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Research Article

Qualitative characterization and clustering of early-maturing barnyard millet (*Echinochloa spp*.) germplasm

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Abstract

Thirty barnyard millet germplasm along with a MDU 1 check variety were characterized for 15 qualitative traits. The characters like growth habit, plant pigmentation, inflorescence color, inflorescence shape, compactness of inflorescence, shape of lower raceme, blade pubescence and grain color showed greater frequency of variants. There were no variants found for traits like branching of lower raceme, senescence and grain shape. The cluster analysis of these 30 accessions using Un weighted Pair Group Method with Arithmetic Mean (UPGMA) led to the grouping of accessions under 11 clusters. Cluster I was the largest cluster with 6 accessions followed by cluster V and VI with 4 each, cluster IV and VIII with 3, clusters II, VII, IX and X with 2 accessions each and Clusters III and XI with one accession each. The genotypes between the clusters are more diverse and hence they could be identified and utilized in future breeding programme.

Key words
Qualitative characterization, barnyard millet

Introduction

Barnyard millet (*Echinochloa spp*.) is one of the oldest domesticated millets in the semiarid tropical regions of Asia and Africa. Two main species, *Echinochloa esculenta* (Japanese barnyard millet) and *Echinochloa frumentacea* (Indian barnyard millet) are being cultivated and grown as cereals. It is considered as a staple cereal in areas where climatic and edaphic conditions are unsuitable for rice cultivation (Yabuno, 1987). In India, barnyard millet was cultivated in about 146,000 ha with production of 151,000 tons during 2016 (Bhat *et al*. 2018). Barnyard millet is grown for human consumption as well as fodder particularly by the hilly and tribal communities in India, China and Japan. High nutrient content and antioxidant effects make it to be considered as a functional food crop. Recently, the demand of the crop has increased due to its highly nutritious grains. The protein content in barnyard millet ranged from 11.1% to 13.9% (Monteiro *et al.*, 1988). The barnyard millet grain contains about 65% carbohydrate, majority of which is in the form of non starchy polysaccharide and dietary fibre. This helps in the prevention of constipation, lowering of blood cholesterol and slow release of glucose into the blood stream during digestion. Thus, it has the potential to provide both food and nutritional security particularly in hills where nutritional deficiencies are in abundance. Despite enormous potential, the crop has not gained the popularity among masses and is still believed to be poor man's food. Utilization of barnyard millet genetic resources for crop improvement falls far short of the desired. Morphological characterization is important for identification of accessions with desirable traits so that they can be employed directly as cultivars or as trait donors for use in crop improvement programs (Upadhyaya *et al.*, 2006)Hence this study was taken up for characterization and evaluation of barnyard millet germplasm for important qualitative traits which thereby constitutes the atmost utilization of desired germplasm by the crop breeders.

Materials and Methods

Twenty nine early maturing barnyard millet germplasm accessions required for this study were obtained from the gene bank, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, India. MDU 1 was used as a check variety. The experiment was carried out in randomized block design (RBD) in two replications along with check variety with a spacing of 30 x 10 cm during *kharif* 2018 and *rabi* 2018-19 at AC and RI, Madurai and Dept. of Forage crops, TNAU, Coimbatore, respectively.

Recommended agronomic practices were followed to raise the crop. Germplasm accessions were characterized for 15 qualitative traits namely, growth habit, plant pigmentation, leaf pigmentation, color of inflorescence, inflorescence shape, compactness of inflorescence, shape of lower raceme, branching of lower raceme, spikelet arrangement, culm branching, blade pubescence, degree of lodging at maturity, senescence, grain color and grain shape and corresponding score was given based on *Echinochloa millet* descriptors developed by IBPGR,1893.The data were subjected to analysis by using NTSYSpc version 2.02i (Rohlf, 1998). Similarity matrix was prepared with similarity coefficient using Simqual. The Unweighted Pair Group Method with Arithmetic Mean (UPGMA) clustering method of the clustering subroutine SAHN was used to construct the dendrogram.

Results and Discussion

In general, qualitative characters show stable and discrete variation that are not mostly influenced by the environment and hence serves as reliable source for plant descriptors. The results of 15 qualitative traits studied are presented in Table 1. The characters like growth habit, plant pigmentation, inflorescence color, inflorescence shape, compactness of inflorescence shape of lower raceme, blade pubescence and grain color showed greater frequency of variants. Medium frequency variants were observed for leaf pigmentation and culm branching. Low frequency of variants were observed for degree of lodging at maturity and spikelet arrangement. There were no variants found for traits like branching of lower raceme and grain shape. Similar results with regards to plant growth habit, pigmentation, culm branching and branching of lower racemes were reported by (Joshi *et al.*, 2015) Similar variation for various qualitative traits in foxtail millet has been reported by(Sapkota *et al.*, 2016) and in barnyard millet by (Renganathan *et al.*, 2017)

The cluster analyses of the 30 accessions for fifteen qualitative characters using the Unweighted Pair Group Method with Arithmetic Mean (UPGMA) method resulted in the grouping of accessions into 11 clusters while truncating the tree at Jaccard's similarity coefficient (1901) of 0.69(Table 2)(Fig. 1). Cluster I was the largest cluster with 6 accessions followed by cluster V and VI with four each, cluster VIII with three, clusters II,VII, IX and X with two accessions each and Clusters III and XI with one accession each. The genotypes IEc 656 and IEc 158 produced solitary cluster indicating the presence of wide diversity for various characters among the accessions. Similar results of solitary clusters were also reported by(Nirubana *et al.*, 2019)in kodo millet. The genotypes within cluster are more diverse than those between clusters. Hence these diverse genotypes can be easily identified and could be used as parent material in hybridization programmes to develop a desired variety.

This study reveals sufficient genetic diversity in barnyard millet for qualitative traits viz., growth habit, plant pigmentation, leaf pigmentation, color of inflorescence, inflorescence shape, compactness of inflorescence, shape of lower raceme, spikelet arrangement, culm branching, blade pubescence, degree of lodging at maturity, and grain color. These variations can be used for easy identification of the genotypes and also can be utilized in breeding programme. The cluster analysis showed that a wide diversity of IEc 656, IEc 158 with other germplasm as they formed solitary clusters. The diverse genotypes between the clusters can be promptly utilized in future breeding programme.

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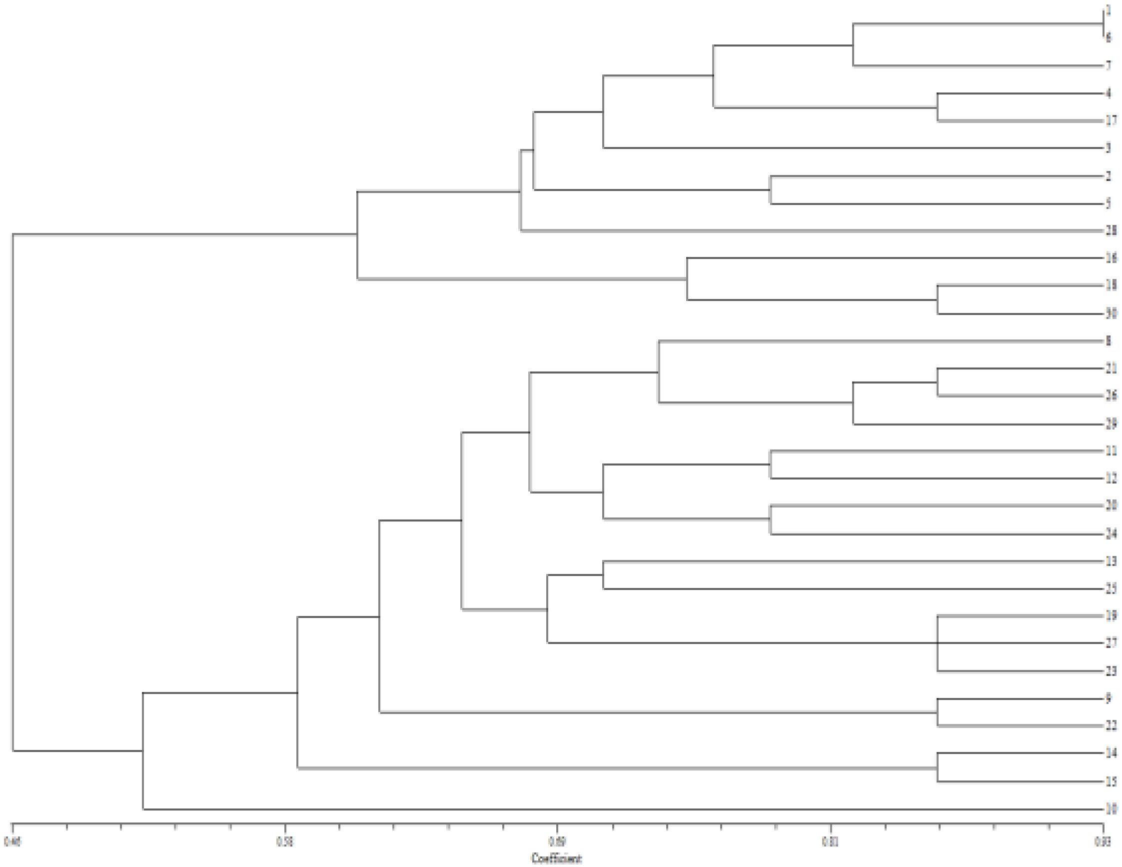
Table 1. Number of phenotypic variants observed for 15 qualitative characters

Character	Score	Phenotype	Number of variants	Percentage of variants
Growth habit	1	Erect	11	36.67
	2	Decumbent	17	56.67
	3	Prostrate	2	6.67
Plant pigmentation	1	Absent	9	30.00
	2	Present	21	70.00
Leaf pigmentation	1	Absent	17	56.67
	2	Present	13	43.33
Color of inflorescence	1	Green	7	23.33
	2	Light purple	17	56.67
	3	Dark purple	6	20.00
Inflorescence shape	1	Cylindrical	17	56.67
	2	Pyramidal	11	36.67
	3	Globose to elliptic	2	6.67
Compactness of inflorescence	3	Open	14	46.67
	5	Intermediate	10	33.33
	7	Compact	6	20.00
Shape of lower raceme	1	Straight	4	13.33
	2	Curved	18	60.00
	3	Slender	8	26.67
Branching of lower raceme	1	Absent	30	100.00
	2	Present	0	0.00
Spikelet arrangement	1	On one side of rachis	3	10.00
	2	Arranged around rachis	27	90.00
Culm branching	3	Low branch number	15	50.00
	5	Medium branch number	15	50.00
	7	High branch number	0	0.00
Blade pubescence	1	Essentially glabrous	11	36.67
	2	Medium pubescent	3	10.00
	3	Strongly pubescent	16	53.33
Degree of lodging at maturity	3	Low	24	80.00
	5	Medium	6	20.00
	7	High	0	0.00
Senescence	0	Absent	30	100.00
	1	present	0	0.00
Grain color	1	Straw white	2	6.67
	2	Grey+Straw white	15	50.00
	3	Brownish grey	2	6.67
	4	Grey	6	20.00
	5	Light grey	5	16.67
Grain shape	1	Concave	30	100.00
	2	Oval	0	0.00

Table 2. Constituents of 11 clusters in barnyard millet germplasm for 15 qualitative traits

Cluster	Number of genotypes contained	Constituent accessions
I	6	IEc 71 (1), IEc 108 (6), 109 (7) IEc 106 (4), IEc 296 (17), Ec 85 (3)
II	2	IEc 82 (2), IEc 107 (5)
III	1	IEc 656 (28)
IV	3	IEc 291 (16), IEc 350 (18), MDU 1 (30)
V	4	IEc 154 (8), IEc 386 (21), IEc 397 (26) , IEc 793 (29)
VI	4	IEc 159 (11), IEc 161 (12), IEc 385 (20), IEc 391 (24)
VII	2	IEc 231 (13), IEc 396 (25)
VIII	3	IEc 356 (19), IEc 399 (27), IEc 389 (23)
IX	2	IEc 157 (9), IEc 387 (22)
X	2	IEc 239 (14), IEc 240 (15)
XI	1	IEc 158 (10)



Each separate line indicates a cluster
Mean genetic dissimilarity – 0.69

Fig. 1. Clustering of 30 accessions of Barnyard millet based on SM coefficient

Non pigmented plant

Pigmented plant

Pigmented leaf

Cylindrical inflorescence with non-pigmented stigma

Pigmented stigma

Dark pigmented inflorescence

Partially pigmented inflorescence

Pyramidal shaped open inflorescence

Elliptical shaped medium compact inflorescence

Globose shaped compact inflorescence

Fig. 2 Morphological differences among Barnyard millet germplasm

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