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Evaluation of different turfgrass genotypes for growth and physiological parameters under the hilly zone of Karnataka

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Abstract
An investigation was carried out to evaluate different turfgrass genotypes for growth and physiological parameters under the hilly zone of Karnataka was carried out at College of Horticulture, Sirsi (UHS, Bagalkote) during the year 2019-20. Among different genotypes earliest to new growth appearance (6.00 days), longest stolon at 60 days after planting and longest root length (18.23 cm) was observed in *Cynodon dactylon* L. (STGC-4). Shortest leaf and highest chlorophyll content was recorded in *Cynodon dactylon* L (STGC-5). Highest number of leaves at 60 days after planting was recorded in *Eremochloa ophiuroides*. Higher number of roots per culm were recorded in Cynodon genotypes. *Pennisetum clandestinum* recorded highest shoot fresh and dry weight at complete stage of establishment. The Cynodon genotypes were found to be most suitable under the hill zone of Karnataka.

Keywords: turfgrass genotypes, growth, physiological parameters

Introduction
Grasses are one of the blessings of nature, which is the earliest stable vegetation to reappear after disasters like volcanic eruptions, floods, droughts, fires, explosions and battlegrounds. Turfgrasses are the symbol of civilization (Sun, 2004) [19]. These are the most important plant group that form a low cost cushioning continuous ground cover that persists under regular mowing and traffic (Turgeon, 2006) [22]. These increases aesthetic and recreational value of any area and serve as an inexpensive, long-lasting ground cover and protect our valuable soil resources. It improves soil fertility by increasing soil structure, organic carbon and micro-organism population in the soil. It can be used as the best cost- effective defensive mechanism against soil erosion and dust problems. Turfgrass ecosystem improves groundwater recharge and surface water quality as it has an excellent ability to trap and retain the runoff water. It also promotes earthworm populations that increase the amount of macro pore space in the soil, which results in higher water- retention ability and infiltration rates (Lee, 1985) [12].

Hill zone of Karnataka covers an area of 2.56 M ha and it receives annual rainfall ranging from 904.4-3695.1 mm. The soils are red sandy, shallow to medium depth, highly leached and have poor water holding and ground water recharge capacity.

Successful selection of a turfgrass for any place requires knowledge of its uses, environment adaptation, quality features and cultural activities. Despite increasing interest on turfs in India, we have very less information on turfgrass species. Growth, adoptability and physiological characteristics of most of the turfgrasses were not studied for our conditions. Evaluation and improvement of turfgrasses suitable for Indian conditions is an emerging research thrust area as very limited work has been done systematically and evaluating the variability within vegetatively propagated cultivars can aid in identity, preservation as well as determining acceptable levels of variation within cultivars. The main problems in the hilly zones are soil erosion, leaching of nutrients, poor water holding and ground water recharging capacity of soil. So turfgrasses can be effectively utilised in mitigation of these problems with improving aesthetic and recreational value in sloppy areas. The present study was conducted to identify the best suitable turfgrasses under the hilly zone of Karnataka.

Material and Methods
The present investigation was conducted at the experimental farm of the Department of Floriculture and Landscape architecture, College of Horticulture, Sirsi, (UHS, Bagalkote) during 2019-20, which is geographically situated in the Agro climatic zone−IX (hilly zone) of Karnataka and lies at 14º37` North latitude and 74 º 85` East longitude with an altitude of 616m

above mean sea level. The total rainfall of this area ranges from 2500-3000 mm, distributed over a period of six months (May to October), with a peak during June to July.

The experiment was laid out in Randomized block design with three replications. Planting was done by dibbling at a spacing of 7.5 cm × 7.5 cm in Zig-Zag rows in a randomized beds of size 1 m X 1 m. Experiment consisted of 16 genotypes *viz.*, *Axonopus compressus* (STGC-1), *Axonopus compressus* (STGC-2), *Axonopus compressus* (STGC- 3), *Cynodon dactylon* L. 'Selection 1', *Cynodon dactylon* L. (STGC-4), *Cynodon dactylon* L. (STGC-5), *C. dactylon* L. × *C. transvaalensis* 'Tifdwarf', *Eremochloa ophiuroides*, *Festuca arundinaceae*, *Paspalum vaginatum*, *Pennisetum clandestinum*, *Poa pratensis*, *Stenotaphrum secundatum*, *Zoysia japonica* (STGC-6), *Zoysia japonica* (STGC-7) and *Zoysia tenuifolia*. All the genotypes were maintained under uniform management practices. Here Sirsi turfgrass collection is abbreviated as STGC.

Growth and physiological characters like days to new growth appearance (days), stolon length (cm), number of leaves per stolon, leaf length (cm), growth habit, number of roots per culm, root length (cm), shoot fresh and dry weight (g/m2) and total chlorophyll content (mg/g) were recorded. New growth appearance was recorded by counting the days from planting to new growth appearance in 50 per cent sprigs in the net plot area. Stolon length (Ubendra, 2014) [23] and number of leaves per stolon were recorded at 60 days after planting. Growth habit (Eggens, 1981) [7], number of roots per stolon, root length (cm), shoot fresh and dry weight (Agnihotri, 2015) [1] recorded at full establishment stage and total chlorophyll content was determined by DMSO (Dimethyl sulphoxide) method. The data on various observations were recorded were statistically analysed using randamised block design described by Panse and Sukhatme (1985) [16].

Result and Discussion

Significant differences were observed between the genotypes for number of days to new growth appearance, stolon length, number of leaves per stolon, leaf length, growth habit, number of roots per culm, root length, shoot fresh and dry weight and total chlorophyll content.

Among different genotypes new growth appearance found earliest in *Cynodon dactylon* L. (STGC-4) (6.00 days) which was on par with *Cynodon dactylon* L. 'Selection 1' (8.33 days). As Cynodon grass is well adapted to the tropical and subtropical climates and widely distributed between the latitudes of 45°N and 45°S (Taliaferro, 1995) [20] and its less water requirement and higher drought tolerance made it to perform well (Christians, 2004) [4]. Among the Cynodon genotypes, *Cynodon dactylon* L. (STGC-4) was earliest to have new growth which might be due to the higher adoptability of native genotypes. Whereas, *Festuca arundinaceae* took longest time (38.67 days) to produce new growth which was at par with *Zoysia japonica* (STGC-7) (38 days) and *Z. tenuifolia* (35.33 days). As Tall fescue is a cool season grass which is comparatively poor adopted to tropical condition and slower growth rate in Zoysia genotypes might be the reason to have new growth at farthest among different turfgrass genotypes. These results were conformity with Agnihotri (2015) [1] in case of Cynodon and Zoysia genotypes.

At 60 days after dibbling longest stolons were observed in *Cynodon dactylon* L. (STGC-4) (61.01 cm) which might be due to the higher adoptability of native genotype (Agnihotri, 2015) [1], inherent genetic character and higher stolon growth rate and longer internode character of Bermuda grass. Whereas, lowest stolon length was observed in Zoysia *japonica* (STGC-7) (5.53 cm) which was on par with *Zoysia tenuifolia* (5.71 cm) and *Zoysia japonica* (STGC-6) (5.88 cm). It is mainly attributed to its slower growth rate among warm season turfgrasses (Agnihotri *et al.*, 2017 and Christians, 2004) [2, 4]. Absence of stolon growth was noticed in Tall fescue as it is having bunch type of growth habit (Christians, 2004) [4].

Table 1: New growth appearance, stolon length. Number of leaves per stolon, leaf length and growth habit of different turfgrass genotypes.

Genotypes	New growth appearance (Days)	Stolon length (cm) at 60 DAP	No. of leaves per stolon at 60 DAP	Leaf length (cm)	Growth habit
G1- *Axonopus compressus* (STGC-1)	30.00	37.22	40.97	8.69	Prostrate
G2- *Axonopus compressus* (STGC-2)	28.33	31.96	40.20	8.87	Prostrate
G3- *Axonopus compressus* (STGC-3)	22.67	36.45	56.33	9.68	Prostrate
G4- *Cynodon dactylon* L. 'Selection 1'	8.33	29.15	82.87	3.45	Semi-prostrate
G5- *C. dactylon* L. × *C. transvaalensis* 'Tifdwarf'	10.33	31.07	91.53	3.33	Semi-prostrate
G6- *Cynodon dactylon* L. (STGC-4)	6.00	61.01	61.53	7.58	Upright
G7- *Cynodon dactylon* L (STGC-5)	11.33	22.32	55.20	3.02	Semi-prostrate
G8- *Eremochloa ophiuroides*	23.33	36.59	93.80	7.00	Prostrate
G9- *Festuca arundinaceae*	38.67	-	-	9.73	Upright
G10- *Paspalum vaginatum*	10.67	38.52	78.87	7.23	Upright
G11- *Pennisetum clandestinum*	22.00	56.94	33.13	17.27	Upright
G12- *Poa pratensis*	20.00	39.87	90.80	7.26	Prostrate
G13- *Stenotaphrum secundatum*	29.33	34.03	77.13	6.13	Prostrate
G14- *Zoysia japonica* (STGC-6)	32.67	5.88	19.67	3.40	Semi-prostrate
G15- *Zoysia japonica* (STGC-7)	38.00	5.53	13.33	3.16	Semi-prostrate
G16- *Zoysia tenuifolia*	35.33	5.71	17.07	3.28	Semi-prostrate
Mean	22.94	31.48	56.83	6.82	
S.Em. ±	1.41	1.16	2.99	0.28	
CD@ 5%	4.09	3.35	8.66	0.81	

Note: G9 does not produced any stolons so statistical analysis of parameters related to stolon was done excluding this treatment.

Among different genotypes at 60 days after dibbling, highest number of leaves per stolon was observed in *Eremochloa ophiuroides* (93.80) which was at par with *Cynodon dactylon* L. × *Cynodon transvaalensis* 'Tifdwarf' (91.53) and *Poa pratensis* (90.80) and followed by *Cynodon dactylon* L. 'Selection 1' (82.87). Whereas, lowest number of leaves per stolon was observed in *Zoysia japonica* (STGC-7) (13.33) which was closely followed by *Zoysia tenuifolia* (17.07) and

Zoysia japonica (STGC-6) (19.67). The differences in number of leaves formed on the stolon with different turfgrass genotypes could be attributed to their inherent genetic constitution (Mathew, 2019) and the number of leaves per stolon is mainly influenced by stolon length, number of nodes per stolon, internodal length, branching habit of stolons and difference in growth rate of turfgrasses at different stages of the growth. The results are in accordance with Mazur and Rice (1999) [15]; Ubendra (2014) [23] and Dhanalakshmi (2015) [6].

Growth habit of different turfgrass genotypes is measured on the basis of angle formed between tiller and stolon. Prostrate growth habit is desirable character for any turfgrass, as prostrate growth habit reduces mowing frequency and also prostrate growth habit makes turfgrass to spread faster as the mature shoots are in contact with the ground and thus, it will facilitate easy rooting at nodes (Gobilik *et al.,* 2013) [8]. Among different turfgrass genotypes *Axonopus compressus* (STGC-1), *Axonopus compressus* (STGC-2), *Stenotaphrum secundatum, Poa pratensis*, *Eremochloa ophiuroides* and *Axonopus compressus* (STGC-3) displayed prostrate growth habit and *Zoysia japonica* (STGC-6), *Zoysia tenuifolia*, *Zoysia japonica* (STGC-7), *Cynodon dactylon* L. 'Selection 1', *C. dactylon* L. × *C. transvaalensis* 'Tifdwarf' and *Cynodon dactylon* L. (STGC-5) displayed semi-prostrate growth habit. While, *Cynodon dactylon* L. (STGC-4), *Paspalum vaginatum*, *Pennisetum clandestinum* and *Festuca arundinaceae* had upright growth habit. Different growth habit among different turf grass genotypes is mainly attributed to their inherent genetical factors.

Among evaluated turfgrass genotypes under hill zone maximum number of roots per culm (12.07) was observed in *C. dactylon* L. × *C. transvaalensis* 'Tifdwarf' which was followed by *Cynodon dactylon* L. (STGC-4) (10.53) and *Cynodon dactylon* L. 'Selection 1' (10.13). While, the longest root (18.23 cm) was observed in *Cynodon dactylon* L. (STGC-4) which was followed by *Cynodon dactylon* L. (STGC-5) (15.21 cm), whereas lowest number of roots per culm (4.00) and shortest root (3.58 cm) was observed in *Festuca arundinaceae* followed by *Stenotaphrum secundatum.* These results are similar with the findings of Harivandi *et al.* (1984) [9]; Ubendra *et al.* (2015) [24]; Dhanalakshmi (2015) [6] and Agnihotri *et al.* (2017) [2]. Presence of deep root system that enables them to withstand drought conditions with good tolerance to heat, diseases and pest (Macolino *et al.*, 2012; Rimi *et al.,* 2012) [13, 17]. Root system in turfgrasses is affected by light, seasonal changes in air temperature, precipitation, environmental conditions that surrounds the turfgrass environment (Rimi *et al.,* 2012) [17], method of establishment, age of the grass species, season of planting, soil physical characters and prevailing weather conditions in the locality (Koski, 1983) [11] and genetic variation (Bonos *et al.,* 2004) [3] and Crush *et al.,* 2007) [5].

Table 2: Number of roots per culm, root length, total chlorophyll content, shoot fresh and dry weight of different turfgrass genotypes.

Genotypes	No. of roots per culm	Root length (cm)	Shoot fresh weight (g/m2)	Shoot dry weight (g/m2)	Total chlorophyll (mg/g)
G1- *Axonopus compressus* (STGC-1)	6.60	8.55	259.80	95.57	0.56
G2- *Axonopus compressus* (STGC-2)	6.87	8.02	222.10	82.08	0.91
G3- *Axonopus compressus* (STGC-3)	6.67	9.11	298.33	106.13	0.62
G4- *Cynodon dactylon* L. 'Selection 1'	10.13	12.80	359.67	168.66	1.41
G5- *C. dactylon* L. × *C. transvaalensis* 'Tifdwarf'	12.07	9.83	380.00	178.93	2.05
G6- *Cynodon dactylon* L. (STGC-4)	10.53	18.23	581.23	273.23	2.41
G7- *Cynodon dactylon* L (STGC-5)	6.47	15.21	136.33	115.36	3.31
G8- *Eremochloa ophiuroides*	6.87	8.14	364.17	178.13	0.63
G9- *Festuca arundinaceae*	4.00	3.58	11.27	3.77	0.32
G10- *Paspalum vaginatum*	8.27	9.60	309.40	98.85	0.73
G11- *Pennisetum clandestinum*	6.97	11.94	756.13	292.55	1.43
G12- *Poa pratensis*	8.27	13.22	553.00	221.43	1.88
G13- *Stenotaphrum secundatum*	5.00	6.53	176.00	64.83	1.35
G14- *Zoysia japonica* (STGC-6)	5.47	7.26	41.53	10.41	0.97
G15- *Zoysia japonica* (STGC-7)	5.07	7.05	34.67	9.60	0.45
G16- *Zoysia tenuifolia*	5.53	6.89	33.33	9.12	0.56
Mean	7.17	9.75	282.31	115.36	1.22
S.Em. ±	0.31	0.35	13.30	6.37	0.06
CD@ 5%	0.88	1.02	38.41	18.39	0.16

In general, turfgrasses which produces higher shoot clipping yield are very much suitable for high maintenance areas like sports fields and greens. Whereas, turfgrasses with lower shoot clipping yield are very much suitable to low maintenance areas like home and public parks lawn (Agnihotri, 2015) [1]. Among evaluated turfgrass genotypes highest Shoot fresh (756.13 g/m2) and dry (292.55 g/m2) weight was observed in *Pennisetum clandestinum* which and this may be due to its higher growth rate and thatch producing capacity (Christians, 2004) [4]. Whereas, lowest Shoot fresh (11.27 g/m2) and dry (3.77 g/m2) weight was recorded in *Festuca arundinaceae* which might be its poor adoptability and establishment, which was at par with Zoysia genotypes. Shoot fresh and dry weight is mainly depending on the shoot density and turf growth rate. Though Zoysia grass has highest density it is not able to produce higher biomass because of its slowest growth compared to other genotypes (Turgeon, 1980) [21]. Shoot fresh and dry weight is also influenced by fertilizer application as clipping yield was found to increase with increase nitrogen application rate (Sangma *et al.*, 2016) [18].

A rich green colour in turf indicates its health and aesthetic quality. In general, leaves which are dark green in colour have higher chlorophyll content (Johnson, 1973) [10]. Among different turfgrass genotypes highest total chlorophyll (3.31 mg/g) was observed in *Cynodon dactylon* L. (STGC-5) which was followed by *Cynodon dactylon* L. (STGC-4) (2.41 mg/g) and *C. dactylon* L. × *C. transvaalensis* 'Tifdwarf' (2.05 mg/g), whereas lowest total chlorophyll was recorded in *Festuca arundinaceae* (0.32 mg/g) which was at par with *Zoysia japonica* (STGC-7) (0.45 mg/g). Difference in total

chlorophyll contents among turfgrass genotypes could be attributed to genotypic variation, environmental stresses like water and temperature (Verhoeven *et al.*, 2005) [25], nutritional deficiencies and parasitic attacks (Viggiani *et al.*, 2015) [26].
From the present study, it is concluded that Cynodon genotypes were found to be most suitable under the hilly zone of Karnataka as they performed with regard to different growth and physiological parameters. Apart from Cynodon genotypes, *Eremochloa ophiuroides*, *Paspalum vaginatum*, *Axonopus compressus, Poa pratensis and Stenotaphrum secundatum* performed well and showed better performance in hilly zone of Karnataka.

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