“Evaluation of turf grasses for various qualitative and quantitative traits under Malwa Plateau of Madhya Pradesh”

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By

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CERTIFICATE- I

This is to certify that the thesis entitled **"Evaluation of turf grasses for various qualitative and quantitative traits under Malwa Plateau of Madhya Pradesh"** submitted in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **HORTICULTURE (Floriculture and Landscape Architecture)** of Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya Gwalior (M.P.) is a record of the bona-fide research work carried out by **Mr. TARUN KUMAR** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instruction.

No part the thesis has been submitted for any other degree or diploma or has been published. All the assistance and help received during the course of this investigation has been acknowledged by the scholar.

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Date…/…/……

List of Contents

List of Tables

List of Figures

List of Appendices

List of Plates

List of Symbols/Abbreviations

Symbol	Abbreviation	Stands for
/	-	Per
@	-	At the rate of
%	-	Percentage
^{0}C	-	Degree Celsius
-	ANOVA	Analysis of variance
-	C.D.	Critical difference
-	Cm	Centimetre
-	cm^2	Centimetre square
-	CRD	Completely Randomized Design
-	CV	Coefficient of Variance
-	cv.	Cultivar
-	DAT	Days after transplanting
-	Df	Degrees of freedom
-	DW	Distilled water
-	EMS	Error Mean Sum of Squares
-	*et al.*	And others/ associates
-	Fig.	Figure
-	G	Gram
-	H	Hour
-	Ha	Hectare
-	*i.e.*	That is
-	K	Potassium
-	Kg	Kilogram
-	L	Litre
-	M.P.	Madhya Pradesh
-	No.	Number
-	Max.	Maximum
-	Mg	Milligram
-	Min.	Minimum

-	Ml	Millilitre
-	Mm	Millimetre
-	MSS	Mean Sum of Squares
-	N	Nitrogen
-	NS	Non significant
-	P	Phosphorus
-	PGR	Plant Growth Regulator
-	PPM	Parts Per Million
-	RVSKVV	Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya
-	S.Ed.	Standard error of difference
-	S.Em ±	Standard error of mean
-	SS	Sum of Squares
-	T	Tonne
-	var.	Variety
-	*Viz.*	Videlicet (Namely)

CHAPTER I
INTRODUCTION

Ornamental horticulture is one of the major field of horticulture that is responsible for attractive the environment through planting ornamental plants and flowers. Flowers have been extolled by poets and painters not due to their aesthetic qualities but also for their therapeutic effects in human life.

The word "lawn" comes from the old French word "laund," which means "wooded district". It's a natural green carpet that covers the floor of an outdoor room. It is the garden's focal point and the hub of social activity (Jenkins, 1994). Turf has a pleasant appearance, gives environmental benefits, and is a safe place to play.

In the Bible reference the use of turf in the earlier period (Roberts *et al*, 1992). Around 157–87 B.C., data documents the growth of size and attractiveness lovely gardens adjoining imperial palaces in China (Huffine and Grau, 1969). The grass family Gramineae, which was later renamed Poaceae by Barnhart in 1895.

It contributes to a sense of cohesion in the garden Turf is regarded as an anti-pollutant that cannot be reached through artificial means. A lush green lawn not only helps to avoid soil erosion and subsequent stream pollution, but also help in reducing heat pollution and noise pollution.

The turf grass is the most biologically rich family in India, more than 1334 species belonging to 261 genera (Karthikeyan, 2005). This equates to roughly 14% of the world's total grass species.

Turfgrasses consist of a remarkably diverse group of species which are selectively used on the basis of applications and/or climatic conditions (Janakiram and Namita, 2014). Cultivated turfgrass is a pervasive feature of the urban landscape in the developed regions of the world.Turf grasses are widely used in enhancing and maintaining the function and beauty of lawns, aesthetic fields, *etc.* all over the world (Agnihotri, R. and S.L. Chawla, 2017).

Lawn is an essential component of every landscape, and its quality is dictated by turf maintenance (Janakiram and Namita, 2015). Turfgrasses have wide range of species that are selectively depending on applications and reducing .impact of climatic circumstances (Janakiram and Namita, 2014).Cultivated turfgrass is ubiquitous part of the urban landscape in developed countries. Turfgrasses are widely utilized all over the world to improve and preserve the function and appearance of garden aesthetic fields, and other areas. Human activities are benefited from turf grass by three ways: functional, recreational and ornamental (Jankairam *et al*. 2015)

These include leaf, internodes, and inflorescence traits as well as the plants overall growth habits. Some traits of turfgrass are widely recognized as the main components of quality: colour, density, uniformity, leaf texture, growth habit, and smoothness (Beard, 1973 and Patton *et al.,* 2007). These parameters are typically rated by visual estimation (Madison and Andersen, 1963). Visual qualities are actually founded on functional qualities and the functional quality of a turfgrass is determined solely by its vegetative plant part and its growth and development (Gobilik *et al.,* 2013)

Proper selection of turf grasses as per climatic conditions, cultural practices and its purpose and utility is important for long term success of turf. Turf grasses are very important not only for aesthetic sense but it also adds the value to the real estate. It has various uses in landscaping. The dense plant canopy of mowed turf grasses is effective in entrapment of water and airborne particulate material as well as in absorbing gaseous pollutants (Wadekar *et al.* 2018). Maintain good quality turf in shade, shade tolerant grass cultivar such as ‘Korean grass’ should be selected for shade garden (Malik*et al*. 2014) Drought and heat alone significantly reduced turf quality (Jiang and Huang, 2001). Bermuda grass cultivars are most susceptible morphological and biochemical responses to water deficit conditions (Riaz *et al*. 2010). Optimum irrigation can retain nutrients and increase chlorophyll content of turfgrass; this should be taken into consideration for irrigation amount (Mathowa*et al*. 2012).

All grasses have segmental morphology in which growth units termed phytomers are continuously created at an apical meristem and go through a

succession of development phases, creating first a leaf, then a bud within the leaf axil, which may commence the formation of a branch (Sharman, 1947). Among successive leaves, the stem may or may not be elongated. After a predetermined life span, leaves generally go through programmed senescence, at which point root primordia form and generate adventitious roots, which require many leaf appearance intervals to fully grow. Unlike known plants such as shrubs or trees, where the seedling stem stays for the duration of the plant's life and increases through secondary thickening, grasses' shoot morphology is maintained over time due to coordinated cycling of the component phytomers through their development phases. The stem could be a “pseudostem” which is actually a whorl of leaves with the youngest emerging from the center and the oldest shed from the outside when the leaf dies or it could be a “pseudostem” which is a whorl of leaves with the youngest emerging from the center and the oldest shed from the outside when the leaf dies, or it could be a “pseudostolon” on or just above the soil surface, or an underground rhizome, might serve as the stem (Silsbury, 1970) documented the coordination of phytomers within the grass shoot or tiller for ryegrass, whereas Fulkerson and Donaghy (2001) described leaf turnover, observing that a ryegrass shoot normally has three active leaves at any given moment. Etter in 1951 reported a comprehensive investigation of the fate of individual phytomers in Poa pratensis plants over a period of years. Lawn grasses are commonly divided into two categories: -

Cool-season grasses: - Cool-season grasses grow in temperatures ranging from 10 to 25 degrees Celsius and preserve their colour even in the harsh cold. Bluegrass (*Poa spp*.), bentgrass (*Agrostis spp*.), ryegrass *(Lolium spp.*), fescues (*Festuca spp.,hybrids*), red fescues (*Festuca rubra*), feather reed grass *(Calamagrostis spp*.), and tufted hair grass (*Deschampsia spp.)* are some examples (De, 2012).

Warm-season grasses: - such as zoysiagrass (*Zoysia spp*.), Bermuda grass (*Cynodon spp.*), St. Augustine grass, Bahia grass *(Paspalum spp.*), centipede grass *(Eremachloa*), carpet grass (*Axonopus*), buffalo grass, and grama grass, thrive in temperatures between 25 and 35 degrees Celsius (De, 2013).

Grass species are usually identified by their cheap and easily collected morphological characteristics. Due to the importance of appearance and quality in the reproduction and selection of aesthetic crops such as grass, diversity assessments are often collected. These include the characteristics of the leaf, internodes, and inflorescences, as well as the general morphology of the plant. Several features of the lawn are widely recognized as the main contributors to quality. Colour, density, uniformity, leaf texture, growth pattern, and smoothness are widely considered to be important qualities of sod (Beard, 1973).

In Malwa Plateau of Madhya Pradesh, no systematic research work has been carried out on the aspect of turf grass evaluation in Madhya Pradesh yet. Therefore, keeping the above facts in view the present investigation entitled **"Evaluation of turf grasses for various qualitative and quantitative traits under Malwa Plateau of Madhya Pradesh"** generate research evidence on the above aspects, the present investigation entitled is being formulated with the following objectives.

Objectives of present investigation:

1. Evaluation of turf grass for quantitative traits.
2. Evaluation of turf grass for qualitative traits.
3. Find out the best turf grass in the experiment.

CHAPTER- II

REVIEW OF LITERATURE

In this chapter, an attempt has been made to review the research work done so far in India and abroad by different workers on the **"Evaluation of turf grasses for various qualitative and quantitative traits under Malwa Plateau of Madhya Pradesh".** The review is presented under the following heads-

2.1. Quantitative parameters

2.2. Qualitative parameters

2.1. Quantitative parameters

Engelke (2000) reported that *Zoysia japonica* genotype 'Palisades' recorded the maximum leaf blade length followed by the genotype 'Meyer' whereas the minimum leaf length was recorded in the genotype 'Cavalier' in greenhouse.

Jankowski *et al*. (2003) evaluated turfgrasses in extensive lawn maintenance with nine turf grass species and cultivars like *Festuca heterophyfla (*Sawa), *F.rubra* (Lee and Jagna}, *Loli'um perenne* (Inka. Niga and Nira), *Agrosris tenuis*, (lgeka and Niwa) and *Acanina* (Nina) and the most profitable lawn maintenance was recorded for the cultivars of *A. tenuis, A. canlna* and *F. hererophylla.*

Kaminski and Peter (2004) reported that cultivar 'Providence' had the highest root length among other cultivars of Creeping bent grass during establishment.

Roche and Loch (2005) made morphological and developmental comparison of seven green quality hybrid bermuda grass (*Cynodon dactylon L. Pers.* × *C. transvaalensis Burtt Davy*) cultivars. The four 'ultra dwarf' cultivars viz. 'Champion Dwarf', 'MS-Supreme', 'Flora Dwarf' and 'Tif Eagle' showed slower vertical extension and produced fewer inflorescences than 'Tif

dwarf', 'Tif green' and 'Novotek'. However, in terms of length of stolon internodes and their overall rate of lateral spread, 'Champion Dwarf', 'Flora Dwarf' and 'Tif Eagle' were comparable to 'Tif dwarf'; 'MS-Supreme' with longer internodes spread faster laterally, while slower than 'Tif green' which had longest stolon internodes. In unmown swards, the four ultra dwarfs produced shorter leaves than 'Tif green', 'Tif dwarf' and 'Novotek' while, leaves of 'Tif Eagle' significantly narrower than those of 'Tif green' and 'Novotek'

Xiao Guang (2005) studied the adaptability of 30 introduced turfgrass varieties and evaluated them for turf quality. The varieties of *Lolium perenne* and *Festuca arundinacea* had a higher emergence rate at early stage, whereas, those in the other species were more stable after emergence. The lawn and turf quality was good in the varieties 'Midnight', 'Kentucky' and 'Conni' of *Poa pratensis*; Goalkeeper, Accont and Fairway of L. Perenne; 'Jaguar 3', 'Fire Phoenix', 'Houndog S', 'Ruby Starfire' and 'Bingo' of *Festuca arundinacea* and Pernille and Maxima of *F. rubra*.

Prerna Verma (2007) evaluated 7 cool season lawn grass species and found that *Lolium perenne* took minimum days for establishment and lowest weed count, while minimum monthly increase in culm length was recorded in *Agrostis vineslis* and *Phleum bertoloni*. The turf colour was reported to be consistent throughout the year, except in December-2006, January and May-2007 and these species also required lowest number of mowing.

Marchione (2008) evaluated five warm season turf species with respect to environmental adaption and suitability for recreational, ornamental and amenity purposes and found highest mean monthly canopy height in *P. notatum* and *P. clandestinum; P. clandestinum* and *Z. japonica* were found best for their good turf quality and green cover percentage. However, *P. notatum* and *B. dactyloides* can be used in those areas where amenity uses (roadside, soil erosion control, etc.) are more important than the ornamental ones.

Zhenping *et al*. (2008) documented the greater leaf length with short days under shade condition in *Zoysia japonica* cv. 'Lanyin No. III'.

Wang *et al*. (2008) noticed that fescue grass cultivar 'Barolex' had the highest root length followed by 'Atlas Fescue' cultivar in control treatment, whereas the lowest root length was noticed in 'Kentucky 31' cultivar under stress conditions.

Leto *et al*. (2008) evaluated 40 native silician biotypes of *Cynodon spp.* CYND 4 showed lowest vertical leaf growth, CYND 4 and CYND 19 showed finest stolons. For turf quality, CYND 4 and CYND 11 rated higher than 'Savannah' while, CYND 4, CYND 10, CYND 11, CYND 12, CYND 30 and CYND 31 showed darkest green colour. CYND 4, CYND 11, CYND 31 had shortest winter dormancy period and CYND 7, CYND 8, CYND 12, CYND 22, CYND 27, CYND 30 and CYND 31 showed highest spring vegetative re-growth rate (75%).

Pessarakli and Kopec (2008) evaluated three warm season grasses like bermudagrass (*Cynodon dactylon* L.) 'Tif way 419', seashore paspalum (*Paspalum vaginatum* Swartz) 'Sea Isle 2000', saltgrass (*Distichlis spicata* L. Greene), *D. stricata* (Gray) 'Beetle' in salinity stress condition using hydroponics system under green house. The canopy colour changed to lighter green in bermuda grass and seashore paspalum as salinity increased, but salt grass maintained the same colour regardless of salinity level. Shoot, root length and clipping dry weight also decreased linearly with increase in salinity, however it was reverse with saltgrass.

Pessarakli and David (2009) reported that 'Galileo' cultivar had greater root length followed by 'Newton' cultivar among different Rye grass cultivars screened for salt tolerance. Cultivar 'Michelangelo' showed greater stolon length followed by cultivar 'Covet' among the other rye grass cultivars when screened for salt stress tolerance.

Jinmin and Demoeden (2009) documented that maximum root length was recorded at 0-6 cm soil depth with heavy and infrequent irrigations; whereas the minimum root length was observed at soil depth soil depth with light and frequent irrigations in Creeping bent grass.

Shortell *et al.* (2009) found significant differences in morphological and agronomic traits between the classification types of Kentucky bluegrass. High density and compact type cultivars showed the shortest plant heights while, Mid-Atlantic, Texas, Kentucky bluegrass hybrids and common type cultivars exhibited the most extensive rhizome spread. Based on the data, it was possible to select Kentucky bluegrass genotypes with certain morphological and agronomic traits including plant height, rhizome spread, panicle height, flag leaf height and length that behave consistently across environments.

Marcum and Pessarakli (2010) observed highest root length and distribution in 'Paragon' cultivar followed by 'Platinum' cultivar of Rye grass while the lowest root length was observed in three intermediate Rye grasses when exposed to 6 dSm^{-1} of salinity level for six weeks.

Riaz *et al*. (2010) studied morphological characters (including shoot fresh weight and dry weight, root fresh weight and dry weight, root and shoot length, root/shoot ratio for fresh and dry weight, leaf thickness, leaf width, leaf area and shoot recovery percentage) and biochemical characters (chlorophyll a, b and total chlorophyll) in *Cynadon dactylon* var. Dacca, fine Dacca and Khabbal. They found that Khabbal perform best in all attributes studied compared to other two cultivars in water deficit conditions.

Severmutlu *et al*. (2011) studied warm-season turfgrass species viz., Bermuda grass (*Cynodon dactylon*), buffalo grass (*Buchloe däctyloides*), zoysia grass (*Zoysia japonica*), bahia grass (*Paspalum notatum*), seashore paspalum (*Paspalum vaginatum*) and centipede grass (*Eremochloa ophiurioides*). Twenty cultivars belonging to these species were evaluated for their establishment, turfgrass, and quality, spring green-up and fall color retention. Bermuda grass, bahia grass and seashore paspalum established 95% or better coverage at 1095 growing degree days [GDD]. ‘Sea Spray’ seashore paspalum; ‘SWI-1044’, ‘SWI-1045’, ‘Princess 77’ and ‘Riviera’ Bermuda grass; ‘Cody’ buffalo grass and ‘Zenith’ zoysia grass exhibited acceptable turfgrass quality for 7 months throughout the growing season. ‘Argentine’ and ‘Pensacola’ Bahia grass, ‘Sea Spray’ seashore paspalum and ‘SWI-1044’ and ‘SWI-1045’ Bermuda grass extended their growing season by

retaining their green color up to 15 days or longer than the rest of the warm season cultivars and/or species in the fall

Venugopal (2012) reported the highest leaf length in perennial rye grass and the lowest leaf length in Korean grass and the longest root length in Argentine Bahia grass followed by perennial Rye grass while the shortest root length was reported in Korean grass. The maximum shoot length was found in Bermuda grass, followed by perennial Rye grass under while the minimum shoot length was recorded in Korean grass.

Nadeem *et al.* (2012) reported that in Tifway, Tifdwarf, Dacca and Khabbal for salinity tolerance and traits like number of stolons, number of roots, length of shoot, root dry weight, shoot dry weight, turf quality, potassium content in stolons and sodium and chloride content in stolons were measured. Tifway was the most tolerant cultivar to salinity. Shoot length, leaf growth and development as well as photosynthesis were significantly affected by high salt concentrations. Mortality of stolons due to sodium and chloride ions accumulation was observed leading to reduced plant growth. Root dry weight, shoot dry weight, metabolite synthesis were also reduced affecting the overall turf quality in all the cultivars.

Volterrani *et al*. (2012) recorded the highest stolon length in 'Tifsport' cultivar followed by 'Santa Ana' cultivar.

Clark and Watkins (2012) carried out an experiment toperformance of native prairie junegrass germplasm and reported highest vertical regrowth in ‘KN5’ cultivar whereas, ‘KC1’ showed highest lateral spread, turf quality, density, mowing quality and colour.

Roche (2013) investigated the performance of 19 varieties, comprising of 13 species of new and commercial warm-season turf grasses in Queensland, Australia. He found that *Zoysia spp.* varieties were the slowest to spread across the surface to produce a complete sward (one-third as fast as green couch varieties, vertically and laterally).

Pooya *et al*. (2013) reported the maximum stolon length in perennial Rye grass 'LPY' cultivar followed by ‘NM2’ cultivar, whereas the minimum stolon length was observed in 'CM' cultivar.

Zulkaliph *et al*. (2013) recorded that *Zoysia malrella* produced maximum shoot dry weight followed by *Cynodon dactylon* under controlled conditions in Peninsular Malaysia.

Lu *et al*. (2013) carried out an experiment to the performance of turf grass under different soil moisture condition. Data revealed that the maximum leaf length was observed in 'Floratam' cultivar of St. Augustine grass at 50 percent soil moisture content, while the minimum leaf length was observed in 'Seville' cultivar of St. Augustine grass at 25 per cent soil moisture content and the maximum stolon length in 'Floratam' cultivar at 75 per cent soil moisture content, while the minimum stolon length was noticed in 'Captiva' cultivar at 25 per cent soil moisture content at five weeks after watering in St. Augustine grass.

Janakiram and Namita (2014) evaluated twelve turfgrass genotypes. All of them under study exhibited fine leaf texture, except *Eragrostis curvula* had medium coarse texture, both *Paspalum notatum* and *Argentine bahia* had coarse texture and *Poa pratensis* L. exhibited medium fine leaf texture*. Agrostis palustris* L. exhibited maximum mean performance for shoot density in 25 cm^2 areas, whereas minimum value was exhibited by *Cynodon dactylon* L. var. Panama.

Malik *et al*. (2014) evaluated quality, growth and physiological potential of various turfgrass cultivars for shade gardens and found that during the growth period of six months, all cultivars exhibited variations in color, texture and visual quality. Maximum quality scores for color was achieved in cultivar ‘Fine Dacca’. Stolon diameter was maximum in the ecotype Khabbal in the month of December. Maximum fresh clipping weight of was noted in the cultivar Fine Dacca in the month of April followed by the ecotype Khabbal. Similarly, the rate of photosynthesis was higher in the cultivar Fine Dacca in the month of March followed by Tif way. Maximum chlorophyll content was observed in the cultivar ‘Tifway’ in the month of December.

Ubendra *et al.* (2015) carried out an experiment to investigate the performance of twelve native turf grasses under tropical condition. Morphological, physiological parameters and visual quality (shoot color, shoot

density and shoot uniformity) were also recorded. Bermuda grass which had the highest root length, root density, dry weight of root, turf quality, total chlorophyll, relative water content and stomatal index (upper) was found to be most drought tolerant followed by *Zoysia japonica* which is best suitable for stress tolerant conditions.

Agnihotri *et al*. (2017 a) carried out an experiment to evaluate different turfgrass species and varieties for the morphological characters under south Gujarat agro-climatic condition, *C. dactylon L.* × *C. transvaalensis* 'Tif dwarf' performed best in most of turf quality parameters and can be subjected to further functional quality trials for sports and athletic turf.

Agnihotri *et al*. (2017 b) conducted an experiment to evaluate the thirteen warm season turfgrass genotypes in which fastest new growth appearance (50%) was observed in *C. dactylon* L. 'Local'. Lowest culm length was recorded in *Zoysia tenuifolia.S. secundatum* showed lowest shoot root ratio. *C. dactylon* L. ‘Panam’ recorded maximum number of floret per spikelet for effective seed production but reduced the turf aesthetic quality. *Z. tenuifolia, Z. matrella* and *C. dactylon L.* × *C. transvaalensis* 'Tifdwarf' showed very fine texture of leaves, good average colour rating, aesthetic appearance, turfing ability in the whole period of experimentation.

Wadekar *et al.* (2018) studied the qualitative and morphological performances of turf grasses. The highest grounds cover was observed in American blue grass and Bermuda grass at 60 DAT. The significantly maximum chlorophyll content was recorded by Bermuda grass which was significantly superior over rest of treatments. Performance for morphological traits indicated, the maximum shoot length in Phosphelone grass, Argentine grass exhibited maximum stem thickness. The maximum leaf length range recorded in Weeping love grass and Taiwan grass recorded shortest leaf length. Phosphelone grass recorded maximum leaf width, while Weeping love grass showed maximum root length. After 120 days of transplanting maximum root shoot ratio was recorded in Argentine grass. The maximum fresh weight of shoot and dry weight of roots was recorded in Weeping love grass whereas, the maximum fresh weight of roots was recorded in Argentine grass.

Agnihotri and Chawla (2018) studied the variability and diversity in thirteen warm season turfgrass genotypes. The mean sum of squares due to genotypes showed significant differences for all the characters. High and moderate estimates of heritability (broad sense) were obtained for all growth related traits of turf grasses high genotypic and phenotypic coefficient of variation were recorded for shoot intensity (GCV=111.20, PCV=111.65) followed by leaf width (GCV=82.90, PCV= 83.77) and days to new growth (GCV=71.60, PCV=72.60). The maximum and minimum cluster mean value was observed for fresh weight and vertical leaf growth among all three clusters, respectively. High genetic advance was found for all characters, except monthly colour rating and turf quality. On basis of D2 analysis, the thirteen genotypes were grouped into three clusters. (The cluster I was very large and comprised of 9 genotypes and cluster II had 3 genotypes. While, cluster III was comprised only single genotype.)

Venugopal *et al*. (2021) revealed that the Crowfoot grass was significantly most promising variety with respect to days taken for establishment, days taken for complete coverage frequency of mowing, clipping yield recuperative ability, longest root length was recorded in Bahia grass, maximum root spread was recorded in Saint Augustine grass, highest root biomass was recorded in Argentine Bahia grass, highest chlorophyll content was recorded in Bahia grass.

2.2. Qualitative parameters

The tiller orientation of each turf grass genotype was used to determine the growth behavior. Tillers were classed as prostrate when the angle between the tiller and the soil surface was less than 30 degrees, semi-prostrate when the angle was between 30 and 59 degrees, and upright when the angle was greater than 60 degrees, as recommended by Eggens (1981).

Maurer *et al*. (2001) evaluated 26 buffalo grass cultivars and accessions for their potential as a high quality turfgrass at the Texas Tech University, Lubbok. They found the top five turfgrasses that consistently had the best turfgrass quality were ‘TTU-227’, ‘TTU-196’, ‘TTU-378’, ‘TTU-12’ and ‘TTU-232.

Harivandi *et al*. (2007) evaluated eighteen bentgrasses varieties for quality, colour and density. The highest average quality rating was recorded in ‘L-93’ while, ‘Penncross’, received lowest quality rating ‘Penncross’ also received lowest colour rating and coarsest leaf texture. All the tested cultivars showed similar density rating in spring, except ‘Putter’, while, ‘Penncross’ showed lowest density in fall in their four years study in California, USA.

Yang Yan Xiao (2010) studied the effect of shading intensity on the growth of Kentucky bluegrass (*Poa pratensis*) simultaneously growth rate, turf quality, weight of grass clipping, SPAD content, relative conductivity and underground biomass under drought stress. According to him, high-quality turf under moderate shading was obtained in the dry season and during the rainy season; high-quality turf was obtained under intense shading. Therefore, moderate shading can be regarded as a turf maintenance measure to reduce damage in Kentucky bluegrass turf induced by heat and drought stress during the summer

Costea *et al*. (2012) reported the quality indices of the turfgrass from Queen Maria Park, Romania and found that turf-density and colour was subjected to improve from season to season, texture of the turf was found to be influenced with the species composing the turf and over all aesthetic appearance was also reported to vary from season to season in the varieties of *Loium perenne* and *Poa pratensis*.

Salman *et al*. (2013) evaluated the adaptability and turf quality of six newly introduced tall fescue (*Festuca arundinacea*) cultivars in comparison with most popular perennial ryegrass (*Lolium perenne* L.). All tall fescue cultivars were better than perennial ryegrass to cope with Mediterranean environmental conditions of Turkey and achieved higher scores in all traits almost in all seasons. ‘Turbo’ and ‘SR 8600’ cultivars performed far better than perennial ryegrass cultivar ‘Henrietta’

CHAPTER- III

MATERIAL AND METHODS

An investigation entitled "**Evaluation of turf grasses for various qualitative and quantitative traits under Malwa Plateau of Madhya Pradesh**" was carried out during December–2020 to May-2021. During the course of experimentation, planting materials used and techniques adopted are here under.

3.1 Experimental location

The present investigation was carried out during winter season of 2020-2021 at field of the Department of Floriculture Landscape Architecture, K.N.K. College of Horticulture, Mandsaur, (M.P). Mandsaur is situated in the Malwa plateau in western part of M.P. at North latitude of 23.45 ^{0} to 24.13 ^{0}and 74.44 ^{0} to 75.18 0 East longitude and an altitude of 435.20 m meters above mean sea level. This region falls under Agro climatic zone no.10 of the state.

3.2 Climate of the Region

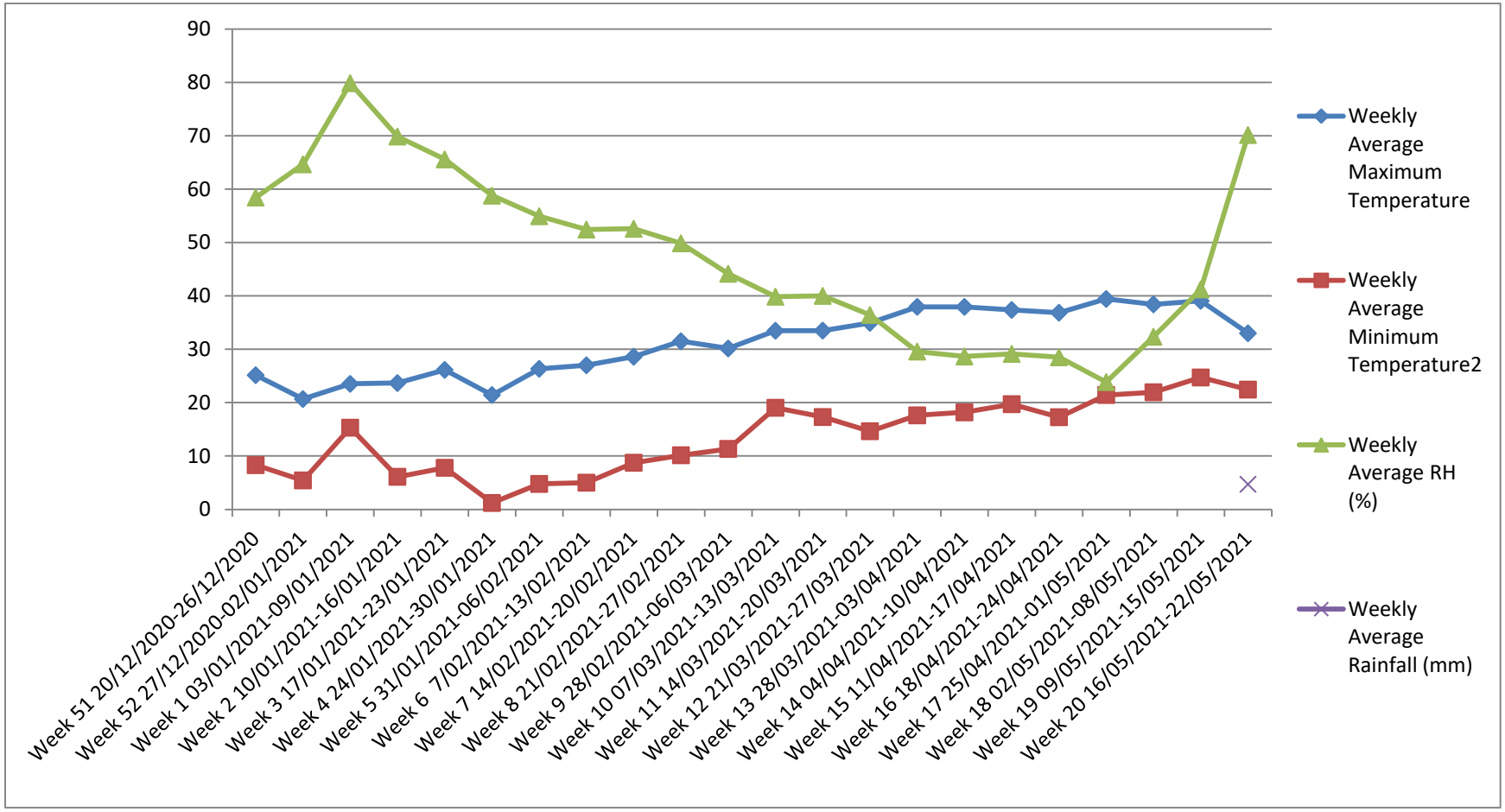
Mandsaur belongs to sub-tropical climate having a temperature range of minimum 5^{0}C and maximum 45^{0}C in winter and summer, respectively. In this area, most of the rainfall is received during mid June to early October with occasional showers in winter. Southwest monsoon is responsible for major portion of annual precipitation. The average rainfall is 714.8 mm. Meteorological data recorded during the period of investigation are presented in (Table 3.1) and are graphically shown in (Fig 3.1).

Table 3.1: Weekly meteorological data was recorded during the period of (December 2020– May 2021).

Standard week	Duration	Temperature		Relative Humidity (%)	Rainfall (mm)
		Max. (^{0}C)	Min. (^{0}C)		
Week 51	20/12/2020-26/12/2020	25.15	8.3	58.42	
Week52	27/12/2020-02/01/2021	20.67	5.44	64.64	
Week 1	03/01/2021-09/01/2021	23.52	15.31	79.85	
Week 2	10/01/2021-16/01/2021	23.67	6.11	69.85	
Week 3	17/01/2021-23/01/2021	26.14	7.80	65.57	
Week 4	24/01/2021-30/01/2021	21.44	1.21	58.78	
Week 5	31/01/2021-06/02/2021	26.34	4.78	54.92	
Week 6	07/02/2021-13/02/2021	27.00	5.01	52.42	
Week 7	14/02/2021-20/02/2021	28.60	8.75	52.57	
Week 8	21/02/2021-27/02/2021	31.50	10.15	49.85	
Week 9	28/02/2021-06/03/2021	30.15	11.34	44.14	
Week 10	07/03/2021-13/03/2021	33.47	19.04	39.85	
Week 11	14/03/2021-20/03/2021	33.50	17.31	40.00	
Week 12	21/03/2021-27/03/2021	34.95	14.65	36.42	
Week 13	28/03/2021-03/04/2021	37.95	17.62	29.57	
Week 14	04/04/2021-10/04/2021	37.94	18.18	28.64	
Week 15	11/04/2021-17/04/2021	37.37	19.72	29.14	
Week 16	18/04/2021-24/04/2021	36.85	17.28	28.5	
Week 17	25/04/2021-01/05/2021	39.42	21.44	23.85	
Week 18	02/05/2021-08/05/2021	38.41	21.95	32.35	
Week 19	09/05/2021-15/05/2021	39.07	24.72	41.21	
Week 20	16/05/2021-22/05/2021	33.00	22.45	70.14	4.71

Source: Meteorological observatory of the K.N.K. College of Horticulture, Mandsaur (M.P.)

Fig 3.1 Weekly meteorological observations during the study period (December 2020- May 2021)



3.3 Soil Characteristics of the Experimental Site

To ascertain physico-chemical characteristics of the soil during the year of study, soil samples from 0-15 cm depth were taken from different spots of the experimental field before application of fertilizer. A representative composite sample was prepared by processing and mixing them together and the sample was analyzed for physical and chemical properties. The soil of experimental field was loam to clay loam having P^H ranging from 6.8-7.05

Table 3.2: Physical and chemical composition of the soil sample of experimental site

Particulars	Value obtained	Method
Physical Characters		
Sand	30%	By international Pipette method (Piper,1950)
Silt	42%	
Clay	28%	
Chemical Characters		
Soil Ph	7.8	Method No. 4 USDA Handbook No. 60 (Richards, 1954)
Electrical Conductivity (dsm-1)	0.40	EC Meter
Available Nitrogen (kg N ha-1)	195 (Low)	Alkaline $KMnO_4$ (Subbiah&Asija, 1956)
Available phosphorus (kg P_2O_5 ha^{-1})	7.6 (Low)	Olsen extraction method (Olsen *et. al.* 1954)
Available potash (kg K_2O ha^{-1})	210 (Low)	Flame photometer method Metson, 1956)

3.3 Experimental Details:

The details of experiment are as under:

1. Location: Research Block, College Campus, K.N.K. College of Horticulture, Mandsaur, (M.P).

2. Year: 2020-2021

3 Experimental designs: Randomized Block Design.

4. Genotype 12

5. Replications: 3

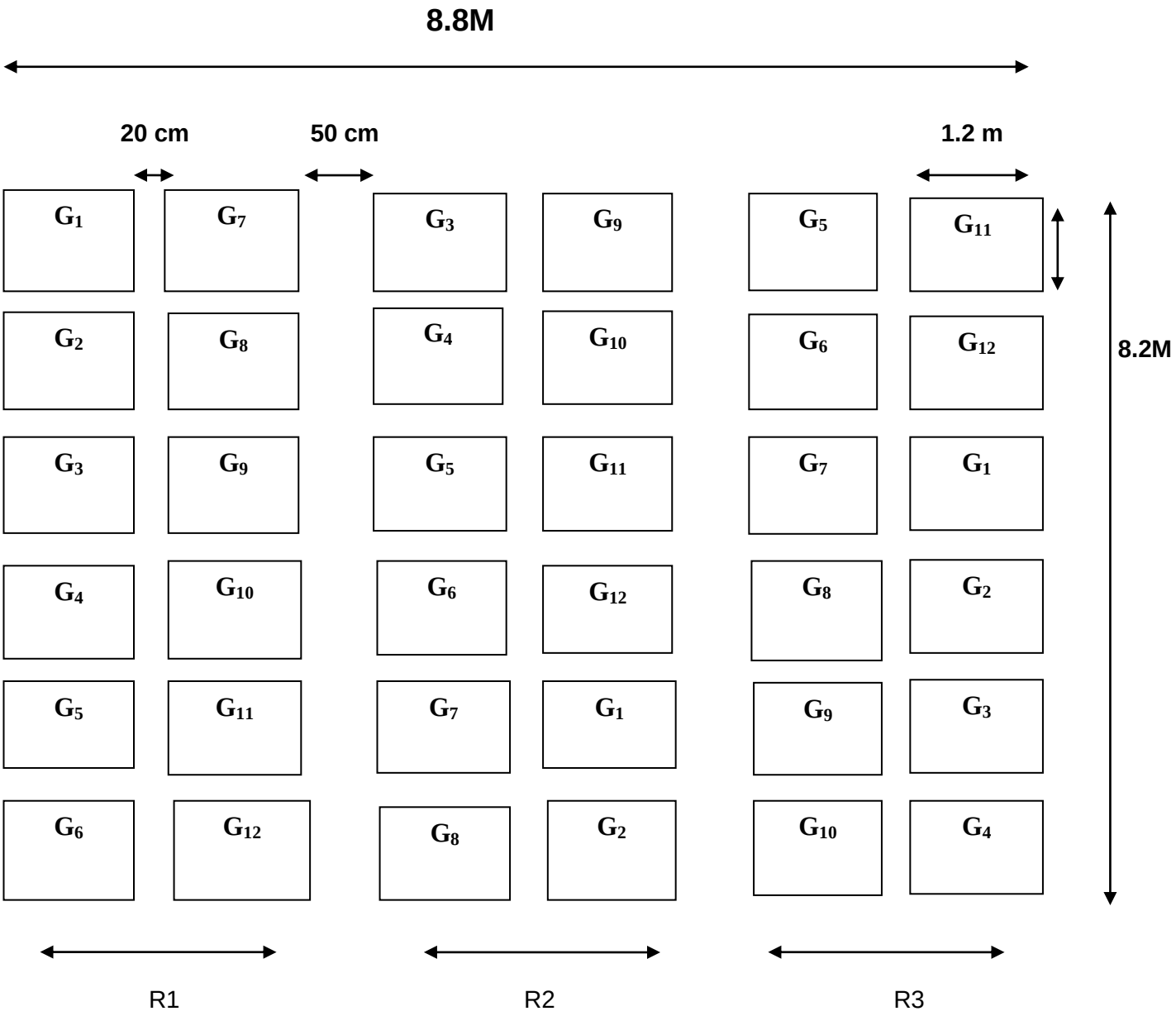
6. Plot size: 1.2 x 1.2 m.

8. Total number of experimental plots: 36

9. Experimental area: 8.2 m x 8.8 m = 72.16 sqm

3.4 Details of layout

The experiment was laid out in Randomized Block Design (RBD) with three replication and 12 treatments in each replication.



Experimental layout

3.4 Treatment details:

S.N.	Symbol	Treatment
1	G_1	Palma (*Cynodon dactylon* L.)
2	G_2	Local (*Cynodon dactylon* L.)
3	G_3	Panama (*Cynodon dactylon* L.)
4	G_4	Manila (*Zoysiamatrella* L. Merr. Philipp)
5	G_5	Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis)*
6	G_6	Maxican grass (*Nassella tenuissima)*
7	G_7	Selection-1 (*Cynodon dactylon* L.)
8	G_8	Tanu varient
9	G_9	Bargusto (*Cynodon dactylon* L.)
10	G_{10}	Crow foot grass *(Dactyloctenium aegyptium)*
11	G_{11}	Bahia grass (*Paspalum notatum*)
12	G_{12}	Centipede grass (*Eremochloao phiuroides* [Munro] Hack)

3.5 Planting Material:

Selection-1, Bargusto, Panama, Local, Palma, Tifd warf 419, Bahia grass, Manila grass, Maxican grass, Cenetepede grass, Crow foot grass and Tanu varient are used in experiment and all of there are available in department of Floriculture and Landscape Architecture, KNK College of Horticulture Mandsaur (M.P.)

Plate2.1:- A view of experimental layout

G_1- Palma

G_2- Local

G_3-Panama

Plate 2(a)-A view of the genotypes Palma, Local and Panama

G_4 Manila

G_5 Tift dwarf 419

G_6 Maxican grass

Plate 2(b).A view of genotypes Manila, Tift dwarf 419 and Maxicam grass

G_7 Selection-1

G_8 Tanu varient

G_9 Bargusto

Plate 2(c). A view of genotypes Selection-1, Tanu varient and Burgusto

G_{10} Crow foot grass

G_{11} Bahia grass

G_{12}Centipede grass

Plate 2(d). A view of genotypes Crow foot grass, Bahia grass and Centipede grass.

3.6. Cultural operation

3.6.1 Planting of grasses

The grass was already planted in the field during the rainy season 2020.

3.6.2 Irrigation

Irrigation was provided as per requirement of the field.

3.6.3 Weeding

Hand weeding was done to control annual and perennial weeds during the establishment of lawn grasses.Weeding was done by cultural practiceses (hand weeding).

3.6.4 Mowing

Mowing is done at 30 day interval by hand mower.

3.6.5 Plant protection

No major pests and diseases were observed in the experimental plots.

3.7 Observation Recorded

Observations on various growth parameters were recorded at monthly.

3.7.1 Observations Recorded

3.7.1.1. Quantitative Parameters

1. Root depth (cm)
2. Shoot density (25 cm^2)
3. Leaf width (mm)
4. Leaf chlorophyll content (SPAD value)
5. Canopy height (cm)
6. Leaf length (cm)
7. Stolon internodal length (cm)
8. Stolon internodal diameter (mm)
9. Fresh clipping yield (g/ m^2)

10. Dry clipping yield (g/ m^2)

3.7.1.2 Qualitative Parameters

1. Growth habit

2. Turf quality rating (1-9)

3.7.1.1Quantitative Parameters

3.7.1.1 Root depth (cm)

Root depth is determined from the observation of soil core samples of 30 cm depth on the monthly basis. This measure provides an insight into the turf's ability to withstand stress, including reduced watering frequency. It was assessed on the basis of length of longest root per core during the experiment. Averages of five random cores from the net plot were taken out carefully with the help of custom made core cutter. Core sample was taken out without damaging the root system and was washed carefully. The length of longest root was measured on geometric scale, expressed in cm and later on average was calculated. (Agnihotri and Chawla 2017).

3.7.1.2 Shoot density (25 cm^2)

On the monthly basis, total number of shoots/stolons was counted from an area of 25 cm^2 by keeping a quadrant of 5 cm x 5 cm randomly on five places in the net plot at the end of experiment and averaged.

3.7.1.3 Leaf width (mm)

Because the width of a turf leaf indicates its texture, Leaf width was measured monthly basis, five flattened leaves were plucked from each plot and the width was measured at a distance of 1 cm from the ligule (the widest section of the leaf blade) using a digital verniercalliper and expressed in millimeters (Veronesi *et al*., 1992). We chose mature, robust leaves that were properly opened but not too old.

3.9.1.4 Leaf chlorophyll content (SPAD value)

On the monthly basis leaf chlorophyll content measure by SPAD Value (PLUS 502) five randomly selected bunch of leaf per plot on the monthly basis.

3.7.1.5 Canopy height (cm):

Canopy height was measured monthly by keeping the geometrical scale straight from ground till the tallest standing tip of the plant at three random positions from each plot then averaged and expressed in centimeters.

3.7.1.6 Leaf length (cm)

On a monthly basis, the length of the third mature leaf from the tip was measured in five flattened random leaves from each plot and averaged. Leaf length was calculated as the distance between the leaf tip and the leaf base in centimeters (leaf collar).

3.7.1.7 Stolon internodal length (cm)

On a monthly basis, five stolons of grasses from each plot were removed and their third internode from the top was measured as the distance between two nodes of mature stolon using geometrical scale, and then averaged.

3.7.1.8 Stolon internodal diameter (mm)

On the monthly basis, average stolon diameter was determined by using 5 stolons of measuring basal internodal diameter with the help of digital verniercalliper in millimeter.

3.7.1.9 Fresh clipping yield (g/m^2)

This yield can be used to measure vertical shoot growth quickly. Clippings were collected from the net plot area every 30 days using a walk-behind lawn mower with a clipping collector. The weight of the clips was used to compute clipping yield. The cuttings from net plots were collected in baskets and weighted for fresh weight in grames, which was then averaged.

3.7.1.10 Dry clipping yield (g/m^2)

Fresh clipping yield was stored in brown paper bags and dried for 48 hours in a forced-air oven at 60°C. The clippings were weighted for their dried weight and averaged once they were completely dry. This was done after each monthly mowing, along with measuring the fresh cutting yield.

3.7.2 Qualitative Parameters

3.7.2.1 Growth habit:

The tiller orientation of each turf grass genotype was used to determine the growth behavior. Tillers were classed as prostrate when the angle between the tiller and the soil surface was less than 30 degrees, semi-prostrate when the angle was between 30 and 59 degrees, and upright when the angle was greater than 60 degrees, as recommended by Eggens (1981).

3.7.2 2 Turf quality rating (1-9)

The monthly ratings were used to calculate the annual mean turf quality rating for each individual genotype which was used to assess best quality.

Assessments of turfgrass quality

All assessments of turfgrass quality were made on a visual basis. Care was taken to insure consistent and accurate evaluations. The following performance criteria were used to asses turfgrass cultivars and species. This method was given by National Turfgrass Evaluation Program, The Pennsylvania Turfgrass Council (Morris and Sherman, 2000).

Quality indicates the overall appearance of the turf and can incorporate several components including density, texture (measure of leaf width), uniformity, colour and stress.Quality was rated using a scale of 1-9, where 9 = highest quality.

i. Colour: This rating reflects the inherent colour of the entry, not yellowing or browning due to mower injury, drought stress, disease, etc. Colour ratings are

usually taken when grass is not under stress. Color was rated on a scale of 1-9, with 9 = the darkest green color.

ii. Uniformity: It denotes the evenness of the surface of the turf which was rated visually on 1-9 scale.

iii.Density: Density is a visual estimate of the number of plants per unit area (excluding diseased or insect-damaged patches of turf). Density was rated on a scale of 1-9, where, 9 = the most dense turf.

iv.Texture: This rating provides an indication of the relative coarseness/ fineness of turf leaf width. Texture is rated on a scale of 1-9, where 9 = the finest-textured turf.

v.Stress: Stress ratings provide an indication of an entry's reaction to a particular disease, pest or environmental stress. These are based on a scale of 1-9 (1 = extensive damage and 9 = no stress visible).

3.8 STATISTICAL ANALYSIS:

The data obtained from present experiment were subjected to "Analysis of Variance" as advocated by Panse and Sukhatme (1984). The Skeleton of ANOVA as per design is as given in Table below

Table 3.5 Skeleton of analysis of variance

Source of variation	**Df**	**SS**	**MSS**	**"F" value Calculated**	**"F" Table Value at 5%**
Ion	(r-1)	RSS	RMS	RMS/EMS	
Treatment	(t-1)	TSS	TMS	TMS/EMS	
Error	(r-1)(t-1)	ESS	EMS		
Total	(rt-1)	TSS			

The critical difference (C.D.) was calculated to assess the significance of difference between treatments, whenever the results were found significant through ‘F’ test, CD at 5 % level of significance was determined. Standard error of mean and CD are calculated using the following formula.

$$S.Em. \pm = \sqrt{\frac{EMS}{R}}$$

$$CD = S.Em. \pm x\sqrt{2} \times t_{5\%\ (edf)}$$

Where

EMS *:* Error mean sum of squares

CHAPTER -IV

RESULTS

The results of the field experiment entitled**"Evaluation of turf grasses for various qualitative and quantitative traits under Malwa Plateau of Madhya Pradesh"** was conducted at field of the Department of Floriculture Landscape Architecture, K.N.K. College of Horticulture, Mandsaur, (M.P.) during the year 2020-2021, are presented in this chapter under following headings:

4.1 Qualitative Parameters

The data regarding different quantitative traits that were studied include root depth (cm), shoot density (25 cm^2), leaf width (mm), leaf chlorophyll content (SPAD value), canopy height (cm), leaf length (cm), stolon internodal length (cm), stolon internodal diameter (mm), fresh clipping yield (g/m^2), dry clipping yield (g/m^2).

4.1.1 Root depth (cm)

The data related to root depthhave been presented in table 4.1 and illustrated in Fig 4.1.

It is evident from the table 4.1 that root depthwas significantly influenced by different turf grasses during all months.

During the month of December 2020, the maximum root depth (17.20 cm) was noticed in Maxican grass (*Nassella tenuissima)* which was at par with Selection-1 (*Cynodon dactylon)* 17.13 cm, Tanu varient 17.10 cm, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis)* 16.03 cm and Palma (*Cynodon dactylon)* and Manila (*Zoysia matrella)* 15.00 cm and the minimum root depth (10.00 cm) was noticed in Bahia grass (*Paspalum notatum)*which was at par with Bargusto (*Cynodon dactylon* L.) 11.00 cm, Centipede grass (*Eremochloa ophiuroides)* 12.00 Panama (*Cynodondactylon*), 12.27 cm and Local (*Cynodon dactylon)* 13.17 cm.

During the month of January 2021, the maximum root depth (17.30 cm) was noticed in Maxican grass (*Nassella tenuissima)* which was at par with

Selection-1 (*Cynodon dactylon)* 17.17 cm, Tanu varient 17.13 cm, Palma (*Cynodon dactylon)* 16.17 cm, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis)* 16.07 cm and Manila (*Zoysia matrella)* 15.03 cm and the minimum root depth (10.33 cm) was noticed in Bahia grass (*Paspalum notatum)*which was at par with Bargusto (*Cynodon dactylon* L.) 11.17 cm, Centipede grass (*Eremochloa ophiuroides)* 12.33 cm, Panama (*Cynodondactylon*), 12.60 cm and Local (*Cynodon dactylon)* 13.20 cm.

During the month of Fabruary 2021, the maximum root depth (17.80 cm) was noticed in Maxican grass (*Nassella tenuissima)* which was at par with Tanu varient 17.53 cm, Selection-1 (*Cynodon dactylon)* 17.50 cm, Palma (*Cynodon dactylon)* 16.20 cm, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis)* 16.23 cm and Manila (*Zoysia matrella)* 15.30 cm and the minimum root depth (10.67 cm) was noticed in Bahia grass (*Paspalum notatum)*which was at par with Bargusto (*Cynodon dactylon* L.) 11.50 cm, Centipede grass (*Eremochloa ophiuroides)* 12.67 cm, Panama (*Cynodondactylon*), 12.77 cm and Local (*Cynodon dactylon)* 13.33 cm.

During the month of March 2021, the maximum root depth (17.97 cm) was noticed in Maxican grass (*Nassella tenuissima)* which was at par with Tanu varient 17.87 cm, Selection-1 (*Cynodon dactylon)* 17.80 cm,Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis)* 17.27 cm, Palma (*Cynodon dactylon)* 16.33 cm, and Manila (*Zoysia matrella)* 15.67 cm and the minimum root depth (10.97 cm) was noticed in Bahia grass (*Paspalum notatum)*which was at par with Bargusto (*Cynodon dactylon* L.) 11.83 cm, Centipede grass (*Eremochloa ophiuroides)* 13.17 cm and Panama (*Cynodondactylon*).]

During the month of April 2021, the maximum root depth (18.33 cm) was noticed in Maxican grass (*Nassella tenuissima)* which was at par with Tanu varient 18.20 cm, Selection-1 (*Cynodon dactylon)* 18.03 cm, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis)* 17.60 cm Palma (*Cynodon dactylon)* 16.67 cm and Manila (*Zoysia matrella)* 15.77 cm and the minimum root depth (11.00 cm) was noticed in Bahia grass (*Paspalum notatum)*which was at par with Bargusto (*Cynodon dactylon* L.) 12.33 cm, Centipede grass

(*Eremochloa ophiuroides)* 13.33 cm, Panama (*Cynodondactylon*), 13.50 cm and Local (*Cynodon dactylon)* 14.23 cm.

During the month of May 2021, the maximum root depth (18.67 cm) was noticed in Maxican grass (*Nassella tenuissima)* which was at par with Tanu varient 18.37 cm, Selection-1 (*Cynodon dactylon)* 18.07 cm, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis)* 17.93 cm Palma (*Cynodon dactylon)* 17.00 cm and Manila (*Zoysia matrella)* 15.83 cm and the minimum root depth (11.40 cm) was noticed in Bahia grass (*Paspalum notatum)*which was at par with Bargusto (*Cynodon dactylon* L.) 12.83 cm, Centipede grass (*Eremochloa ophiuroides)* 13.67 cm, Panama (*Cynodondactylon*), 13.83 cm and Local (*Cynodon dactylon)* 14.57 cm.

During the all month minimum average root depth (10.72 cm) was found in Bahia grass (*Paspalum notatum)*while maximum root depth (17.87 cm) was found in Maxican grass (*Nassella tenuissima).*

Table 4.1 Root depth (cm)

Root depth (cm)							Average Data
Genotypes	**Year**						
	2020	**2020-2021**					
	December	**January**	**February**	**March**	**April**	**May**	
G1 -Palma (*Cynodon dactylon* L.)	16.03	16.17	16.20	16.33	16.67	17.00	16.40
G2 -Local (*Cynodon dactylon* L.)	13.17	13.20	13.33	13.50	14.23	14.57	13.66
G3- Panama (*Cynodon dactylon* L.)	12.27	12.60	12.77	13.17	13.50	13.83	13.02
G4- Manila (*Zoysia matrella* (L.) Merr. Philipp	15.00	15.03	15.30	15.67	15.77	15.83	15.43
G5-Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*)	16.03	16.07	16.23	17.27	17.60	17.93	16.85
G6-Maxican grass (*Nassella tenuissima)*	17.20	17.30	17.80	17.97	18.33	18.67	17.87
G7-Selection-1 (*Cynodon dactylon* L.)	17.13	17.17	17.50	17.80	18.03	18.07	17.61
G8-Tanu variant	17.10	17.13	17.53	17.87	18.20	18.37	17.7
G9-Bargusto (*Cynodon dactylon* L.)	11.00	11.17	11.50	11.83	12.33	12.83	11.77
G10-Crow foot grass *(Dactyloctenium aegyptium)*	14.03	14.20	14.70	14.93	15.27	15.43	14.76
G11-Bahia grass (*Paspalum notatum*)	10.00	10.33	10.67	10.97	11.00	11.40	10.72
G12-Centipede grass (*Eremochloao phiuroides* [Munro] Hack)	12.00	12.33	12.67	13.17	13.33	13.67	12.86
S.E m. (±)	**0.93**	**0.96**	**0.87**	**0.89**	**1.19**	**1.23**	
CD (5%)	**2.72**	**2.81**	**2.56**	**2.62**	**3.49**	**3.59**	

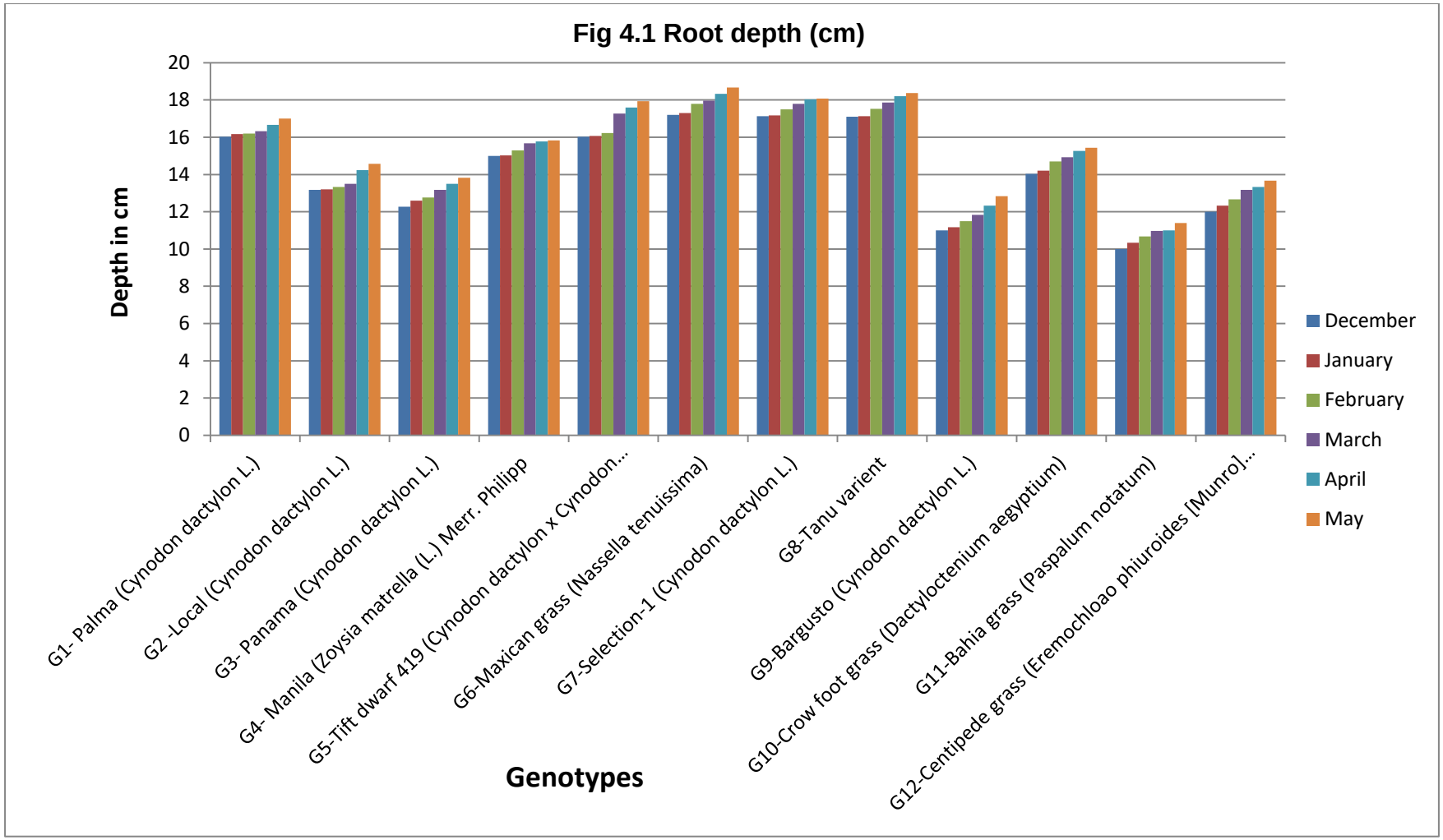


Fig 4.1 Root depth (cm)
Depth in cm
20
18
16
14
12
10
8
6
4
2
0
G1- Palma (Cynodon dactylon L.)
G2 -Local (Cynodon dactylon L.)
G3- Panama (Cynodon dactylon L.)
G4- Manila (Zoysia matrella (L.) Merr. Philipp
G5-Tift dwarf 419 (Cynodon dactylon x Cynodon...
G6-Maxican grass (Nassella tenuissima)
G7-Selection-1 (Cynodon dactylon L.)
G8-Tanu varient
G9-Bargusto (Cynodon dactylon L.)
G10-Crow foot grass (Dactyloctenium aegyptium)
G11-Bahia grass (Paspalum notatum)
G12-Centipede grass (Eremochloao phiuroides [Munro]...
Genotypes
December
January
February
March
April
May

4.1.2 Shoot density (25 cm^2)

The data related to shoot densityhave been presented in table 4.2 and illustrated in Fig 4.2

It is evident from the table 4.2 that shoots density was significantly influenced by different turf grasses during all month.

During the month of December 2020, the maximum shoot density (73.33) was found in Crow foot grass (*Dactyloctenium aegyptium)* and it was statistically superior to rest of the turf grass shoot density (28.33) was noticed in Manila (*Zoysia matrella)*, which was at par with Local (*Cynodon dactylon)* 34.40.

During the month of January 2021, the maximum shoot density (73.87)was found in Crow foot grass (*Dactyloctenium aegyptium)* which was at par with Selection-1 (*Cynodon dactylon*) 72.47, Bahia grass (*Paspalum notatum*) 70.33, Maxican grass (*Nassella tenuissima)* 69.27, Crow foot grass (*Dactyloctenium aegyptium)* 68.20, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 65.60. Whereas minimum shoot densitynoticed (46.73) was recorded with Panama (*Cynodondactylon*), Local (*Cynodon dactylon)* 49.93 and Palma (*Cynodon dactylon)* 51.07.

During the month of February 2021, the maximum shoot density (67.67) was found in Centipede grass (*Eremochloa ophiuroides)*, which was at par with Crow foot grass (*Dactyloctenium aegyptium)* 66.73, Bahia grass (*Paspalum notatum*) 66.40, Selection-1 (*Cynodon dactylon*) and Tanu varient 61.87 and the minimum shoot densitynoticed (38.33) was noticed in Manila (*Zoysia matrella)* which was at par with Panama (*Cynodondactylon*) 42.83 and Local (*Cynodon dactylon)* 44.80.

During the month of March 2021, the maximum shoot density (68.47) was found in Centipede grass (*Eremochloa ophiuroides)*, which was at par with Tanu varient 67.00, Bargusto (*Cynodon dactylon*) 62.20 and Selection-1 (*Cynodon dactylon*) 61.07 and the minimum shoot density(52.33) was noticed in Palma (*Cynodon dactylon)* followed by Local (*Cynodon dactylon)* 53.63, Maxican grass (*Nassella tenuissima)* 56.13, Panama (*Cynodondactylon*) 56.27, Manila (*Zoysia matrella)* 56.87, Bahia grass (*Paspalum notatum*)

57.33, Crow foot grass (*Dactyloctenium aegyptium)* 57.47 and Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 57.67.

During the month of April 2021, the maximum shoot density (75.60,) wasfound in Bahia grass (*Paspalum notatum*) which was at par with Selection-1 (*Cynodon dactylon*) 74.87, Panama (*Cynodondactylon*) 73.13, Maxican grass (*Nassella tenuissima)* 71.20 and Local (*Cynodon dactylon)* 70.93. Whereas minimum shoot density (61.73) was noticed in Centipede grass (*Eremochloa ophiuroides)* which was at par with Tanu varient 63.90, Bargusto (*Cynodon dactylon*) 64.20, Manila (*Zoysia matrella)* 64.73, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 65.67. Palma (*Cynodon dactylon)* 65.93 and Crow foot grass (*Dactyloctenium aegyptium)* 66.87.

During the month of May 2021, the maximum shoot density (75.13) wasfound in Bahia grass (*Paspalum notatum*) which was at par withPanama (*Cynodondactylon*) 75.07, Selection-1 (*Cynodon dactylon*) 74.40, Crow foot grass (*Dactyloctenium aegyptium)* 72.87 and Maxican grass (*Nassella tenuissima)* 71.80. While minimum shoot density (66.60) wasnoticed in Manila (*Zoysia matrella)* and Tanu varient which was at par with Centipede grass (*Eremochloa ophiuroides)* and Local (*Cynodon dactylon)* 66.67, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 66.93,Bargusto (*Cynodon dactylon*) 67.47.

During the all month minimum average shoot density (51.96) was found in Manila (*Zoysia matrella),* while maximum shoot density (68.52) was found in Crow foot grass (*Dactyloctenium aegyptium)*.

Table 4.2 Shoot density (25 cm^2)

Shoot density(25cm^2)							
Genotpyes	**Year**						**Average data**
	2020	**2020-2021**					
	December	**January**	**February**	**March**	**April**	**May**	
G1- Palma (*Cynodon dactylon* L.)	40.40	51.07	47.07	52.33	65.93	67.33	54.02
G2 -Local (*Cynodon dactylon* L.)	34.40	49.93	44.80	53.63	70.93	66.67	53.39
G3- Panama (*Cynodon dactylon* L.)	48.20	46.73	42.83	56.27	73.13	75.07	57.03
G4- Manila (*Zoysia matrella* (L.) Merr. Philipp	28.33	56.93	38.33	56.87	64.73	66.60	51.95
G5-Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*)	59.13	65.60	56.00	57.67	65.67	66.93	61.83
G6-Maxican grass (*Nassella tenuissima)*	55.73	69.27	57.40	56.13	71.20	71.80	63.58
G7-Selection-1 (*Cynodon dactylon* L.)	37.40	72.47	61.87	61.07	74.87	74.40	63.68
G8-Tanu varient	47.67	64.33	61.87	67.00	63.90	66.60	61.89
G9-Bargusto (*Cynodon dactylon* L.)	50.33	68.20	60.00	62.20	64.20	67.47	62.06
G10-Crow foot grass *(Dactyloctenium aegyptium)*	73.33	73.87	66.73	57.47	66.87	72.87	68.52
G11-Bahia grass (*Paspalum notatum*)	48.07	70.93	66.40	57.33	75.60	75.13	65.57
G12-Centipede grass (*Eremochloao phiuroides* [Munro] Hack)	56.67	69.27	67.67	68.47	61.73	66.67	65.08
S. Em. (±)	**2.23**	**3.11**	**2.49**	**3.17**	**2.66**	**1.31**	
CD (5%)	**6.53**	**9.13**	**7.31**	**9.28**	**7.80**	**3.85**	

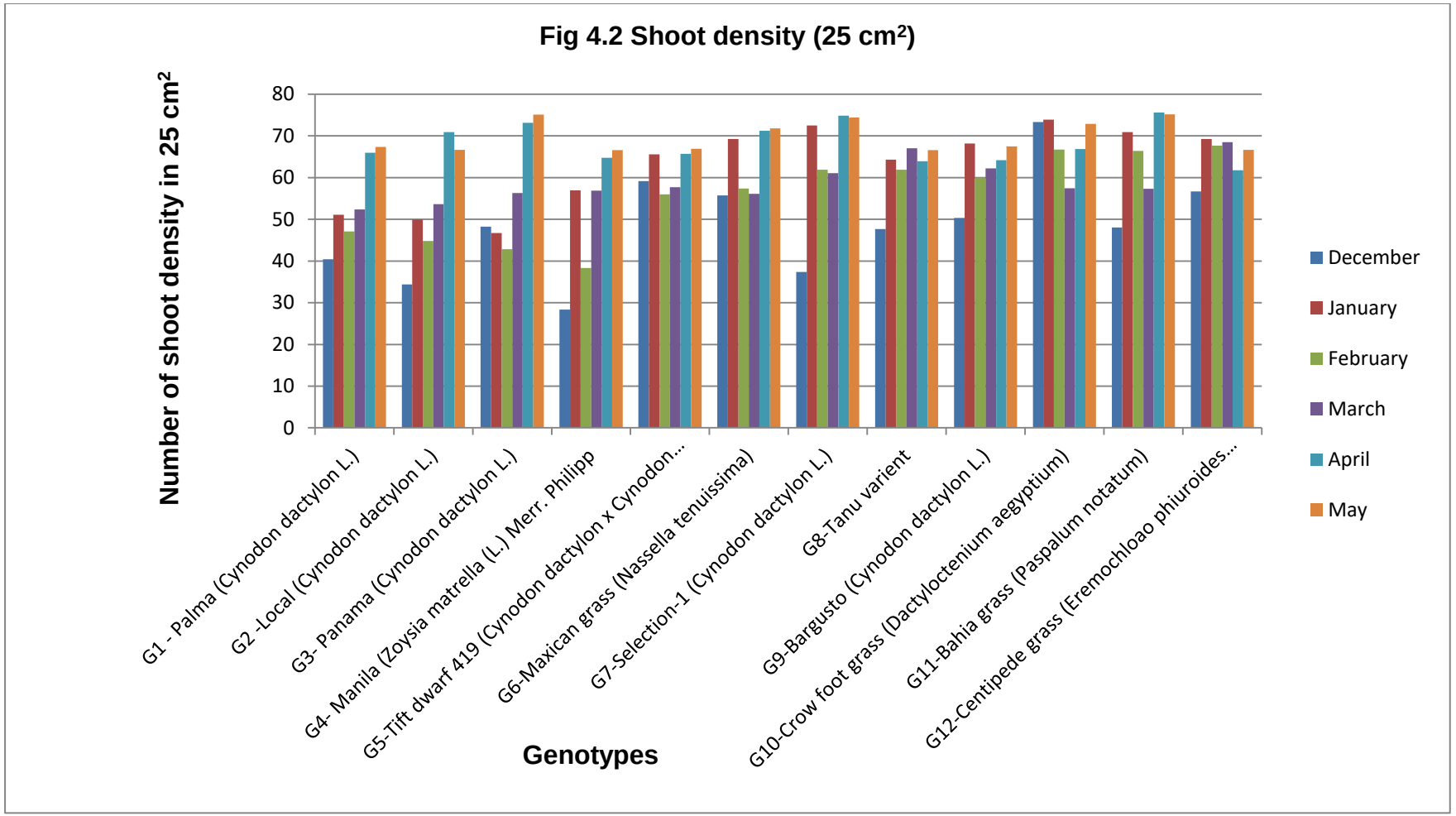


Fig 4.2 Shoot density (25 cm²)
Number of shoot density in 25 cm²
80
70
60
50
40
30
20
10
0
G1 - Palma (Cynodon dactylon L.)
G2 -Local (Cynodon dactylon L.)
G3- Panama (Cynodon dactylon L.)
G4- Manila (Zoysia matrella (L.) Merr. Philipp
G5-Tift dwarf 419 (Cynodon dactylon x Cynodon...
G6-Maxican grass (Nassella tenuissima)
G7-Selection-1 (Cynodon dactylon L.)
G8-Tanu varient
G9-Bargusto (Cynodon dactylon L.)
G10-Crow foot grass (Dactyloctenium aegyptium)
G11-Bahia grass (Paspalum notatum)
G12-Centipede grass (Eremochloao phiuroides...
Genotypes
December
January
February
March
April
May

4.1.3 Leaf width (mm)

The data related to leaf width (mm) have been presented in table 4.3 and illustrated in Fig 4.3

It is evident from the table 4.3 that leaf width was significantly influenced by different turf grasses during the month of January and February 2021. However, during the month of December 2020, March, April and May 2021 effected turf grass on leaf width (mm) was statistically non significant.

During the month of December 2020, the maximum leaf width (1.87 mm) was found in Maxican grass (*Nassella tenuissima)* which was at par with Local (*Cynodon dactylon)* 1.82 mm, Tanu varient 1.80 mm, Crow foot grass (*Dactyloctenium aegyptium)* 1.73 mm and the minimum leaf width (1.40 mm) was noticed in Manila (*Zoysia matrella)*.

During the month of January 2021, the maximum leaf width (1.87 mm) was found in Panama (*Cynodondactylon*) which was at par with Palma (*Cynodon dactylon)* 1.73 mm. Tanu varient 1.63 mm and Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 1.50 mm and the minimum leaf width (1.17mm) was noticed in Bargusto (*Cynodon dactylon*) followed by Crow foot grass (*Dactyloctenium aegyptium)* 1.23 mm.

During the month of February 2021, the maximum leaf width (1.63 mm) was found in Panama (*Cynodondactylon*) which was at par with Palma (*Cynodon dactylon)* 1,57 mm, Tanu varient 1.53 mm, Local (*Cynodon dactylon)* 1.50 mm, Centipede grass (*Eremochloa ophiuroides)* 1.47 mm, Selection-1 (*Cynodon dactylon)* 1.44 mm, Maxican grass (*Nassella tenuissima)* 1.43 mm, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 1.40 mm and the minimum leaf width (1.03 mm) noticed was Bargusto (*Cynodon dactylon*) followed by Bahia grass (*Paspalum notatum*) 1.21 mm, Crow foot grass (*Dactyloctenium aegyptium)* 1.27 mm and Manila (*Zoysia matrella)* 1.31 mm.

During the month of March 2021, the maximum leaf width (1.43 mm) was found in Panama (*Cynodondactylon*), Palma (*Cynodon dactylon)* and Local (*Cynodon dactylon).*The minimum leaf width (1.20 mm) noticed in Bargusto (*Cynodon dactylon*).

During the month of April 2021, the maximum leaf width (1.60 mm) was found in Local (*Cynodon dactylon)* which was at par with Centipede grass (*Eremochloa ophiuroides)* 1.47 mm, Palma (*Cynodon dactylon)* and Manila (*Zoysia matrella)* 1.40 mm, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 1.37 mm and Maxican grass (*Nassella tenuissima)* 1.30 mm. The minimum leaf width (1.17 mm) noticed inBargusto (*Cynodon dactylon*) and Crow foot grass (*Dactyloctenium aegyptium)*.

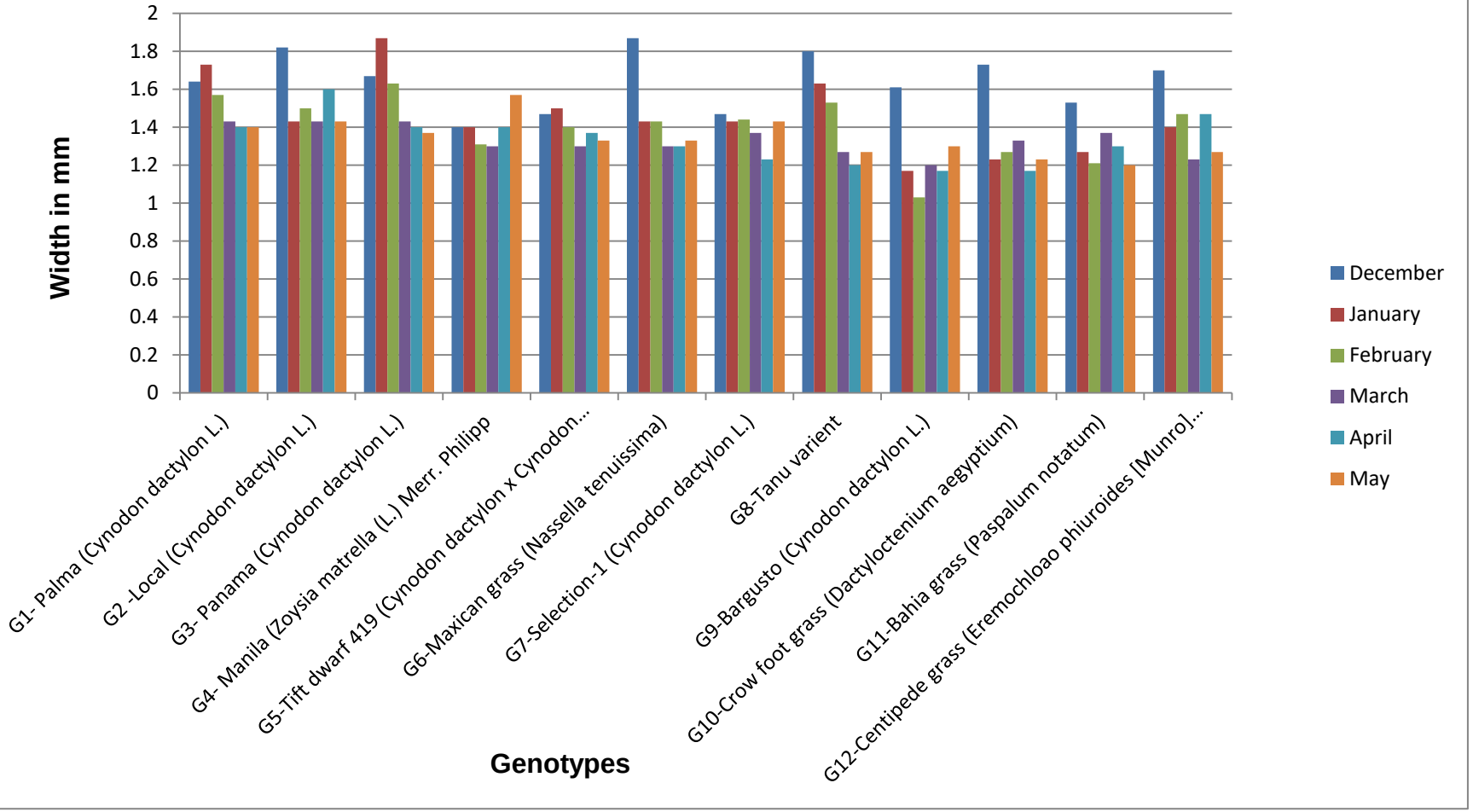
During the month of May 2021, the maximum leaf width (1.57 mm) was found in Manila (*Zoysia matrella)* which was at par with Local (*Cynodon dactylon)* and Selection-1 (*Cynodon dactylon)* 1.43 mm and the minimum leaf width (1.20 mm) was noticed in Bahia grass (*Paspalum notatum*) 1.20 mm, which was at par with Crow foot grass (*Dactyloctenium aegyptium)* 1.23 mm.

During the all month, minimum cumulative leaf width (1.24 mm) was found in Bargusto (*Cynodon dactylon* L.), while maximum leaf width (1.56 mm) was found in Panama (*Cynodon dactylon* L.)

Table 4.3 Leaf width (mm)

Leaf width (mm)							
Genotypes	**Year**						**Average data**
	2020	**2020-2021**					
	December	**January**	**February**	**March**	**April**	**May**	
G1- Palma (*Cynodon dactylon* L.)	1.64	1.73	1.57	1.43	1.40	1.40	1.52
G2 -Local (*Cynodon dactylon* L.)	1.82	1.43	1.50	1.43	1.60	1.43	1.53
G3- Panama (*Cynodon dactylon* L.)	1.67	1.87	1.63	1.43	1.40	1.37	1.56
G4- Manila (*Zoysia matrella* (L.) Merr. Philipp	1.40	1.40	1.31	1.30	1.40	1.57	1.39
G5-Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*)	1.47	1.50	1.40	1.30	1.37	1.33	1.39
G6-Maxican grass (*Nassella tenuissima)*	1.87	1.43	1.43	1.30	1.30	1.33	1.44
G7-Selection-1 (*Cynodon dactylon* L.)	1.47	1.43	1.44	1.37	1.23	1.43	1.39
G8-Tanu varient	1.80	1.63	1.53	1.27	1.20	1.27	1.45
G9-Bargusto (*Cynodon dactylon* L.)	1.61	1.17	1.03	1.20	1.17	1.30	1.24
G10-Crow foot grass *(Dactyloctenium aegyptium)*	1.73	1.23	1.27	1.33	1.17	1.23	1.32
G11-Bahia grass (*Paspalum notatum*)	1.53	1.27	1.21	1.37	1.30	1.20	1.31
G12-Centipede grass (*Eremochloao phiuroides* [Munro] Hack)	1.70	1.40	1.47	1.23	1.47	1.27	1.42
S.Em. (±)	**0.16**	**0.13**	**0.10**	**0.13**	**0.12**	**0.11**	
CD (5%)	**0.47**	**0.37**	**0.30**	**0.38**	**0.36**	**0.31**	

Fig 4.3 Leaf width (mm)



4.1.4 Leaf chlorophyll content (SAPD value)

The data related to leaf chlorophyll content have been presented in table 4.4 and illustrated in Fig 4.4

It is evident from the table 4.4 that leaf chlorophyll content was significantly influenced by different turf grasses during the month of December 2020, January, February and April 2021. However, during the month of March and May 2021 effected of turf grasses on fresh clipping yield was statistically non significant.

During the month of December 2020, the maximum leaf chlorophyll content (22.99,) was found in Selection-1 (*Cynodon dactylon*) which was at par with Maxican grass (*Nassella tenuissima)* 22.30, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 22.06 Bargusto (*Cynodon dactylon*) 21.61 and Centipede grass (*Eremochloa ophiuroides)* 21.05. Whereas minimum leaf chlorophyll content (12.99) was noticed in Local (*Cynodon dactylon)*) which was at par with Tanu varient 14.57, Manila (*Zoysia matrella)* 15.21 and Panama (*Cynodondactylon*) 15.43.

During the month of January 2021, the maximum leaf chlorophyll content (20.83) was found in Selection-1 (*Cynodon dactylon*) which was at par with Bargusto (*Cynodon dactylon*) 19.38, Crow foot grass (*Dactyloctenium aegyptium)* 18.38, Centipede grass (*Eremochloa ophiuroides)* 18.11, Palma (*Cynodon dactylon)* 17.56, Tanu varient 17.55 and Bahia grass (*Paspalum notatum*) 17.44 and the minimum leaf chlorophyll content (13.91) was noticed in Local (*Cynodon dactylon)*), which was at par with Panama (*Cynodondactylon*) 14.73, Maxican grass (*Nassella tenuissima)* 15.49, Manila (*Zoysia matrella)* 15.89 and Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 17.13.

During the month of February 2021, the maximum leaf chlorophyll content (22.29) was found in Panama (*Cynodondactylon*) 22.29, which was at par with Palma (*Cynodon dactylon)* 21.67, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 22.03, Bahia grass (*Paspalum notatum*) 21.53, Local (*Cynodon dactylon)* 21.21, Tanu varient 21.03 , Maxican grass

(*Nassella tenuissima)*20.63, Crow foot grass (*Dactyloctenium aegyptium)* 20.30 and Bargusto (*Cynodon dactylon*) 20.00, whereas minimum leaf chlorophyll content (16.32) was noticed in Centipede grass (*Eremochloa ophiuroides)*, which was at par with Manila (*Zoysia matrella)* 16.54.

During the month of March 2021, the maximum leaf chlorophyll (27.38) content found in Panama (*Cynodondactylon*) which was at par with Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 21.27, Crow foot grass (*Dactyloctenium aegyptium)* and Centipede grass (*Eremochloa ophiuroides)* 20.57, and the minimum leaf chlorophyll content (19.21) was noticed in Bahia grass (*Paspalum notatum*), which was at par with Bargusto (*Cynodon dactylon*) 19.32, Maxican grass (*Nassella tenuissima)* 19.39, Panama (*Cynodondactylon*) 19.53 and Selection-1 (*Cynodon dactylon*) 19.84.

During the month of April 2021, maximum leaf chlorophyll content (21.41) was found in Tanu varient which was at par with Bargusto (*Cynodon dactylon*) 19.81, Crow foot grass (*Dactyloctenium aegyptium)*19.36, Centipede grass (*Eremochloa ophiuroides)* 18.39. Whereas, minimum leaf chlorophyll content (14.21) was noticed in Local (*Cynodon dactylon)*which was at par with Panama (*Cynodondactylon*) 15.02, Manila (*Zoysia matrella)* 15.36, Maxican grass (*Nassella tenuissima)* 15.91 and Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 16.07

During the month of May 2021, the maximum leaf chlorophyll content (21.45) found in Tanu varient which was at par with Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 22.35, Palma (*Cynodon dactylon)* 22.31, Crow foot grass (*Dactyloctenium aegyptium)* 22.17, Maxican grass (*Nassella tenuissima)* 21.89, Centipede grass (*Eremochloa ophiuroides)* 21.25, Manila (*Zoysia matrella)* 21.12,Bargusto (*Cynodon dactylon*) 20.45 and the minimum leaf chlorophyll content (18.78) was noticed in Local (*Cynodon dactylon).*

Maximum average leaf chlorophyll content (20.15) was noticed in Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) during experimental period and minimum average leaf chlorophyll content (16.77) was found in Local (*Cynodon dactylon)*.

Table4.4 Leaf chlorophyll content (SAPD value)

Leaf Chlorophyll content (SPAD value)							
Genotypes	**Year**						
	2020	2020-2021					**Average data**
	December	**January**	**February**	**March**	**April**	**May**	
G1- Palma (*Cynodon dactylon* L.)	17.76	17.56	22.21	20.11	18.15	22.31	19.68
G2 -Local (*Cynodon dactylon* L.)	12.99	13.91	21.21	19.53	14.21	18.78	16.77
G3- Panama (*Cynodon dactylon* L.)	15.43	14.73	22.29	27.38	15.02	20.43	19.21
G4- Manila (*Zoysiamatrella* (L.) Merr. Philipp	15.21	15.89	16.54	20.22	15.36	21.12	17.39
G5-Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*)	22.06	17.13	22.03	21.27	16.07	22.35	20.15
G6-Maxican grass (*Nassella tenuissima)*	22.30	15.49	20.63	19.39	15.91	21.89	19.26
G7-Selection-1 (*Cynodon dactylon* L.)	22.99	20.83	19.41	19.84	17.84	19.33	20.04
G8-Tanu variant	14.57	17.55	21.03	20.21	21.41	22.45	19.53
G9-Bargusto (*Cynodon dactylon* L.)	21.61	19.38	20.00	19.32	19.81	20.45	20.09
G10-Crow foot grass *(Dactyloctenium aegyptium)*	19.99	18.38	20.30	20.57	19.36	22.17	20.12
G11-Bahia grass (*Paspalum notatum*)	18.95	17.44	21.53	19.21	18.16	20.35	19.27
G12-Centipede grass (*Eremochloao phiuroides* [Munro] Hack)	21.05	18.11	16.32	20.57	18.39	21.25	19.28
S.Em. (±)	**0.90**	**1.19**	**0.85**	**2.40**	**1.04**	**1.13**	
CD (5%)	**2.63**	**3.48**	**2.50**	**7.04**	**3.06**	**3.31**	

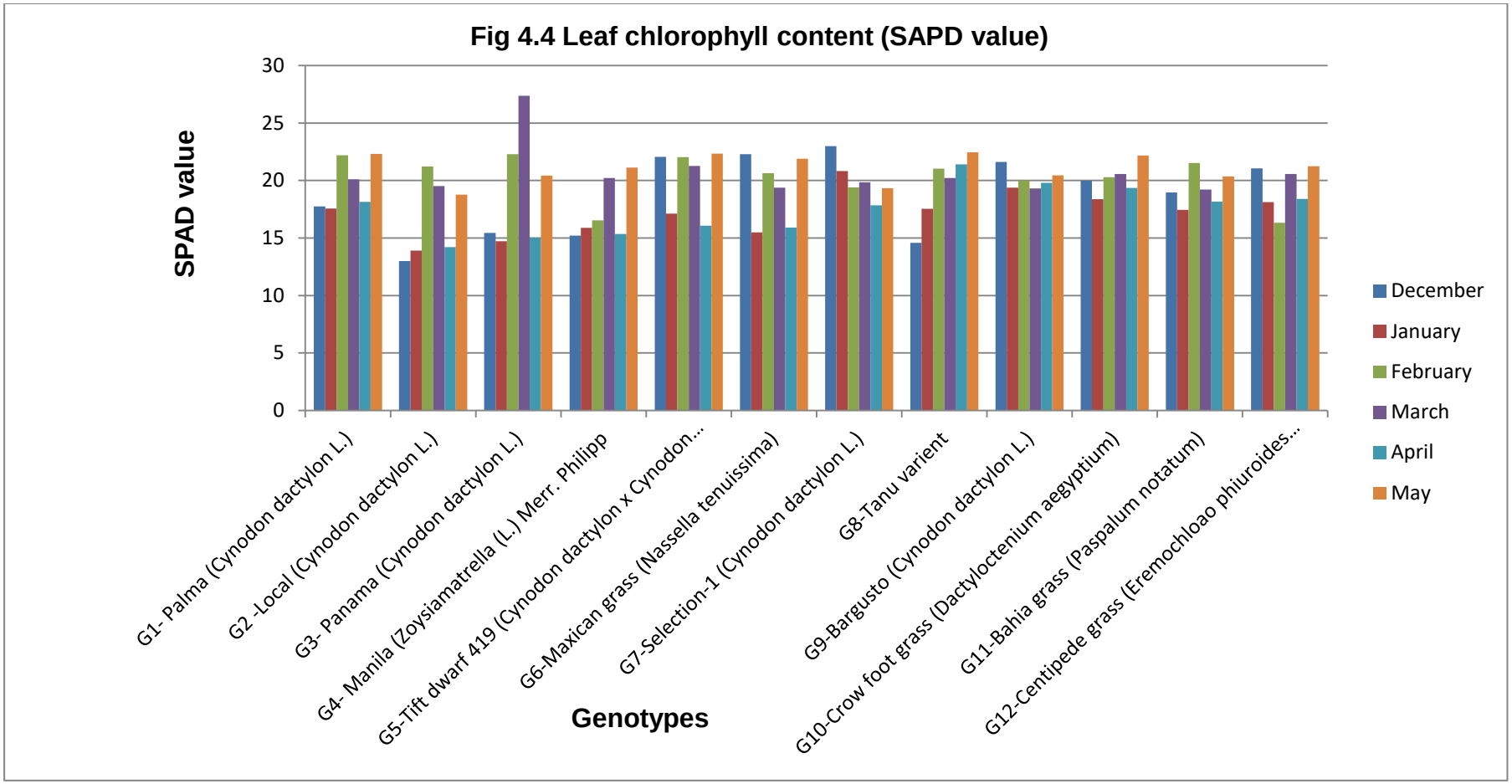


Fig 4.4 Leaf chlorophyll content (SAPD value)
SPAD value
30
25
20
15
10
5
0
G1- Palma (Cynodon dactylon L.)
G2 -Local (Cynodon dactylon L.)
G3- Panama (Cynodon dactylon L.)
G4- Manila (Zoysiamatrella (L.) Merr. Philipp
G5-Tift dwarf 419 (Cynodon dactylon x Cynodon...
G6-Maxican grass (Nassella tenuissima)
G7-Selection-1 (Cynodon dactylon L.)
G8-Tanu varient
G9-Bargusto (Cynodon dactylon L.)
G10-Crow foot grass (Dactyloctenium aegyptium)
G11-Bahia grass (Paspalum notatum)
G12-Centipede grass (Eremochloao phiuroides...
Genotypes
December
January
February
March
April
May

4.1.5 Canopy height (cm)

The data related to canopy height (cm) have been presented in table 4.5 and illustrated in Fig 4.5

It is evident from the table 4.5 that canopy height (cm) was significantly influenced by different turf grasses during the month of December 2020, January, February, March and April 2021. However, during the month of May 2021 effected of turf grass on canopy height (cm) was statistically non significant.

During December 2020, the maximum canopy height (8.63 cm) was recorded in Crow foot grass (*Dactyloctenium aegyptium)* which was at par with Tanu varient 7.68 cm, Centipede grass (*Eremochloa ophiuroides)* 7.37 cm, Bahia grass (*Paspalum notatum*) 7.19 cm, Maxican grass (*Nassella tenuissima)* 7.14 cm and Panama (*Cynodondactylon*) 7.12 cm, however minimum canopy height (5.15 cm) was recorded with Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*), which was at par with Bargusto (*Cynodon dactylon*) 5.43 cm, Selection-1 (*Cynodon dactylon*) 5.95 cm and Palma (*Cynodon dactylon* L*)* 6.62 cm.

During January-2021, the maximum canopy height (7.82 cm) was recorded in Crow foot grass (*Dactyloctenium aegyptium)*, which was at par with Tanu varient 7.61 cm, Bahia grass (*Paspalum notatum*) 7.47 cm, Selection-1 (*Cynodon dactylon*) 7.28 cm, Panama (*Cynodondactylon*) 7.23 cm and Palma (*Cynodon dactylon)* 7.18 cm. While minimum canopy height (5.53 cm) was observed in Bargusto (*Cynodon dactylon*) which was statistically at par with Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) and Centipede grass (*Eremochloa ophiuroides)* 6.23 cm and Maxican grass (*Nassella tenuissima)* 6.53 cm.

In month February 2021, maximum canopy height (7.65 cm) was observed in Tanu varient, which was found to be at par with Selection-1 (*Cynodon dactylon*) 7.33 cm , Panama (*Cynodondactylon*) 7.16 cm, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 7.13 cm, Maxican grass (*Nassella tenuissima)* 7.00 cm, Centipede grass (*Eremochloa ophiuroides)* 6.85 cm and Bahia grass (*Paspalum notatum*) 6.82 cm. However minimum

canopy height (5.74 cm) was recorded in Palma (*Cynodon dactylon)*which was at par with Bargusto (*Cynodon dactylon*) 6.08 cm, Local (*Cynodon dactylon)* 6.58 cm, Crow foot grass (*Dactyloctenium aegyptium)* 6.59 cm and Manila (*Zoysia matrella)* 6.61 cm.

During the month of March 2021, the maximum canopy height (7.85 cm) was noticed in Local (*Cynodon dactylon)* which was at par with Panama (*Cynodondactylon*) 7.58 cm, Selection-1 (*Cynodon dactylon*) 7.30 cm, Manila (*Zoysia matrella)* 6.97 cm. Palma (*Cynodon dactylon)* 6.81 cm. However minimum canopy height (3.69 cm) was recorded in Bargusto (*Cynodon dactylon*) which was at par with Centipede grass (*Eremochloa ophiuroides)* 4.76 cm.

For the month of April 2021, the maximum canopy height (7.95 cm) was noticed in Local (*Cynodon dactylon)*, which was at par with Panama (*Cynodondactylon*) 7.11 cm, Manila (*Zoysia matrella)* and Tanu varient 6.60 cm, Selection-1 (*Cynodon dactylon*) 6.59 cm, Bargusto (*Cynodon dactylon*) 6.47 cm, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 6.45 cm and Palma (*Cynodon dactylon)* 6.40 cm. Whereas minimum canopy height (3.61 cm) was noticed in Centipede grass (*Eremochloa ophiuroides)* which was at par with Bahia grass (*Paspalum notatum*) 4.86 cm.

In the month of May-2021, maximum canopy height (7.52 cm) was noticed in Local (*Cynodon dactylon)* followed by Panama (*Cynodondactylon*) 7.22 cm, Bahia grass (*Paspalum notatum*) 7.08 cm, Selection-1 (*Cynodon dactylon*) and Crow foot grass (*Dactyloctenium aegyptium)*7.07 cm. Whereas minimum canopy height (6.39 cm) was noticed in Centipede grass (*Eremochloa ophiuroides)*

During the all month minimum average canopy height (5.63 cm) was found in Bargusto (*Cynodon dactylon* L.), while maximum canopy height (7 .39 cm) was found in Local (*Cynodon dactylon).*

Table4.5 Canopy height (cm)

Canopy height (cm)							
Genotypes	**Year**						
	2020	**2020-2021**					**Average Data**
	December	**January**	**February**	**March**	**April**	**May**	
G1- Palma (*Cynodon dactylon* L.)	6.62	7.18	5.74	6.81	6.40	6.61	6.56
G2 -Local (*Cynodon dactylon* L.)	7.25	7.23	6.58	7.85	7.95	7.52	7.39
G3- Panama (*Cynodon dactylon* L.)	7.12	7.25	7.16	7.58	7.11	7.22	7.24
G4- Manila (*Zoysiamatrella* (L.) Merr. Philipp	6.71	6.95	6.61	6.97	6.60	6.95	6.79
G5-Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*)	5.15	6.23	7.13	6.55	6.45	6.62	6.35
G6-Maxican grass (*Nassella tenuissima)*	7.14	6.53	7.00	6.36	5.77	6.51	6.55
G7-Selection-1 (*Cynodon dactylon* L.)	5.95	7.28	7.33	7.30	6.59	7.07	6.92
G8-Tanu variant	7.68	7.61	7.65	6.32	6.60	7.04	7.15
G9-Bargusto (*Cynodon dactylon* L.)	5.43	5.53	6.08	3.69	6.47	6.58	5.63
G10-Crow foot grass *(Dactyloctenium aegyptium)*	8.63	7.82	6.59	5.15	5.30	7.07	6.76
G11-Bahia grass (*Paspalum notatum*)	7.19	7.47	6.82	5.15	4.86	7.08	6.42
G12-Centipede grass (*Eremochloao phiuroides* [Munro] Hack)	7.37	6.23	6.85	4.76	3.61	6.39	5.86
S.Em. (±)	**0.52**	**0.37**	**0.33**	**0.43**	**0.65**	**0.38**	
CD (5%)	**1.53**	**1.10**	**0.98**	**1.28**	**1.92**	**1.12**	

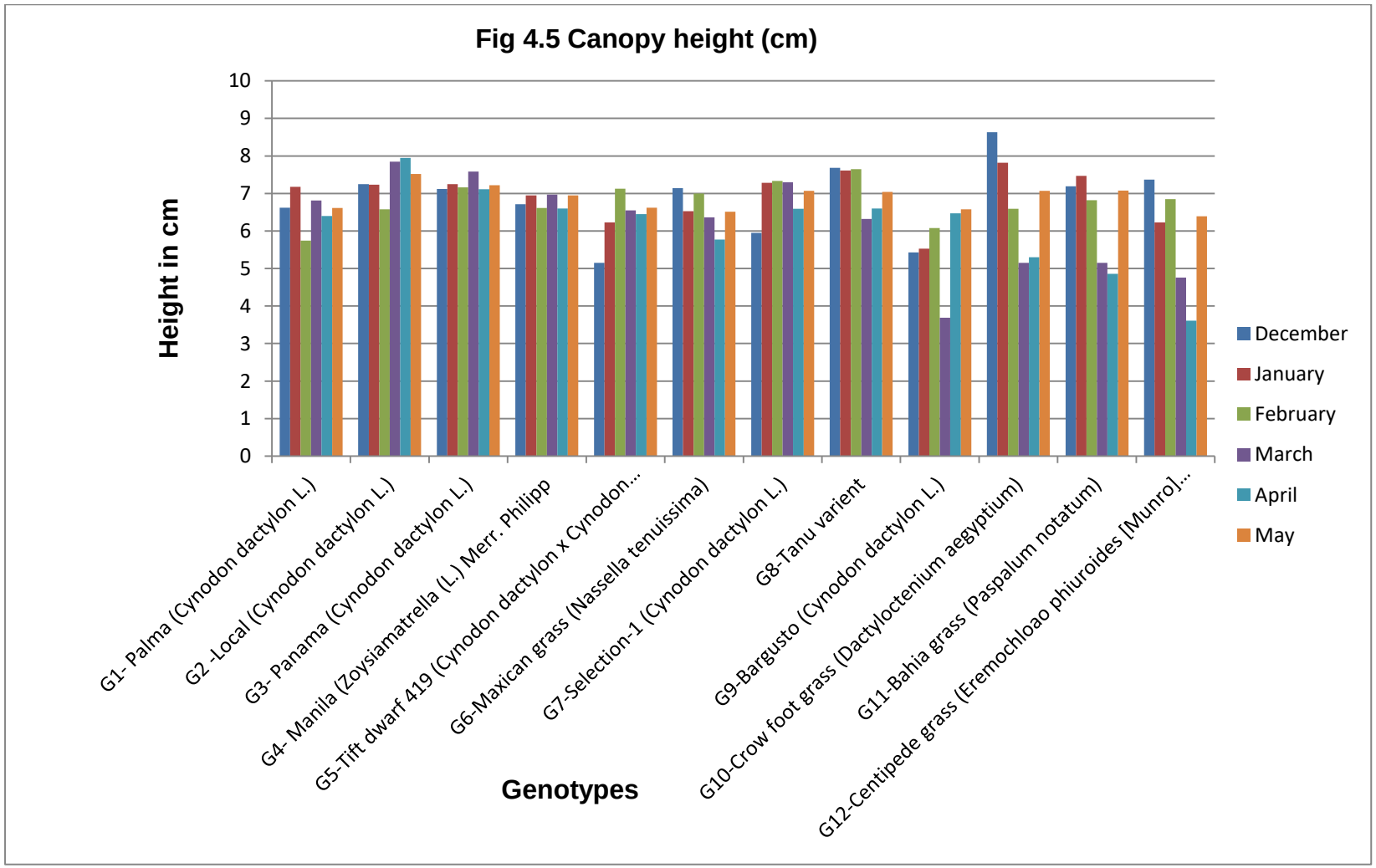


Fig 4.5 Canopy height (cm)
Height in cm
10
9
8
7
6
5
4
3
2
1
0
G1- Palma (Cynodon dactylon L.)
G2 -Local (Cynodon dactylon L.)
G3- Panama (Cynodon dactylon L.)
G4- Manila (Zoysiamatrella (L.) Merr. Philipp
G5-Tift dwarf 419 (Cynodon dactylon x Cynodon...
G6-Maxican grass (Nassella tenuissima)
G7-Selection-1 (Cynodon dactylon L.)
G8-Tanu varient
G9-Bargusto (Cynodon dactylon L.)
G10-Crow foot grass (Dactyloctenium aegyptium)
G11-Bahia grass (Paspalum notatum)
G12-Centipede grass (Eremochloao phiuroides [Munro]...
Genotypes
December
January
February
March
April
May

4.1.6 Leaf length (cm)

The data related to leaf length (cm) have been presented in table 4.6 and illustrated in Fig 4.6

It is evident from the table 4.6 that leaf length was significantly influenced by different turf grasses during the month of December 2020 and March 2021. However during the month of January, February, April and May 2021 effected of turf grass on leaf length (cm) was statistically non significant.

During the month of December 2020, the maximum leaf length (3.70 cm) was found in Crow foot grass (*Dactyloctenium aegyptium)* which was at par with Bahia grass (*Paspalum notatum*) 3.57 cm,Tanu varient 3.36 cm, Centipede grass (*Eremochloa ophiuroides)* 3.25 cm and Manila (*Zoysia matrella)* 3.09 cm, while minimum leaf length (1.96 cm) was noticed Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) which was at par with Selection-1 (*Cynodon dactylon*)1.97 cm, Palma (*Cynodon dactylon)* 1.98 cm, Bargusto (*Cynodon dactylon*) 2.20 cm, Maxican grass (*Nassella tenuissima)* 2.38 cm and Local (*Cynodon dactylon)* 2.59 cm.

During the month of January 2021 the maximum leaf length (3.33 cm) was found in Panama (*Cynodondactylon*) which was at par with Crow foot grass (*Dactyloctenium aegyptium)* 3.28 cm and Bahia grass (*Paspalum notatum*) 3.19 cm, and the minimum leaf length (1.99 cm) was noticed in Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) and Bargusto (*Cynodon dactylon*) which was at par with Tanu varient 2.03 cm, Manila (*Zoysia matrella)* 2.20 cm and Centipede grass (*Eremochloa ophiuroides)* 2.24 cm.

During the month of February 2021, the maximum leaf length (3.23 cm) was found in Local (*Cynodon dactylon)* which was at par with Panama (*Cynodondactylon*) 2.73 cm, Bahia grass (*Paspalum notatum*) 2.71 cm, Centipede grass (*Eremochloa ophiuroides)* 2.59 cm, Tanu varient 2.46 cm and Maxican grass (*Nassella tenuissima)* 2.43 cm, while minimum leaf length (1.61 cm) noticed in Bargusto (*Cynodon dactylon*) which was at par with Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 2.10 cm and Crow foot grass (*Dactyloctenium aegyptium)* 2.11 cm.

During the month of March 2021 the maximum leaf length (4.49 cm) was found in Panama (*Cynodondactylon*). While minimum leaf length (2.29 cm) was noticed in Bargusto (*Cynodon dactylon*) followed by Maxican grass (*Nassella tenuissima)* 2.41 cm, Palma (*Cynodon dactylon)* 2.45 cm, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 2.52 cm, Crow foot grass (*Dactyloctenium aegyptium)* 2.88 cm, Centipede grass (*Eremochloa ophiuroides)* 2.89 cm, Tanu varient 2.93 cm, Bahia grass (*Paspalum notatum*) 2.94 cm and Selection-1 (*Cynodon dactylon*) 2.95 cm.

During the month of April 2021, the maximum leaf length (4.12 cm) was found in Panama (*Cynodondactylon*) which was at par with Local (*Cynodon dactylon)* 3.39 cm and Manila (*Zoysia matrella)* 3.03 cm, while minimum leaf length (2.12 cm) was noticed in Palma (*Cynodon dactylon)*

During the month of May 2021, the maximum leaf length (3.67 cm) found in Panama (*Cynodondactylon*) which was at par with Local (*Cynodon dactylon)* 3.25 cm, Tanu varient 3.12 cm and Selection-1 (*Cynodon dactylon*) 3.11 cm. While the minimum leaf length (2.20 cm) was noticed in Palma (*Cynodon dactylon)* which was at par with Bargusto (*Cynodon dactylon*) 2.25 cm, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 2.39 cm, Maxican grass (*Nassella tenuissima)* 2.44 cm and Bahia grass (*Paspalum notatum*) 2.55 cm.

During the all month minimum average leaf length (2.1 cm) was found in Bargusto (*Cynodon dactylon* L.), while maximum leaf length (3.50 cm) was found in Panama (*Cynodon dactylon* L.).

Table4.6 Leaf length (cm)

Leaf length (cm)							
Genotypes	Year						Average data
	2020	2020-2021					
	December	January	February	March	April	May	
G1- Palma (*Cynodon dactylon* L.)	1.98	2.48	2.27	2.45	2.17	2.20	2.25
G2 -Local (*Cynodon dactylon* L.)	2.59	2.51	3.23	3.68	3.39	3.25	3.10
G3- Panama (*Cynodon dactylon* L.)	2.89	3.33	2.73	4.29	4.12	3.67	3.50
G4- Manila (*Zoysia matrella* (L.) Merr. Philipp	3.09	2.20	2.28	3.03	3.00	3.01	2.76
G5-Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*)	1.96	1.99	2.10	2.52	2.57	2.39	2.25
G6-Maxican grass (*Nassella tenuissima)*	2.38	2.55	2.43	2.41	2.65	2.44	2.47
G7-Selection-1 (*Cynodon dactylon* L.)	1.97	2.80	2.39	2.95	2.88	3.11	2.68
G8-Tanu varient	3.36	2.03	2.46	2.93	2.95	3.12	2.80
G9-Bargusto (*Cynodon dactylon* L.)	2.20	1.99	1.61	2.29	2.26	2.25	2.1
G10-Crow foot grass *(Dactyloctenium aegyptium)*	3.70	3.28	2.11	2.88	2.80	2.84	2.93
G11-Bahia grass (*Paspalum notatum*)	3.57	3.19	2.71	2.94	2.49	2.55	2.90
G12-Centipede grass (*Eremochloao phiuroides* [Munro] Hack)	3.25	2.24	2.59	2.89	2.76	2.97	2.78
S.Em. (±)	**0.24**	**0.34**	**0.32**	**0.24**	**0.37**	**0.31**	
CD (5%)	**0.70**	**1.00**	**0.94**	**0.72**	**1.07**	**0.90**	

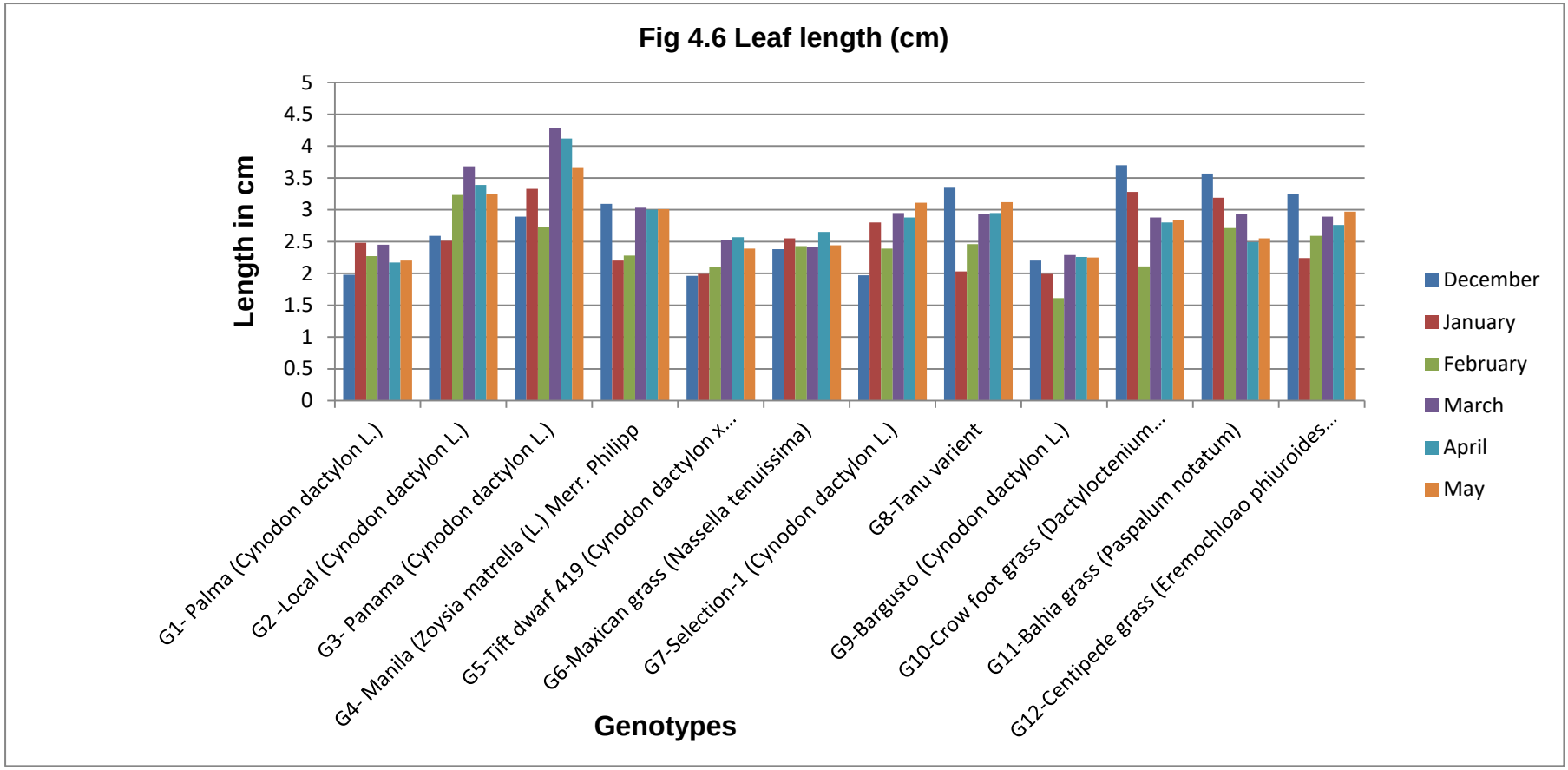


Fig 4.6 Leaf length (cm)
Length in cm
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
G1- Palma (Cynodon dactylon L.)
G2 -Local (Cynodon dactylon L.)
G3- Panama (Cynodon dactylon L.)
G4- Manila (Zoysia matrella (L.) Merr. Philipp
G5-Tift dwarf 419 (Cynodon dactylon x...
G6-Maxican grass (Nassella tenuissima)
G7-Selection-1 (Cynodon dactylon L.)
G8-Tanu varient
G9-Bargusto (Cynodon dactylon L.)
G10-Crow foot grass (Dactyloctenium...
G11-Bahia grass (Paspalum notatum)
G12-Centipede grass (Eremochloao phiuroides...
Genotypes
December
January
February
March
April
May

4.1.7 Stolon internodal length (cm)

The data related to stolon internodal length (cm) have been presented in table 4.7 and illustrated in Fig 4.7

It is evident from the table 4.7 that stolon internodal length (cm) was significantly influenced by different turf grasses during the month of March and May 2021. However during the month of December 2020, January, February and April 2021 effected of turf grass on stolon internodal length (cm) statistically non significant.

During the month of December 2020, the maximum stolon internodal length (2.14 cm) was found in Crow foot grass (*Dactyloctenium aegyptium)* which was at par with Local (*Cynodon dactylon)* 2.12 cm and (*Cynodon dactylon)* 2.05 cm. Whereas minimum stolon internodal length (1.65 cm) noticed inMaxican grass (*Nassella tenuissima)* which was at par with Bargusto (*Cynodon dactylon*) 1.71 cm and Tanu varient 1.75 cm.

During the month of January 2021, the maximum stolon internodal length (2.24 cm) was found in Crow foot grass (*Dactyloctenium aegyptium)* which was at par with Centipede grass (*Eremochloa ophiuroides)* 2.14 cm, Bargusto (*Cynodon dactylon*) and Maxican grass (*Nassella tenuissima)* 2.13 cm, , Panama (*Cynodondactylon*) 2.11 cm, Manila (*Zoysia matrella)* 2.01 cm. Whereas minimum stolon internodal length (1.71 cm) was noticed inTift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) and Tanu varient .

During the month of February 2021, the maximum stolon internodal length (2.51 cm) was found in Panama (*Cynodondactylon*) which was at par with Manila (*Zoysia matrella)* 2.41 cm, Maxican grass (*Nassella tenuissima)* 2.40 cm, Local (*Cynodon dactylon)* 2.35 cm, Tanu varient 2.34 cm, Selection-1 (*Cynodon dactylon*) 2.20 cm. While minimum stolon internodal length (1.84 cm) was noticed in Bargusto (*Cynodon dactylon*) which was at par with Crow foot grass (*Dactyloctenium aegyptium)* 1.96 cm, Bahia grass (*Paspalum notatum*) 2.08 cm.

During the month of March 2021, the maximum stolon internodal length (2.43 cm) was found in Panama (*Cynodondactylon*) which was at par with

Local (*Cynodon dactylon)* 2.19 cm, Manila (*Zoysia matrella)* 2.02 cm and the minimum stolon internodal length (1.25 cm) was noticed in Maxican grass (*Nassella tenuissima)* and Selection-1 (*Cynodon dactylon*), which was at par with Bargusto (*Cynodon dactylon*) 1.38 cm,Tanu varient 1.42 cm, Bahia grass (*Paspalum notatum*) and Centipede grass (*Eremochloa ophiuroides)* 1.51 cm.

During the month of April 2021, the maximum stolon internodal length (2.47 cm) was found in Panama (*Cynodondactylon*) which was at par with Centipede grass (*Eremochloa ophiuroides)* 2.42 cm, Palma (*Cynodon dactylon)* 2.19 cm. While minimum stolon internodal length (1.77 cm) was noticed with Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) which was at par with Selection-1 (*Cynodon dactylon*) 1.79 cm, Bargusto (*Cynodon dactylon*) 1.83 cm.

During the month of May 2021, the maximum stolon internodal length (2.38 cm) was found in Panama (*Cynodondactylon*) which was at par with Centipede grass (*Eremochloa ophiuroides)* 2.24 cm, Bahia grass (*Paspalum notatum*) 2.20 cm, Palma (*Cynodon dactylon)* 2.19 cm, Selection-1 (*Cynodon dactylon*) 2.15 cm, Local (*Cynodon dactylon)* 2.14 cm, Crow foot grass (*Dactyloctenium aegyptium)* 2.07 cm and minimum stolon internodal length (1.74 cm) was noticed with Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) which was at par with Tanu varient 1.85 cm, Bargusto (*Cynodon dactylon*) 1.90 cm and Manila (*Zoysia matrella)* 1.98 cm.

During the all month minimum average stolon internodal length (1.79 cm) was found in Bargusto (*Cynodon dactylon* L) while maximum stolon internodal length (2.31 cm) was found in Panama (*Cynodon dactylon* L).

Table4.7 Stolon internodal length (cm)

Stolon internodal length (cm)							Average Data
Genotypes	Year						
	2020	2020-2021					
	December	January	February	March	April	May	
G1- Palma (*Cynodon dactylon* L.)	2.05	1.99	2.17	1.76	2.19	2.19	2.05
G2 -Local (*Cynodon dactylon* L.)	2.12	1.95	2.35	2.19	2.13	2.14	2.14
G3- Panama (*Cynodon dactylon* L.)	2.01	2.11	2.51	2.43	2.47	2.38	2.31
G4- Manila (*Zoysiamatrella* (L.) Merr. Philipp	1.88	2.01	2.41	2.02	1.96	1.98	2.04
G5-Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*)	1.80	1.71	2.11	1.74	1.77	1.74	1.81
G6-Maxican grass (*Nassella tenuissima)*	1.65	2.13	2.40	1.25	1.95	2.05	1.90
G7-Selection-1 (*Cynodon dactylon* L.)	1.84	2.06	2.20	1.25	1.79	2.15	1.88
G8-Tanu varient	1.75	1.71	2.34	1.42	1.95	1.85	1.83
G9-Bargusto (*Cynodon dactylon* L.)	1.71	2.13	1.84	1.38	1.83	1.90	1.79
G10-Crow foot grass *(Dactyloctenium aegyptium)*	2.14	2.24	1.96	1.73	1.97	2.07	2.01
G11-Bahia grass (*Paspalum notatum*)	1.80	2.07	2.08	1.51	2.05	2.20	1.95
G12-Centipede grass (*Eremochloao phiuroides* [Munro] Hack)	1.85	2.14	2.14	1.51	2.42	2.24	2.05
S.Em. (±)	**0.18**	**0.11**	**0.14**	**0.24**	**0.18**	**0.11**	
CD (5%)	**0.15**	**0.33**	**0.41**	**0.70**	**0.53**	**0.31**	

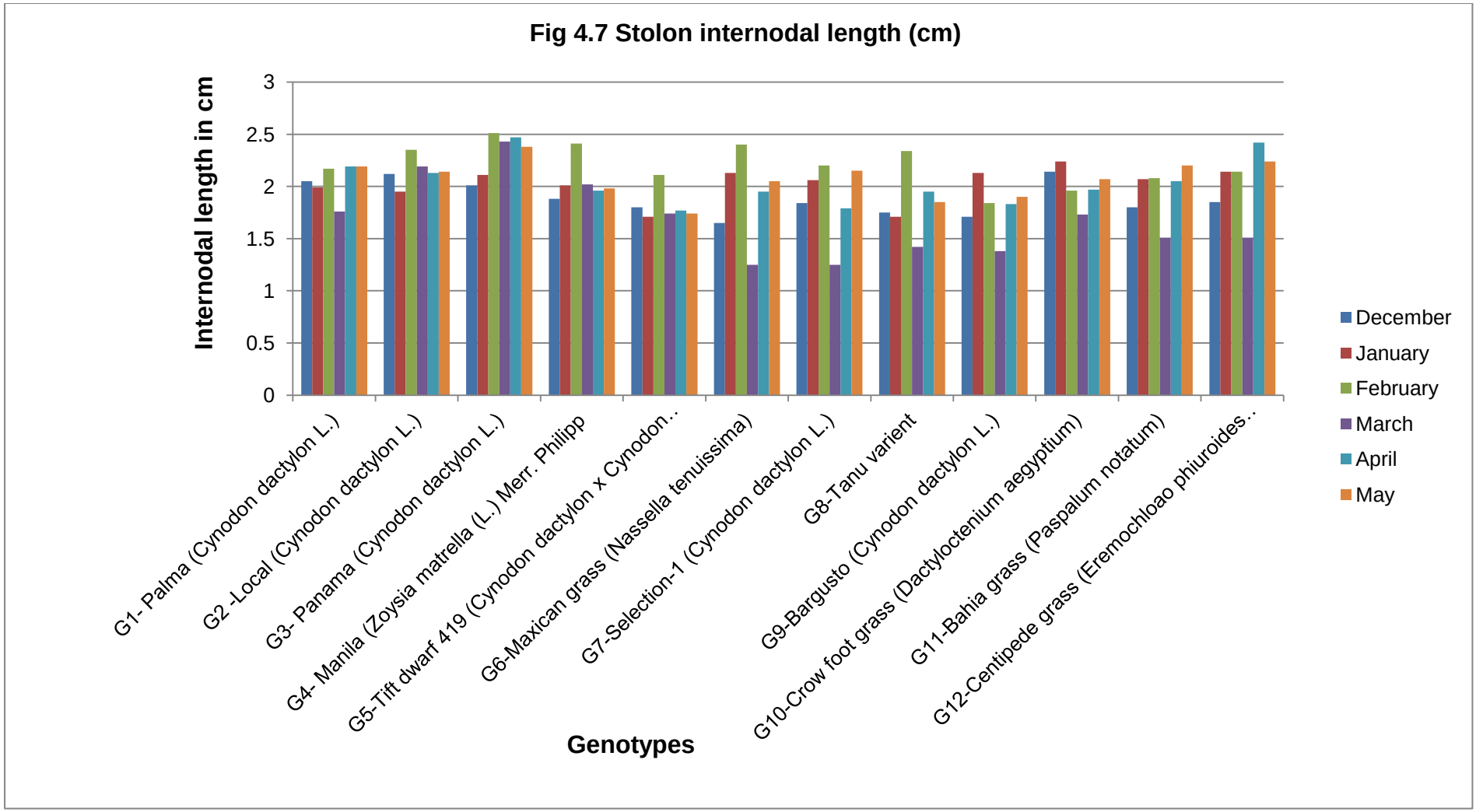


Fig 4.7 Stolon internodal length (cm)
Internodal length in cm
3
2.5
2
1.5
1
0.5
0
G1- Palma (Cynodon dactylon L.)
G2 -Local (Cynodon dactylon L.)
G3- Panama (Cynodon dactylon L.)
G4- Manila (Zoysia matrella (L.) Merr. Philipp
G5-Tift dwarf 419 (Cynodon dactylon x Cynodon..
G6-Maxican grass (Nassella tenuissima)
G7-Selection-1 (Cynodon dactylon L.)
G8-Tanu varient
G9-Bargusto (Cynodon dactylon L.)
G10-Crow foot grass (Dactyloctenium aegyptium)
G11-Bahia grass (Paspalum notatum)
G12-Centipede grass (Eremochloao phiuroides..
Genotypes
December
January
February
March
April
May

4.1.8 Stolon internodal diameter (mm)

The data related to stolon internodal diameter (mm) have been presented in table 4.8 and illustrated in Fig 4.8

It is evident from the table 4.8 that stolon internodal diameter (mm) was significantly influenced by different turf grasses during the month of December 2020, January, and April 2021. However during the month of February, March, April and May 2021 effected for turf grasses on stolon internodal diameter (mm) was statistically non significant.

During the month of December 2020, the stolon internodal diameter (1.10 mm) wasfound in Tanu varient which was at par withSelection-1 (*Cynodon dactylon*) 0.97 mm**,** Centipede grass (*Eremochloa ophiuroides)* 0.90 mm,Maxican grass (*Nassella tenuissima)* , Panama (*Cynodondactylon*) and Local (*Cynodon dactylon)* 0.83 mm and the minimum stolon internodal diameter (0.60 mm) was noticed in Bargusto (*Cynodon dactylon*) and Bahia grass (*Paspalum notatum*) which was at par with Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) and Crow foot grass (*Dactyloctenium aegyptium)* 0.77 mm.

During the month of January 2021, the stolon internodal diameter (1.37 mm) found in Centipede grass (*Eremochloa ophiuroides)*. Whereas minimum stolon internodal diameter (0.77 mm) was noticed in Bahia grass (*Paspalum notatum*) which was at par with Crow foot grass (*Dactyloctenium aegyptium)*and Local (*Cynodon dactylon)* 0.83 mm and Palma (*Cynodon dactylon)* 0.90 mm.

During the month of February 2021, the maximum stolon internodal diameter (0.97 mm) was found in Bahia grass (*Paspalum notatum*) which was at par withTift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*), Centipede grass (*Eremochloa ophiuroides)* and Manila (*Zoysia matrella)* 0.90 mm and the minimum stolon internodal diameter (0.73 mm) was noticed in Palma (*Cynodon dactylon).*

During the month of March 2021, the maximum stolon internodal diameter (1.13 mm) was found in Panama (*Cynodondactylon*) and wasminimum stolon

internodal diameter (0.90 mm) was noticed in Tanu varient which was at par with Bahia grass (*Paspalum notatum*) 0.93 mm,

During the month of April 2021, the maximum stolon internodal diameter (1.07 mm) was found in Panama (*Cynodondactylon*) 1.07 mm, which was at par with Crow foot grass (*Dactyloctenium aegyptium)* and Maxican grass (*Nassella tenuissima)* 1.00 mm, Palma (*Cynodon dactylon)* 0.97 mm, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis)* and Bargusto (*Cynodon dactylon*) 0.90 mm and minimum stolon internodal diameter (0.73 mm) was noticed in Tanu varient followed by Centipede grass (*Eremochloa ophiuroides)* 0.80 mm and Manila (*Zoysia matrella)* 0.83 mm.

During the month of May 2021, the maximum stolon internodal diameter (1.03 mm) wasfound in Panama (*Cynodondactylon*), which was at par with Bargusto (*Cynodon dactylon*) and Crow foot grass (*Dactyloctenium aegyptium)* 1.00 mm, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis)* 0.97 mm and Palma (*Cynodon dactylon)* 0.93 mm and the minimum stolon internodal diameter (0.73 mm) was noticed in Tanu varient, which was at par with Maxican grass (*Nassella tenuissima)* 0.77 mm, Bahia grass (*Paspalum notatum*) 0.83 mm and Selection-1 (*Cynodon dactylon)* 0.87 mm.

Maximum average stolon internodal diameter(1.01 mm) was found in Centipede grass (*Eremochloa ophiuroides)* during experimental period and minimum cumulative stolon internodal diameter(0.81 mm) was found in Bahia grass (*Paspalum notatum*)

Table4.8 Stolon internodal diameter (mm)

Stolon internodal diameter (mm)							
Genotypes	**Year**						**Average Data**
	2020	**2020-2021**					
	December	**January**	**February**	**March**	**April**	**May**	
G1- Palma (*Cynodon dactylon* L.)	0.80	0.90	0.80	1.10	0.97	0.93	0.91
G2 -Local (*Cynodon dactylon* L.)	0.83	0.83	0.80	1.07	0.93	0.90	0.89
G3- Panama (*Cynodon dactylon* L.)	0.83	0.93	0.87	1.13	1.07	1.03	0.97
G4- Manila (*Zoysiamatrella* (L.)	0.80	1.00	0.90	1.07	0.83	0.87	0.91
G5-Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*)	0.77	1.00	0.90	1.07	0.90	0.97	0.93
G6-Maxican grass (*Nassella tenuissima)*	0.83	1.03	0.83	0.97	1.00	0.77	0.90
G7-Selection-1 (*Cynodon dactylon* L.)	0.97	1.03	0.80	0.97	0.90	0.87	0.92
G8-Tanu variant	0.90	1.03	0.73	0.90	0.73	0.73	0.83
G9-Bargusto (*Cynodon dactylon* L.)	0.60	0.67	0.87	0.97	0.90	1.0	0.83
G10-Crow foot grass *(Dactyloctenium aegyptium)*	0.77	0.83	0.80	1.03	1.00	1.0	0.90
G11-Bahia grass (*Paspalum notatum*)	0.60	0.77	0.90	0.93	0.87	0.83	0.81
G12-Centipede grass (*Eremochloao phiuroides* [Munro] Hack)	1.10	1.37	0.97	0.97	0.80	0.90	1.01
S.Em. (±)	**0.09**	**0.08**	**0.07**	**0.08**	**0.06**	**0.09**	
CD (5%)	**0.27**	**0.22**	**0.20**	**0.22**	**0.18**	**0.25**	

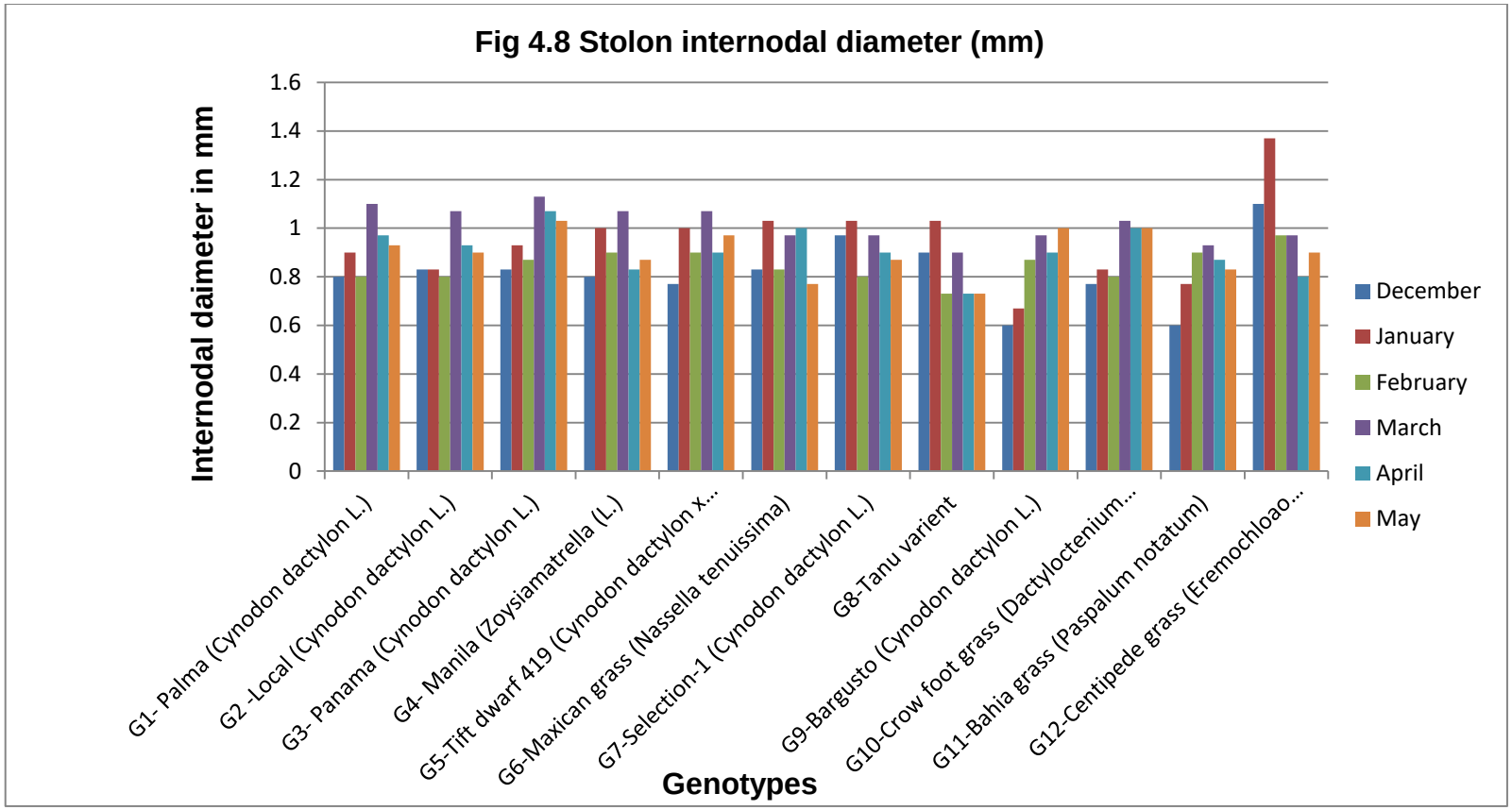


Fig 4.8 Stolon internodal diameter (mm)
Internodal daimeter in mm
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
G1- Palma (Cynodon dactylon L.)
G2 -Local (Cynodon dactylon L.)
G3- Panama (Cynodon dactylon L.)
G4- Manila (Zoysiamatrella (L.)
G5-Tift dwarf 419 (Cynodon dactylon x...
G6-Maxican grass (Nassella tenuissima)
G7-Selection-1 (Cynodon dactylon L.)
G8-Tanu varient
G9-Bargusto (Cynodon dactylon L.)
G10-Crow foot grass (Dactyloctenium...
G11-Bahia grass (Paspalum notatum)
G12-Centipede grass (Eremochloao...
Genotypes
December
January
February
March
April
May

4.1.9 Fresh clipping yield (g/m^2)

The data related to fresh clipping yield have been presented in table 4.9 and illustrated in Fig 4.9

It is evident from the table 4.9 that fresh clipping yield was significantly influenced by different turf grasses during the month of December 2020, February, March, April and May 2021. However during the month of January 2021 effected of turf grass on fresh clipping yield was statistically non significant.

During the month of December 2020, the maximum fresh clipping yield (163.10 g) was found in Palma (*Cynodon dactylon)* which was at par with Crow foot grass (*Dactyloctenium aegyptium)* 150.77 g, Centipede grass (*Eremochloa ophiuroides)* 147.07 g, Tanu varient 131.07 g, Bahia grass (*Paspalum notatum*) 124.77 g, whereas minimum fresh clipping yield (66.57 g) was noticed in Bargusto (*Cynodon dactylon*) which was at par with Panama (*Cynodondactylon*) 74.23 g, Manila (*Zoysia matrella)* 81.17 g, Local (*Cynodon dactylon)* 90.57 g, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 92.77 g, Selection-1 (*Cynodon dactylon*) 97.60 g.

During the month of January 2021, the maximum fresh clipping yield (113.33 g) found in Crow foot grass (*Dactyloctenium aegyptium)*which was at par with Palma (*Cynodon dactylon)* 104.67 g, Maxican grass (*Nassella tenuissima)* 104.00 g, Bahia grass (*Paspalum notatum*) 99.67 g, Panama (*Cynodondactylon*) 95.00 g, Selection-1 (*Cynodon dactylon*) 94.67 g, Tanu varient 90.00 g, Centipede grass (*Eremochloa ophiuroides)* 86.00 g, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 85.00g, whereas minimum fresh clipping yield (53.33 g) was noticed in Bargusto (*Cynodon dactylon*) 53.33 g, which was at par with Manila (*Zoysia matrella)* 81.33 g.

During the month of February 2021, the maximum fresh clipping yield (108.33 g) was found in Crow foot grass (*Dactyloctenium aegyptium)*which was at par with Centipede grass (*Eremochloa ophiuroides)* 98.67 g, Local (*Cynodon dactylon)* 86.33 g, Selection-1 (*Cynodon dactylon*) 82.67 g, whereas minimum fresh clipping yield(35.00 g) was noticed in Bargusto (*Cynodon dactylon*) which was at par with Palma (*Cynodon dactylon)* 48.00 g,

Panama (*Cynodondactylon*) 49.00 g, Bahia grass (*Paspalum notatum*) 58.67 g and Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 61.00 g.

During the month of March 2021, the maximum fresh clipping yield (108.33 g) was found in Selection-1 (*Cynodon dactylon*) which was at par with Centipede grass (*Eremochloa ophiuroides)* 103.00 g, Tanu varient 100.67 g, Local (*Cynodon dactylon)* 95.67 g, Crow foot grass (*Dactyloctenium aegyptium)* 90.33 g and Bahia grass (*Paspalum notatum*) 89.67 g, whereas minimum fresh clipping yield (38.00 g) was noticed in Bargusto (*Cynodon dactylon*) which was at par with Manila (*Zoysia matrella)*40.67 g, Palma (*Cynodon dactylon)* 41.33 g, Panama (*Cynodondactylon*) 42.67 g, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 64.00 g and Selection-1 (*Cynodon dactylon*) 66.67 g.

During the month of April 2021, the maximum fresh clipping yield (230.19 g) was found in Selection-1 (*Cynodon dactylon*) and it was statistically superior to rest of the turf grass, whereas minimum fresh clipping yield (90.89 g) was noticed in Bargusto (*Cynodon dactylon*) which was at par with Manila (*Zoysia matrella)* 95.33 g, Palma (*Cynodon dactylon)* 107.14 g, Panama (*Cynodondactylon)* 107.20 g, Bahia grass (*Paspalum notatum*) 107.82 g, Tanu variant 113.13 g, Local (*Cynodon dactylon)* 120.93 g, Centipede grass (*Eremochloa ophiuroides)* 130.52 g, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 136.57 g, Maxican grass (*Nassella tenuissima)* 143.97 g, and Bahia grass (*Paspalum notatum*) 112.82 g

During the month of May 2021 the maximum fresh clipping yield (226.34 g) was found in Selection-1 (*Cynodon dactylon*) whereas minimum fresh clipping yield (91.26 g) was noticed in Bargusto (*Cynodon dactylon*) which was at par with Manila (*Zoysia matrella)* 98.97 g, Tanu varient 102.30 g, Palma (*Cynodon dactylon)* 102.34 g, Panama (*Cynodondactylon)* 108.43 g, Local (*Cynodon dactylon)* 118.57 g, Centipede grass (*Eremochloa ophiuroides)* 126.60 g, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 129.90 g and Maxican grass (Nassella *tenuissima)* 131.16 g.

Maximum average fresh clipping yield (137.96 g/m^2) was noticed in Selection-1 (*Cynodon dactylon*) during experimental period and minimum average fresh clipping yield (62.50 g/m^2) was noticed in Bargusto (*Cynodon dactylon*) .

Table4.9 Fresh clipping yield (g/m^2)

Fresh clipping yield (g/m^2)							
Genotypes	**Year**						**Average data**
	2020	**2020-2021**					
	December	**January**	**February**	**March**	**April**	**May**	
G1-Palma (*Cynodon dactylon* L.)	163.10	104.67	48.00	41.33	107.14	102.34	94.43
G2 -Local (*Cynodon dactylon* L.)	90.57	79.67	86.33	95.67	120.93	118.57	98.62
G3- Panama (*Cynodon dactylon* L.)	74.23	95.00	49.00	42.67	107.20	108.43	79.42
G4- Manila (*Zoysia matrella* (L.) Merr. Philipp	81.17	81.33	61.00	40.67	95.33	98.97	76.41
G5-Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*)	92.77	85.00	67.67	64.00	136.57	129.90	95.98
G6-Maxican grass (*Nassella tenuissima)*	110.53	104.00	82.67	66.67	162.39	131.16	109.57
G7-Selection-1 (*Cynodon dactylon* L.)	97.60	94.67	70.67	108.33	230.19	226.34	137.96
G8-Tanu varient	131.07	90.00	70.00	100.67	113.13	102.30	101.19
G9-Bargusto (*Cynodon dactylon* L.)	66.57	53.33	35.00	38.00	90.89	91.26	62.50
G10-Crow foot grass *(Dactyloctenium aegyptium)*	150.77	113.33	108.33	90.33	143.97	166.45	128.86
G11-Bahia grass (*Paspalum notatum*)	124.77	99.67	58.67	89.67	107.82	112.82	98.90
G12-Centipede grass (*Eremochloao phiuroides* [Munro] Hack)	147.07	86.00	98.67	103.00	130.52	126.60	115.31
S. Em. (±)	**14.73**	**10.82**	**9.70**	**10.30**	**21.25**	**20.85**	
C D (5%)	**43.21**	**31.71**	**28.46**	**30.21**	**62.33**	**61.16**	

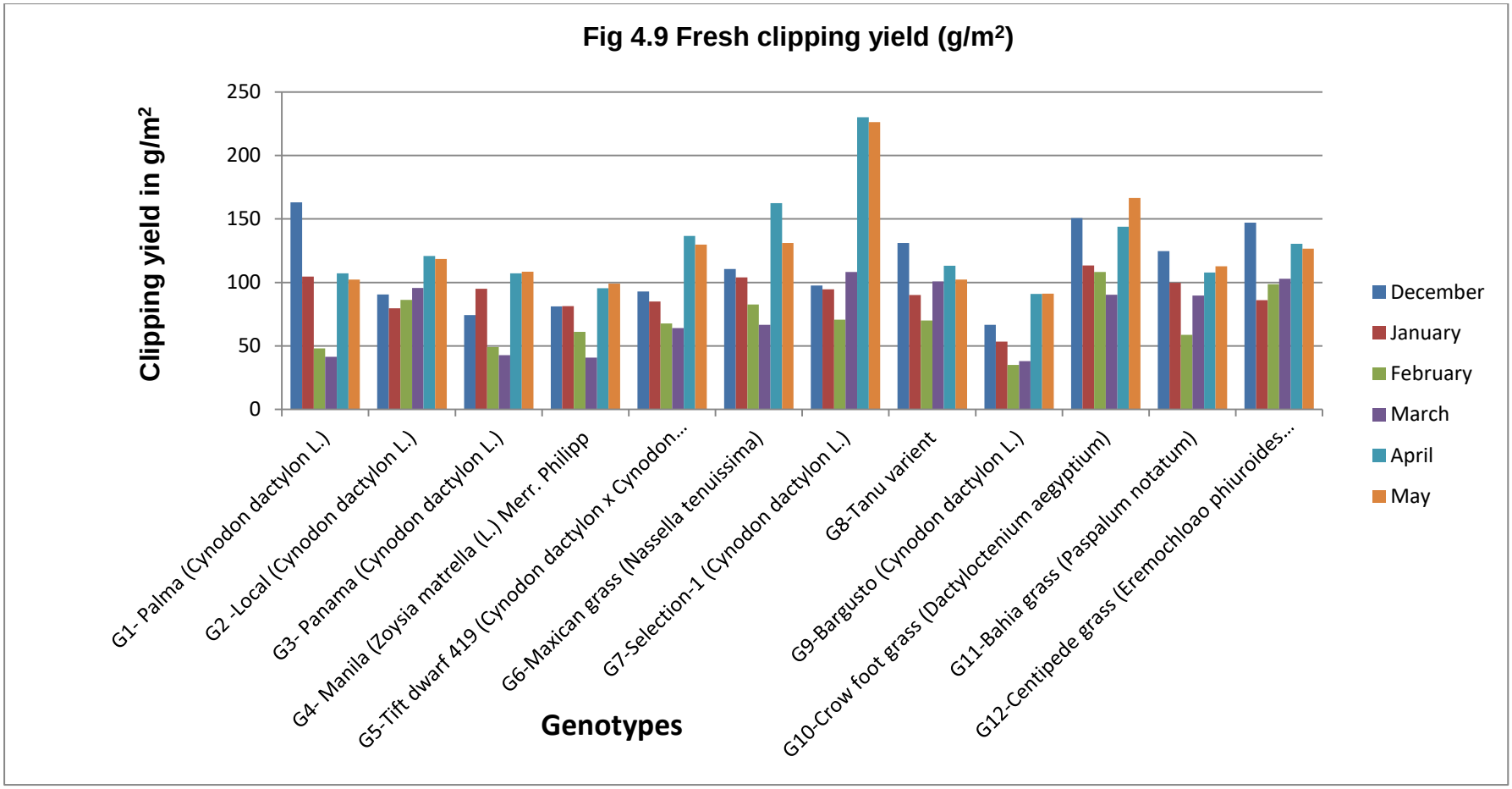


Fig 4.9 Fresh clipping yield (g/m²)
Clipping yield in g/m²
250
200
150
100
50
0
G1- Palma (Cynodon dactylon L.)
G2 -Local (Cynodon dactylon L.)
G3- Panama (Cynodon dactylon L.)
G4- Manila (Zoysia matrella (L.) Merr. Philipp
G5-Tift dwarf 419 (Cynodon dactylon x Cynodon...
G6-Maxican grass (Nassella tenuissima)
G7-Selection-1 (Cynodon dactylon L.)
G8-Tanu varient
G9-Bargusto (Cynodon dactylon L.)
G10-Crow foot grass (Dactyloctenium aegyptium)
G11-Bahia grass (Paspalum notatum)
G12-Centipede grass (Eremochloao phiuroides...
Genotypes
December
January
February
March
April
May

4.1.10 Dry clipping yield (g/m^2)

The data related to fresh clipping yield have been presented in table 4.10 and illustrated in Fig 4.10

It is evident from the table 4.10 that dry clipping yield was significantly influenced by different turf grasses in all month.

During the month of December 2020, the maximum dry clipping yield (53.43 g) was found in Palma (*Cynodon dactylon)*, which was at par with Centipede grass (*Eremochloa ophiuroides)* 49.80 g, Crow foot grass (*Dactyloctenium aegyptium)* 47.67 g, Tanu varient 43.27 g, Bahia grass (*Paspalum notatum*) 38.37 g and Maxican grass (*Nassella tenuissima)* 36.10 g. Whereas minimum dry clipping yield (20.80 g) was noticed in Panama (*Cynodondactylon*), which was at par with Local (*Cynodon dactylon)* 27.97 g, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 29.23 g Manila (*Zoysia matrella)* 31.40 g and Selection-1 (*Cynodon dactylon*) 31.57 g,

During the month of January 2021, the maximum dry clipping yield (40.67 g) was found in Crow foot grass (*Dactyloctenium aegyptium)*which was at par with Bahia grass (*Paspalum notatum*) 39.00 g, Palma (*Cynodon dactylon)* 36.33 g, Maxican grass (*Nassella tenuissima)* 35.00 g, Panama (*Cynodondactylon*) 34.00 g and Centipede grass (*Eremochloa ophiuroides)* 30.67 g. Whereas minimum dry clipping yield (17.33 g) was noticed in Bargusto (*Cynodon dactylon*), which was at par with Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 23.33 g, Local (*Cynodon dactylon)* and Selection-1 (*Cynodon dactylon*) 24.67 g, Manila (*Zoysia matrella)*26.00 g and Tanu variant 27.33 g.

During the month of February 2021, maximum dry clipping yield (42.00 g) found in,Crow foot grass (*Dactyloctenium aegyptium)*which was at par with Crow foot grass (*Dactyloctenium aegyptium)* 37.00 g whereas minimum dry clipping yield (12.00 g) noticed in Bargusto (*Cynodon dactylon*), followed by Panama (*Cynodondactylon*) 15.00 g, Palma (*Cynodon dactylon)* 16.67 g, Manila (*Zoysia matrella)* 19.00 g, and Bahia grass (*Paspalum notatum*) 20.67 g.

During the month of March 2021, the maximum dry clipping yield (37.33 g) was found in Selection-1 (*Cynodon dactylon*) which was at par with Local (*Cynodon dactylon)* 36.33 g, Centipede grass (*Eremochloa ophiuroides)* 34.67 g, Tanu varient 32.33 g, Crow foot grass (*Dactyloctenium aegyptium)* 30.67 g, Bahia grass (*Paspalum notatum*) 30.33 g, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) and Maxican grass (*Nassella tenuissima)* 25.67 g. Whereas minimum dry clipping yield (10.33 g) was notice in Bargusto (*Cynodon dactylon*) which was at par with Palma (*Cynodon dactylon)* 12.67 g, Panama (*Cynodondactylon*) 13.00 g, and Manila (*Zoysia matrella)* 15.33 g.

During the month of April 2021, the maximum dry clipping yield (77.08 g) was found inSelection-1 (*Cynodon dactylon*). Whereas minimum dry clipping yield (28.00 g) was noticed in Bargusto (*Cynodon dactylon*) which was at par with Manila (*Zoysia matrella)* 31.67 g, Palma (*Cynodon dactylon*) 34.59 g, Panama (*Cynodondactylon*) 35.67 g, Bahia grass (*Paspalum notatum*) 37.10 g,Tanu varient 37.73 g, Local (*Cynodon dactylon)* 39.80 g, Centipede grass (*Eremochloa ophiuroides)* 43.17 g, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 44.37 g and Crow foot grass (*Dactyloctenium aegyptium)* 47.80 g.

During the month of May 2021, the maximum dry clipping yield (80.03 g) was found in,Selection-1 (*Cynodon dactylon*) and the minimum dry clipping yield (30.87 g) was noticed in Bargusto (*Cynodon dactylon*) which was at par with Manila (*Zoysia matrella)* 32.63 g, Palma (*Cynodon dactylon*) 34.50 g, Tanu varient 35.13 g, Panama (*Cynodondactylon*) 35.90 g, Bahia grass (*Paspalum notatum*) 37.37 g, Local (*Cynodon dactylon)* 40.83 g, Centipede grass (*Eremochloa ophiuroides)* 41.73 g, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) 43.43 g. and Crow foot grass (*Dactyloctenium aegyptium)* 47.57 g.

Maximum average dry clipping yield (45.33 g/m^2) was noticed in Selection-1 (*Cynodon dactylon*) during experimental period and minimum average dry clipping yield (22 .14 g/m^2) was found in Bargusto (*Cynodon dactylon*).

Table4.10 Dry clipping yield (g/m^2)

Dry clipping yield (g/m^2)							
Genotypes	**Year**						**Average Data**
	2020	**2020-2021**					
	December	**January**	**February**	**March**	**April**	**May**	
G2 -Palma (*Cynodon dactylon* L.)	53.83	36.33	16.67	12.67	35.59	34.50	31.59
G2 -Local (*Cynodon dactylon* L.)	27.97	24.67	26.67	36.33	39.80	40.83	32.71
G3- Panama (*Cynodon dactylon* L.)	20.80	34.00	15.00	13.00	35.67	35.90	25.72
G4- Manila (*Zoysiamatrella* (L.) Merr. Philipp	31.40	26.00	19.00	15.33	31.67	32.63	26.00
G5-Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*)	29.23	23.33	23.67	25.67	44.37	43.43	31.61
G6-Maxican grass (*Nassella tenuissima)*	36.10	35.00	33.33	25.67	54.97	52.80	39.64
G7-Selection-1 (*Cynodon dactylon* L.)	31.57	24.67	21.33	37.33	77.08	80.03	45.33
G8-Tanu variant	43.27	27.33	25.33	32.33	37.73	35.13	33.52
G9-Bargusto (*Cynodon dactylon* L.)	34.33	17.33	12.00	10.33	28.00	30.87	22.14
G10-Crow foot grass *(Dactyloctenium aegyptium)*	47.67	40.67	37.00	30.67	47.80	47.57	41.89
G11-Bahia grass (*Paspalum notatum*)	38.37	39.00	20.67	30.33	37.10	37.37	33.80
G12-Centipede grass (*Eremochloao phiuroides* [Munro] Hack)	49.80	30.67	42.00	34.67	43.17	41.73	40.34
S. Em. (±)	**6.13**	**3.74**	**2.97**	**4.15**	**7.20**	**6.85**	
C D (5%)	**17.98**	**10.96**	**8.71**	**12.17**	**21.11**	**20.09**	

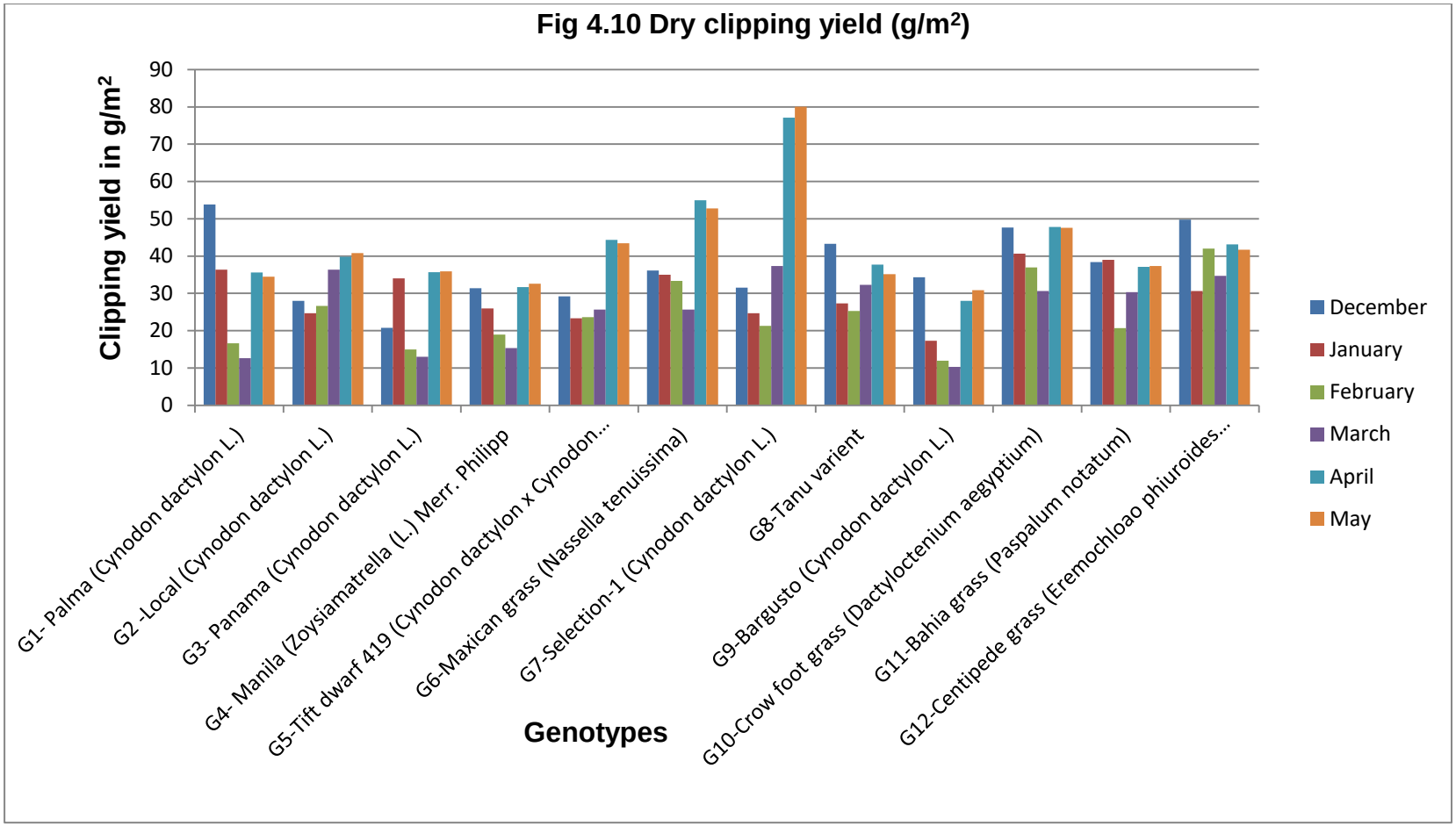


Fig 4.10 Dry clipping yield (g/m²)
Clipping yield in g/m²
90
80
70
60
50
40
30
20
10
0
G1- Palma (Cynodon dactylon L.)
G2 -Local (Cynodon dactylon L.)
G3- Panama (Cynodon dactylon L.)
G4- Manila (Zoysiamatrella (L.) Merr. Philipp
G5-Tift dwarf 419 (Cynodon dactylon x Cynodon...
G6-Maxican grass (Nassella tenuissima)
G7-Selection-1 (Cynodon dactylon L.)
G8-Tanu varient
G9-Bargusto (Cynodon dactylon L.)
G10-Crow foot grass (Dactyloctenium aegyptium)
G11-Bahia grass (Paspalum notatum)
G12-Centipede grass (Eremochloao phiuroides...
Genotypes
December
January
February
March
April
May

4.2.2. Qualitative Parameters

The data regarding different qualitative traits that were studied includegrowth habit and turf quality rating (1-9)

4.2.1. Growth habit

Growth habit of different turf grass on the basis of angle formed between tillrer and stolon is presented in table 4.11

Centipede grass (*Eremochloa ophiuroides),* Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis)* and Local (*Cynodon dactylon)* displayed prostrate growth while other grass Selection-1 (*Cynodon dactylon),*Panama (*Cynodondactylon*), Manila (*Zoysia matrella)*, Bahia grass (*Paspalum notatum*) and Maxican grass (*Nassella tenuissima)* showed semi prostrate growth habit and Bargusto (*Cynodon dactylon*), Palma (*Cynodon dactylon)*, Tanu varient Crow foot grass (*Dactyloctenium aegyptium),*showed upright growth habit .

Table 4.11 Growth habit

Genotypes	Growth habit
G1 –Palma (*Cynodon dactylon* L.)	Upright
G2 -Local (*Cynodon dactylon* L.)	Prostrate
G3- Panama (*Cynodon dactylon* L.)	Semi prostrate
G4- Manila (*Zoysia matrella* (L.) Merr. Philipp	Semi prostrate
G5-Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*)	Prostrate
G6-Maxican grass (*Nassella tenuissima)*	Semi prostrate
G7-Selection-1 (*Cynodon dactylon* L.)	Semi prostrate
G8-Tanu varient	Upright
G9-Bargusto (*Cynodon dactylon* L.)	Upright
G10-Crow foot grass *(Dactyloctenium aegyptium)*	Upright
G11-Bahia grass (*Paspalum notatum*)	Semi prostrate
G12-Centipede grass (*Eremochloao phiuroides* [Munro] Hack)	Prostrate

Plate 3:- A view of Growth habit

Prostrate growth – Tift dwarf 419, Centipede grass, Local.

Semi prostrate growth – Selection-1, Panama, Manila, Bahia, Maxican

Upright Growth –Bargusto, Palma, Tanu varient, Crow foot grass

4.2.2. Turf quality rating (1-9)

The data related to turf quality rating (1-9) have been presented in table 4.12 and illustrated in Fig 4.12

It is evident from the table 4.12 that turf quality rating was significantly influenced by different turf grasses in all month.

During the month of December 2020, the maximum turf quality rating (6.40) wasfound in Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis)* which was at par with Crow foot grass (*Dactyloctenium aegyptium)* and Maxican grass (*Nassella tenuissima)* 5.73, Bahia grass (*Paspalum notatum*) 5.33, Centipede grass (*Eremochloa ophiuroides)* (5.20) and the minimum turf quality (3.93) was noticed in Manila (*Zoysia matrella)*which was at par with Tanu varient 4.13, Local (*Cynodon dactylon)* (4.47), Panama (*Cynodon dactylon)* 4.73 and Palma (*Cynodon dactylon)* 4.93.

During the month of January 2021, the maximum turf quality rating (6.53) was found in Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis)* and Selection-1 (*Cynodon dactylon)*, which was at par with Crow foot grass (*Dactyloctenium aegyptium)* 6.17, Bargusto (*Cynodon dactylon*) 5.87 and Bahia grass (*Paspalum notatum*) 5.60, and the minimum turf quality rating (4.27) was found in Maxican grass (*Nassella tenuissima)* which was at par with Panama (*Cynodondactylon*) 4.40, Manila (*Zoysia matrella)* 4.47 and Local (*Cynodon dactylon)* 4.60.

During the month of February 2021, the maximum turf quality rating (6.27) was found in Crow foot grass (*Dactyloctenium aegyptium)* which was at par with Tanu variant 5.80,Panama (*Cynodon dactylon)* 5.80, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis)* 5.73, Centipede grass (*Eremochloa ophiuroides)* 5.67.While minimum turf quality (3.87) was noticed in Manila (*Zoysia matrella)*, which was at par with Bargusto (*Cynodon dactylon*) 4.53, Bahia grass (*Paspalum notatum*) 4.60

During the month of March 2021, the maximum turf quality rating (6.00) was found in Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis)* which was at par with Crow foot grass (*Dactyloctenium aegyptium)*5.80,Centipede grass (*Eremochloa ophiuroides)* 5.67 and Panama

(*Cynodon dactylon)* 5.40.While minimum turf quality (4.73) was noticed in Bargusto (*Cynodon dactylon*) which was at par with Local (*Cynodon dactylon)* 4.67, Bahia grass (*Paspalum notatum*) and Palma (*Cynodon dactylon)* (4.80).

During the month of April 2021, the maximum turf quality rating (6.20) was found in Crow foot grass (*Dactyloctenium aegyptium)* which was at par with Maxican grass (*Nassella tenuissima)* 6.07, Palma (*Cynodon dactylon)* 5.87 and Local (*Cynodon dactylon)* 5.53.While minimum turf quality (4.27) was noticed in Panama (*Cynodon dactylon)* which was at par with Manila (*Zoysia matrella)* 4.40 and Bargusto (*Cynodon dactylon*) 5.13

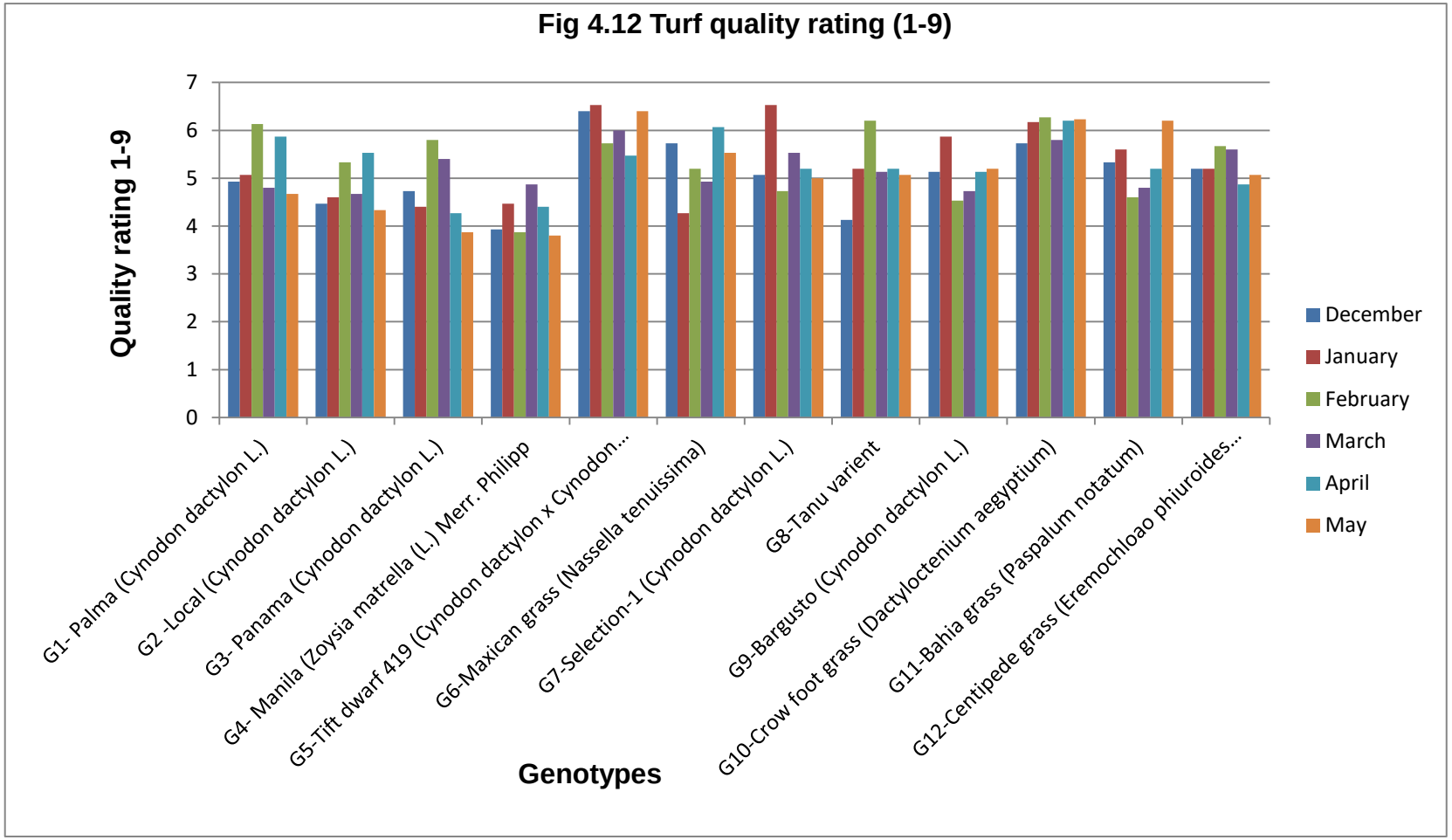
During the month of May 2021, the maximum turf quality rating (6.23) was found inTift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis)* which was at par with Crow foot grass (*Dactyloctenium aegyptium)* 6.23, Bahia grass (*Paspalum notatum*) 6.20 and Maxican grass (*Nassella tenuissima)* 5.53.While minimum turf quality (3.80) was noticed in Manila (*Zoysia matrella)* which was at par with Local (*Cynodon dactylon*) 4.33, Palma (*Cynodon dactylon*) 4.67 and Selection-1(*Cynodon dactylon*) 5.00

During the entire period of experimentation, genotype that showed the average of quality rating was Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis)*which was followed by Crow foot grass (*Dactyloctenium aegyptium)* and Centipede grass (*Eremochloa ophiuroides)*, whereas showed the lowest of quality rating was found in Manila (*Zoysia matrella*) which was followed Panama (*Cynodon dactylon*)

Table4.12 Turf quality rating (1-9)

Turf quality rating (1-9)							
Genotypes	**Year**						
	2020	**2020-2021**					**Average data**
	December	**January**	**February**	**March**	**April**	**May**	
G1 –Palma (*Cynodon dactylon* L.)	4.93	5.07	6.13	4.80	5.87	4.67	5.24
G2 -Local (*Cynodon dactylon* L.)	4.47	4.60	5.33	4.67	5.53	4.33	4.82
G3- Panama (*Cynodon dactylon* L.)	4.73	4.40	5.80	5.40	4.27	3.87	4.74
G4- Manila (*Zoysia matrella* (L.) Merr. Philipp	3.93	4.47	3.87	4.87	4.40	3.80	4.22
G5-Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*)	6.40	6.53	5.73	6.00	5.47	6.40	6.08
G6-Maxican grass (*Nassella tenuissima)*	5.73	4.27	5.20	4.93	6.07	5.53	5.28
G7-Selection-1 (*Cynodon dactylon* L.)	5.07	6.53	4.73	5.53	5.20	5.00	5.34
G8-Tanu varient	4.13	5.20	6.20	5.13	5.20	5.07	5.15
G9-Bargusto (*Cynodon dactylon* L.)	5.13	5.87	4.53	4.73	5.13	5.20	5.09
G10-Crow foot grass *(Dactyloctenium aegyptium)*	5.73	6.17	6.27	5.80	6.20	6.23	6.06
G11-Bahia grass (*Paspalum notatum*)	5.33	5.60	4.60	4.80	5.20	6.20	5.28
G12-Centipede grass (*Eremochloao phiuroides* [Munro] Hack)	5.20	5.20	5.67	5.60	4.87	5.07	5.26
S.Em. (±)	**0.21**	**0.42**	**0.15**	**0.30**	**0.33**	**0.22**	
CD (5%)	**0.60**	**1.24**	**0.45**	**0.87**	**0.98**	**0.64**	

Fig 4.12 Turf quality rating (1-9)



CAPTER –V

DISCUSSION

In this chapter an attempt has been made to evaluate the possible reasons of the variability obtained due to treatment differences in the present investigation entitled **"Evaluation of turf grasses for various qualitative and quantitative traits under Malwa Plateau of Madhya Pradesh"**The findings described in the preceding chapter have been critically discussed here indetail.

The results of the present investigation are discussed with proper reasoning in the light of available literature

The quality criteria may vary depending on the type of turf grass, the purpose for which it will be used and the person assessing it.

5.1 Quantitative parameters

5.1.1 Root depth (cm)

Turf grasses absorb water primarily through their root system and turfgrass species differ in their rooting abilities. Some species have a deep root system, while others have a shallow root system. Warm season turf grasses generally produce deep root system (Turgeon, 1980). Grasslands with deeper and denser roots can consume more nutrients and water, which increases productivity and reduces nutrient losses. The selection of specific species and varieties of grasses could be an effective management tool to enhance rooting depth and density (Agnihotri, R. 2017)**.**

Findings from result suggest that Maxican grass (*Nassella tenuissima)* had deepest roots followed by Tanu varient, Selection-1 (*Cynodon dactylon)*. While Bahia grass (*Paspalum notatum*) displayed shallowest root depth followed by Bargusto (*Cynodon dactylon* L.), Centipede grass (*Eremochloa ophiuroides)* and Panama (*Cynodon dactylon* L).

Although the rooting depth of each type of grass is genetically controlled and environmental factors significantly influence it (Weicko, 2006).

Rooting characteristics of lawn grasses have a significant impact on their response to abiotic stresses, and this is supported by many previous reports (Turgeon, 2008 and Wadekar *et al*. 2018).

Genetic variation is the main reason for significant differences in root depth between different species or varieties of grass (Bonos *et al*. 2004 and Crush *et al*. 2007).

5.1.2. Shoot density (25 cm^2)

Density is a measure of number of aerial shoots per unit area. It can vary with genotypic, natural environmental and cultural factors. High density (dense) is a requirement for density because the main function of the grass is to cover the soil. In field sports, high density is needed not only to cover the ground, but also to form a cushion to reduce player injuries and also to provide a smooth playing field (Agnihotri, R. 2017).

Most shoot dense turf among the tested genotypes was reported in Crow foot grass *(Dactyloctenium aegyptium)* which was followed by Bahia grass (*Paspalum notatum*) and Centipede grass (*Eremochloao phiuroides),* Selection-1 (*Cynodon dactylon* L.) and lowest shoot density was found in Manila grass (*Zoysia matrella* L.)

The differences among the genotype regarding shoot density may be distributed to genetic makeup of individual and environment. These results are confirmed by Turgeon (2008), Janakiram and Namita (2014) and Agnihotri *et al* (2017).

5.1.3 Leaf width (mm)

Leaf width is a parameter for measuring of turf grass texture. This is primarily a genetically controlled parameter, but in a stresses condition, leaf size may indicate adaptation. Narrow leaves allow for fine textured grass cover. For uniformity and smoothness, it is necessary that the grass shoots have the same shape, size and orientation. The latter serve not only for aesthetic reasons, but also to increase the stiffness and strength of the grass in order to withstand compaction or support golf balls (Turgeon, 2008).

Shortest leaf width was shown by Bargusto (*Cynodon dactylon* L.), followed by Bahia grass (*Paspalum notatum*) and Crow foot grass *(Dactyloctenium aegyptium)*, while widest leaf was found in Panama (*Cynodon dactylon* L.) followed by Local (*Cynodon dactylon* L.) and Palma (*Cynodon dactylon* L.).

Genetic variation is the main reason for significant differences in leaf width between different genotype.

These results are confirmed by with the finding of Marchione (2004).

5.1.4 Leaf chlorophyll content (SPAD value)

The chlorophyll content represents the intensity of the green colour and is a quantitative quality indicator. The role of chlorophyll in providing energy for plant metabolism has long been established. However, there is very little information on the comparative seasonal fluctuations of this biochemical component in grasses. The leaf chlorophyll content was positively correlated with visual turf rating (Madison and Anderson, 1963).

Highest leaf chlorophyll content was noticed in Tiftdwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) followed by Crow foot grass *(Dactyloctenium aegyptium),* whereas lowest leaf chlorophyll content noticed in Local (*Cynodon dactylon* L.) followed by Manila (*Zoysia matrella* L. Merr. Philipp) and Panama (*Cynodon dactylon* L.)

The chlorophyll content is influenced by the genetic characteristics of the species, by the conditions of environmental stress (Viggiani *et al*. 2015; Leto *et al*. 2008 and Bierman *et al*. 2004).

Malik *et al*. (2014) noticed that chlorophyll content (a / b) is different for all cultivars in all growing seasons, with the best indicators *for C.dactylon L. × C. transvaalensis* "Tifdwarf" for maximum chlorophyll content.

5.1.5 Canopy height (cm)

Canopy height measures the vertical growth of the turf. Golf greens are very closely mowed turfs or which are very low growing. Different grass

genotypes have different predetermined heights on which they display best of their visual characteristics. In this experiment for uniformity in application of management practices, all of them were mowed at one height

In all months, Bargusto (*Cynodon dactylon* L.) recorded lowest cumulative canopy height and it was followed by Tiftdwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*), Palma (*Cynodon dactylon* L.), Maxican grass (*Nassella tenuissima).* While highest canopy height was found in Local (*Cynodon dactylon* L.). The difference between genotypes can be explained by their genetic constitution.

The difference in canopy height was attributed to the habit of growing genotypes, as confirmed by Viggiani *et al*. (2015). A similar behavior was found by Ubendra *et al.* (2015) that the strong influence of precipitation contributed to the highest values of the parameters associated with growth.

Harivandi *et al*. (1984) also noted that within the same genus, grasses of a certain type may differ slightly from each other. The exact position of the turf grass in the canopy height list may change as you learn more about it or create improved varieties.

5.1.6 Leaf length (cm)

Smaller leaf length is a desired character as it contributes to finer texture and better visual attributes.

Longer leaf length among the tested genotypes was found in Panama (*Cynodon dactylon* L.) followed by Local (*Cynodon dactylon* L.) and Crow foot grass *(Dactyloctenium aegyptium*). While shorter leaf length was noticed in Bargusto (*Cynodon dactylon* L.). This difference may be due to the fact that different genotype performance is depend upon their genetics and environment.

These results are in line with findings of Atkins *et al*. (1991), Malik *et al*. (2014), Wadekar *et al* (2018)

5.1.7 Stolon internodal length (cm)

Shorter stolon internodal length is required as they produce denser turf thus better visual quality

Panama (*Cynodon dactylon* L.) noticed maximum stolon internodal length followed by Local (*Cynodon dactylon* L.), Palma (*Cynodon dactylon* L.) and Centipede grass (*Eremochloao phiuroides* [Munro] Hack). Whereas minimum stolon internodal length was noticed in Bargusto (*Cynodon dactylon* L.) followed by Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*), Tanu varient and Selection-1 (*Cynodon dactylon* L.).

The differences among genotype regarding stolon internodal length may be due to their genetic constitution and environment.

Leto *et al*. (2008) evaluated the bioagronomic parameters of 40 *Cynodon* biotypes and found significant differences among them in relation to the length of the stolon internodes.These result are in line with the finding of Agnihotri *et al* (2017).

5.1.8 Stolon internodal diameter (mm)

Smaller stolon internodal diameter is better for the turf quality.

Minimum stolon internodal diameter was found inBahia grass (*Paspalum notatum*) follwed by Bargusto (*Cynodon dactylon* L.), Tanu varient and Local (*Cynodon dactylon* L). While Centipede grass (*Eremochloao phiuroides* [Munro] Hack) was reported maximum stolon internodal diameter.

Leto *et al.* (2008) and Agnihotri *et al.* (2017) also reported the variantion of internodal diameter of the stolon, mainly as a genetic trait that varies considerably even within the same species.

5.1.9 Fresh and dry clipping yield

The higher clipping performance, the better variety suitable for areas with high maintenance requirements, such as green and sports fields, while grass with high density and low total yield of fresh and dry grass is suitable for areas with low maintenance, such as lawns, parks, public spaces, and soil conservation

Every time higher fresh and dry clipping yield along with average yields is found in Selection-1 (*Cynodon dactylon* L.) and lowest clipping yield was noted in Bargusto (*Cynodon dactylon* L*)* followed by Manila (*Zoysia matrella* (L.) Merr. Philipp).

Springer *et al.* (2014) also noted an excellent response of savanna grass in terms of fresh and dry biomass accumulation and correlated it with better physiological and morphological adaptations as it produced comparatively more stolons, which increased shearing efficiency.

The results for fresh and dry weights are consistent with those of Xu and Huang (2000), Sweeney *et al.* (2001), Baldwin *et al*. (2006) and Jankiram and Namita (2014).

5.2 Qualitative parameters

Evaluation can start in any direction, but visual qualities are usually achieved first, as they do not require extensive study. Common observed qualities are density, color, growth pattern, texture, uniformity and smoothness (Turgeon, 2008; Romani *et al*., 2004 and Leto *et al*., 2004).

Turgeon (2008) and Emmons (2000) have outlined the requirements of turfgrass visual qualities.

5.2.1 Growth habit

A prostate growth habit for the turf grasses is desirable because the prostate grass can be maintained at a lower mowing height and further more the grass can spread faster because mature shoots are in contact with the ground and therefore knots can easily take root. (Gobilik *et al*. 2013).

Centipede grass (*Eremochloa ophiuroides),* Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis)* and Local (*Cynodon dactylon)* displayed prostrate growth, while other grass Selection-1 (*Cynodon dactylon),*Panama (*Cynodondactylon*), Manila (*Zoysia matrella)*, Bahia grass (*Paspalum notatum*) and Maxican grass (*Nassella tenuissima)* showed semi prostrate growth habit and Bargusto (*Cynodon dactylon*), Palma (*Cynodon dactylon)*,

Tanu varient Crow foot grass (*Dactyloctenium aegyptium),*showed upright growth habit.

Kenworthy *et al*. (2007) reported that shooting angle measurements do have the potential to quantify differences in prostrate / upright growth habits between African Bermuda, Common Bermuda, and Tif way hybrid grass genotypes. In addition, shooting angle measurements have made it possible to identify and exclude those genotypes that are more easily influenced by changing environmental conditions.

5.2.2. Turf rating (1-9)

All turf quality assessments were done visually. Steps have been taken to ensure consistent and accurate assessments. The following performance criteria were used to evaluate the varieties and types of lawn grasses. This method was provided by the Pennsylvania National Lawn Assessment Program (Morris and Sherman, 2000).

During the entire period of experimentation, genotype that showed the average of quality rating was Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis)*which was followed by Crow foot grass (*Dactyloctenium aegyptium)* and Centipede grass (*Eremochloa ophiuroides)*, whereas showed the lowest of quality rating was found in Manila (*Zoysia matrella*) which was followed Panama (*Cynodon dactylon*).

Malik *et al.* (2014) also reported that the quality characteristics of the grass sod changed during the growing season

CHAPTER VI

SUMMARY, CONCLUSION AND SUGGESTING FOR FURTHER WORK

6.1 Summary:

The present investigation entitled "**Evaluation of turf grasses for various qualitative and quantitative traits under Malwa Plateau of Madhya Pradesh**" was conducted during the period from December 2020 to May 2021 at the Department of Floriculture and Landscape Architecture, K.N.K. College of Horticulture, Mandsaur, Rajmata Vijyaraje Scindia Krishi Vishwa Vidyalaya Gwalior (M.P.)

Twelve turf grass genotypes *viz.* Palma (*Cynodon dactylon* L.) Local (*Cynodon dactylon* L.), Panama (*Cynodon dactylon* L.), Manila (*Zoysia matrella* L. Merr. Philip) Tiftdwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*), Maxican grass (*Nassella tenuissima),* Selection-1 (*Cynodon dactylon* L.), Tanu variant, Bargusto (*Cynodon dactylon* L.), Crow foot grass *(Dactyloctenium aegyptium),* Bahia grass (*Paspalum notatum*) and Centipede grass (*Eremochloao p hiuroides* [Munro] Hack) were taken under three replication for the study.

6.1.1 Quantitative Parameters

Maxican grass (*Nassella tenuissima)* was recorded maximum root depth followed by Tanu varient. However minimum root depth was noticed in Bahia grass (*Paspalum notatum)* followed by Bargusto (*Cynodon dactylon* L.).

Manila grass (*Zoysia matrella* L. Merr. Philipp) registerded minimum density of shoot and maximum shoot density was found in Crow foot grass *(Dactyloctenium aegyptium)* followed by Bahia grass (*Paspalum notatum*).

Bargusto (*Cynodon dactylon* L.) registered minimum leaf width followed by Bahia grass (*Paspalum notatum*) whereas maximum leaf width was noticed in Panama (*Cynodon dactylon* L.).

Maximum leaf chlorophyll content (SPAD Value) was recorded in Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis)* followed by Crow foot grass *(Dactyloctenium aegyptium)* and the minimum leaf chlorophyll content (SPAD Value) found was in Local (*Cynodon dactylon* L.).

Maximum canopy height, was reported in Local (*Cynodon dactylon* L.) which was followed by Panama (*Cynodon dactylon* L.) and minimum canopy height was reported in Bargusto (*Cynodon dactylon* L.) which was followed by Centipede grass (*Eremochloao phiuroides* [Munro] Hack)

Smallest leaf length was found in Bargusto (*Cynodon dactylon* L.). While longest leaf length was found in Panama (*Cynodon dactylon* L.) followed by Local (*Cynodon dactylon* L.).

Minimum average stolon internodal length was recorded in Bargusto (*Cynodon dactylon* L.) followed by Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis*) and Panama (*Cynodon dactylon* L.) had maximum stolon internodal length.

Highest average stolon internodal diameter was noticed in Centipede grass (*Eremochloao phiuroides* [Munro] Hack) and lowest average internodal was noticed in Bahia grass (*Paspalum notatum*) followed by Bargusto (*Cynodon dactylon* L.).

Overall maximum fresh and dry clipping yield was noticed in Selection-1 (*Cynodon dactylon* L.) and minimum was found in Bargusto (*Cynodon dactylon* L.)

6. 2.1 Qualitative Parameters

Centipede grass (*Eremochloa ophiuroides),* Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis)* and Local (*Cynodon dactylon)* displayed prostrate growth while other grass Selection-1 (*Cynodon dactylon),*Panama (*Cynodondactylon*), Manila (*Zoysia matrella)*, Bahia grass (*Paspalum notatum*) and Maxican grass (*Nassella tenuissima)* showed semi prostrate growth habit and Bargusto (*Cynodon dactylon*), Palma (*Cynodon dactylon)*, Tanu varient Crow foot grass (*Dactyloctenium aegyptium),*showed upright growth habit.

Maximum turf quality rating was noticed in Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis)* followed byCrow foot grass (*Dactyloctenium aegyptium),* while minimum turf rating was found in Manila (*Zoysia matrella)*.

6.2 Conclusion:

In the present investigation, the different turf grasses showed the best results with respect of different parameters examined here.

Among the turf grasses, Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis)* followed byCrow foot grass (*Dactyloctenium aegyptium)* performed best in turf quality.Maximum leaf chlorophyll content (SPAD Value) was also recorded in Tift dwarf 419 (*Cynodon dactylon* x *Cynodon transvaalensis)*

The minimum leaf width, minimum canopy height, smallest leaf length, minimum average stolon internodal length, minimum fresh and dry clipping yield was found in Bargusto (*Cynodon dactylon* L.).

Maxican grass (*Nassella tenuissima)* was recorded maximum root depth, while maximum shoot density was found in Crow foot grass *(Dactyloctenium aegyptium)* followed by Bahia grass (*Paspalum notatum*).

Lowest average stolon internodal diameter was noticed in Bahia grass (*Paspalum notatum*).

On the basis of above finding it may be concluded that under Malwa Plateu of M.P. different turf grasses may be used for different purposes.

6.3 Suggesting for further work:

1. The study should be carried out separately on different varieties of the same genus or species, since comparing species with different growth characteristics is tedious.

2. The most effective turf grass can be studied visually in a variety of environmental conditions.

3. Further research should be carried out in different agro-climatic regions to determine the critical growing season in order to obtain the best lawn quality.

4. The lawn grasses performing well under Malwa Plateau of Madhya Pradesh may be evaluated again

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APPENDICES

Appendix- 1: Analysis of variance for the Root depth (cm)

Source of variation	D.F.	Mean sum of squares					
		Root depth (cm)					
		December (2020)	January (2021)	February (2021)	March (2021)	April (2021)	May (2021)
Replication	2	1.31	1.24	3.23	7.84	7.41	15.39
Treatment	11	19.34	17.95	18.19	18.40	18.53	18.21
Error	22	2.58	2.76	2.29	2.38	4.24	4.29
Total	35						

Appendix- 2: Analysis of variance for the Shoot density (25cm^2)

Source of variation	D.F.	Mean sum of squares					
		Shoot density (25cm^2)					
		December(2020)	January(2021)	February(2021)	March(2021)	April (2021)	May(2021)
Replication	2	27.68	3.02	54.22	4.88	16.90	16.91
Treatment	11	449.18	272.39	310.06	73.18	65.91	41.08
Error	22	14.88	29.06	18.66	30.06	21.20	5.16
Total	35						

Appendix- 3: Analysis of variance for the Leaf width (mm)

Source of variation	D.F.	Mean sum of squares					
		Leaf width (mm)					
		December(2020)	January(2021)	February(2021)	March(2021)	April (2021)	May(2021)
Replication	2	0.00	0.05	0.01	0.04	0.02	0.03
Treatment	11	0.07	0.12	0.09	0.02	0.05	0.03
Error	22	0.08	0.05	0.03	0.05	0.05	0.03
Total	35						

Appendix- 4: Analysis of variance for the Leaf chlorophyll content (SPAD value)

Source of variation	D.F.	Mean sum of squares					
		Leaf chlorophyll content (SPAD value)					
		December(2020)	January(2021)	February(2021)	March(2021)	April (2021)	May(2021)
Replication	2	1.09	2.37	17.70	32.32	10.17	0.93
Treatment	11	35.94	11.41	12.40	14.64	4.84	14.17
Error	22	2.41	4.22	2.17	17.29	3.81	3.26
Total	35						

Appendix- 5: Analysis of variance for the Canopy height (cm)

Source of variation	D.F.	Mean sum of squares					
		Canopy height (cm)					
		December(2020)	January(2021)	February(2021)	March(2021)	April (2021)	May(2021)
Replication	2	0.45	0.04	0.90	1.56	0.96	1.74
Treatment	11	2.84	1.37	0.83	4.78	3.82	0.35
Error	22	0.82	0.42	0.33	0.57	1.29	0.43
Total	35						

Appendix- 6: Analysis of variance for the Leaf length (cm)

Source of variation	D.F.	Mean sum of squares					
		Leaf length (cm)					
		December(2020)	January(2021)	February(2021)	March(2021)	April (2021)	May(2021)
Replication	2	0.51	0.31	0.28	1.03	0.83	0.21
Treatment	11	1.26	0.74	0.54	0.96	0.82	0.61
Error	22	0.17	0.35	0.31	0.18	0.40	0.28
Total	35						

Appendix- 7: Analysis of variance for the Stolon internodal length (cm)

Source of variation	D.F.	Mean sum of squares					
		Stolon internodal length (cm)					
		December(2020)	January(2021)	February(2021)	March(2021)	April (2021)	May(2021)
Replication	2	0.05	0.02	0.05	0.24	0.30	0.03
Treatment	11	0.08	0.08	0.12	0.42	0.15	0.10
Error	22	0.09	0.04	0.06	0.17	0.10	0.03
Total	35						

Appendix- 8: Analysis of variance for the Stolon internodal diameter (mm)

Source of variation	D.F.	Mean sum of squares					
		Stolon internodal diameter (mm)					
		December(2020)	January(2021)	February(2021)	March(2021)	April (2021)	May(2021)
Replication	2	0.01	0.01	0.01	0.03	0.00	0.01
Treatment	11	0.06	0.09	0.01	0.02	0.03	0.03
Error	22	0.02	0.02	0.01	0.02	0.01	0.02
Total	35						

Appendix- 9: Analysis of variance for theFresh clipping yield (g/ m^2)

Source of variation	D.F.	Mean sum of squares					
		Fresh clipping yield (g/ m^2)					
		December(2020)	January(2021)	February(2021)	March(2021)	April (2021)	May(2021)
Replication	2	1981.68	45.86	32.25	530.58	2045.56	2045.56
Treatment	11	3091.20	725.29	1386.12	2268.61	4347.97	4347.97
Error	22	651.14	350.95	282.46	318.31	1355.15	1355.15
Total	35						

Appendix- 10: Analysis of variance for the Dry clipping yield (g/ m^2)

Source of variation	D.F.	Mean sum of squares					
		Dry clipping yield (g/ m^2)					
		December(2020)	January(2021)	February(2021)	March(2021)	April (2021)	May(2021)
Replication	2	332.11	5.58	22.53	75.11	229.78	165.66
Treatment	11	293.26	153.04	247.99	297.91	506.78	535.90
Error	22	112.80	41.92	26.44	51.69	155.35	140.78
Total	35						

Appendix- 11: Analysis of variance for the Turf rating (1-9)

Source of variation	D.F.	Mean sum of squares					
		Turf rating (1-9)					
		December(2020)	January(2021)	February(2021)	March(2021)	April (2021)	May(2021)
Replication	2	0.21	0.42	0.15	0.30	0.33	0.27
Treatment	11	0.60	1.24	0.45	0.87	0.98	0.78
Error	22	7.02	13.73	5.01	9.94	10.95	9.01
Total	35						

VITA

The author of this thesis **Mr. Tarun Kumar** S/o Mr. Vijay Kumar was born on 19thAugust 1997 in Kawardha at Chhatisgarh. He passed High School from Govt. Higher Secondary School, Kotari Mungeli (C.G) and Higher Secondary School from Sarswati Shishu Mandir Higher Secondary School, Mungeli (C.G.).

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