Forage Res., **47**(4) : pp. 499-503 (2022) **http://forageresearch.in**

EXPLOITING NATURAL GENETIC VARIABILITY IN GUINEA GRASS ACCESSIONS OF DIVERSE ORIGIN

K. SHAMINI*, K. N. GANESAN, T. EZHILARASI AND B. MEENA KUMARI

Department of Forage Crops, Centre for Plant Breeding and Genetics
Tamil Nadu Agricultural University, Coimbatore-641 003
(e-mail : kshamini93@gmail.com)

(Received : 12 Februry 2022; Accepted : 29 March 2022)

SUMMARY

Guinea grass (*Panicum maximum* Jacq.), which is originated from Africa, was introduced to India. It plays a major role in livestock productivity due to its higher biomass and shorter duration. In considering the livestock productivity, intensive research on guinea grass was initiated and up on exploration from different parts of India, a total of 150 genotypes were conserved. Out of which, 75 germplasm accessions were studied to assess their genetic diversity for various biometric traits *viz*., plant height, number of tillers, leaf length, leaf weight, leaf stem ratio and green fodder yield. The analysis of variance was highly significant for the traits plant height, number of tillers, leaf length, leaf weight and green fodder yield which revealed the presence of genetic variability among the 75 genotypes. By using the tocher method of genetic diversity analysis, 75 genotypes were grouped into 15 clusters, thereby indicating the greater genetic diversity in the explored genetic materials. The numbers of genotypes were more in cluster 1 which consists of 29 genotypes followed by cluster 3 and 5 which includes 13 and 11 genotypes respectively. The inter cluster distances were greater than the intra cluster distances, which indicates that the genotypes selected for breeding from different clusters will be genetically diverse. The intra cluster distance were more in cluster 14 followed by 8 and 5. The genetically more divergent genotypes were present in cluster 15 and 3 as evident from the inter cluster distance value of 8.75. It is concluded that an intensive selection applied on the genotypes selected from divergent clusters would enable the breeders to develop guinea grass varieties with enhanced green fodder yield and quality.

Key words : Guinea grass, Diversity, Tocher method

In India, one third of the grasses possess fodder value and most of the tropical grasses were originated from Africa. Guinea grass (*Panicum maximum* Jacq.) is originated from Africa and spread over to tropical and sub tropical regions as introduced crop. It is a medium height (2-2.7m) grass with palatable smooth stem and leaves. It can be propagated through seed and rooted slips and plays an important role in livestock productivity due to its higher biomass, nutrition, drought and shade tolerant nature (Alonso *et al*., 2006). Nutrient content in Guinea grass is more at the height of 60-90 cm but it get decreased with the increase of plant height and contains 8 to 12% of crude protein and 31% of crude fiber (Humphreys and Patridge, 1995). It grows well under wide range of soils with good drainage except clay soil and can withstand continuous grazing at the rate of 2.5 cattles/ha (Aganga and Tshwenyane, 2004). It can be cultivated under both rainfed and irrigated conditions. Preferred time of sowing under rainfed condition is 2nd fortnight of June to end of July and throughout the year is suitable for irrigated situations. It requires 30 to 35 thousands of rooted slips for one hectare of land area with a spacing of 50 cm´50 cm. First harvest should be done at 60 days after planting and the subsequent harvest at 45 days of interval. In a year, 5-7 cuts can be done with the optimum yield of 350 to 400t/ha/yr.

In IGFRI (Indian Grassland and Fodder Research Institute), more than 8500 germplasm of different forage crops are conserved and it includes 704 accessions of Guinea grass (https://www.igfri.res.in/). In Guinea grass, ploidy level ranged from triploid (2n=3X=24) to nonoploid (2n=9X=72). Paucity of forage crop resources needs consideration towards the exploration and conservation of forage crop species. Breeding efforts in tropical grasses is limited due to the presence of apomixis, poor seed set, photo and thermo sensitivity *etc* and hence the improvement of forage crops in terms of green fodder yield as wells as quality through advanced breeding technique is imperative. In contrast, the true apomictic nature plays beneficial in breeding programme to fix the hybrid vigor. Evaluation and selection is the prime objective of plant breeding as for as grasses are concerned. For the genetic enhancement of green biomass in Guinea grass, plant needs to be evaluated for its genetic variability and selection should be done considering the genetically associated traits of green fodder yield. With the above background, the present study was designed to analyze the diversity of 75 Guinea grass accessions collected from different parts of India to identify the superior genotypes possessing high quality and biomass for further genetic enhancement of Guinea grass.

MATERIALS AND METHODS

The present study comprised of 75 accessions of Guinea grass explored from different parts of India. Explored accessions were planted during *rabi*, 2021 with a spacing of 50 cm ´50 cm in a randomized block design with two replications. All the recommended package of practices were followed. The seven phenotypic traits were recorded on three individual plants per replication *viz*., plant height, number of tillers, leaf length, leaf breath, leaf weight, leaf stem ratio and green fodder yield. Genetic diversity study was performed using Mahalanobis D^2 statistics (Mahaloanobis, 1936) and clustering of genotypes using Tocher's method suggested by Rao (1952). The data were analyzed using software INDOSTAT version 9.1 developed by INDOSTAT Services Ltd. Hyderabad, India.

RESULTS AND DISCUSSION

Creation of variation is inevitable in plant breeding to make the crop improvement programme viable. Such genetic variations can be exploited through exploration and collection, hybridization, mutagens *etc*. Current research deals with the study of diverse

TABLE 1

Analysis of variance of mean sum of squares for different characters in Guinea grass

Sources of variation	df	Plant height (cm)	No. of tillers	Leaf length (cm)	Leaf breadth (cm)	Leaf weight (g)	Leaf stem ratio	Green fodder yield (g)
Replication	1	9.92	0.38	37.80	0.02	17.23	0.08	38298.95
Genotypes	74	441.82**	7.98**	40.38**	0.08**	448.79**	0.01	8086.11**
Error	74	64.91	1.52	21.35	0.04	130.33	0.01	4897.51

** Significant at 1% level.

TABLE 2

Clustering pattern of 75 accessions using D^2 statistics

Cluster no.	Number of accessions	Accessions
1	29	FD637, FD674, FD695, FD694,FD663,FD653,FD675, FD652, FD683, FD606, FD696, FD697, FD684, FD660, FD138, FD688, FD687, FD677, FD672, FD701, FD782, FD783, FD54, FD135, FD59, FD656, FD678, FD681,FD666
2	1	FD658
3	13	FD673,FD699,FD693,FD671,FD669,FD676,FD668,FD659,FD655,FD670,FD662,FD661,FD702
4	1	FD665
5	11	FD690,FD785,FD686,FD787,FD689,FD786,FD692,FD679,FD618,FD680,FD594
6	1	FD780
7	1	FD705
8	9	FD703,FD706,FD654,FD137,FD744,FD657,FD781,FD682,FD784
9	1	FD704
10	1	FD685
11	1	FD5
12	1	FD698
13	1	FD700
14	3	FD664,FD667,FD136
15	1	FD691

germplasms of Guinea grass collected from different parts of India. Analysis of variance was carried out in 75 germplasms of Guinea grass using mean values of seven biometric traits and presented in Table 1. The results showed that the significant differences observed for all the traits except leaf stem ratio. Similar results reported by Sudrik *et al.* (2015). It indicates that the materials under study possess the sufficient genetic variability for six biometric traits *viz*., plant height, number of tillers, leaf length, leaf breath, leaf weight and green fodder yield studied.

Genetic divergence of Guinea grass germplasm accessions was assessed through the numerical approach of Mahalanobis' D^2 statistics (Table 2&4). The 75 germplasm were grouped into 15 clusters based on the distance value and results revealed the existence of greater genetic diversity in the germplasm (Fig. 2). Under clustering pattern, more number of germplasm found in cluster 1 followed by cluster 3 & 5 with 29, 13 and 11 germplasms respectively. Cluster 8 and 14 possesses nine and three germplasm accessions respectively and the rest of the clusters (2, 4, 6, 7, 9, 10, 11, 12, 13&15) possess single germplasm each. Similar results were obtained by Kumari *et al*., 2018 in rice. The inter cluster distance was also observed to be more than the intra cluster distance. Intra cluster values (D) ranged from 0.00 to 4.41 and the highest intra cluster distance was recorded in cluster 14 followed by cluster 8 and 4 with the value of 4.41, 3.90 and 3.35 respectively. No intra cluster distances were found in the clusters 2, 4, 6, 7, 9, 10, 11, 12, 13 and 15 and it indicates that no variability found within in these clusters. Similar results were were recorded by Ramakrishnan *et al*. (2019) in Guinea grass. The inter cluster distance (D) values ranged from 2.63 to 8.75. The highest value registered was between cluster 15 and 3 (8.75) followed by cluster 14 and 11 (4.41) and the least value registered was between cluster 12 and 4 with 2.63. Obtained results are in accordance with the results of More *et al*., 2006 in fodder maize, Kumari *et al*., 2018 and Bhadru *et al.,* 2012 in rice.

Cluster mean analysis indicates the presence of genetic variability for different traits under study (Table 3). Higher mean value for plant height was registered in cluster 3, number of tillers in cluster 8, leaf length and leaf weight in cluster 14, leaf breath in cluster 13, leaf stem ratio in cluster 12 and green fodder yield in cluster 2. Based on the ranking method, the contribution of different traits to the total divergence was estimated and presented in Table 5 & Fig. 1. The

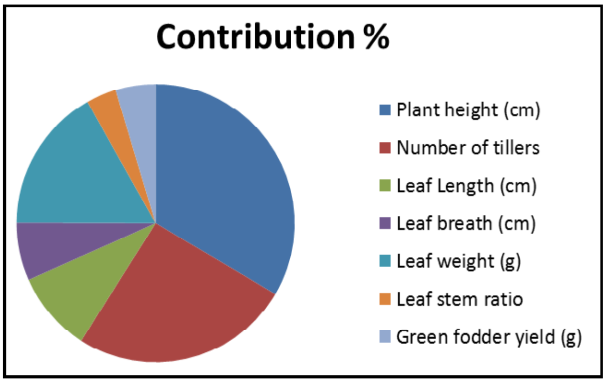

Fig. 1. Graphical representation of percentage contribution of seven agronomic traits in Guinea grass towards genetic divergence.

TABLE 3
Cluster mean values for seven traits in Guinea grass

Clusters	Plant height (cm)	Number of tillers	Leaf Length (cm)	Leaf breath (cm)	Leaf weight (g)	Leaf stem ratio	Green fodder yield (g)
1	153.88	14.88	51.99	1.51	111.05	0.46	365.64
2	166.25	15.50	60.15	1.65	110.00	0.29	484.50
3	170.77	14.38	55.31	1.57	102.52	0.41	373.66
4	160.85	13.60	52.00	1.75	141.30	0.47	467.30
5	129.75	14.70	52.57	1.34	105.05	0.52	316.99
6	157.70	17.50	50.05	1.55	90.00	0.32	377.50
7	168.75	17.00	52.50	1.95	100.80	0.44	344.30
8	167.18	19.02	54.78	1.63	104.06	0.41	370.97
9	143.65	13.50	60.00	1.25	92.10	0.51	273.80
10	147.75	13.50	53.95	1.65	89.05	0.39	362.30
11	154.75	14.00	42.25	1.10	105.10	0.42	375.10
12	161.85	13.50	60.50	1.65	135.00	0.55	382.00
13	146.90	14.00	58.00	2.00	126.70	0.43	429.20
14	160.72	18.35	61.22	1.78	147.47	0.45	484.13
15	124.00	14.80	49.00	1.50	145.15	0.51	436.65

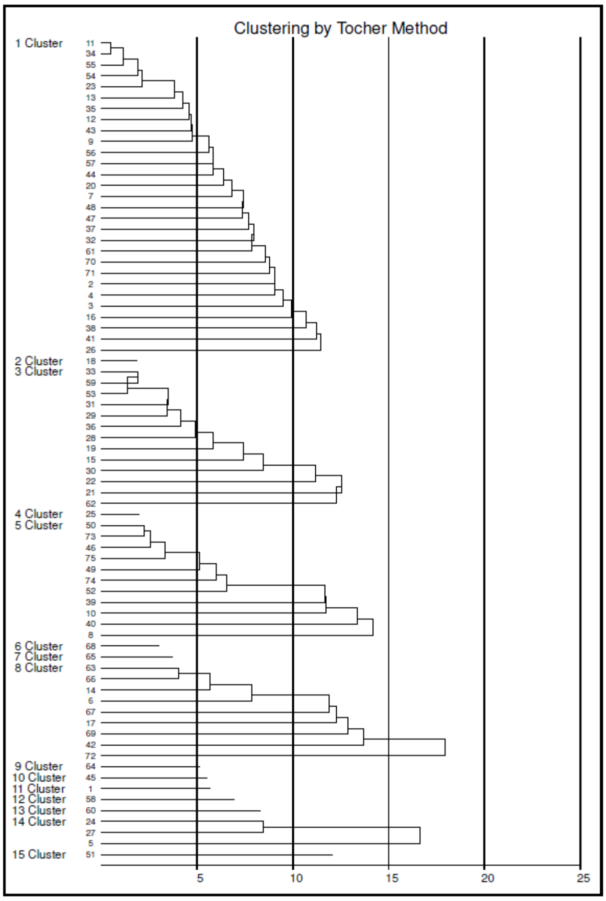

Fig. 2. Dendrogram showing clustering pattern in 75 accessions of Guinea grass based on biometric traits.

TABLE 5

Percentage contribution of seven agronomic traits in Guinea grass towards genetic divergence

Sources	Time ranked 1st	Contribution %
Plant height (cm)	930	33.51
Number of tillers	707	25.48
Leaf Length (cm)	259	9.33
Leaf breath (cm)	187	6.74
Leaf weight (g)	466	16.79
Leaf stem ratio	97	3.50
Green fodder yield (g)	129	4.65

percentage contribution of each trait to the genetic divergence was found to be higher for plant height (33.51%) followed by number of tillers (25.48%) and leaf weight (16.79%). Hence, these traits were found to be the potential contributors to the genetic divergence in all the germplasm of Guinea grass studied.

CONCLUSION

The present study concluded that the sufficient genetic divergence observed in the experimental material. Mahalanobis D^2 statistics carried out in 75 germplasm of Guinea grass towards the assessment of clustering pattern revealed that the genotypes fall into same cluster having lowest degree of divergence whereas, the genotypes belonging to

TABLE 4

Average Intra (bold) and Inter cluster (D^2) and distance (D) value for 15 clusters in Guinea grass

Clusters	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	8.70 (2.95)	12.40 (3.52)	17.39 (4.17)	15.05 (3.88)	4.60 (21.16)	14.75 (3.84)	12.82 (3.58)	24.30 (4.93)	13.84 (3.72)	13.32 (3.65)	13.99 (3.74)	16.65 (4.08)	16.65 (4.08)	37.70 (6.14)	36.24 (6.02)
2		0.00 (0.00)	10.50 (3.24)	14.29 (3.78)	35.76 (5.98)	17.06 (4.13)	10.90 (3.30)	22.09 (4.70)	17.06 (4.13)	14.75 (3.84)	24.30 (4.93)	12.04 (3.47)	16.32 (4.04)	32.49 (5.70)	55.06 (7.42)
3			9.30 (3.05)	21.16 (4.60)	46.65 (6.83)	26.11 (5.11)	16.00 (4.00)	33.76 (5.81)	18.49 (4.30)	18.23 (4.27)	21.34 (4.62)	16.32 (4.04)	30.58 (5.53)	56.25 (7.50)	76.56 (8.75)
4				0.00 (0.00)	36.84 (6.07)	36.36 (6.03)	22.00 (4.69)	40.44 (6.36)	30.69 (5.54)	23.72 (4.87)	24.01 (4.90)	6.92 (2.63)	11.56 (3.40)	33.06 (5.75)	35.28 (5.94)
5					11.22 (3.35)	26.83 (5.18)	35.05 (5.92)	41.73 (6.46)	19.98 (4.47)	20.07 (4.48)	27.77 (5.27)	41.86 (6.47)	27.35 (5.23)	53.00 (7.28)	22.75 (4.77)
6						0.00 (0.00)	8.24 (2.87)	11.76 (3.43)	22.94 (4.79)	21.53 (4.64)	21.07 (4.59)	38.07 (6.17)	28.20 (5.31)	39.56 (6.29)	47.47 (6.89)
7							0.00 (0.00)	13.69 (3.70)	23.91 (4.89)	18.40 (4.29)	26.94 (5.19)	21.62 (4.65)	17.64 (4.20)	34.12 (5.84)	54.46 (7.38)
8								15.21 (3.90)	36.00 (6.00)	38.56 (6.21)	37.70 (6.14)	38.44 (6.20)	35.05 (5.92)	31.92 (5.65)	57.46 (7.58)
9									0.00 (0.00)	9.18 (3.03)	20.16 (4.49)	21.07 (4.59)	26.21 (5.12)	58.22 (7.63)	53.29 (7.30)
10										0.00 (0.00)	18.15 (4.26)	26.63 (5.16)	20.70 (4.55)	62.57 (7.91)	50.27 (7.09)
11											0.00 (0.00)	32.26 (5.68)	39.94 (6.32)	64.80 (8.05)	49.28 (7.02)
12												0.00 (0.00)	13.32 (3.65)	33.06 (5.75)	50.27 (7.09)
13													0.00 (0.00)	26.73 (5.17)	25.70 (5.07)
14														19.45 (4.41)	38.56 (6.21)
15															0.00 (0.00)

different clusters having maximum divergence. The genetically more divergent genotypes present in cluster 15 and 3 as evident from the inter cluster distance value of 8.75. It is concluded that an intensive selection applied on the genotypes selected from divergent clusters would enable the breeders to develop guinea grass varieties with enhanced green fodder yield and quality.

REFERENCES

Aganga, A. A and S. Tshwenyane, 2004 : Potentials of Guinea grass (Panicum maximum) as Forage crop in livestock production. *Pakistan Journal of Nutrition*. **3(1)**: 1-4.

Alonso, J., G. Febles, T.E. Ruiz and G. Achang, 2006 : Effect of the shade on the grass associated with a silvopastoral system of leucaena-Guinea grass in different stages. *Cuban J. Agricultural Science,* **40(4)**: 485-493.

Bhadru, D., V. T. Rao, Y. C. Mohan and D. Bharathi, 2012 : Genetic variability and diversity studies in yield and its component traits in rice (*Oryza sativa* L.). *SABRAO J. Breeding and Genetics*. **44 (1)**: 129-137, 2012.

Humphreys, L.R. and I.J. Patridge, 1995 : A guide to better pastures for the tropics and sub-tropics. Published by NSW agriculture 5th edition: Grasses for the tropics: Guinea grass (*Panicum maximum*).

IGFRI. Indian Grassland and Fodder Research Institute. Available online: https://www.igfri.res.in/ (accessed on 15 December 2021).

Kumari, S., P.K. Singh, P. Bisen, B. Loitongbam, V.P. Rai and B. Sinha, 2018 : Genetic diversity analysis of rice (*Oryza sativa* L.) germplasm through morphological markers. *IJAEB.,* 953-957.

Mahalanobis, P. C., 1936 : The generalized distance in statistics. *Proceeding of the National Ins. of Sci. of India*. **12** : 49-55.

More, A. J., K.D. Bhiote and S.R. Pardeshi, 2006 : Genetic diversity studies in forage maize (*Zea mays* L.). *Res. Crops,* **7 (3)**: 728-730.

Ramakrishnan, P., C. Babu, K. Iyanar and N. Manivannan, 2013 : Assessment of genetic diversity in germplasm of Guinea grass (*Panicum maximum* Jacq.). *Indian. J. Agric. Res.,* **A-5225** : 1-5.

Rao, C. R., 1952 : Advanced Statistical Methods in Biometrical Research. *John Wiley and Sons*, New York. pp. 126-152.

Sudrik, B.P., M.Abraham, and U.C. Thomas, 2015 : Genetic divergence in Guinea grass (*Panicum maximum* Jacq.). *Proceeding of the XXIII International Gr Grassland Congr assland Congress (Sustainable use of Grassland Resources for Forage Production, Biodiversity and Environmental Protection).*