuruvai kepai
C III	3	Kupam, Mobbu navne, Kangani
C IV	1	Vellai tenai
C V	3	Kaoni, KEP 5-1 (F × M), SE 480
C VI	3	Koni dhan, SE 2994, SE 4929
C VII	5	A 109/1-1, SE 703, SE 21741, SE 7230/3-1, DT 4696
C VIII	8	Hirlla navne, Tanguni, KEP 8-1 (F×M), PR 4722, KEP 6 (F × M), SAR 1659-1, SAR 1706, DT 4675
C IX	1	Co 7
C X	11	Bhedi, Kangani, Mosu tenai, Navne, Kawni, Kangni, KEP 16 (F × M), SE 201, JNSE 9 A, SE 7261/2-1, DT 4688
C XI	13	Korra, Kaon, ISe 249 A; Navne, SAR 2 (F × M), SAR 1903, A 107/1, SE 2482, SE 105/1-/, Bili navne, DT 4682, ISe 397 A; Kangni, SE 3045, ISe 277 F; Bahadur

The presence of morphological divergence in foxtail millet germplasm (Fig. 4) also influences the yield performance through different quantitative traits. The genotype Kangani in cluster X registered early days to 50 % flowering (45.67 days). The high-yielding genotype Bili navne in cluster XI contributed a high mean value for a maximum of four yield contributing traits *viz.*, number of productive tillers per plant (10.13), panicle width (1.38 cm), single panicle weight (5.93 g) and grain yield per plant (22.25 g). Hence the selected genotype Bili navne can be utilized as a parent in a crossing programme will be reflected with the transmission of these identified characters in the segregating generations. Genotype Kupam in cluster III recorded higher mean value for plant height (120.40 cm) and panicle length (12.60 cm) while: KEP 5-1 (F × M) in cluster V registered high values for flag leaf length (34.23 cm) and flag leaf width (2.03 cm). KEP 8 (F × M) and Hirlla navne in cluster VIII recorded maximum mean value for panicle excretion (26.85 cm) and straw yield per plant (43.91 g), respectively. SAR 17186 in cluster I registered the maximum mean value for the character length of inflorescence (34.84 cm). The check variety CO 7 in cluster IX registered a maximum mean value for the number of tillers per plant (12.23) (Table 5).

In the present study, the genotypes SAR 1718, Kuruvai kepai, Vellai tenai and the check variety CO7 were individually grouped in cluster I, cluster II, cluster IV and cluster IX respectively, which may be due to their distinct phenotypic appearance driven by underlying genetic factors and environmental adaptations. The genotype SAR 1718 had medium pubescence, compact and elliptic inflorescence and medium degree of lodging at maturity. Kuruvai kepai had purple pigmentation, medium sheath and blade pubescence and dead senescence. These traits suggest genetic variations influencing plant architecture and stress responses, which could explain their separate clustering. The genotype Vellai tenai had spongy inflorescence compactness. CO7 had anthocyanin pigments on the leaf, an oblong inflorescence shape with long bristles. Anthocyanin presence is often linked to abiotic stress tolerance, which may contribute to its distinct grouping. The high-yielding genotypes Bhedi (19.54 g), Kangani (20.47 g), Navne (9.20 g) and SE 201 (10.38 g) were found to be under cluster X. These genotypes shared traits such as non-pigmentation, medium compact and ovate inflorescence and short inflorescence lobes, indicating common genetic factors that contribute to higher grain production and efficient resource allocation. All non-pigmented had medium compact and ovate inflorescence with short inflorescence lobes. The same as in cluster V, genotypes KEP 5-1 (F × M) (19.41 g) and Kaoni (11.33 g) registered similar characters, likely due to shared genetic backgrounds influencing grain size and inflorescence structure. Adding up Bili navne (22.25 g) with other 12 genotypes in cluster XI, Hirlla navne (19.66 g) with other 7 genotypes in cluster VIII, A 109/1-1 (10.94 g) with other 4 genotypes in cluster VII and SAR 1718 (8.43g) alone in cluster I registered high yield, which may be due to their distinct phenotypic appearance (Table 6). The clustering pattern suggests that genotypes with similar adaptive traits like drought resistance, disease tolerance and nutrient uptake efficiency tend to group due to their shared genetic makeup and selective pressures in different environments. Previous studies reported similar results (8, 10-15). The grouping of genotypes is usually based on the genetic background of the various genotypes, but the morphological differences expressed by the genotypes are due to the varied environmental conditions. These findings reinforce that ecological interactions can modify phenotypic expressions of genetically similar genotypes, further shaping cluster formation.

Conclusion

The above information on morphological characters in foxtail millet germplasm provides an idea that would assist in selecting high-yielding genotypes. Generally, diversity based on morphological characters is not important when the breeding programme aims to improve yield. However, the environment influences morphological traits when selecting high-yielding foxtail millet plants. The morphological characteristics, *viz.* non-pigmented plants having medium compact and ovate inflorescence with short inflorescence lobes, are to be considered along with the quantitative characters to gain outstanding results in developing varieties and hybrids in foxtail millet.

Fig. 4. Morphological Variation in panicle architecture with in *Setaria italica* accessions.

Table 5. Morphological divergence of best performing foxtail millet genotypes for yield contributing traits

Characters	Range	Mean	SEd	Best performing genotypes	Divergence in cluster
Days to 50% flowering	45.67 - 64.33	53.80	1.26	Kangani	**X**
Plant height	54.61 - 120.40	80.71	1.01	Kupam	**III**
Number of tillers per plant	3.27 - 12.23	5.83	0.33	CO 7	**IX**
Number of productive tillers per plant	2.53 - 10.13	5.03	0.34	Bili navne	**XI**
Flag leaf length (cm)	14.94 - 34.23	21.75	1.14	KEP 5-1 (F × M)	**V**
Flag leaf width (cm)	0.96 - 2.03	1.38	0.11	KEP 5-1 (F × M)	**V**
Panicle exertion	10.33 - 26.85	16.37	1.66	KEP 8 (F × M)	**VIII**
Length of inflorescence	15.71 - 34.84	24.24	1.08	SAR 1718	**I**
Panicle length	6.05 - 12.60	9.05	0.67	Kupam	**III**
Panicle width	0.69 - 1.38	0.99	0.03	Bili navne	**XI**
Single panicle weight (g)	0.51 - 5.93	1.97	0.09	Bili navne	**XI**
Straw yield per plant (g)	4.23 - 43.91	14.04	2.14	Hirlla navne	**VIII**
Grain yield per plant (g)	1.50 - 22.25	6.44	1.12	Bili navne	**XI**

Table 6. Identified top 10 high yielding foxtail millet genotypes and its divergence in clusters

Sr. No.	Accession	Grain yield / plant (g)	Divergence in cluster
1	**Bili navne**	22.25*	XI
2	**Kangani**	20.47*	X
3	**Hirlla navne**	19.66*	VIII
4	**Bhedi**	19.54*	X
5	**KEP 5-1 (F × M)**	19.14*	V
6	**Kaoni**	11.33	V
7	**A 109/1-1**	10.94	VII
8	**SE 201**	10.38	X
9	**Navne**	9.20	X
10	**SAR 1718**	8.43	I

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Authors' contributions

GA and CV participated in the conceptualization, methodology, writing and editing of the original draft of the manuscript. All the authors read and approved the final version of the manuscript.

Compliance with ethical standards

Conflict of interest: The authors do not have any conflict of interest to declare.

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References

1. Ingle KP, Suprasanna P, Narkhede GW, Ceasar A, Abdi G, Raina A, et al. Biofortified foxtail millet: towards a more nourishing future. Plant Growth Regul. 2023;99(1):25–34. https://doi.org/10.1007/s10725-022-00900-2
2. Gobikashri N, Kumar KU, Flora GJ, Kousalya A, Kavinesh VS. Correlation and regression studies of growth, yield attributes, yield and nutrient uptake of foxtail millet under different varieties and landraces. Int J Environ Clim Change. 2023;13(8):1139–45. https://doi.org/10.9734/ijecc/2023/v13i82052
3. Maharajan T, Duraipandiyan V, Krishna TP, Soosaimanickam M. Nutritional values of foxtail millet (*Setaria italica*) and other millets used for common diseases and management. Curr Nutri Food Sci. 2024;20(9):1056–68. https://doi.org/10.2174/0115734013266504231025050553
4. Iqbal S, Bhat MA, Sheikh TA, Baba ZA. Deciphering the importance of underutilized millet crop towards sustainable feed and food sources. Curr J Appl Sci Technol. 2023;42(48):165–75. https://doi.org/10.9734/cjast/2023/v42i484351
5. Nagaraja TE, Parveen SG, Aruna C, Hariprasanna K, Singh SP, Singh AK, et al. Millets and pseudocereals: A treasure for climate resilient agriculture ensuring food and nutrition security. Indian J Gen Plant Breed. 2024;84(01):1–37. https://doi.org/10.31742/ISGPB.84.1.1
6. Tiwari H, Naresh RK, Kumar L, Kataria SK, Tewari S, Saini A, et al. Millets for food and nutritional security for small and marginal farmers of North West India in the context of climate change: A review. Int J Plant Soil Sci. 2022;34(23):1694–705. https://doi.org/10.9734/ijpss/2022/v34i232594
7. Mareri L, Parrotta L, Cai G. Environmental stress and plants. Int J Mol Sci. 2022;23(10):5416. https://doi.org/10.3390/ijms23105416
8. Reddy VG, Upadhyaya H, Gowda C. Characterization of worlds' foxtail millet germplasm collections for morphological traits. Int Sorghum Millets Newsletter. 2006;47:107–09.
9. Lin H, Liao G, Chiang C, Kuoh C, Chang S. Genetic diversity in the foxtail millet (*Setaria italica*) germplasm as determined by agronomic traits and microsatellite markers. Australian J Crop Sci. 2012;6(2):342–49.
10. Yogeesh L, Shankar K, Prashant S, Lokesh G. Genetic variation and morphological diversity in foxtail millet. Int J Sci Envt Tech. 2015;4(6):1496–502. https://doi.org/ 10.9734/ijecc/2022/v12i1131285
11. Amarnath K, Prasad A, Reddy C. DUS characterization of germplasm accessions in foxtail millet (*Setaria italica* (L.) Beauv.). Int J Curr Microbiol Appl Sci. 2019;8(2):2410–22. https://doi.org/10.20546/ijcmas.2019.802.281
12. Kim EJ, Sa KJ, Yu CY, Lee JK. Morphological variation of foxtail millet (*Setaria italica* (L.) P. Beauv.) germplasm collected in Korea, China and Pakistan. Korean J Breed Sci. 2010;42(2): https://doi.org/10.5958/0975-928X.2016.00038.7
13. Brunda S, Kamatar M, Naveenkumar K, Hundekar R, Sowmya H. Evaluation of foxtail millet S*etaria italica* genotypes for grain yield and biophysical traits. J Global Biosci. 2015;4(5):2142–49.
14. Anand G, Thamizhmani S, Vanniarajan C. Genetic diversity study in germplasm lines of foxtail millet (*Setaria italica* (L.) Beauv). Electron J Plant Breed. 2020;11(03):976–80. https://doi.org/10.37992/2020.1103.159
15. Rajalakshmi K, Manivannan N, Anand G, Vanniarajan C, Harish S. Genetic divergence among blackgram (*Vigna mungo* (L.) Hepper) genotypes using Mahalanobis D2 statistic. Electron J Plant Breed. 2020;11(01):116–19. https://doi.org/10.37992/2020.1101.020

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