

Original Research Article

<https://doi.org/10.20546/ijcmas.2018.712.023>

Characterization and Identification of DUS Traits in Reference Set of Foxtail Millet Germplasm (*Setaria italica* (L.) Beauv.)

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ABSTRACT

There is wide genetic diversity available in foxtail millet and characterizing these resources is a prerequisite for genetic improvement. Establishment of the distinctness and to understand the qualitative differentiation among 223 genotypes of reference set of foxtail millet comprising of core set, trait specific genotypes and released varieties in the country were characterized using augmented design during *Kharif* 2012 at experimental plots of Project Coordinating Unit (small millets), GKVK, Bangalore were characterized for four types with 16 qualitative traits which were identified as Distinctiveness, Uniformity and Stability (DUS) test. Study of DUS traits indicated that, majority of the genotypes harboured higher level of ample polymorphism towards erect growth habit, medium sheath pubescence, essentially glabrous blade pubescence, non-pigmented auricle, drooping leaf attitude, non-pigmented inflorescence, pigmented anther, medium bristles on inflorescence, medium inflorescence compactness, long inflorescence lobes, medium lobe compactness, cylindrical inflorescence shape, non-pigmented plants at maturity, presence of apical sterility, white grain colour and oval grain shape score were most predominantly observed in the studied set. These identified DUS traits will be useful for breeders, researchers and farmers to identify and choose the restoration and conservation of beneficial genes and characterization of new varieties of foxtail millet for release and registration.

Keywords

Reference set, Germplasm, Qualitative characters, Characterization, DUS test

Article Info

Accepted:

04 November 2018

Available Online:

10 December 2018

Introduction

Foxtail millet is one of the world's oldest cultivated crop belongs to the grass family Poaceae. Foxtail millet ranks second in the total world's production of millets and is an important staple food for millions of people in

Southern Europe and Asia (Marathee, 1993). Qualitative characters are useful criterion for characterization of group of materials, as they show high heritability and stable expression. Further, if qualitative characters show association with yield components, it can serve as a marker in selection process which

are less influenced by environmental fluctuations. Qualitative traits are easily scorable/assayable, show simple inheritance (single/oligogenic) and stable expression, and selectively neutral (Smith and Smith, 1992), they serve as diagnostic descriptors of germplasm accessions and hence useful to avoid mistakes in labelling, aid identification and minimize duplication in the germplasm and helps easy retrieval of desired accessions from the germplasm database. Qualitative traits polymorphism has been attributed to diversity in phylogeny (Noirot *et al.*, 1996). Characterization should eventually lead to a system of recording and storing useful data that can be readily retrieved and made available to others and help in planning breeding programmes (Debas *et al.*, 1994). Germplasm forms the raw material for any crop improvement program. There is wide genetic diversity available in foxtail millet and characterizing these resources is a prerequisite for the genetic improvement of its cultivars.

The characterization and evaluation are the important pre requisites for effective utilization of germplasm and also to identify sources of useful genes (Upadhyay *et al.*, 2010). Characterization of germplasm is useful to identify and avoid duplication. Qualitative traits being more stable over generations (Raut, 2003) hence are reliable for characterization of germplasm/varieties. Systematic study and characterization of such germplasm is not only important for utilizing the appropriate attribute based donors, but also essential in the present era for protecting the unique foxtail millet. Thus, there is a need to collect, exploit, and evaluate the untapped germplasm. In this context, an attempt was made to characterize a set of foxtail millet germplasm for different morphological traits and identify the variability available in the collection. Keeping in view of these facts, the present investigation was planned to characterize a reference set of foxtail millet in

order to understand the qualitative differentiation for Distinct, Unique and Stable traits to reduce redundancy.

Materials and Methods

The material for the present investigations consisted of two hundred and twenty three germplasm accessions including core set, trait specific accessions and all the released varieties in the country along with 3 National check varieties (SiA 326, SiA 3085 and PS 4) represented as reference set which includes extensive collections from various parts of world maintained at National

Active Germplasm Collection Site (NAGS) were characterized into four groups *viz.*, growth, leaf, floral and grain traits with respect to growth habit, sheath pubescence, blade pubescence, auricle pigmentation, leaf attitude, inflorescence pigmentation, anther pigmentation, inflorescence bristles, inflorescence compactness, inflorescence lobes, lobe compactness, inflorescence shape, plant pigmentation at maturity, apical sterility, grain colour and grain shape using 16 qualitative traits which were identified as Distinctiveness, Uniformity and Stability (DUS) test. The material was grown in augmented design during *Kharif* 2012 at experimental plots of Project Coordinating Unit (small millets), Zonal Agricultural Research Station, University of Agricultural Sciences, GKVK, Bangalore which is located at an altitude of 930 m above mean sea level 13° 05' North and 77°35' East latitude and longitude, respectively. Each accession was grown in a single row of 3 m length with a spacing of 30 cm between rows and 10 cm between plants within a row (30 cm X 10 cm) for characterization of reference set at different stages of crop growth was carried out. Observations were recorded on five randomly chosen plants of each accession for growth, leaf, floral and grain traits. The

reference set germplasm were characterized based on the descriptors of *Setaria italica* and *S. pumila* (IBPGR, 1985) and by using evaluation of foxtail millet germplasm catalogue developed by Project Coordinating Unit (Small millets), UAS, GKVK, Bangalore 2002. Based on morphologically distinct features, a visual scoring were recorded for qualitative characters. Frequency distributions for all the qualitative traits were computed using statistical analysis SPSS version 20.0 software.

Results and Discussion

The reference set germplasm under study showed wide range of variability for all the qualitative traits studied. Sixteen qualitative traits were recorded for two hundred and twenty three accessions. Frequency distribution of different qualitative traits revealed large variation for each trait. The accessions were based on the variability present in each one of the qualitative traits under different sub descriptors. The results for each trait are described briefly is presented in Table 1 and its graphical representation is shown in Figure 1. Characterization at different growth stages of crop were discussed below.

Growth traits

Depending on the growth habit of foxtail millet, the accessions were classified into erect, erect geniculate, decumbent and prostrate were observed in evaluated germplasm accessions. Maximum number of 190 accessions (85.2 %) showed erect type followed by erect geniculate (20 accessions and 9.0 %), decumbent (9 accessions and 4.0 %) and only 4 accessions (1.8 %) had prostrate growth habit. Similar findings have been reported in foxtail millet by Gopal Reddy *et al.*, (2006) and Gopal Reddy *et al.*, (2009) in finger millet.

Leaf traits

Regarding sheath pubescence, majority of accessions (111 accessions and 49.8 %) exhibited medium pubescent followed by essentially glabrous (100 accessions and 44.8 %), while 12 accessions (5.4 %) exhibited strongly pubescent. As many as 121 accessions (54.3 %) showed essentially glabrous blade pubescent followed by medium blade pubescent (88 accessions and 39.5 %) and 14 accessions (6.3 %) had strongly blade pubescent, indicating pubescence is reported in effective for conferring resistance to insect pests in dolichos bean (Jagadeesh Babu *et al.*, 2008). These findings are in consonance with those of Gopal Reddy *et al.*, (2007) in proso millet germplasm. With respect to auricle pigmentation, accessions with non-pigmented auricle (197 accessions and 88.3 %) were more frequent compared to pigmented auricle (26 accessions and 11.7 %).

The present finding is in consonance with those of Gopal Reddy *et al.*, (2006) in foxtail millet and Chandrashekhar Hardari (2009) in finger millet. Shigeta (1985) reported that high yield was associated with purple pigmentation in plant parts. Rao (1948) found that pigmented genotypes were more resistant to blast disease. Regarding leaf attitude, genotypes were more frequent (79 accessions and 35.4 %) towards drooping type than those bearing intermediate (73 accessions and 32.7 %) and erect leaf attitude (71 accessions and 31.8 %). Similar finding was reported by Selvi *et al.*, (2013) in maize.

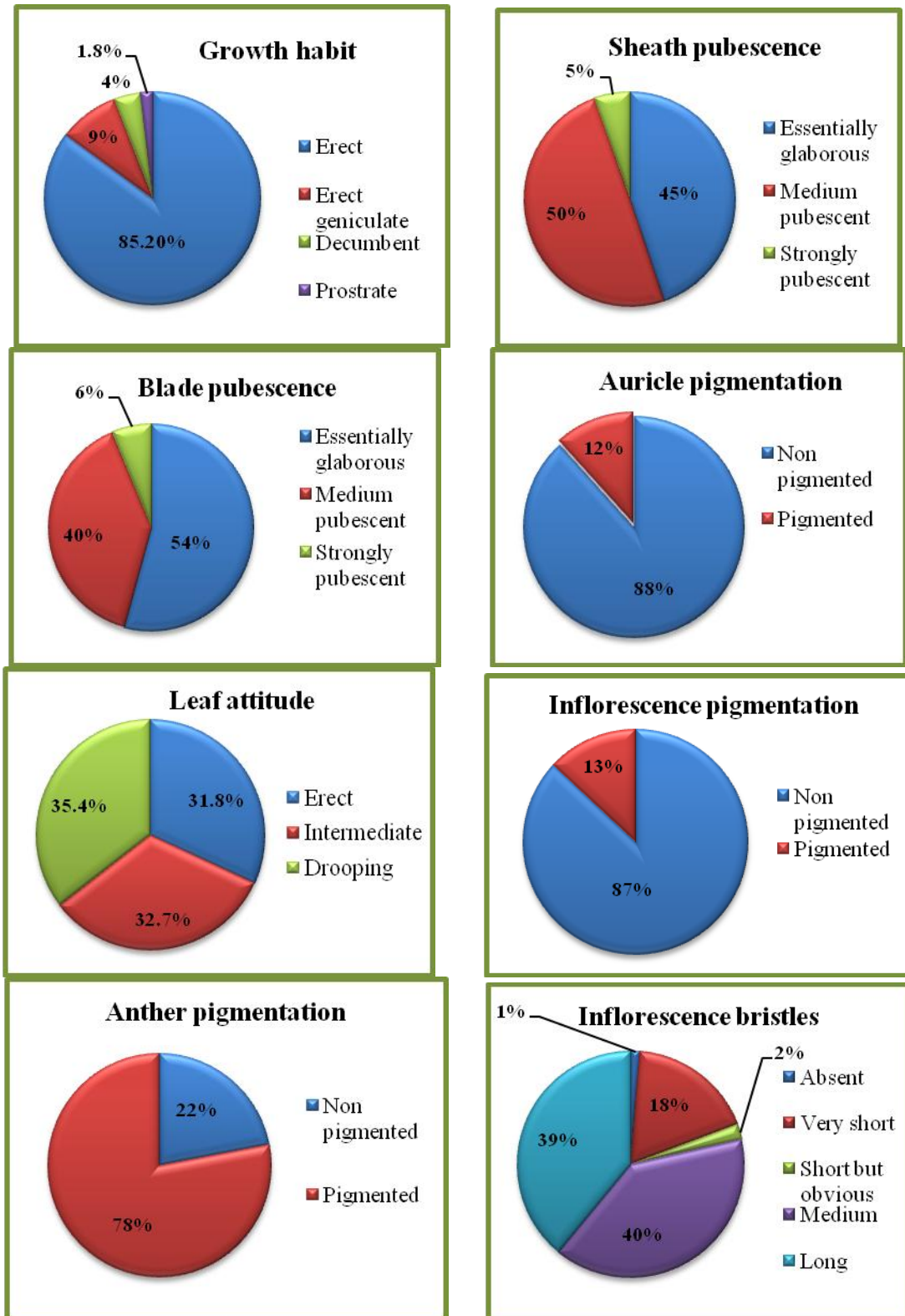
Floral traits

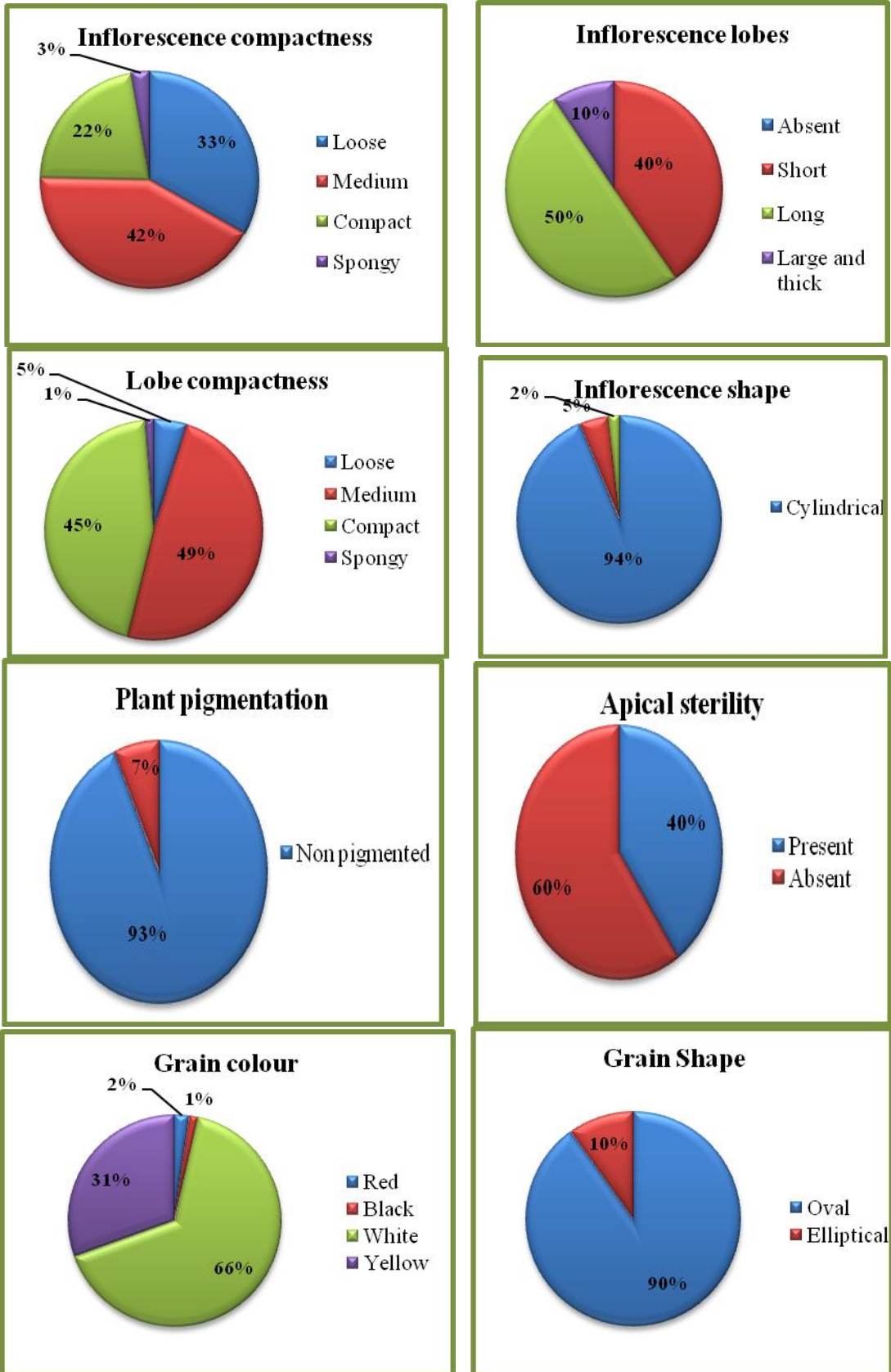
The accessions with non-pigmented inflorescence were represented in higher frequency (194 accessions and 87.0 %) than those with pigmented inflorescence (29 accessions and 13.0 %).

Table.1 Variability for qualitative traits and their frequency in reference set of foxtail millet

Sl. No.	Descriptors	Score	Sub descriptors	Frequency	Percentage
I	Growth traits				
1	Growth habit	1	Erect	190	85.2
		2	Erect geniculate	20	9.0
		3	Decumbent	9	4.0
		4	Prostrate	4	1.8
II	Leaf traits				
2	Sheath pubescence	1	Essentially glabrous	100	44.8
		5	Medium pubescent	111	49.8
		9	Strongly pubescent	12	5.4
3	Blade pubescence	1	Essentially glabrous	121	54.3
		5	Medium pubescent	88	39.5
		9	Strongly pubescent	14	6.3
4	Auricle pigmentation	0	Non pigmented	197	88.3
		1	Pigmented	26	11.7
5	Leaf attitude	1	Erect	71	31.8
		5	Intermediate	73	32.7
		7	Drooping	79	35.4
III	Floral traits				
6	Inflorescence pigmentation	0	Non pigmented	194	87.0
		1	Pigmented	29	13.0
7	Anther pigmentation	0	Non pigmented	49	22.0
		1	Pigmented	174	78.0
8	Inflorescence bristles	0	Absent	3	1.3
		1	Very short	40	17.9
		3	Short but obvious	5	2.2
		5	Medium	88	39.5
		7	Long	87	39.0
9	Inflorescence compactness	3	Loose	74	33.2
		5	Medium	94	42.2
		7	Compact	49	22.0
		9	Spongy	6	2.7
10	Inflorescence lobes	0	Absent	0	00.0
		3	Short	90	40.4
		7	Long	112	50.2
		9	Large and thick	21	9.4
11	Lobe compactness	3	Loose	11	4.9
		5	Medium	109	48.9
		7	Compact	100	44.8
		9	Spongy	3	1.3
12	Inflorescence shape	1	Cylindrical	209	93.7
		2	Pyrimidical	10	4.5
		3	Obviate	4	1.8
13	Plant pigmentation	0	Non pigmented	208	93.3
		1	Pigmented (Purple)	15	6.7
14	Apical sterility in Panicle	1	Present	90	40.4
		0	Absent	133	59.6
IV	Grain traits				
15	Grain colour	1	Red	5	2.2
		2	Black	3	1.3
		3	White	147	65.9
		4	Yellow	68	30.5
16	Grain Shape	1	Oval	201	90.1
		0	Elliptical	22	9.9

Fig.1 Pie diagram depicting variability for qualitative traits among 223 foxtail millet reference set





At late flowering stage, frequency of pigmented anther was predominant (174 accessions and 78 %) followed by non-pigmented anther (49 accessions and 22.0 %) indicating that high yield was associated with purple pigmentation in plant parts was reported by Shigeta (1985) in finger millet. With respect to inflorescence bristles, as many as 88 accessions (39.5 %) were medium bristles on inflorescence followed by 87 accessions (39.0 %) with long bristles, very short bristles (40 accessions and 17.9 %), short but obvious (5 accessions and 2.2 %) and 3 accessions (1.3 %) showed absence of bristles indicating that inflorescence bristles containing silica can significantly enhance insect pest resistance in plants with consequent yield increases according to Laing (2006) in poaceae family. This observation in foxtail millet is in accordance with Vetriventhan (2011). Inflorescence compactness was classified into four classes (low, medium, compact and spongy). Of which medium (94 accessions and 42.2 %) inflorescence was the most prevalent in reference set followed by loose inflorescence (74 accessions and 33.2 %), compact inflorescence (49 accessions and 22.0 %) and only 6 accessions were found to be spongy inflorescence (2.7 %). High yielding accessions in the present study possessed either compact or medium compact inflorescence and agrees with the earlier findings of Ayyangar and Rao (1932) in finger millet and Vetriventhan (2011) in foxtail millet. Among the 223 accessions, long inflorescence lobes were the most common class represented by 112 accessions (50.2 %) followed by short inflorescence lobes (90 accessions and 40.4 %) and 21 accessions were 9.4 per cent showed large and thick inflorescence, indicating long inflorescence lobes pertains to higher yield. With respect to lobe compactness, all the four classes were observed in 223 germplasm accessions *viz.*, loose, medium, compact, and

spongy. Majority of accessions (109 accessions and 48.9 %) exhibited medium lobe compactness followed by compact lobe (100 accessions and 44.8 %), loose lobe compactness (11 accessions and 4.9 %) and only 3 accessions (1.3 %) were spongy types. This report is in consonance with those of Vetriventhan (2011) suggesting medium and compacted lobes with consequent yield increase and farmers preference.

Regarding inflorescence shape majority of accessions were cylindrical (209 accessions and 93.7 %) shape followed by pyrimidical shape (10 accessions and 4.5 %) and only 4 accessions (1.8 %) represented obviate shape. Among the 223 accessions, 208 accessions (93.3 %) did not show pigmentation, while purple plant pigmentation was present in 15 accessions (6.7 %) at maturity indicating that high yield was associated with purple pigmentation in plant parts was reported by Shigeta (1985) in finger millet. This result was supported by Gopal Reddy *et al.*, 2006 and Vetriventhan, 2011. Apical sterility was present in 90 accessions (40.4 %), whereas absent in 133 accessions (59.6 %) at maturity indicating increase in yield level.

Grain traits

Grain colour was divided into four classes (red, black, white and yellow). White colour was most common in reference set (147 accessions and 65.9 %) followed by yellow colour (68 accessions and 30.5 %), red colour (5 accessions and 2.2 %) and black colour (3 accessions and 1.3 %). Similar findings have been reported by Gopal Reddy *et al.*, (2006) in foxtail millet. However, creamy white was in higher frequency, as this is the most favored color among the farmers.

Regarding grain shape, as many as 201 accessions (90.1 %) had oval grain shape followed by 22 accessions (9.9 %) with

elliptical grain shape. This frequency distribution contrastingly agrees with earlier findings of Chandrashekhar Hardari, (2009)

The present studies concluded that, it could be opined from the aforesaid discussion that the germplasm accessions reported in the present investigation harbour tremendous polymorphism for several qualitative traits towards erect growth habit, medium sheath pubescence, essentially glabrous blade pubescence, non-pigmented auricle, drooping leaf attitude, non-pigmented inflorescence, pigmented anther, medium bristles on inflorescence, medium inflorescence compactness, long inflorescence lobes, medium lobe compactness, cylindrical inflorescence shape, non-pigmented plants at maturity, presence of apical sterility, white grain colour and oval grain shape score were the most predominant classes in various qualitative traits. A few of the polymorphic traits could be used as diagnostic descriptors for germplasm characterization, purity assessment and genetic studies. The accessions bearing highly compact inflorescence and pigmented types are of farmer's preference could be used as donors for developing high yielding cultivars with high farmer and consumer preference. These identified DUS traits will be used in characterization of new varieties of foxtail millet for release and registration.

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How to cite this article:

Harshiya Banu, Jayarame Gowda and Channabyre Gowda, M.V. 2018. Characterization and Identification of DUS Traits in Reference Set of Foxtail Millet Germplasm (*Setaria italica* (L.) Beauv.). *Int.J.Curr.Microbiol.App.Sci.* 7(12): 175-183.
doi: <https://doi.org/10.20546/ijemas.2018.712.023>