Plant Archives Vol. 25, No. 1, 2025 pp. 1157-1162 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.no.1.174

LEAF PARAMETERS AS INFLUENCED BY DIFFERENT TURF GENOTYPES

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(Date of Receiving-23-11-2024; Date of Acceptance-30-01-2025)

ABSTRACT

The present investigation was carried out at College of Horticulture, Venkataramannagudem, West Godavari District of Andhra Pradesh during the years 2022-24 in *Rabi* season to evaluate fourteen different turf genotypes for establishment and growth under local conditions. The experiment was laid out in RBD replicated two times. Results revealed that, among different turf genotypes *Cynodon dactylon* L. 'Tif Dwarf 419' (G_4) recorded the shortest leaf length (3.22 cm) and leaf width (1.26 mm). While, *Paspalum notatum* 'Argentine' (G_8) (31.20 cm) recorded the highest leaf length and *Paspalum notatum* (G_7) (10.92 mm) recorded the highest leaf width The total Chlorophyll content was maximum in *Paspalum notatum* 'Coarse' (G_9) (41.56) and minimum in *Zoysia japonica* (G_{13}) (5.57) at 120 days after planting.

Key words : *Rabi*, Turf genotypes, Establishment, Leaf width, Total chlorophyll content.

Introduction

Turf grasses are the plants that form a continuous ground cover, which can endure frequent mowing and foot traffic. These are part of the *Gramineae* or *Poaceae* family, recognized as the most biologically diverse family in India that are instrumental in enhancing and maintaining the beauty and functionality of lawns, ornamental fields, and various other environments worldwide. These turf grasses include a remarkably diverse selection of species that are chosen based on their applications and the climatic conditions in which they thrive (Janakiram and Namita, 2014). Selecting the right turf grass species or variety is essential, considering its intended use - low-maintenance lawns, sports fields, residential yards, or public spaces. While cultural practices influence performance, locally adapted varieties are equally important. In the context of ornamental crops like turf grass, the breeding and selection processes focus primarily on appearance and quality, which are often assessed in diversity studies. Key traits that are evaluated include leaf, internodes, inflorescence traits and the overall growth habits of the plants. The main quality components of turf grass are widely recognized as colour, density, uniformity, leaf texture, growth habit, and smoothness (Patton *et al*., 2007).

Materials and Methods

The experimental site was located at College of Horticulture, Dr.Y.S.R Horticultural University, Venkataramannagudem, West Godavari District, Andhra Pradesh. The location falls under Agro climatic Zone-10, Humid, East Coast Plain and Hills (Krishna-Godavari Zone) with an average annual rainfall of 900 mm at an altitude of 18 m (59 feet) above the mean sea level. The experimental site was geographically situated at 16º 63' N latitude and 81º 27' E longitude with hot humid summer and mild winter climate. The experiment was laid out in Randomized block design with two replications. Planting was done by dibbling at a spacing of 10 cm × 10 cm in zig-zag rows in randomized flat beds of size 2 m × 2 m. Hand weeding was done at 40 days interval. Experiment consisted of 14 turf genotypes *viz*., *Axonopus*

Table 1 : Leaf length (cm) in different turf genotypes at different growth stages.

Turf genotypes	Leaf length (cm)								
	20 DAP			40 DAP			60 DAP		
	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled
G_1 : *Axonopus compressus*	3.38	3.60	**3.49**	4.36	4.50	**4.43**	5.42	5.54	**5.48**
G_2 : *Cynodon dactylon* L. 'Panama'	2.31	2.33	**2.32**	2.88	2.92	**2.90**	3.13	3.15	**3.14**
G_3 : *Cynodon dactylon* L. 'Selection 1'	1.61	1.64	**1.63**	1.93	1.97	**1.95**	2.19	2.23	**2.21**
G_4 : *Cynodon dactylon* L. 'Tif Dwarf 419'	1.38	1.53	**1.46**	1.62	1.65	**1.63**	1.79	1.82	**1.81**
G_5 : *Dactyloctenium aegyptium*	3.54	3.58	**3.56**	4.17	4.23	**4.20**	5.06	5.10	**5.08**
G_6 : *Eremochloa ophiuroides*	3.14	3.19	**3.17**	3.34	3.38	**3.36**	3.62	3.66	**3.64**
G_7 : *Paspalum notatum*	14.65	14.62	**14.63**	16.12	16.28	**16.20**	18.50	18.66	**18.58**
G_8 : *Paspalum notatum* 'Argentine'	15.40	15.56	**15.48**	21.36	21.44	**21.40**	23.15	23.37	**23.26**
G_9 : *Paspalum notatum* 'Coarse'	14.98	15.08	**15.03**	18.80	19.04	**18.92**	22.23	22.45	**22.34**
G_{10}: *Paspalum vaginatum*	2.10	2.11	**2.10**	2.43	2.46	**2.44**	2.73	2.72	**2.72**
G_{11} : *Stenotaphrum secundatum*	3.46	3.50	**3.48**	4.20	4.21	**4.20**	4.48	4.52	**4.50**
G_{12} : *Stenotaphrum secundatum* 'Variegatum'	4.04	4.08	**4.06**	4.79	4.83	**4.81**	5.49	5.55	**5.52**
G_{13} : *Zoysia japonica*	1.89	1.94	**1.92**	2.18	2.18	**2.18**	2.65	2.67	**2.66**
G_{14} : *Zoysia matrella*	1.81	1.75	**1.78**	1.99	2.01	**2.00**	2.51	2.53	**2.52**
Mean	**5.26**	**5.32**	***5.29***	**6.44**	**6.51**	***6.47***	**7.35**	**7.43**	***7.39***
SE m ±	0.12	0.19	**0.04**	0.03	0.03	**0.03**	0.05	0.06	**0.04**
CD at 5%	0.38	0.59	**0.11**	0.10	0.10	**0.11**	0.15	0.19	**0.11**

Table 1 continued…

Turf genotypes	Leaf length (cm)								
	80 DAP			100 DAP			120 DAP		
	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled
G_1 : *Axonopus compressus*	6.28	6.50	**6.39**	8.18	8.28	**8.23**	8.38	8.54	**8.46**
G_2 : *Cynodon dactylon* L. 'Panama'	3.32	3.36	**3.34**	3.84	3.88	**3.86**	4.35	4.41	**4.38**
G_3 : *Cynodon dactylon* L. 'Selection 1'	2.71	2.75	**2.73**	3.14	3.21	**3.18**	3.66	3.71	**3.69**
G_4 : *Cynodon dactylon* L. 'Tif Dwarf 419'	2.21	2.25	**2.23**	2.63	2.65	**2.64**	3.20	3.24	**3.22**
G_5 : *Dactyloctenium aegyptium*	5.45	5.51	**5.48**	6.07	6.13	**6.10**	7.81	7.91	**7.86**
G_6 : *Eremochloa ophiuroides*	4.03	4.09	**4.06**	5.16	5.20	**5.18**	6.14	6.23	**6.19**
G_7 : *Paspalum notatum*	19.93	20.19	**20.06**	23.49	23.71	**23.60**	27.67	28.03	**27.85**
G_8 : *Paspalum notatum* 'Argentine'	26.35	26.29	**26.32**	26.93	27.19	**27.06**	31.20	31.20	**31.20**

Table 1 continued…

Table 1 continued…

G_9 : *Paspalum notatum* 'Coarse'	25.30	25.62	**25.46**	26.33	27.14	**26.73**	28.81	29.19	**29.00**
G_{10} : *Paspalum vaginatum*	2.99	3.01	**3.00**	3.68	3.75	**3.71**	4.23	4.29	**4.26**
G_{11} : *Stenotaphrum secundatum*	5.01	5.07	**5.04**	7.35	7.41	**7.38**	8.76	8.81	**8.79**
G_{12} : *Stenotaphrum secundatum* 'Variegatum'	6.32	6.38	**6.35**	8.44	8.52	**8.48**	10.69	10.62	**10.66**
G_{13} : *Zoysia japonica*	2.99	2.97	**2.98**	3.54	3.58	**3.56**	4.08	4.14	**4.11**
G_{14} : *Zoysia matrella*	2.86	2.90	**2.88**	3.31	3.33	**3.32**	4.01	4.10	**4.05**
Mean	**8.27**	**8.35**	***8.31***	**9.43**	**9.57**	***9.50***	**10.93**	**11.03**	***10.98***
SE m ±	0.04	0.04	**0.05**	0.07	0.10	**0.10**	0.05	0.05	**0.06**
CD at 5%	0.13	0.12	**0.16**	0.20	0.32	**0.31**	0.17	0.14	**0.19**

compressus (G_1), *Cynodon dactylon* L. 'Panama' (G_2), *Cynodon dactylon* L. 'Selection 1' (G_3), *Cynodon dactylon* L. 'Tif Dwarf 419' (G_4), *Dactyloctenium aegyptium* (G_5), *Eremochloa ophiuroides* (G_6), *Paspalum notatum* (G_7), *Paspalum notatum* 'Argentine' (G_8), *Paspalum notatum* 'Coarse' (G_9), *Paspalum vaginatum* (G_{10}), *Stenotaphrum secundatum* (G_{11}), *Stenotaphrum secundatum* 'Variegatum' (G_{12}), *Zoysia japonica* (G_{13}) and *Zoysia matrella* (G_{14}). All the genotypes were maintained under uniform management practices. Leaf length and width of the third mature leaf from the tip were recorded from 10 randomly flattened leaves per plot across fourteen genotypes and averaged at 20, 40, 60, 80, 100 and 120 days after planting. The total chlorophyll content was recorded from three leaves of same physiological age from randomly selected plants using a SPAD meter at 120 DAP. The data on these observations were statistically analysed using randomised block design described by Panse and Sukhatme (1985).

Results and Discussion

Leaf length (cm)

The data on leaf length (cm) as influenced by turf genotypes is presented in Table 1. Significant differences were noticed between different turf genotypes for leaf length at all growth stages (20 to 120 DAP) during the year 2022-23 and 2023-24 as well as in pooled analysis. A gradual increase in leaf length (cm) was observed in all of the turf genotypes with passage of time. As per pooled values, the mean of leaf length (cm) showed an increase from 5.29 cm (20 DAP) to 10.98 cm (120 DAP). In pooled data, among different genotypes *Cynodon dactylon* L. 'Tif Dwarf 419' (G_4) (3.22 cm) recorded the shortest leaf length, which was preceded by *Cynodon dactylon* L. 'Selection 1' (G_3) (3.69 cm). *Paspalum notatum* 'Argentine' (G_8) recorded the highest leaf length (31.20 cm) which was followed by *Paspalum notatum* 'Coarse' (G_9) (29 cm).

Differences in leaf length among turf grass species could be attributed to genetic variations between varieties and species. Abdullah *et al*. (2010) reported that Paspalum grass leaves were approximately 2½ times larger than Common Bermuda grass leaves. Similar findings were reported by Lakshmipathy (2017) and Singh and Bala (2023) in studies conducted under the semi-arid and subtropical climatic conditions of New Delhi and Ludhiana, respectively.

Leaf width (mm)

The data on leaf width (mm) as influenced by turf genotypes is presented in Table 2. Significant differences were noticed between different turf genotypes for leaf

Table 2 : Leaf width (mm) in different turf genotypes at different growth stages.

Turf genotypes	Leaf width (mm)								
	20 DAP			40 DAP			60 DAP		
	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled
G_1 : *Axonopus compressus*	7.19	7.12	**7.16**	8.12	8.09	**8.11**	8.38	8.35	**8.37**
G_2 : *Cynodon dactylon* L. 'Panama'	1.80	1.85	**1.83**	1.29	1.27	**1.28**	2.11	2.12	**2.12**
G_3 : *Cynodon dactylon* L. 'Selection 1'	1.13	1.14	**1.14**	1.42	1.40	**1.41**	1.52	1.49	**1.51**
G_4 : *Cynodon dactylon* L. 'Tif Dwarf 419'	1.03	1.05	**1.04**	1.17	1.18	**1.18**	1.21	1.23	**1.22**
G_5 : *Dactyloctenium aegyptium*	5.35	5.30	**5.33**	6.29	6.27	**6.28**	7.12	7.15	**7.14**
G_6 : *Eremochloa ophiuroides*	2.15	2.17	**2.16**	2.27	2.25	**2.26**	2.31	2.29	**2.30**
G_7 : *Paspalum notatum*	6.30	6.29	**6.30**	6.59	6.55	**6.57**	7.30	7.32	**7.31**
G_8 : *Paspalum notatum* 'Argentine'	3.82	3.85	**3.84**	4.12	4.10	**4.11**	4.57	4.55	**4.56**
G_9 : *Paspalum notatum* 'Coarse'	6.42	6.40	**6.41**	7.39	7.40	**7.40**	8.17	8.15	**8.16**
G_{10} : *Paspalum vaginatum*	1.72	1.68	**1.70**	1.80	1.79	**1.80**	1.92	1.93	**1.93**
G_{11} : *Stenotaphrum secundatum*	5.12	5.10	**5.11**	5.39	5.35	**5.37**	5.83	5.85	**5.84**
G_{12} : *Stenotaphrum secundatum* 'Variegatum'	6.35	6.36	**6.36**	6.95	6.92	**6.94**	7.32	7.30	**7.31**
G_{13} : *Zoysia japonica*	1.18	1.15	**1.17**	1.22	1.20	**1.21**	1.89	1.90	**1.90**
G_{14} : *Zoysia matrella*	1.10	1.08	**1.09**	1.18	1.16	**1.17**	1.35	1.31	**1.33**
Mean	**3.62**	**3.61**	***3.61***	**3.94**	**3.92**	***3.93***	**4.36**	**4.35**	***4.36***
SE m ±	0.05	0.07	**0.05**	0.05	0.08	**0.06**	0.06	0.09	**0.07**
CD at 5%	0.15	0.22	**0.16**	0.17	0.25	**0.18**	0.17	0.26	**0.21**

Table 2 continued…

Turf genotypes	Leaf width (mm)								
	80 DAP			100 DAP			120 DAP		
	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled	2022-23	2023-24	Pooled
G_1 : *Axonopus compressus*	8.59	8.62	**8.61**	9.47	9.50	**9.49**	10.33	10.28	**10.31**
G_2 : *Cynodon dactylon* L. 'Panama'	2.25	2.28	**2.27**	2.32	2.30	**2.31**	2.52	2.48	**2.50**
G_3 : *Cynodon dactylon* L. 'Selection 1'	1.92	1.90	**1.91**	2.02	1.98	**2.00**	2.08	2.10	**2.09**
G_4 : *Cynodon dactylon* L. 'Tif Dwarf 419'	1.23	1.20	**1.22**	1.25	1.27	**1.26**	1.26	1.25	**1.26**
G_5 : *Dactyloctenium aegyptium*	7.35	7.32	**7.34**	7.75	7.73	**7.74**	8.13	8.09	**8.11**
G_6 : *Eremochloa ophiuroides*	2.42	2.40	**2.41**	2.55	2.52	**2.54**	2.95	2.93	**2.94**
G_7 : *Paspalum notatum*	8.13	8.10	**8.12**	9.67	9.69	**9.68**	10.93	10.90	**10.92**
G_8 : *Paspalum notatum* 'Argentine'	4.89	4.85	**4.87**	5.25	5.22	**5.24**	5.32	5.30	**5.31**
G_9 : *Paspalum notatum* 'Coarse'	8.62	8.60	**8.61**	9.18	9.15	**9.17**	9.32	9.30	**9.31**
G_{10} : *Paspalum vaginatum*	2.15	2.13	**2.14**	2.29	2.26	**2.28**	2.32	2.28	**2.30**
G_{11} : *Stenotaphrum secundatum*	6.35	6.32	**6.34**	7.12	7.10	**7.11**	7.48	7.45	**7.47**
G_{12} : *Stenotaphrum secundatum* 'Variegatum'	7.57	7.55	**7.56**	7.86	7.85	**7.86**	8.02	8.03	**8.03**
G_{13} : *Zoysia japonica*	2.00	2.03	**2.02**	2.08	2.05	**2.07**	2.10	2.11	**2.11**
G_{14} : *Zoysia matrella*	1.40	1.42	**1.41**	1.41	1.39	**1.40**	1.42	1.40	**1.41**
Mean	**4.63**	**4.62**	***4.63***	**5.02**	**5.00**	***5.01***	**5.30**	**5.28**	***5.29***
SE m ±	0.06	0.09	**0.64**	0.72	0.81	**0.75**	0.58	0.65	**0.63**
CD at 5%	0.18	0.27	**1.94**	2.18	2.46	**2.27**	1.76	1.97	**1.91**

width at all growth stages (20 to 120 DAP) during the year 2022-23 and 2023-24 as well as in pooled analysis. Mean leaf width as per pooled values, showed an increase from 3.61 mm (20 DAP) to 5.29 mm (120 DAP). *Cynodon dactylon* L. 'Tif Dwarf 419' (G_4) (1.26 mm) recorded the shortest leaf width which was preceded by *Zoysia matrella* (G_{14}) (1.41 mm). While, *Paspalum notatum* (G_7) (10.92) recorded the highest leaf width followed by *Axonopus compressus* (G_1) (10.31 mm) at 120 DAP.

Table 3 : Total chlorophyll content (SPAD units) in different turf genotypes at 120 DAP.

Turf genotypes	Total chlorophyll content (SPAD units)		
	2022-23	2023-24	Pooled
$G_{1:}$ *Axonopus compressus*	26.19	25.84	**26.02**
$G_{2:}$ *Cynodon dactylon* L. 'Panama'	8.80	8.31	**8.56**
$G_{3:}$ *Cynodon dactylon* L. 'Selection 1'	16.38	16.36	**16.37**
$G_{4:}$ *Cynodon dactylon* L. 'Tif Dwarf 419'	8.48	7.98	**8.23**
$G_{5:}$ *Dactyloctenium aegyptium*	23.67	23.86	**23.77**
$G_{6:}$ *Eremochloa ophiuroides*	20.36	21.02	**20.69**
$G_{7:}$ *Paspalum notatum*	33.24	32.80	**33.02**
$G_{8:}$ *Paspalum notatum* 'Argentine'	35.07	36.62	**35.85**
$G_{9:}$ *Paspalum notatum* 'Coarse'	40.30	42.82	**41.56**
$G_{10:}$ *Paspalum vaginatum*	10.62	10.04	**10.33**
$G_{11:}$ *Stenotaphrum secundatum*	26.82	25.34	**26.08**
$G_{12:}$ *Stenotaphrum secundatum* 'Variegatum'	8.76	8.04	**8.40**
$G_{13:}$ *Zoysia japonica*	5.02	6.12	**5.57**
$G_{14:}$ *Zoysia matrella*	11.73	12.15	**11.94**
Mean	**19.67**	**19.81**	***19.74***
SE m ±	0.23	0.36	**0.52**
CD at 5%	0.70	1.09	**1.60**

Cynodon dactylon L. 'Tif Dwarf 419,' closely followed by *Zoysia matrella*, *Cynodon dactylon* L. 'Selection 1' and *Zoysia japonica*, recorded the finest leaf width among the different turf genotypes in this study. In contrast, the highest leaf width was observed in *Paspalum* and *Axonopus* grasses due to their leaves exhibiting maximum horizontal growth. Leaf width, a genetically controlled parameter, determines turf grass texture, with narrower leaves contributing to a finer texture. Differences in leaf width among cultivars of the same species were also observed, as reported by Marchione (2004). De Luca *et al*. (2008) highlighted that the narrower the leaf width, the finer the turf texture. Uniform shoot shape, size and orientation enhance aesthetics, rigidity, and resilience, improving turf durability and functionality (Turgeon, 2005). Similar findings were reported by Geren *et al*. (2009), Agnihotri *et al*. (2017) and Kanara *et al*. (2024) under Gujarat agro-climatic conditions.

Total Chlorophyll content (SPAD units)

The data on total chlorophyll content (SPAD units) as influenced by turf genotypes is presented in Table 3. Significant differences were noticed between different turf genotypes for total chlorophyll content during the year 2022-23 and 2023-24 as well as in pooled analysis at 120 DAP. The mean total chlorophyll content during the year 2022-23 was 19.67 and during the year 2023-24 it was 19.81. The pooled mean of total chlorophyll content was 19.74. In pooled analysis, maximum total chlorophyll content was observed in *Paspalum notatum* 'Coarse' (G_9) (41.56), which was followed by *Paspalum notatum* 'Argentine' (G_8) (35.85) and minimum total chlorophyll content (5.57) was found in *Zoysia japonica* (G_{13}), which was preceded by *Cynodon dactylon* L. 'Tif Dwarf 419' (G_4) (8.23).

Significant variations in chlorophyll content might be due to genotypic characters. This is in agreement with the findings of Lakshmipathy (2017) and Venugopal *et al.* (2021).

Conclusion

Based on findings of the experiment, it is concluded that under Venkataramannagudem agro-climatic conditions, the turf genotype *Cynodon dactylon* L. 'Tif Dwarf 419' exhibited the finest leaf texture, characterized by the shortest leaf length and width. In contrast, the turf genotype *Paspalum* recorded the highest values for leaf length, leaf width and total chlorophyll content.

Acknowledgement

The authors would like to acknowledge Dr. YSRHU-CoH, Venkataramannagudem (AP) for providing technical and financial resources for undertaking the investigation.

References

Abdullah, M.H.A., Iqrar A.K., Fahad A.S., Michael L.D., Sulaiman A. and Tanveer A. (2010). Evaluation of warm season turfgrass under different irrigation regimes in an arid region. *Notulae Scientia Biologicae*, **2**, 30–38.

Agnihotri, R., Chawla S.L. and Patil S. (2017). Evaluation of warm season turfgrasses for various qualitative and quantitative traits under Gujarat agro-climatic conditions. *Indian J. Agricult. Sci.*, **87(7)**.

De Luca, A., Volterrani M., Gaetani M., Grossi N., Croce P., Mocioni M. and Lulli F. (2008). Warm season turfgrass adaptation in Europe north of the 45° parallel. Available at: http://www.federgolf.it.

Geren, H., Avcioglu R. and Curaoglu M. (2009). Performances of some warm season turfgrasses under Mediterranean conditions. *Afr. J. Biotechnol.*, **8**, 4469–4474.

Janakiram, T. and Namita (2014). Genetic divergence analysis in turfgrasses based on morphological traits. *Indian J. Agricult. Sci.*, **84(9)**, 1035–1039.

Kanara, K.K., Leua H.N., Nandre B.M., Wankhade V.R. and

Patel S.B. (2024). Performance of various turfgrass genotypes under North Gujarat condition. *Int. J. Res. Agron.*, **SP-7(7)**, 726–729.

Lakshmipathy, M. (2017). Evaluation of different turfgrasses under different seasons, shade, and growth regulator regimes. *Ph.D. dissertation*. Indian Agricultural Research Institute, New Delhi, India.

Marchione, V. (2004). Evaluation of growth rates and aesthetic parameters of several Bermuda grass cultivars in southern Italy. *Acta Horticulturae*, **661**, 399–401.

Panse, V.G. and Sukhatme P.V. (1985). *Statistical methods for agricultural workers*. Revised by Sukhatme, P.V. and Amble, V.N. New Delhi: ICAR, pp.187–202.

Patton, A.J., Volenec J.J. and Reicher Z.J. (2007). Stolon growth and dry matter partitioning explain differences in zoysia grass establishment rates. *Crop Sci.*, **47**, 1237–1245.

Singh, S. and Bala M. (2023). Evaluation of diverse turfgrass species suitable for lawn under Punjab conditions. *J. Ornamen. Horticult.*, **26(1&2)**, 37–44.

Turgeon, A.J. (2005). Turfgrass species. In: *Turfgrass management*, 7th ed. Upper Saddle River, New Jersey: Pearson Education, Inc., pp.59–119.

Venugopal, U., Fatmi U. and Deepanshu (2021). Evaluation of different turf grasses under Prayagraj agro-climatic conditions. *J. Pharmacog. Phytochem.*, **10(1)**, 2456–2458.