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PRINCIPAL COMPONENT ANALYSIS FOR EVALUATION OF GUINEA GRASS (*PANICUM MAXIMUM* JACQ.) GERMPLASM ACCESSIONS

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ABSTRACT

The goal of investigation is to determine the contribution of morphological traits to variability in 60 Guinea grass germplasm through Principal Component Analysis (PCA). From principal component analysis, 4 principal components (PC) had eigen values more than unity and accounted for 76.50% of the total variance, suggesting that traits such as plant height, number of tillers per plant, number of leaves per plant and leaf weight are the principal discriminatory traits in the germplasm. Amongst first four PCs, PC1 was accounted high proportion of total variance (34.60%) and the remaining three principal components *viz.,* PC2, PC3 and PC4 revealed 20.40, 11.30 and 10.20% of total variance respectively. It is suggested that, these characters can be considered as selection criteria in improving the fodder yield. On account of this genetic variability it has been found that genotypes GGLC 12, GGLC 19, FD 679 and GGLC 1 were potential genotypes. The genetic potential of these genotypes can be exploited in future breeding programs. Further, these genotypes are recommended for commercial cultivation to meet the fodder needs of the country.

INTRODUCTION

Guinea grass (*Panicum maximum* Jacq.) is a most adapted cereal fodder crop, cultivated throughout the tropics and semi tropics. It is largely apomictic and predominantly exist in tetraploid form. It is also endowed with virtues like profuse tillering, high leafiness, thin stems, short duration, *etc.,* all of which contributes towards high biomasss production and better palatability. At present in India there is a deficit of 64 per cent of green fodder, and hence there is a need of over production of quality fodder especially the range grasses which could rejuvenate the fast degrading grasslands. In order to improve the productivity, adaptability and quality of Guinea grass, it is important to understand the genetic variability that exist in the population which also helps in their conservation and germplasm management (Tiwari and Chandra, 2010).

To develop a new variety there is need of the magnitude of genetic variability in the base material and the vast of variability for desired characters. A good knowledge on genetic diversity or genetic similarity could be helpful in long term selection gain in plants (Meena *et al.,* 2015). Hence, genetic variability and diversity is of prime interest to the plant breeder as it plays a key role in framing and successful breeding programme. Most of the varieties were developed through clonal selection from local germplasm. Thereafter, breeder started generating breeding material through mutation. The important aspects of breeding varieties of Guinea grass is to develop high biomass with more crude protein content and less crude fibre content for fodder purposes.

As we know, fodder yield of Guinea grass is complex quantitative trait and under pleiotropic gene control at the same times it is highly influenced by environment and contributed by many other traits. Furthermore, selection based on only yield is misleading. For effective selection, information on nature and magnitude of variation in population, and the extent of environmental influence on the expression of characters are necessary (Santosh Arya *et al.,* 2013). High magnitude of variability in a population provides the opportunity for selection to evolve a variety having desirable characters. A large number of variables are often measured by plant breeders, some of which may not be of sufficient discriminatory power for germplasm evaluation, characterization, and management. Continuous evaluation of germplasm contributed to variation in the Guinea grass population. Recently Principal Component Analysis (PCA) used to reveal patterns and eliminate redundancy in data sets (Adams, 1995; Amy and Pritts, 1991) as morphological and physiological variations routinely occur in crop.

Keeping in view the aforesaid problems, an attempt was made to show variation among the genotypes and identify traits that contribute to variability in this population and for their possible exploitation in breeding programs to attain the anticipated improvement in fodder yield of Guinea grass.

MATERIALS AND METHODS

The experimental material consisted of 60 germplasm accessions of Guinea grass (*Panicum maximum* Jacq.) obtained from various countries were evaluated in a Randomized Block Design with two replications. Each accession were planted using rooted slips on one side of ridge of 4 m length, adopting a spacing of 60 õ 50 cm. All the recommended agronomic practices were followed to raise healthy crop. The biometrical observations on fodder yield were recorded on single plant basis at the time of harvesting as per descriptors for *Panicum miliaceum* L. (UPOV, 2007), and characterization of perennial *Panicum* species (Wouw *et al.*, 2008). Five plants were selected randomly from each genotype at maturity for measuring plant height (cm), number of tillers per plant, number of leaves per plant, leaf weight (g), leaf stem ratio, green fodder yield per plant (g) and dry matter content (%) and quality parameters such as crude protein, crude fibre and crude fat content (%). The average of five plants was subjected to analysis of variance and test of significance as per the method of Fisher (1953). The Principal Component Analysis was carried out to identify plant traits that contribute most of the observed variation among the genotypes. It was done by the method described by Upadhyaya *et al.* (2002). Mean values of 60 genotypes for ten quantitative traits were used to perform Principal Component Analysis using the statistical package NTSYS pcv2.02i (Rholf, 1992).

RESULTS AND DISCUSSION

The progress in breeding programme for economic characters often depends on the availability of a large germplasm representing a diverse genetic variation. In order to ensure the efficient and effective use of crop germplasm, its characterization is imperative and multivariate analysis provides a good evaluation of landraces by identifying the traits that should be further evaluated at the genetic level (Rabbani *et al.*, 1998). Dasgupta and Das (1984) considered multivariate analysis best for choosing promising genotypes for breeding programme. Subdividing the variance into its components assists the genetic resources conservation and utilization and enables in planning for use of appropriate gene pools in crop improvement for specific plant attributes (Pecetti and Damania, 1996).In the present investigation, the analysis of variance revealed that mean sum of squares for genotypes was highly significant for all the traits investigated. This significance suggested the presence of substantial amount of genetic variability among the genotypes **(Table 1)**.

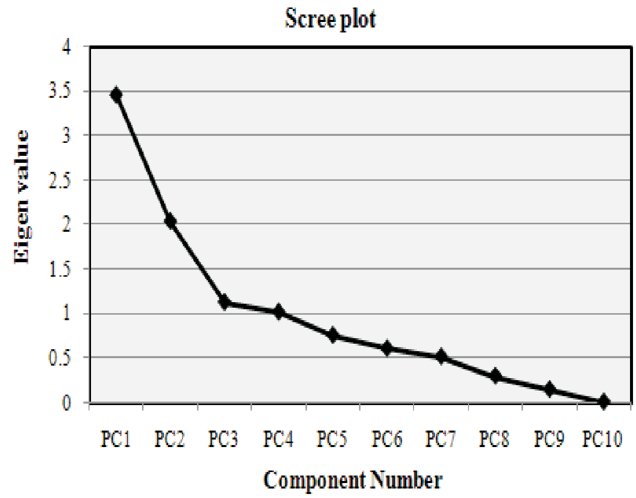

Figure 1 : Scree plot constructed using 10 principal components

According to Principal Component Analysis 4 principal components had eigen values more than unity and accounted for 76.50 per cent of the total variance in the data (**Table 2**). Amongst first four PCs, PC1 with eigen value 3.46 accounted high proportion of the total variance (34.60) and the remaining three principal components *viz.,* PC2, PC3 and PC4 with eigen value 2.04, 1.13 and 1.02, respectively recorded 20.40, 11.30 and 10.20 per cent of total variance, respectively, while the other Principal Components (*i.e.* PC 5 to PC 10) had weak or no discriminatory power. Thus, the most important descriptors were those associated with first four principal components.

Table 1 : Analysis of variance for different traits of 60 genotypes of Guinea grass

S. . No	Source of variation	Plant height (cm)	Number of tillers per plant	Number of leaves per plant	Leaf weight (g)	Leaf stem ratio	Green fodder yield per plant (g)	Dry matter content (%)	Crude protein(%)	Crude fibre (%)	Crude fat(%)
1	Treatment	527.18*	20.45**	2152.79**	792.64**	0.0078**	5001.93**	19.44*	2.85**	8.52**	0.07**
2	Error	332.26	10.32	369.01	170.12	0.002	1097.98	11.68	0.44	0.21	0.03

** Significant at 1% level; * Significant at 5% level

Table 2 : Eigen values and percentage of variation in respect of growth and yield parameters in 60 germplasm accessions of Guinea grass

Principal Component	Eigen value	Per cent variation	Cumulative variation
1.	3.46	34.60	34.60
2.	2.04	20.40	55.00
3.	1.13	11.30	66.30
4.	1.02	10.20	76.50
5.	0.76	7.60	84.10
6.	0.61	6.10	90.20
7.	0.52	5.20	95.40
8.	0.30	3.00	98.40
9.	0.15	1.50	99.90
10.	0.01	0.10	100.00

Table 3 : Eigen value (Load) of the first four principal components and their contribution to total variation of Guinea germplasm collections

S. No.	Variables	PC1	PC2	PC3	PC4
1.	Plant height (cm)	-0.634	0.417	-0.042	-0.268
2.	Number of tillers per plant	0.715	0.130	0.323	-0.375
3.	Number of leaves per plant	0.877	0.040	0.079	0.255
4.	Leaf weight (g)	0.816	0.334	0.086	0.383
5.	Leaf stem ratio	0.731	-0.262	0.078	0.326
6.	Dry matter content (%)	-0.047	0.798	-0.037	-0.087
7.	Crude protein content (%)	0.271	0.158	0.863	-0.150
8.	Crude fibre content (%)	-0.544	0.413	0.498	-0.185
9.	Crude fat content (%)	0.138	-0.493	0.216	0.558
10.	Green fodder yield per plant (g)	0.454	0.754	0.041	0.198
	Eigen value	3.46	2.04	1.13	1.02
	Per cent variation	34.60	20.40	11.30	10.20
	Cumulative variation	34.60	55.00	66.30	76.50

Extraction method: Principal Component Analysis - non rotated values

Eigen values of 10 principal components have been shown in the scree plot (Fig. 1).

The criterion of Raji (2002) was chosen to determine the cut off limit for the coefficients of the proper vectors, this criterion treated coefficients was greater than 0.3 as having large effect to be considered important while traits having a coefficient value lesser than 0.3 were considered not to have important effects on the overall variation observed in the present study. Eigen vectors (loadings) of the first four principal components were presented in **Table 3**.

The results showed that number of leaves had the highest positive loadings followed by leaf weight (0.816), leaf stem ratio (0.731), number of tillers per plant (0.715) and green fodder yield (0.454) and other characters showed positive loading in first principal component (PC1) were crude protein content and crude fat content. Thus, this component was the weighted average of the characters which determine the yield level. These traits have the largest participation in the divergence and carry the largest portion of its variability. This principal component used for genotype differentiation, could distinguished between yielding genotypes with large number of leaves per plant and greatest leaf weight. These results are in agreement with the findings Salini *et al.* (2010) for number of tillers per plant and Asaigbe *et al.* (2014) for number of leaves per plant. While plant height (-0.634) and crude fibre content (-0.544) in PC1 registered highest negative loading.

In PC2, dry matter content (0.798), green fodder yield (0.754), plant height (0.417) and crude fibre content (0.413) exhibited highest positive loadings except crude fat content (-0.493) and leaf stem ratio (-2.62) which had negative loading. Other characters showed positive loadings in PC2. Thus, this component weighted by both productivity and fodder quality characteristics. Hence, the traits green fodder yield per plant as an important productivity factor, as well as dry mater content which is fodder quality determining trait. These results were in accordance with the results of Asaigbe *et al.* (2010) for plant height and Mirjana *et al.* (2008) for quality.

Crude protein content (0.863) and crude fibre content (0.498) recorded highest positive loading in PC3. All other remaining characters exhibited positive loading in third principal component (PC3) except plant height and dry matter content which had negative loading. Crude fat content and leaf weight registered highest positive loadings of 0.558 and 0.383, while plant height, number of tillers per plant, dry matter content, crude protein content and crude fibre content negative loadings of -0.268, -0.375, -0.087, -0.150 and -0.185 in PC4, number of leaves per plant, leaf stem ratio and green fodder yield showed positive loading respectively. Generally, from the last two principal components (*i.e.* PC 3 and PC 4) fodder quality content is dominant. Correlation of crude protein content with the third principal component is high, as well as crude fat content with the fourth principal component is high. These results agree with the finding of Asaigbe *et al.* (2014) for number of leaves per plant and Mirjana *et al.* (2008) for quality.

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