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MORPHOLOGICAL CHARACTERIZATION AND DENDROGRAM ANALYSIS OF DUS (DISTINCTIVENESS, UNIFORMITY, STABILITY) TRAITS IN MAIZE INBRED LINES (*ZEA MAYS* L.)

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ABSTRACT

Maize is one of the major international commercial crop. This experiment was conducted under AICRP on Maize, at Zonal Agriculture Research Station (ZARS), V. C. Farm, Mandya, UAS Bangalore, India to study the Morphological Characterization and Dendrogram analysis of DUS (Distinctiveness, Uniformity, Stability) traits in Maize Inbred Lines (*Zea mays* L.) The Distinctness, Uniformity and Stability (DUS) characterization of farmers, extant and novel varieties is mandated by the PPVFRA (2001), which also suggests that varieties be registered for any one particular novel character. Any effective plant breeding programme requires a basic understanding of the existence of genetic diversity and variability in a population as well as the link between various features. So, Characterization and evaluation are crucial prerequisites for the efficient use of genetic material as well as the discovery of new sources for beneficial genes. Characterization of screened inbred lines was done with 18 inbred lines to differentiate them morphologically based on DUS characters under uninfected condition as per the guidelines of PPVFRA (2001). A Dendrogram has been constructed based on the morphological traits that distinguishes among inbred lines revealing notable variation among 18 inbred lines which can be utilized in selection for further breeding programme.

Key words : *Zea mays*, Morphological characterization, Dendrogram analysis, DUS.

Introduction

Maize (*Zea mays* L.) has extensive adaptability and increased productivity potential. It is originated in Central America and Mexico and is one of the widely used cereals globally. It is produced in a wide range of conditions all over the world (Dowswell *et al.*, 1996). It is a member of the *Poaceae* grass family's *Maydeae* tribe with chromosome number 2n = 20. Rice, wheat and maize three main cereal crops that contribute to food security throughout the globe (Gull *et al.*, 2020). It has greater importance in the global agricultural economy for its industrial value, food for human, and feed for animals.

Any effective plant breeding programme requires a fundamental understanding of the existence of genetic diversity and variability in a population as well as the link between various features (Baishan *et al.*, 2010). The ability to promote genetic diversity through traditional breeding methods is largely dependent on the presence of a wide range of genetic material and significant genetic variability. So, characterization and evaluation are crucial prerequisites for the efficient use of germplasm as well as the discovery of new sources for beneficial genes (Gupta *et al.*, 2016).

Under the "Protection of Plant Varieties and Farmers' Rights Act", annuals as well as tree and vines can be registered and protected for 15 years and 18 years respectively. A variety can only be registered and protected if it meets the requirements of stability, uniformity and distinctiveness (Anonymous, 2007). This implies that the new variety's traits must be Distinct-Uniform-Stable (DUS). This requires the examination of the variety, if it conforms to the standards of DUS test

(Gupta *et al*., 2015). Thus, characterization of inbred lines was done to distinguish inbred lines morphologically based on DUS charactersas per the guidelines of PPVFRA (2001) (Abru *et al*., 2006).

Materials and Methods

A total of 18 inbred lines that includes inbred developed from AICRP, Mandya (MAI series); CIMMYT, Mexico (Z series and V series) and IIMR Ludhiana; were grown at the AICRP on Maize, ZARS, V.C. Farm, Mandya in the month of September of late *Kharif* 2021 with a spacing of 0.6m×0.2m in Augmented block design. During crop growth observations were taken on plant height, leaf angle between blade and stem, type of seed, ear of shape, width of the leaf blade, Leaf: Anthocyanin coloration of sheath, leaf altitude, Stem: Anthocyanin coloration of brace roots, Tassel: Anthocyanin coloration at base of glume, Tassel: Anthocyanin coloration of glumes excluding base, Tassel: Anthocyanin coloration at base of glumes, Tassel:

Table 1 : Characterization of maize inbred lines based on different qualitative traits.

S. no.	Character	Type	Descriptor code	No. of inbred lines
1	Plant height	Short	3	3
		Medium	5	11
		Long	7	4
2	Width of leaf blade	Narrow	3	5
		Medium	5	1
		Broad	7	12
3	Angle between leaf blade and stem	Narrow	3	7
		Wide	7	11
4	Attitude of leaf blade	Straight	1	6
		Drooping	9	12
5	Stem: Anthocyanin coloration of brace root	Present	9	6
		Absent	1	14
6	Leaf: anthocyanin coloration of sheath	Present	9	12
		Absent	1	6

Table 2 : Characterisation of maize inbred lines based on tassel characteristics.

S. no.	Character	Type	Descriptor code	No. of inbred lines
1	Days to 50 % Anthesis	Very early	1	5
		Early	2	9
		Medium	5	4
2	Anthocyanin coloration of glumes excluding base	Absent	1	9
		Present	9	9
3	Anthocyanin coloration at the base of glumes	Present	91	5
		Absent	1	13
4	Anthocyanin coloration of anthers	Present	9	6
		Absent	1	12
5	Density of spikelet	Dense	7	7
		Sparse	3	11
6	Angle between main axis and lateral branches	Narrow	3	6
		Wide	7	12
7	Tassel length	Short	3	2
		Medium	5	9
		Long	7	7
8	Attitude of lateral branches	Straight	3	5
		Curved	7	13

Anthocyanin coloration of anthers, density of spikelet, angle between main axis and lateral branches, density of spikelet, attitude of lateral branches, anthocyanin coloration of silk, color of top of seed, ear placement (cm), ear length, anthocyanin coloration of glumes of ear, kernel row per ear, ear shape, kernel per row, test weight (Madhukeshwar *et al*., 2015). All the data were analyzed through NTSYSpc-2.2 and an UPGMA dendrogram has been constructed (Nayak *et al*., 2015).

Results and Discussion

A significant difference was observed in plant height which ranged from 97.4cm (MAI1) to191cm (MAI7) which showed three inbred lines had found to be short (< 120 cm), 11 inbred lines were medium (120-150 cm) in height and four lines were long (>150 cm) (Table 1). Five inbred lines were having narrow leaf blade which were less than 8cm, 12 inbred lines were having broad leaf blade more than 9 cm and one inbred line was having medium width of leaf blade which is 8-9cm (Table 1). All the inbred were divided in to two categories based on anthocyanin coloration of brace root. Anthocyanin coloration of brace root was absent in 14 inbred lines where as it was present in six inbred lines (Table 1). Based on attitude of leaf blade, all the inbred were classified into two categories *viz*., straight and drooping. Six inbred lines had shown straight leaf blasé and 12 inbred lines were drooping in nature (Table 1). Anthocyanin pigments of sheath was absent in six inbred line and 12 inbred lines did not show anthocyanin pigments of sheath (Table 1). Based on leaf blade, six inbred lines had straight leaf blade and 12 inbred lines were having Drooping leaf blade. Based on 50 percent anthesis, five inbred lines had very early flowering (<45DAS), nine inbred lines were early in flowering (45-50DAS) and remaining four inbred lines were medium in flowering (50-55 DAS) (Table 2). This had shown closer proximity with the findings observed by Nayak *et al*. (2015. The nine inbred lines were found to have anthocyanin coloration of glumes excluding base whereas, 9 inbred lines did not have anthocyanin coloration of glumes excluding base (Table 2). All inbred lines were classified into two categories with 13 inbred lines were nothaving anthocyanin pigment in glumes and five inbred lines were having anthocyanin pigment at the base of glumes (Table 2). The eleven inbred lines had sparse density of spikelets and seven inbred lines were having dense spikelet (Table 2). Among all inbred lines, six inbred lines were having narrow angle (<45º) and twelve inbred lines were found to have wide angle between main axis and lateral branches (Table 2). Out of total inbred lines, two inbred lines were having

Table 3 : Characterization of maize inbred lines based on ear characteristics.

S. no.	Character	Type	Descriptor code	No. of inbred lines
1	Ear length without husk	Short	3	5
		Medium	5	13
2	Ear diameter	Medium	5	13
		Long	7	5
3	Kernel arrangement	Spiral	2	6
4	Kernel shape	Round	2	13
		Toothed	4	5
5	Ear shape	Conical	1	9
		Conico-cylindrical	2	1
		Cylindrical	3	8
6	Ear: anthocyanin coloration of glumes ofear	White	1	18

Table 4 : Characterization of maize inbred lines based on silk characteristics.

S. no.	Character	Type	Descriptor code	No. of inbred lines
1	Time of silk emergence	Very early	1	9
		Early	3	7
		Medium	5	2
2	Anthocyanin coloration of silk	Present	7	12
		Absent	9	6

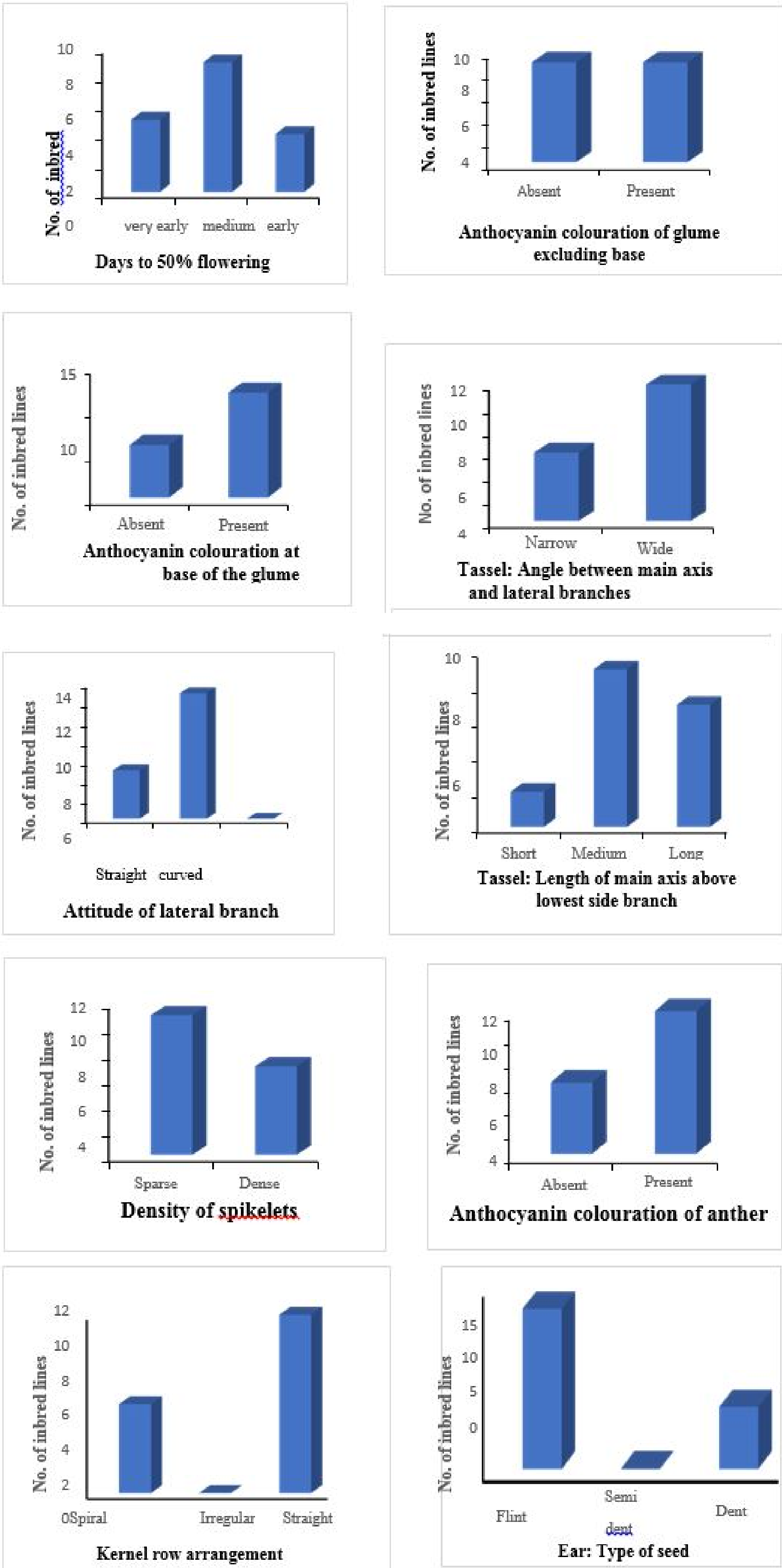


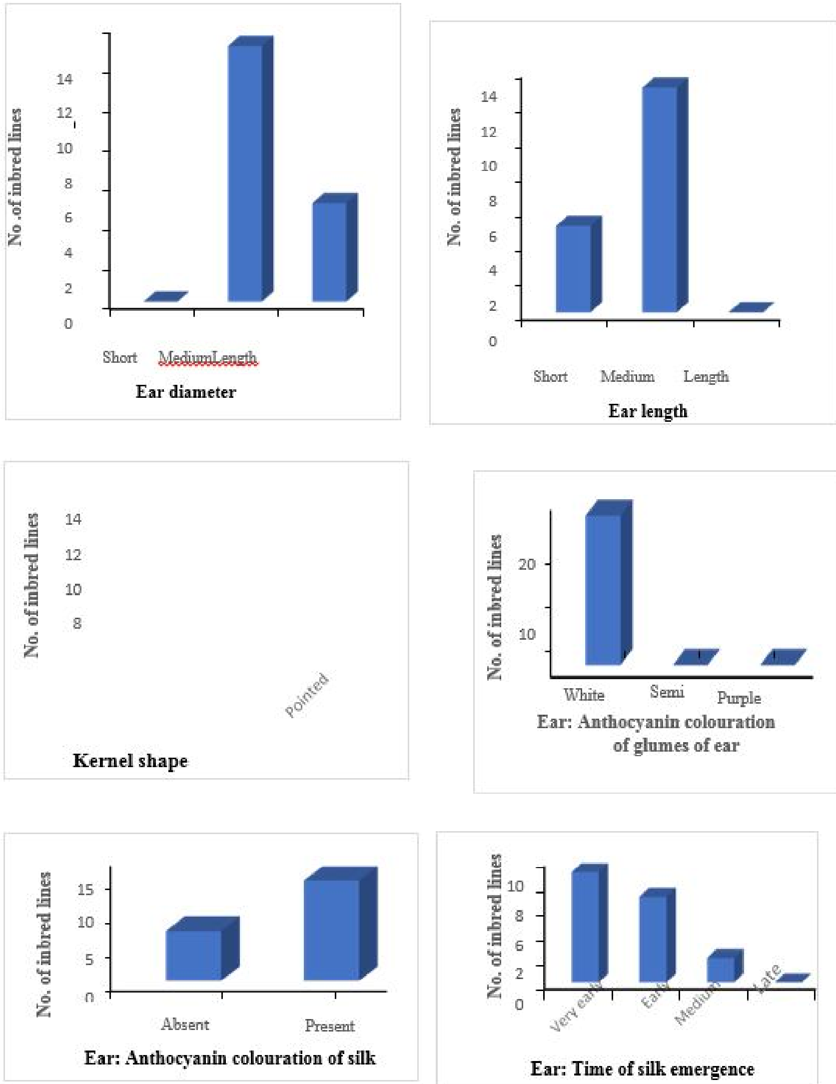
Fig. 1 : Graphical representation of Morphological characteristics of maize inbred line.

Fig. 1 continued...

short tassel length, nine inbred lines were having medium tassel length and remaining seven inbred lines having long tassel length (Table 2). All the inbred lines were grouped into two categories with thirteen inbred lines were not having anthocyanin pigment in glumes and five inbred lines were having anthocyanin pigment at the base of glumes (Table 2).

Out of total inbred lines, two inbred lines were having short tassel length; nine inbred lines were having medium tassel length and remaining seven inbred lines having long tassel length (Table 2). All the inbred lines were divided into two categories. Among all inbred lines, five inbred lines had straight attitude and remaining thirteen inbred lines had curved attitude of lateral branches (Table 2). Five inbred lines had short ear (<10cm), thirteen inbred lines were having medium ear length with more than 10-15 cm (Table 3). Ear diameter ranged between 10cm (Z485-20) to17.4 cm (MAI-759). All the inbred lines were found to have long ear diameter without husk (Table 3). Among all the inbred lines six inbred lines were found to have spiral kernel row arrangement and remaining twelve inbred lines were having irregular kernel arrangement (Table 3). Out of eighteen inbred lines, thirteen inbred lines were having round shaped kernel and remaining five inbred lines were having toothed kernel shape (Table 3). Similar result has been found out by Pinnisch *et al.* (2012). The nine inbred lines were classified as very early (<48 days), seven inbred lines were early (48-52 days) and remaining two inbred lines were medium flowering (53-58 days) (Table 4). Among all inbreds, six inbred did not have anthocyanin coloration of silk and remaining twelve inbred lines shown anthocyanin coloration of silk (Table 4). Among eighteen inbred lines, nine inbred lines had flint corn and seven inbred lines were having dent corn (Table 5). The four inbred lines were having yellow

Fig. 1 continued...



colored seed, four inbred lines were having yellow color seed with cap and ten inbred lines were having orange color seed (Table 5). This kind of findings has been observed by Thirusenduraselvi *et al.* (2013).

An UPGMA dendrogram of 18 maize inbred lines has been made based on qualitative characters (Yadav *et al*., 2010). In this current investigation dissimilarity Co-efficient has found between 0.53 and 0.82, which showed MAI 753 and QPM 25 were most diverse than rest of the 16 inbred lines. Among 18 inbred lines under study MAI 755 and MAI 723 were most similar lines followed by MAI 7 and MAI 391 (Fig. 2).

Conclusion

Among all the selected inbred lines characterized morphologically during *kharif* 2021, most of the inbred lines were medium having mean plant height 120-150 cm, broad leaf blade which was more than 9 cm width, wide (>45º) angle b/w leaf blade and stem, drooping leaf blade where anthocyanin pigment of brace root and sheat hwere absent.

Maximum number of inbred lines had found early (45-50 days) in anthesis, sparse spikelet, wide angle b/w main axis and lateral branches, curved lateral

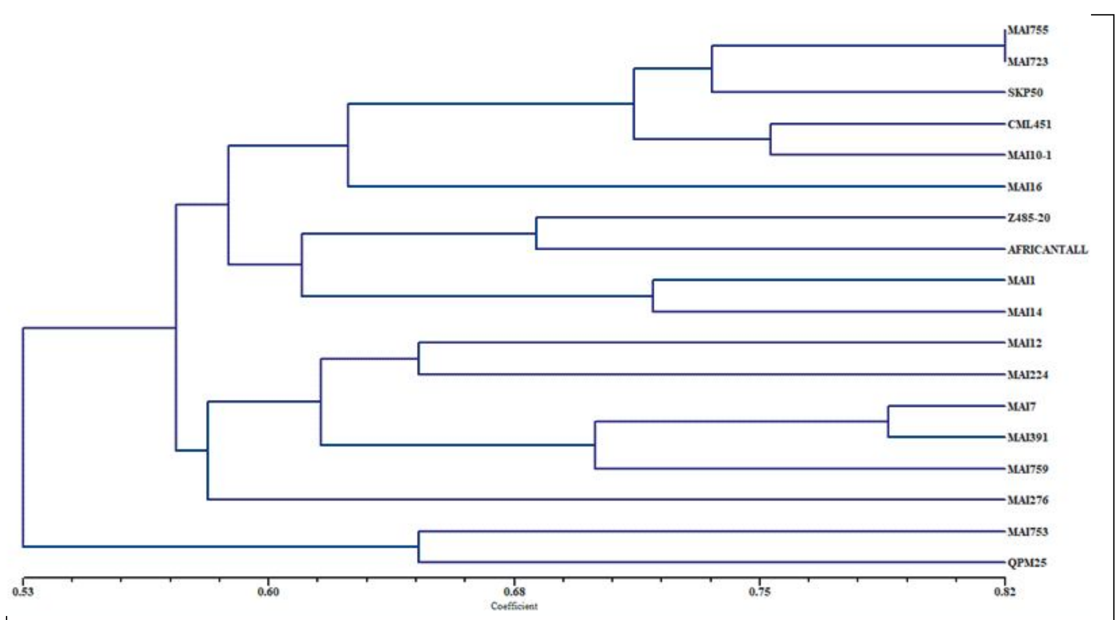


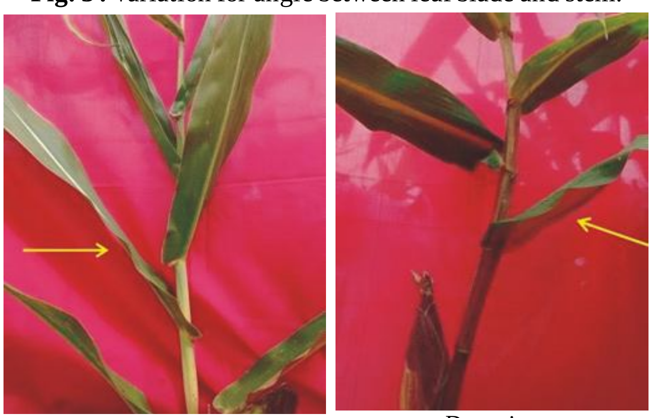
Fig. 2 : UPGMA Dendrogram of 18 maize inbred lines.

Table 5 : Characterization of maize inbred lines based on seed characteristics.

S. no.	Character	Type	Descriptor code	No. of inbred lines
1	Type of seed	Flint	1	9
		Dent	3	7
2	Color top of seed	Yellow	7	12
		Yellow with cap	9	6
		Orange	5	10

Narrow (<45^0) MAI12 Wide (>45^0) MAI276

Fig. 3 : Variation for angle between leaf blade and stem.



Straight MAI753 Drooping MAI7

Fig. 4 : Variation for attitude of blade.

Absent MAI14 Present MAI1

Fig. 5 : Variation for anthocyanin coloration of leaf sheath.

Present MAI 12 Present MAI 723

Fig. 6 : Variation for anthocyanin coloration at excluding base of glume.

Present MAI12 Present MAI723

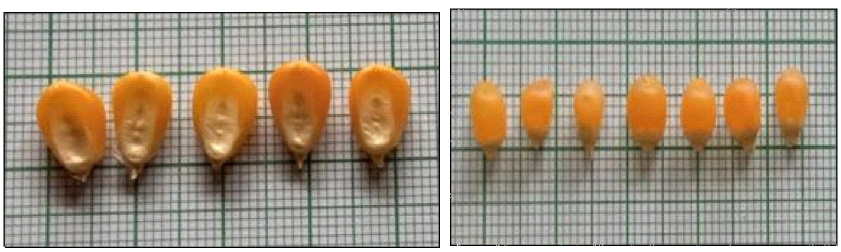
Fig. 7 : Anthocyanin coloration of anthers.

branches with medium tassel length, where anthocyanin pigment was there at the base of glumes and absent in anthers. These selected inbred lines were mostly having flint type of seed with yellow color where anthocyanin coloration was present. Many of the inbred lines were having medium ear length with spiral arrangement and round shape of kernel.

The dendrogram analysis revealed the distinguishing traits of inbred lines for favorable selection and revealed that, morphological differences occur due to variations in genetic constitution. This could be better exploited by

Sparse (MAI16) | Absent MAI755

Fig. 8 : Anthocyanin coloration of spikelet.



Dense MAI7 | Toothed (MAI723)

Fig. 9 : Variation in kernel shape.

Absent (MAI 7) | Present (MAI224)

Fig. 10 : Anthocyanin coloration of silk.

breeders depending on the requirements for breeding programme.

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