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Morphological Characterization of Foxtail Millet (*Setaria italica* (L.) Beauv.) Genotypes According to DUS Descriptors

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ABSTRACT: Morphological characterization of 34 foxtail millet genotypes for 18 DUS characters revealed existence of varied polymorphism for the characters. The experimental research was conducted at AICRP on small millets, Zonal Agricultural Research Station, Shenda Park, Kolhapur (M.S.), India during *Kharif* 2022. It was observed that the plant growth habit erect (23) was dominant over decumbent (11); for leaf colour light green (16) was predominant over dark green (7) followed by green (11); absence of pigmentation at auricle (22) was dominant over presence (12). For leaf attitude, erect (23) was dominating over droopy (11) type; for leaf sheath pubescence and leaf blade pubescence, absence of pubescence was dominant over its presence. Medium (30) flag leaf blade length was dominant over long (3) and short (1); medium (29) flag leaf blade width was dominant over narrow (5). In inflorescence shape oblong(28) was predominant over cylindrical(6). There was observance of hundred per cent bristles on inflorescence among genotypes with length of bristles varying, long (17) was dominant over short (10) and medium (7); for peduncle length medium (29) was dominant over short (2) and long (3). Majority of the genotypes were showing apical sterility. For inflorescence compactness, medium (16) and compact (17) were predominant over lax (1). The majority of the genotypes showed presence of lobes. For ear head length, medium (18) was dominant over long (14) and short (2). In seed colour whitish (15) and yellow (17) was predominant over orange (2); for seed shape oval (25) type was predominant over elliptical (9) type of seed. As the study was based upon the given guidelines of PPV & FRA Act 2001, so each character was thoroughly observed and noted accordingly. Some characters were lightly visible, so taking observations of them was quite tedious job. All the authors contributed equally in this experimental study.

Keywords: Foxtail millet, DUS, Genotypes, Morphological characterization, Characters.

INTRODUCTION

Foxtail millet (*Setaria italica* (L.) Beauv.) is locally referred to as "Kaang" or "Raal" in Marathi, "Kaangni" or "Kakum" in Hindi, "Tenai" in Tamil, "Korra" in Telugu, and "Navane" in Kannada. Foxtail millet holds significance as a staple crop for human consumption, cultivated annually. It is prominently grown in countries such as India, Nepal, Sri Lanka, Pakistan, Russia, Ukraine, the Middle East, Turkey and Romania. The earliest traces of foxtail millet cultivation dates back approximately 8000 years, discovered along the ancient course of the Yellow River in Cishan, China, during the Asian region's prehistoric period. Within the grass family Poaceae, foxtail millet, classified under the genus Setaria, is a member of the tribe Paniceae and subfamily Panicoideae. Foxtail millet is annual crop, known for its autogamous (self-pollinated) nature, possesses a diploid chromosome number (2n=18). Belonging to the C4 monocot plant group, it exhibits efficient photosynthesis and is commonly referred to as Italian millet. The foxtail millet typically stands 120–200 cm tall, featuring slender, erect, leafy stems that can gracefully bend under the weight of its ear heads. Characterized by an upright stature, few-branched stems, and well-developed deep roots, it embodies essential agricultural traits.

Regarding global millet production, foxtail millet claims the second position with a yield of approximately 2166 Kg/ha, (as reported by icrisat.org in 2023). It stands out as the most productive among various millet varieties. Due to its short growing season, foxtail millet exhibits a certain resilience to drought conditions. Its ability to thrive with minimal input requirements makes it highly adaptable to the farming practices of resource-constrained farmers. In situations where the primary crop faces failure, foxtail millet can serve as a short-term catch crop both within the regular growing season and during contingency periods.

DUS (Distinctiveness, Uniformity, Stability) characterization plays a crucial role in assessing the utility, adaptability, and novelty of any crop variety. The application of DUS testing aligns with the

Protection of Plant Varieties and Farmers' Rights Act, 2001 (PPV & FRA). This testing serves the dual purpose of identifying varieties and safeguarding them against infringement. Meeting the DUS criteria, which involves being distinct, uniform, stable, and new, is essential for the recognition and protection of varieties. The characterization of diverse genotypes, focusing on qualitative traits, holds significance for their inclusion in future breeding programs. The present experimental study was conducted to characterize foxtail millet genotypes based on qualitative attributes, adhering to the DUS guidelines outlined by PPV & FRA, 2001.

MATERIAL AND METHODS

The experimental material used for the present work was comprised of 32 foxtail millet genotypes with 2 checks that are PS-4 and DHFt-109-3 collected from AICRP on small millets, Zonal Agricultural Research Station, Shenda Park, Kolhapur, Maharashtra, India. These genotypes were sown in randomized block design in three replications during *Kharif* 2022 at AICRP on small millets, Zonal Agricultural Research Station, Shenda Park, Kolhapur, Maharashtra, India. The name of genotypes used for study given in Table 1.

Table 1: List of foxtail millet genotypes included in the studies.

Sr. No.	Genotype	Sr. No.	Genotype
1.	KOPFX-2103	18.	KOPFX-2109
2.	KOPFX-2105	19.	KOPFX-2110
3.	KOPFX-2108	20.	KOPFX-2111
4.	KOPFX-2112	21.	KOPFX-2114
5.	KOPFX-2113	22.	KOPFX-2117
6.	KOPFX-2115	23.	KOPFX-2118
7.	KOPFX-2116	24.	KOPFX-2120
8.	KOPFX-2119	25.	KOPFX-2122
9.	KOPFX-2121	26.	KOPFX-2124
10.	KOPFX-2123	27.	KOPFX-2125
11.	KOPFX-2132	28.	KOPFX-2126
12.	KOPFX-2128	29.	KOPFX-2127
13.	KOPFX-2101	30.	KOPFX-2129
14.	KOPFX-2102	31.	KOPFX-2130
15.	KOPFX-2104	32.	KOPFX-2131
16.	KOPFX-2106	33.	DHFt-109-3(Check)
17.	KOPFX-2107	34.	PS-4-(Check)

Data recorded: Observations were recorded on five randomly selected plants for total eighteen qualitative characters which include *viz.*, plant growth habit, leaf colour, plant pigmentation at auricle, leaf attitude, leaf sheath pubescence, leaf blade pubescence, flag leaf blade length(cm), flag leaf blade width(cm), inflorescence shape, inflorescence bristles, inflorescence length of bristles, peduncle length(cm), inflorescence apical sterility, inflorescence compactness, inflorescence lobes, ear head length(cm) seed colour and seed shape.

Table 2: Frequency distribution of 34 Foxtail millet genotypes for various qualitative characters according to DUS parameters.

Sr. No.	Character	State of expression	Score	Number of genotypes	Frequency distribution (%)
1.	Plant growth habit	Erect	1	23	68
		Decumbant	5	11	32
		Prostrate	7	-	-
2.	Leaf colour	Light Green	1	16	47
		Green	2	11	32
		Dark Green	3	7	21
		Yellow	5	-	-
		Purple	7	-	-
		Deep Purple	8	-	-
3.	Plant pigmentation at auricle	Absent	1	22	65
		Present	9	12	35
4.	Leaf attitude	Erect	3	23	68
		Droopy	7	11	32
5.	Leaf sheath pubescence	Absent	1	19	56
		Present	9	15	44
6.	Leaf blade pubescence	Absent	1	21	62
		Present	9	13	38
7.	Flag leaf blade length(cm)	Short	3	1	3
		Medium	5	30	88
		Long	7	3	9
8.	Flag leaf blade width(cm)	Narrow	3	5	15
		Medium	5	29	85

		Wide	7	-	-
9.	Inflorescence shape	Oblong	1	28	82
		Pyramidal	3	-	-
		Cylindrical	5	6	18
10.	Inflorescence bristles	Absent	1	-	-
		Present	9	34	100
11.	Inflorescence length of bristles	Short	3	10	29
		Medium	5	7	21
		Long	7	17	50
12.	Peduncle length(cm)	Short	3	2	6
		Medium	5	29	85
		Long	7	3	9
		Very long	9	-	-
13.	Inflorescence apical sterility	Absent	1	24	71
		Present	9	10	29
14.	Inflorescence compactness	Lax	3	1	3
		Medium	5	16	47
		Compact	7	17	50
15.	Inflorescence lobes	Absent	1	6	18
		Present	9	28	82
16.	Ear head length(cm)	Short	1	2	6
		Medium	3	18	53
		Long	5	14	41
17.	Seed colour	Whitish	1	15	44
		Yellow	3	17	50
		Brown	4	-	-
		Orange	6	2	6
		Black	7	-	-
18.	Seed shape	Elliptical	2	9	26
		Oval	4	25	74

RESULTS AND DISCUSSION

Plant growth habit: Characterization of 34 genotypes on the basis of plant growth habit indicated that the erect (23) type was dominant (13) over decumbent. Comparable findings were documented by Reddy *et al.* (2006); Amgai *et al.* (2011); Vetriventhan (2011); Sapkota *et al.* (2016) concerning the dominance of the erect growth habit.

Leaf colour: The examination of thirty-four genotypes revealed diverse leaf colorations, including light green (16), green (11), and dark green (7), indicating significant variability in leaf colour. Comparable findings were reported by Ahmed *et al.* (2017); Makwana *et al.* (2023) in their respective evaluation studies.

Plant pigmentation at auricle: The material under experimental study revealed absence of pigmentation (22) and presence of pigmentation (12) at auricle. This aligns with the similar observation reported by Banu *et al.* (2018); Amarnath *et al.* (2019).

Leaf attitude: The experimental genotypes were grouped into erect (23) and droopy (11) for leaf attitude. Erect was dominant over droopy pattern of leaf attitude. Similar results were revealed by Banu *et al.* (2018) in their qualitative study.

Leaf sheath pubescence: Concerning leaf sheath pubescence, the genotypes were classified into those with the absence of pubescence (19) and those with the presence of pubescence (15). Similar outcomes were noted by Layton and Kellogg (2014); Singh *et al.* (2016); Banu *et al.* (2018) in their respective experiments regarding leaf sheath pubescence.

Leaf blade pubescence: Regarding leaf blade pubescence, the genotypes were divided into those with the absence of pubescence (21) and those with the presence of pubescence (13). Comparable findings were observed by Radha *et al.* (2014); Banu *et al.* (2018) in their respective experiments concerning leaf blade pubescence.

Flag leaf blade length(cm): Majority of the genotypes under study exhibited medium (30) length while the remaining were short (1) and long (3) flag leaf blade length. This finding was also noted by Amarnath *et al.* (2019) that medium type of flag leaf blade length was dominant over short and long.

Flag leaf blade width(cm): Majority of the genotypes under study exhibited medium (29) blade width while the remaining were narrow (5). This finding is in accordance with Amarnath *et al.* (2019) quoted that medium type of flag leaf blade width was dominant over narrow.

Inflorescence shape: The experimental material possessed three different types of inflorescence shape *i.e.*, oblong (28), cylindrical (6) and pyramidal (0). The results found are in conformity with the results of Kavya *et al.* (2017); Amarnath *et al.*, (2019) that most of the genotypes having oblong inflorescence shape.

Inflorescence bristles: No variability was detected in the inflorescence bristles among the genotypes, as all exhibited the presence of bristles. Corresponding outcomes were reported by Kavya *et al.*, (2017); Banu *et al.* (2018) in their respective morphological investigations.

Inflorescence length of bristles: Regarding the inflorescence length of bristles, considerable variability was noted, with instances of short (10), medium (7), and long (17) lengths. Kavya *et al.* (2017) reported analogous findings, indicating that the dominance of long length over short and medium lengths persists in this characteristic.

Peduncle length(cm): The characterization of 34 genotypes based on peduncle length revealed a majority

with medium length (29), a few with short length (2), and the remaining with long length (3). This outcome aligns with the observations made by Amgai *et al.* (2011); Amarnath *et al.* (2019), showing the dominance of the medium peduncle length type.

Inflorescence apical sterility: The apical sterility was observed between genotypes as presence (10) and absence (24) under study. The results were in accordance with the findings of Banu *et al.* (2018).

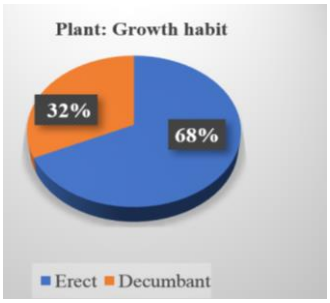
Inflorescence compactness: The experimental genotypes under study possessed three different types i.e., lax (1), medium (16) and compact (17) of inflorescence compactness. The results found are in consonance with Kavya *et al.* (2017); Banu *et al.* (2018); Amarnath *et al.* (2019) and that medium type is dominant in inflorescence compactness.

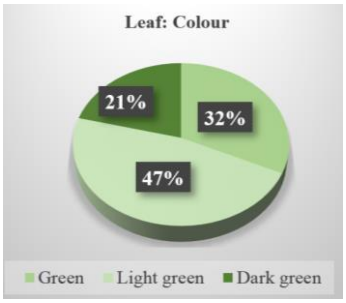
Inflorescence lobes: The trait inflorescence lobes in the present genotype accessions were categorized as present (28) or absent (6). Similar findings were reported by Kavya *et al.* (2017); Ahmed *et al.* (2017) that majority of genotypes possess lobes.

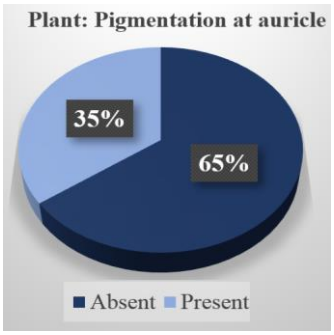
Ear head length(cm): In the evaluation of ear head length among the observed genotypes, the majority exhibited medium length (18), followed by long (14), and a couple with short lengths (2). This discovery corresponds with the outcomes reported by Nehra *et al.* (2016); Amarnath *et al.* (2019).

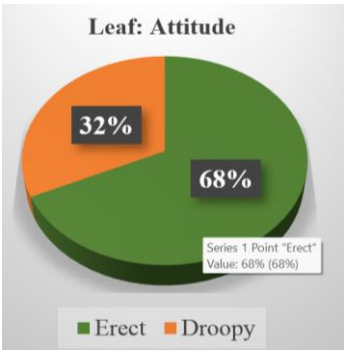
Seed colour: The genotypes examined in the study were categorized according to seed colour, revealing whitish (15), yellow (17), and a couple with orange seeds (2). This observation corresponds with the results reported by Kavya *et al.* (2017), Banu *et al.* (2018); Amarnath *et al.* (2019).

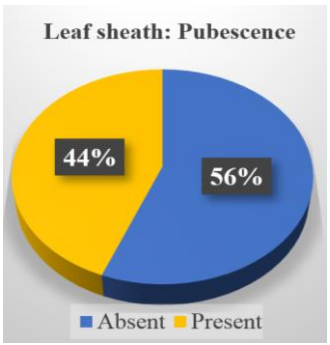
Seed shape: The genotypes were categorised based on seed shape, resulting in classifications of elliptical (9) and oval (25). Similar outcomes were documented by Kavya *et al.* (2017); Ahmed *et al.* (2017).

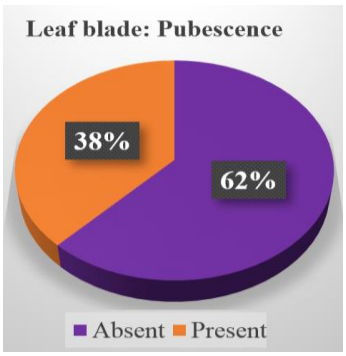












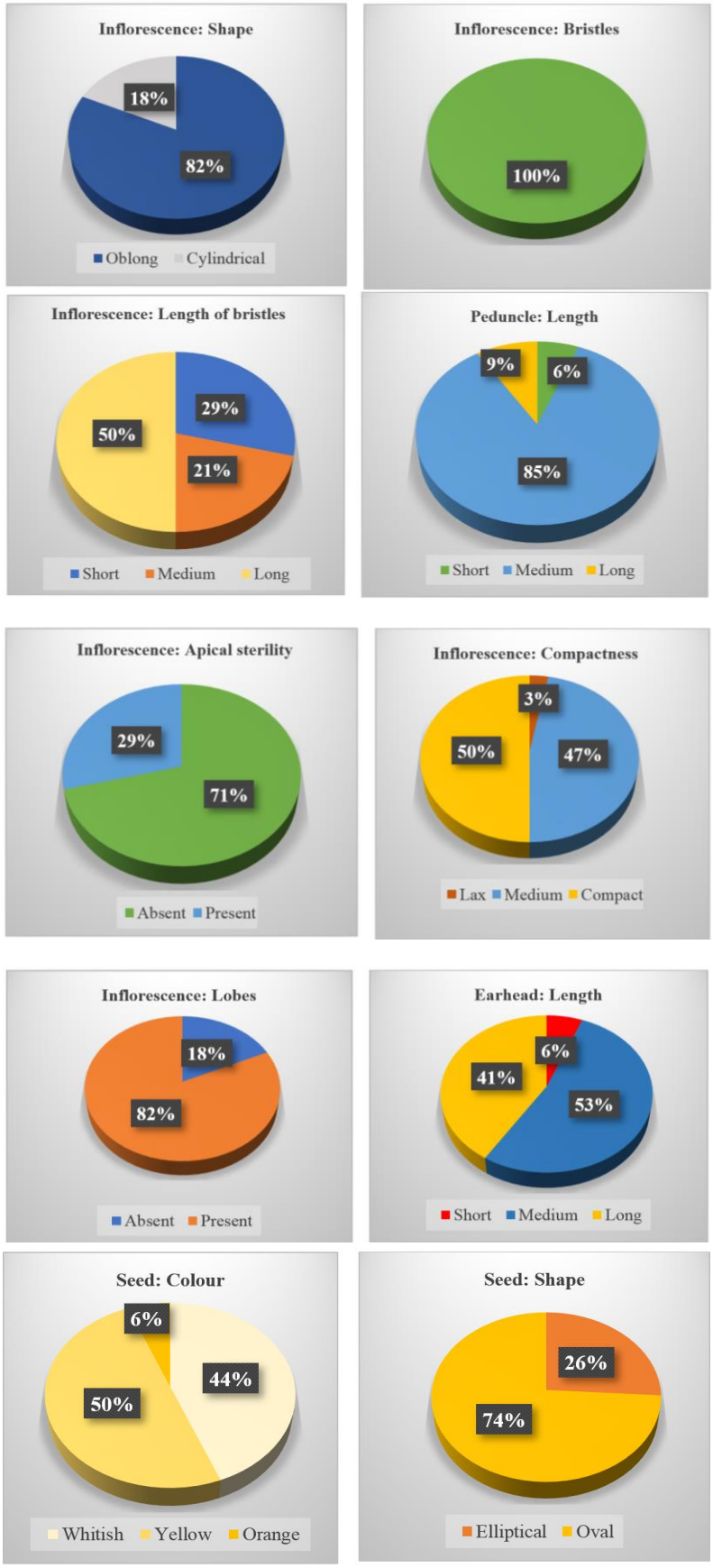


Fig. 1. Frequency distribution of 34 Foxtail millet genotypes for growth habit, leaf colour, pigmentation at auricle, leaf attitude, leaf sheath pubescence, leaf blade pubescence. flag leaf blade length, flag leaf blade width, for inflorescence shape, bristles, length of bristles, peduncle length. apical sterility, inflorescence lobe, inflorescence compactness, ear head length, seed colour and seed shape.

CONCLUSIONS

Out of eighteen qualitative characters studied under experiment according to DUS guidelines, presence of inflorescence bristles was unimorphic, plant growth habit, pigmentation at auricle, leaf attitude, leaf sheath and leaf blade pubescence, flag leaf blade width, inflorescence shape, inflorescence apical sterility, inflorescence presence of lobes and seed shape were dimorphic, leaf colour, flag leaf blade length, inflorescence length of bristles, peduncle length, inflorescence compactness, ear head length and seed colour were exhibited trimorphic state of expression.

FUTURE SCOPE

The promising genotypes identified in this study are according to the DUS guidelines of PPV & FRA Act 2001, which can be further useful for developing new varieties based on DUS descriptors and for doing hybridization programme.

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Conflict of Interest. None.

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