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Comparing the effect of different irrigation regimes and recovery potential of Cynodon dactylon (L.) Pers. hybrid and Cenchrus clandestinus Hocsht ex Chiov. Moronne turf grasses, Johannesburg, South Africa

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Article

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Comparing the effect of different irrigation regimes and recovery potential of *Cynodon dactylon* (L.) Pers. hybrid and *Cenchrus clandestinus* Hocsht ex Chiov. Moronne turf grasses, Johannesburg, South Africa.

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ABSTRACT

South Africa is a water scares country and there is a general perception that turfgrass irrigation has a negative environmental impact on available water resources. The aim of this research project was to compare the yield and recovery period of two widely utilized turfgrass species in South Africa, *Cynodon dactylon* and *Cenchrus clandestinus* under different irrigation regimes in three different seasons. The yield for both turfgrass species was determined electronically by making use of a plate meter and manually by making use of the clip and weigh method. According to the plate meter readings the yield of both species was similar in all three seasons under the different irrigation regimes, whereas the clip and weigh method indicated that the yield of *Cenchrus clandestinus* was higher for all four irrigation regimes in all three seasons. An irrigation regime of 15 mm administered in two increments per week for an acceptable quality *Cenchrus cladestinus* lawn and an irrigation regime of 20 mm administered in two increments per week for an acceptable quality *Cynodon dactylon* lawn is recommended for homeowners in the Johannesburg region. Through photographical evidence it was determined that *Cenchrus clandestinus* recuperated quicker after the winter than *Cynodon dactylon.*

Keywords: Kikuyu, Bermuda grass, Couch grass, Irrigation, Autum, Spring, Summer.

INTRODUCTION

South Africa is classified as a semi-arid environment and a water stressed country. The growing population and development place the available and limited water resources under pressure resulting in water shortages (Jansen van Vuuren 1997; Hoy 2018). Although turfgrass is an important aspect of urban landscapes, there is a general conception that turfgrass irrigation and water use has a negative environmental impact (Lindsey et al. 2025). According to Bormann et al., (2001) and Simmons et al., (2011) turfgrasses constitute the largest irrigated crop in America, covering 16 million hectares of which 10 million hectares is residential lawn. Since water is a limited resource, it is emphasised that critical aspects concerning the selection and management of turfgrass irrigation (Trenholm et al. 2017) needs to be investigated. The possibilities of including and implementing turfgrass as part of a water-smart landscape must be explored (United States, Environmental Protection Agency 2025). Knowledge of turfgrass water requirements and drought resistance for different turfgrass species can assist in water conservation through the selection of appropriate species for specific climatic conditions (Jansen van Vuuren 1997; Colmer and Barton 2017) as turfgrass has various known environmental, economic and social benefits (Lindsey et al. 2025).

Approximately half the area of a typical residential landscape is covered in turfgrass grown on previously disturbed urban soils (Bigelow and Soldat 2013), whereas parks and recreational areas are covered almost entirely with turfgrass. Limaye (1996) indicates that turfgrass is a major component of amenity landscapes worldwide. Although amenity landscapes provide many benefits to society, it accounts for between 31% - 50% of water supplied for domestic and urban use (Hoy 2018) and if irrigated, it accounts for most of the domestic summer-water use in semi-arid and arid environments (Beard and Green 1994; Kjelgren et al. 2000).

Incorrect maintenance and overwatering or irrigation of lawns, sports fields, and golf courses cause water wastage, a scarce commodity in South Africa.

Turfgrass

Turfgrass is defined as a monocotyledon creeping grass type ground cover, composed of densely growing leaves, kept relatively short by continuous mowing (Sherratt 2011). Lawn turfgrasses are grown for their aesthetic appeal and provide moderate to high-quality turf that serves a decorative purpose in landscapes and can also act as mulch. Turfgrasses have been utilized by humans in the urban environment for centuries and the environmental benefits of turf grass in an urban environment have been documented through research for more than three decades (Beard and Green 1994; Braun et al. 2024; Lindsey et al. 2025). It is well known that turfgrass benefits include functional, recreational, and aesthetic benefits to urban living, which include providing cooling protective groundcover for human activities, erosion and dust control and mitigation of the urban heat island effect. Turfgrasses enhance the beauty and attractiveness of urban living areas (Beard and Green 1994; Kjelgren et al. 2000), improve mental health, social harmony, and work productivity, especially in densely populated urban areas. Turfgrass is also considered an essential component of private gardens, public landscapes and parks (Beard and Green 1994). Turfgrass as a land use has a positive impact on urban runoff water quality and has lower runoff and sediment loss than bare soil (Gross et al. 1990; Lindsey et al. 2025).

Statements have been made indicating that most turfgrasses and especially Kikuyu grass, are high water users (Jansen van Vuuren 1997) and the irrigation of turfgrass, typical in many urban areas does increase the demand for water resources (Serena et al. 2019). Additionally, some homeowners irrigate lawns throughout dormant periods as they incorrectly assume that turfgrasses must be kept green to survive (Beard and Green 1994), while others water them as they have a unique role in the aesthetics of the landscape (Monteiro 2017). The average homeowner is unaware of when and how much water is required to maintain turfgrass areas at an acceptable level (Serena et al. 2019).

RESEARCH JUSTIFICATION

The limited water resources in South Africa must be shared amongst the ever-expanding population, the growing business sector, and the large demanding agriculture industry. This study provides scientifically sound information on the irrigation requirements of two different turfgrasses used in residential home gardens for three seasons, spring, summer and autumn.

RESEARCH AIM AND OBJECTIVES

The study aimed to determine the irrigation quantity required to maintain an acceptable quality of couch grass (*Cynodon dactylon* (L.) Pers.) hybrid and Kikuyu (*Cenchrus clandestinus* Hocsht ex Chiov.) Moronne turfgrass in Johannesburg, Gauteng, South Africa.

The objectives of the study are:

- To determine how much water is needed (mm per week), against predefined application rates, to maintain an acceptable quality and yield of *Cynodon* and Kikuyu turfgrass as a residential lawn in an urban area.
- To determine the recovery period for the two different grass species after the dormant period under different irrigation regimes.

SIGNIFICANCE OF THE STUDY

The study provided scientifically proven information about the water use requirements related to the quality and yield of Kikuyu and *Cynodon* turfgrasses in South Africa under open field conditions. The results of this study will assist Rand Water (the official water supplier of the province) in developing educational campaigns and promotional material for their water conservation/water use campaigns to educate homeowners on sustainable lawn irrigation practices. Finally, the study provided information for targeted interventions of role players to promote the responsible watering of turf.

RESEARCH DESIGN AND METHODOLOGY

Study Area

A field study was conducted at Evergreen Turf (Pty/Ltd), Eikenhof, Johannesburg, South Africa. Evergreen Turf is recognised as the largest supplier of instant lawn in southern Africa with 450 hectares of lawn under propagation. At the Eikenhof farm, level, study plots were constructed specifically for the Kikuyu and *Cynodon* turfgrass research project.

The topography of the study area can be described as an undulating plain gradually sloping down to the Klip River, running east-west from the study site. The water of the Klip River is used for the irrigation of the experimental sites.

According to Mucina and Rutherford (2006), the vegetation type in the study area is the Carletonville Dolomite Grassland (Gh 15) characterized by the occurrence on dolomite soils. However, all-natural vegetation has been replaced by turf grass and crops at the study site.

Climatic conditions

According to the Köppen-Geiger climate classification Eikenhof, Johannesburg falls in the Cwb climatic category, experiencing warm, temperate, dry winters and warm summers (Conradie 2012). Severe, frequent frost occurs in winter (Mucina and Rutherford 2006). In the Perennial rainfall region, the most rainfall is experienced during the summer period (December – February). The average annual rainfall is 760 mm, with January the wettest month (154.14 mm) and July the driest month (2.28 mm). The warmest month is January with an average temperature of 29.75^{o}C and the coldest month is July with an average temperature of 7.79^{o}C (Weather and Climate 2025).

Geology and Soils

The geology of the study area according to Mucina and Rutherford (2006) consists predominantly of dolomite and chert of the Malmani Subgroup (Transvaal Supergroup). Supporting mostly shallow Mispah and Glenrosa soil forms typically of the Fa land type. Deeper red to yellow apedal soils (Hutton and Clovelly forms) occur sporadically, representing the Ab land type.

Soil analysis of the study site was conducted by Omnia Nutriology, a member of the Omnia Group, to determine the nutrient content, pH and colour of the topsoil. The average pH for five (5) samples was 5.1 with the highest value reported as pH 5.3 and the lowest being pH 4.7. The soil form was indicated as a Glenrosa and the colour indicated as dark brown.

Turfgrass species

Cenchrus clandestinus (Hochst. ex Chiov.) Morrone commonly known as Kikuyu is native to East Africa and used in countries such as Australia, New Zealand, South Africa and southern California America as an ornamental garden lawn due to its drought resistance, ability to tolerate very high traffic, and its fast repair capabilities (De 2017). Kikuyu, a C_4 warm-season grass is well known for its robust nature, its rapid growth rate and its low maintenance requirements, all contributing to make it a practical choice for home lawns, sports fields, and public parks in Gauteng (Fraser et al. 2017; Nic 2023). Its versatility and prostrate mat-forming characteristics led to the adoption of Kikuyu in Australia by local government, homeowners and sporting organisations in urban environments (Accend Admin 2025). It is also regarded as turf choice in Gauteng gardens. Kikuyu can alleviate soil contamination and remediate soils, enhancing the use of previously unproductive land. However, the aggressive growth habit of this species is considered a problem in certain regions (Fraser et al. 2017).

Kikuyu have adaptive and survival mechanisms to drought such as an extensive root system (Skerman and Riveros 1990), biochemical protectants that reduce the effect of toxic osmolytes and inorganic ions (Radhakrishnan et al.

2006), extended longevity and seed viability (Helfgott 1994), and micro buds in leaf axis of rhizomes (Morris 2009). According to Biran et al. (1981) and Jansen van Vuuren (1997), the water usage of Kikuyu grass is high with an average evapotranspiration rate of 4.41 mm day^{-1} and a crop factor of 0.78. It can be as high as 8.66 mm day^{-1} with a crop factor of 0.97, ascribed to its rapid vertical leaf extension rate and a large leaf area and reduced horizontal leaf orientation.

Cynodon dactylon (L.) Pers. commonly known as Bermuda or Couch grass is native to East Africa. It is a low-statured, creeping, warm-season perennial grass that can tolerate a broad range of soil types and moisture levels. Commonly found in disturbed areas where the soils have high levels of nitrogen (Bartman 2024), which in turn increases the evapotranspiration rate (Jansen van Vuuren (1997). *Cynodon* 'Tiffsport®' or TifSport® is a patented Bermuda grass, engineered by the University of Georgia and the Department of Agriculture using a gamma mutant of Midiron Bermuda bred from indigenous parent varieties. It has better cold resistance, colour and vigour than other *Cynodon* cultivars and is used for golf fairways, athletic fields, landscaping and lawns (USDA 2016). *Cynodon* is a fine leaf textured grass, with a high tolerance for traffic, a good tolerance for drought and cold and goes dormant in winter (Bartman 2024). It flourishes in regions where the temperature ranges from 6 – 28ºC and requires an annual rainfall between 625 – 1750 mm per annum. It is however sensitive to shade (Bartman 2024). According to Jansen van Vuuren (1997), the average evapotranspiration rates of Bermuda grasses ranged from 1.32 to 8.81 mm day^{-1} depending on the cultivar.

Research Design

To answer the aim and objectives of the study a quantitative research design was implemented, as it is the process of collecting and analysing numerical data to find patterns, averages and make predictions concerning the quality of turfgrass, and the irrigation needed to maintain an acceptable quality lawn.

Methodology

Open field turfgrass research strips were established from sods by Evergreen Turf (Pty/Ltd) from September 2023 to November 2023. The establishment process for both turf species was completed according to best practises followed at Evergreen Turf (Evergreen Turf (Pty/Ltd) (n.d). The Kikuyu and *Cynodon* turfgrass strips were grown parallel to each other with a one-meter bare soil area separating the two different turf grass species. Irrigation was provided using one supply pipe (placed in the one-meter bare soil strip) down the centre of the two turf grass species strip, with individual sprinklers providing the same irrigation treatment (5 mm; 15 mm; 20 mm and 25 mm) to both turfgrass species at the same time to each irrigation treatment block (**Fig 1**). Fertilizer NPK at a ratio of 5:1:5 ($30g/m^{2)}$ was applied with the initial establishment of the lawn at the beginning of the new growing season. LAN ($30g/m^2$) was administered after the grass core was well established as a follow up.



Fig. 1 The experimental set-up, (A) Kikuyu turf grass strip and (B) *Cynodon dactylon* turf grass strip; with the irrigation pipe placed in the middle of the two turfgrass strips

Sample strips for the study were sectioned into four irrigation treatment blocks measuring 5 m x 12 m for both Kikuyu and *Cynodon*. Each of the treatment blocks received a different irrigation volume. The selected irrigation treatment volumes were 25 mm, 20 mm, 15 mm and 5 mm per week. The selection of the 25 mm was informed by various literature citing it as being commonly used in residential landscapes (Accend Admin, 2025; Rand Water, n.d.). The irrigation volumes and application rates were set to half the volume and applied twice a week, respectively. Soil moisture was determined at three different locations in each irrigation block by making use of 3-way soil moisture meters once a week when the clipping of the turf was done. Both experimental lawn strips were then mowed at a mowing height of 2.5 cm once a week after data collection.

Climate data including temperature, rainfall, wind etc. were collected from an electronic/wireless weather station Tornado Twitter Aviator supplied by iWeather near the study site daily.

Study plots were evaluated once a week for visual quality on a scale 0 to 5 (0 = dead turf, 5 = optimal quality) based on adapted studies by Krans and Morris (2007) and Leinauer et al. (2014) using digital images. Digital images were taken randomly at selected locations within each plot and assessed by measuring colour and coverage. The American turfgrass visual assessment standards have been adapted for implementation, as no criteria for South African turfgrass is available.

Visual Assessment

A healthy lawn exhibits a deep green colour, uniform growth, a soft feel, is resistant to weeds, pests and drought.

Colour and Uniformity: Rating scale 5 or 4 out of 5: Consistent green colour, even growth without bare patchiness or significant brown spots which can indicate water stress, disease or nutrient deficiencies.

Cynodon	Kikuyu
	
Cynodon	Kikuyu
	

Signs of Stress: Rating scale 3 or 2 out of 5: Discolouration, brown turf grass patches, wilting, slow growth or indications of disease.

Cynodon	Kikuyu
	
Cynodon	Kikuyu
	

Weeds and Pests: Rating scale 1 or 0 out of 5: Signs of pest infestations, bare soil patches, dead turf grass, the occurrence of weeds etc. can indicate underlying issues such as water stress in the lawn's health.

Cynodon	Kikuyu
	
Cynodon	Kikuyu
	

Biomass and yield

Turfgrass productivity under different irrigation treatment regimes was analysed electronically using a plate meter and manually using a disc pasture meter, clip and weigh method (CW). The grass biomass and height were measured digitally using an EC09 Electronic plate meter (PM) for each turfgrass species in each treatment block. The PM is an instrument that is used to estimate aboveground standing grass biomass per hectare (kg grass matter/ha) and is a convenient alternative to cutting, drying, and weighing grass samples for measuring biomass. Data was collected from thirty randomly selected disc drops in each of the irrigation treatment blocks.

Additionally, the grass biomass and height were also determined manually by making use of a 60 cm diameter disc pasture meter (DPM). This tool was developed for estimating grass biomass in cultivated pastures, typically expressed in kilograms of dry grass matter per hectare (kg DM/ha) dropping the DPM and determining the height using the height indicated on the rod. Three (3) discs (60 cm in diameter) were randomly dropped in each of the different irrigation treatment blocks, and the location of the dropped disc was demarcated and the new turf growth clipped, collected, dried and weighed by making use of a Shimadzu UW620H 3 decimal scale to establish the biomass production for a week. Clipped grass was collected in brown paper bags, the wet weight (WW) of the three individual clippings was determined and the average calculated. The samples were airdried for a week, the dry weight (DW) weighed and average of the three samples determined to calculate the yield in kg DM/ha using the following calculation

DM Yield (kg DM/ha) = Wet Weight (WW) of grass (kg) x DM% x 35 368.18 (area of disks required to make up a hectare).

According to literature, the amount of leaf matter produced (yield) in a specific time is directly linked to water use (evapotranspiration), the higher the yield, the higher the water use (Biran et al. 1981; Jansen van Vuuren 1997).

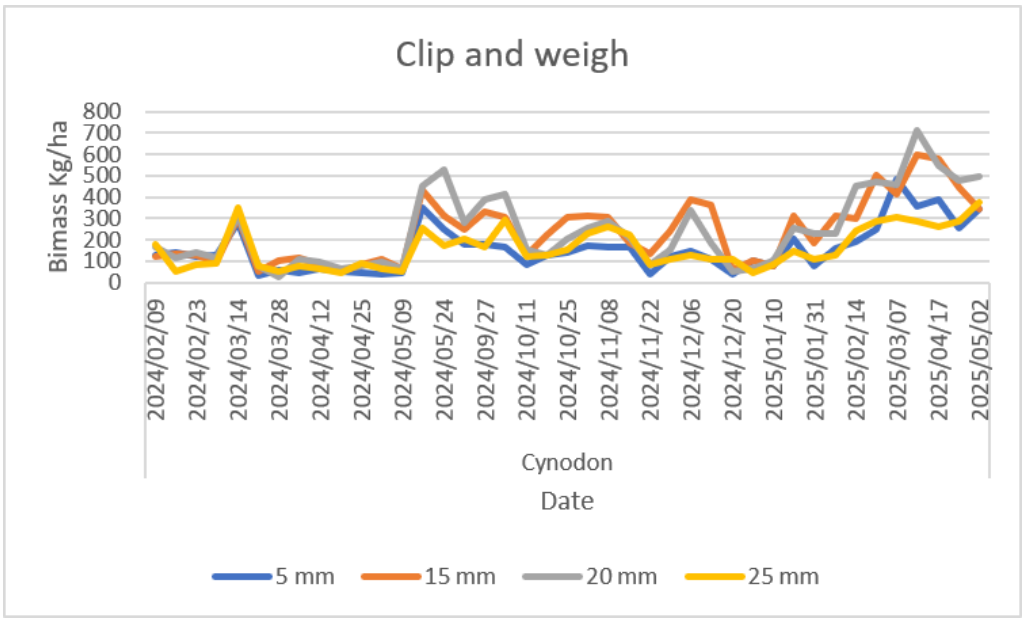
Data collection

Data was collected over two growing seasons from February 2024 to May 2025. Data collection was conducted once a week from February 2024 and terminated at the end of May 2024 due to frost. Data collection resumed in September 2024, following the first summer rains and after the preparation of the study site was completed. The experiment was then terminated again in the first week of May 2025, when the first frost was experienced at the study site. A total of 164 clipped turfgrass samples were collected for each turfgrass species, 41 turfgrass clipping samples for each irrigation regime over the period of data collection.

Data analysis

Results and discussion

Biomass and yield



a

b

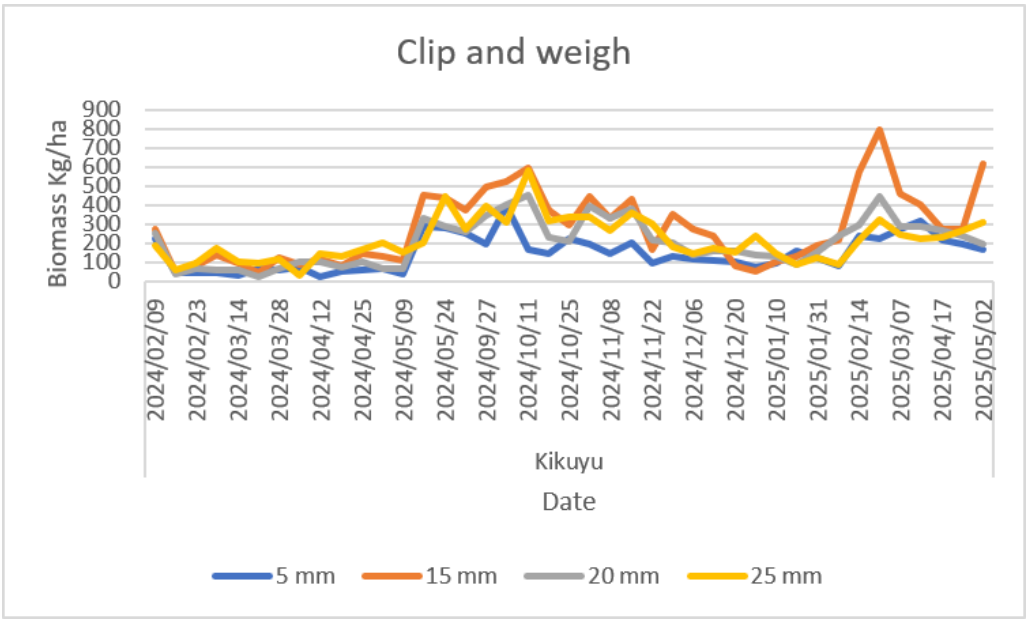
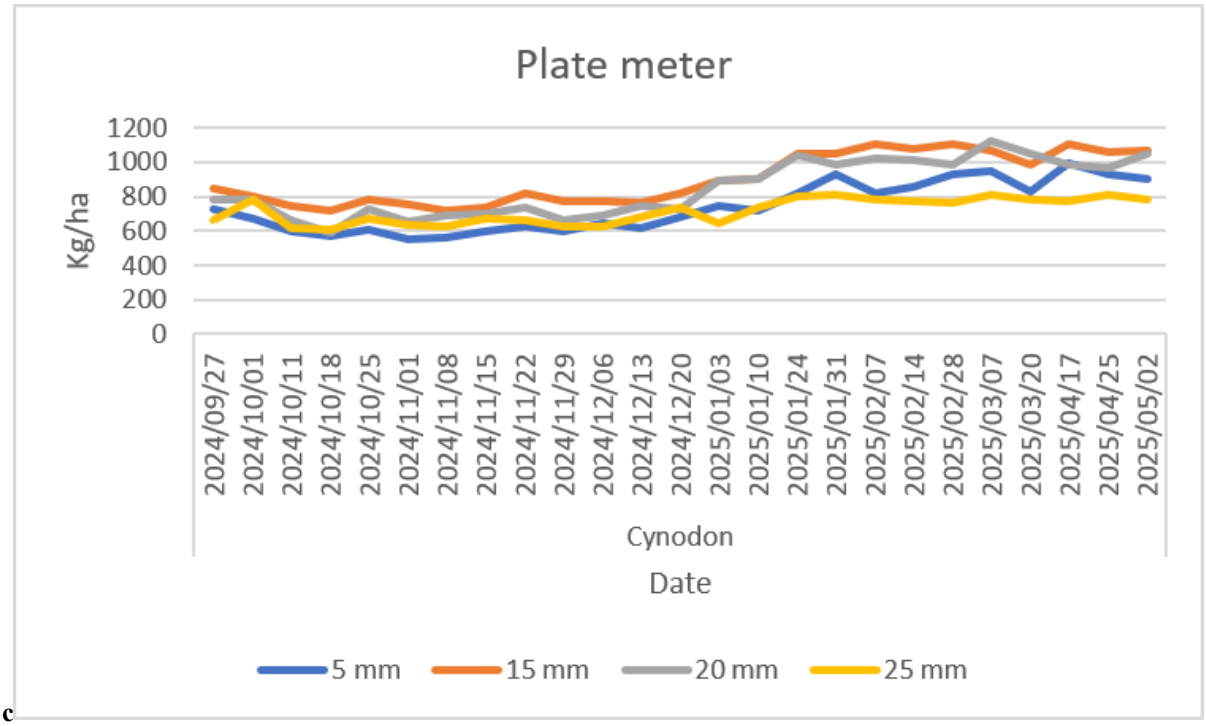


Fig. 2a/b Indicates the biomass production as determined by clip and weigh in Kg/ha for *Cynodon* and Kikuyu for the one-year growth period summer Feb 2024 – autumn May 2025

c



d

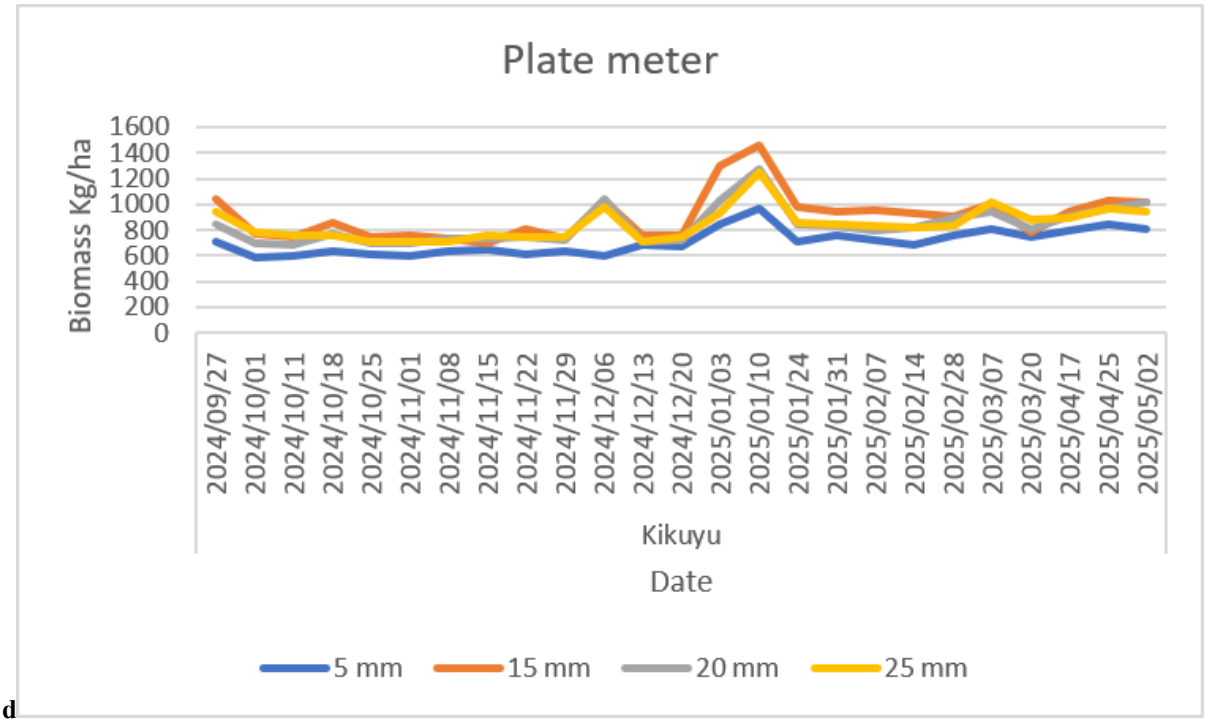


Fig. 2c/d Indicates the biomass production as determined by the plate meter in Kg/ha for *Cynodon* and Kikuyu for the one-year growth period spring Sept 2024 – autumn May 2025

Evident in figures 2 a-d is that the yield for both *Cynodon* and Kikuyu was similar across the data collection period. Initially, (Summer 2023 = (Feb 2024); Autum 2024 = (March – May 2024) the yield was lower which can be ascribed to the period required for the root systems of the turf grass to establish. An increase in yield was noted for both *Cynodon* and Kikuyu in spring 2024 (Sept – Nov 2024); Summer (Dec 2024 - Feb 2025) and Autumn

2025 (March- May 2025). According to Gonzales et al. (1990) the relationships between biomass and height are influenced by season and management of Bermudagrass pastures.

Biomass and yield: Plate meter

The biomass results obtained by making use of an EC09 Electronic plate meter, for the different seasons, as well as for the four (4) irrigation regimes**,** for the two turfgrass species indicated an average autumn yield for Kikuyu of 3999.71 kg/ha, less than the autumn yield obtained for *Cynodon* 4610.12 kg/ha at a 5 mm irrigation regime, 2.5 mm twice a week. The results indicated that the spring yield for both grasses at 5 mm was similar *Cynodon* (6125.87 kg/ha) and Kikuyu (6254.47 kg/ha). The yield for *Cynodon* at 5 mm for the summer period was higher but not significantly higher (7761,65 kg/ha) than that for Kikuyu (7382.14 kg/ha) at the same irrigation regime (**Fig 3a**).

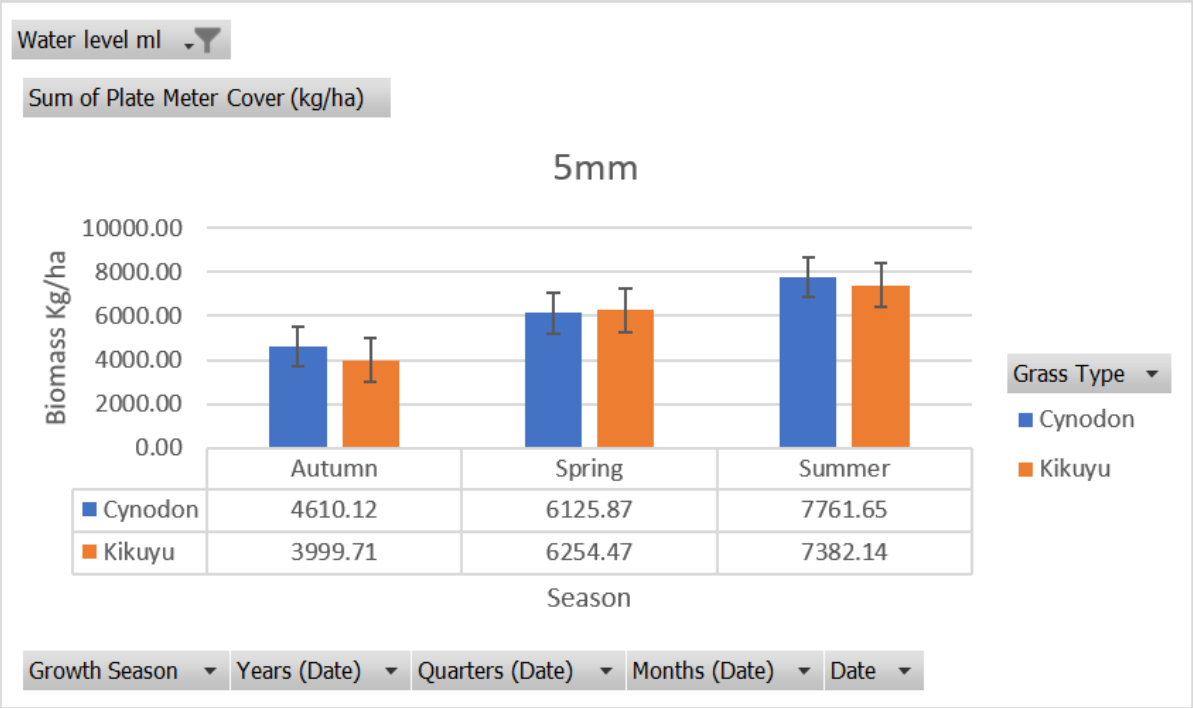


Fig. 3a Bar graph depicting the average biomass per hectare for *Cynodon* and Kikuyu at an irrigation treatment regime of 5 mm across three different seasons using an electronic plate meter

Figure 3b depicts the results obtained by making use of the electronic plate meter indicating an average autumn yield for Kikuyu of 4767.87 kg/ha, similar to the autumn yield obtained for *Cynodon* 4710.72 kg/ha at a 15 mm irrigation regime, 7.5 mm twice a week. The results indicated that the spring yield for both grasses at 15 mm was similar *Cynodon* (7694.21 kg/ha) and Kikuyu (7920.54 kg/ha). The yield for Kikuyu at 15 mm for the summer period was higher (10 010.13 kg/ha) than that for *Cynodon* (9551.17kg/ha), indicating that the water use of Kikuyu is higher than that of *Cynodon* at 15 mm twice a week 7.5 mm.

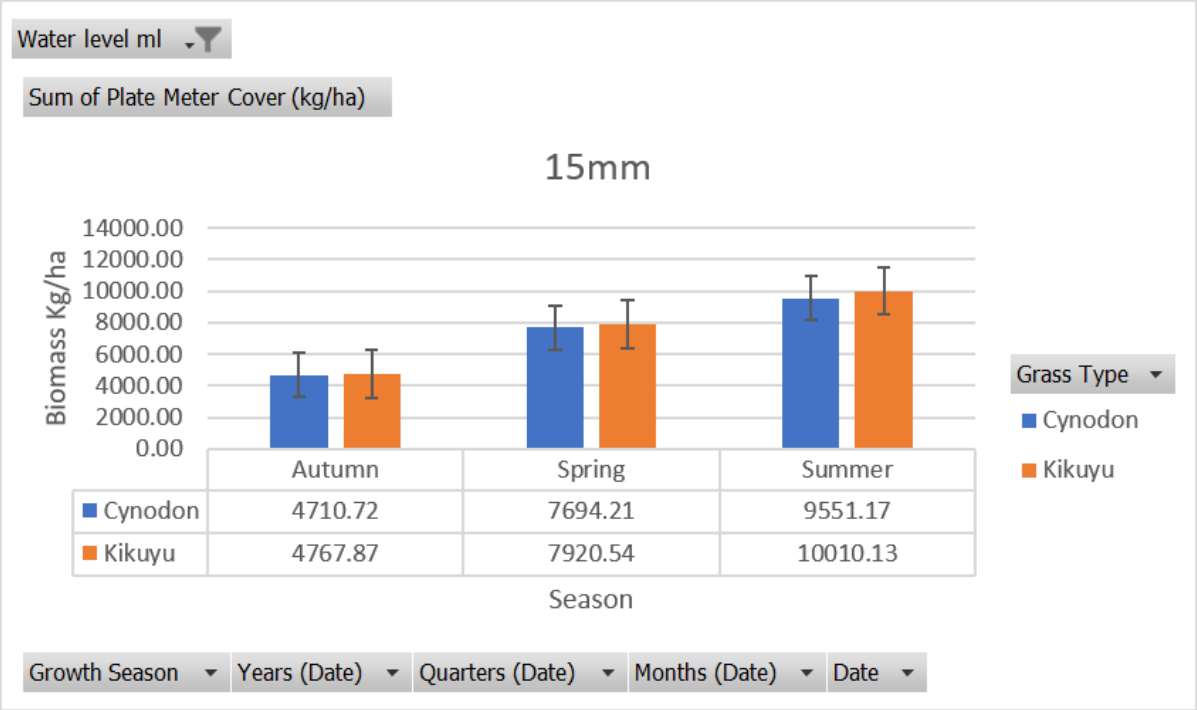


Fig. 3b Bar graph depicting the average biomass per hectare for *Cynodon* and Kikuyu under 15 mm irrigation treatment regime across three different seasons, using an electronic plate meter

It is evident from figure 3c that the yield for Kikuyu (4640.99 kg/ha) at a 20 mm irrigation regime, 10 mm twice a week during autumn is less than the yield for *Cynodon* (5194.25 kg/ha) for the same irrigation regime and same period. During spring the yield for Kikuyu (6675,70 kg/ha) was slightly less than that of *Cynodon* (6991.20 kg/ha), whereas for the summer it was similar for Kikuyu (8993.97 kg/ha) and *Cynodon* (8945.90 kg/ha), indicating that the water use for *Cynodon* is higher than that of Kikuyu at 20 mm twice a week 10 mm.

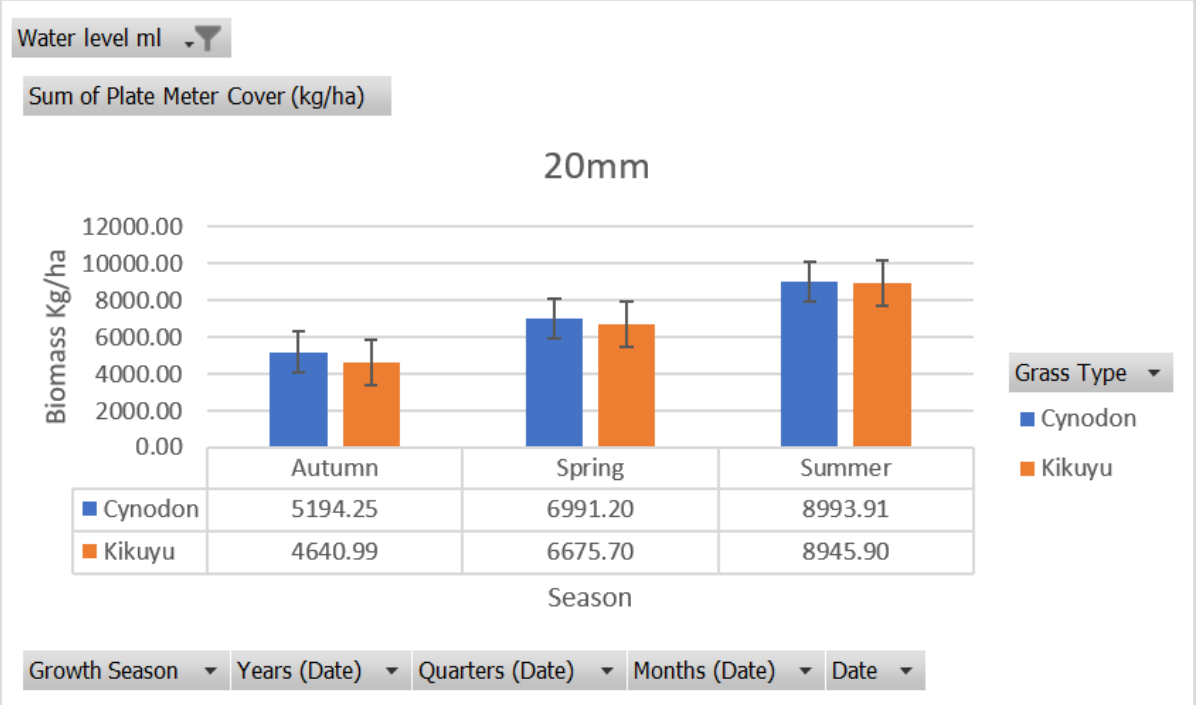


Fig. 3c Bar graph depicting the average biomass per hectare for *Cynodon* and Kikukyu irrigation under 20 mm treatment regime across three different seasons, using an electronic plate meter

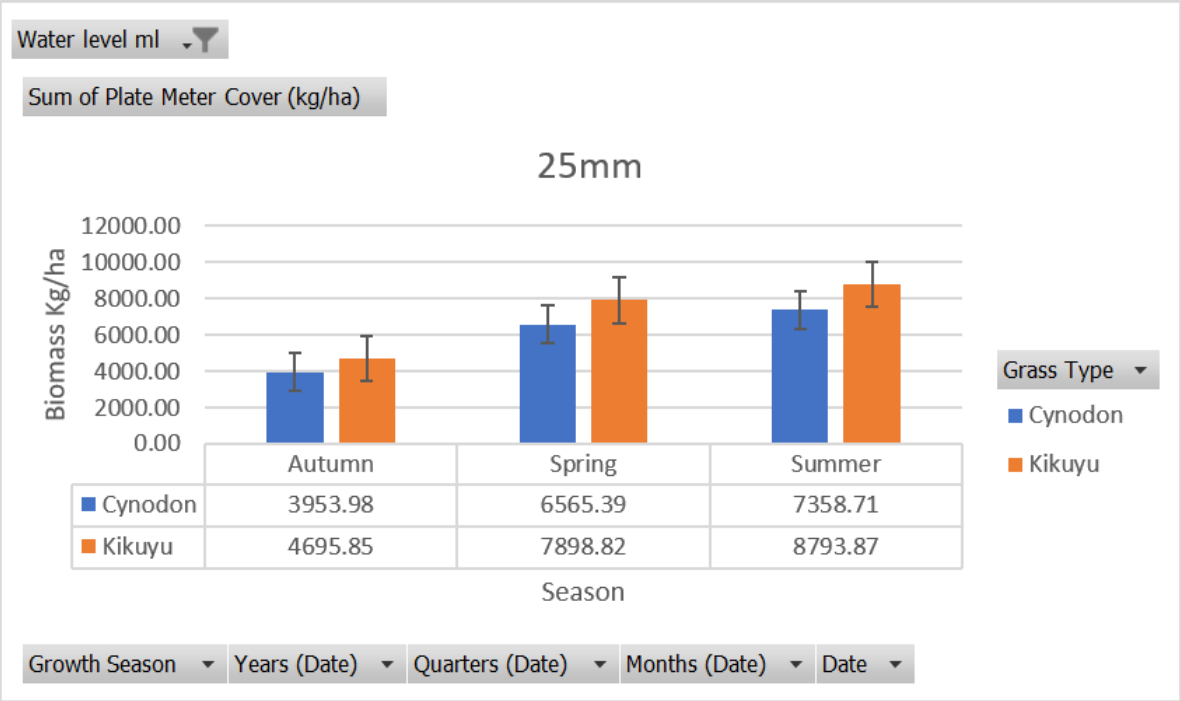


Fig. 3d Bar graph depicting the average biomass per hectare for *Cynodon* and Kikuyu under 25 mm irrigation treatment regime of across three different seasons, measured using an electronic plate meter

The plate meter results depicted in Figure 3d indicate that the yield for Kikuyu at 25 mm irrigation applied in 2 increments of 12.5 mm twice a week surpasses the yield of *Cynodon* in all three seasons (autumn Kikuyu 4695,85; *Cynodon* 3953.98), spring (Kikuyu 7898.82; *Cynodon* 6565.39) (summer Kikuyu 8793.87: *Cynodon* 7358.71) and consequently water use of *Cynodon* in all three seasons.

Clip and Weigh method:

To determine the biomass (yield) for both turfgrass species, grass clippings were collected in demarcated disc localities in each irrigation regime, the wet - and dry weight determined to calculate the yield. It was observed that during the autumn season, the average yield for *Cynodon* and Kikuyu was 4003.34 kg/ha and 6617.16 kg/ha, respectively, under an irrigation treatment regime of 5 mm applied 2.5 mm twice a week (**Fig 5a**). In the spring season, the average yield was recorded as 1884.83 kg/ha for *Cynodon* and 3259.99 kg/ha for Kikuyu, respectively. During the summer season, the average yield for *Cynodon* was 6179.61 kg/ha and 7108.30 kg/ha for Kikuyu. It was further noticed that the summer yield for *Cynodon* (6179.61 kg/ha) was similar to the autumn yield for Kikuyu (6617.16 kg/ha). Overall, Kikuyu had the highest yields in all the seasons, irrigation treatment regimes and consequently the highest water use when compared to *Cynodon*.

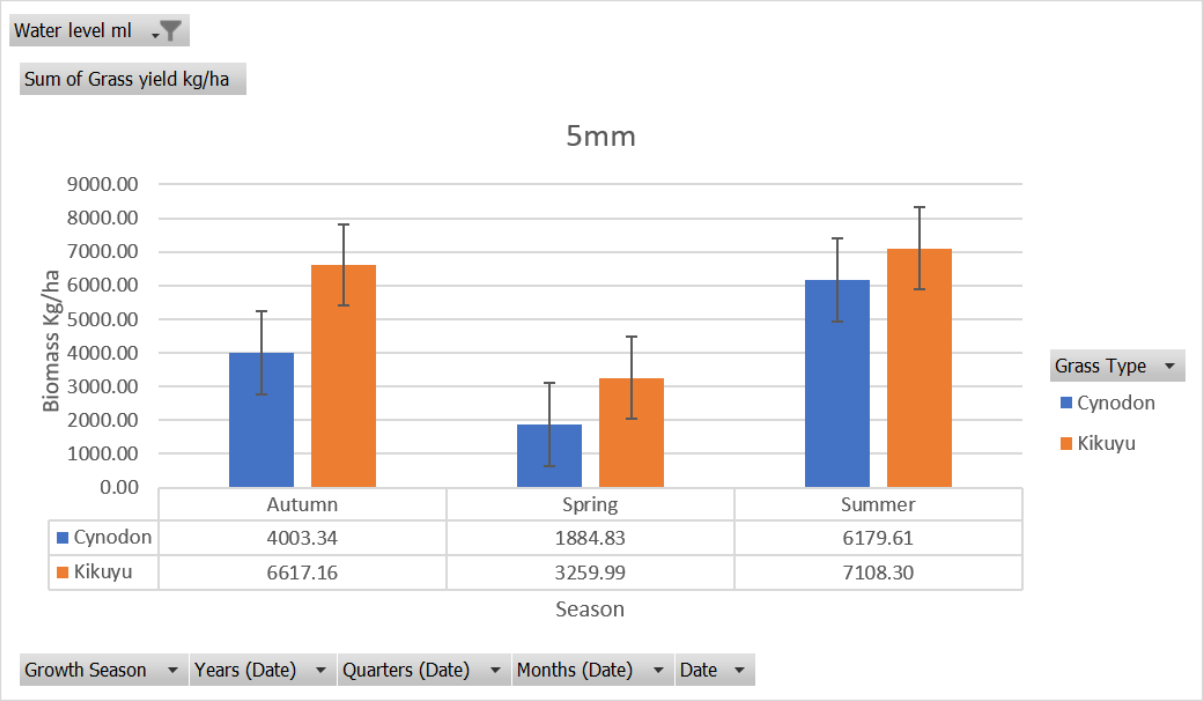


Fig. 4a Bar graph depicting the average biomass per hectare for *Cynodon* and Kikuyu under the 5 mm irrigation treatment regime, across three different seasons, measured using the clip and weigh method

Figure 4b indicates the biomass per kilogram for *Cynodon* and Kikuyu under the 15 mm irrigation treatment regime, at an application rate of 7.5 mm twice a week. From the yield data, it was evident that Kikuyu had a higher water use than *Cynodon,* across all seasons.

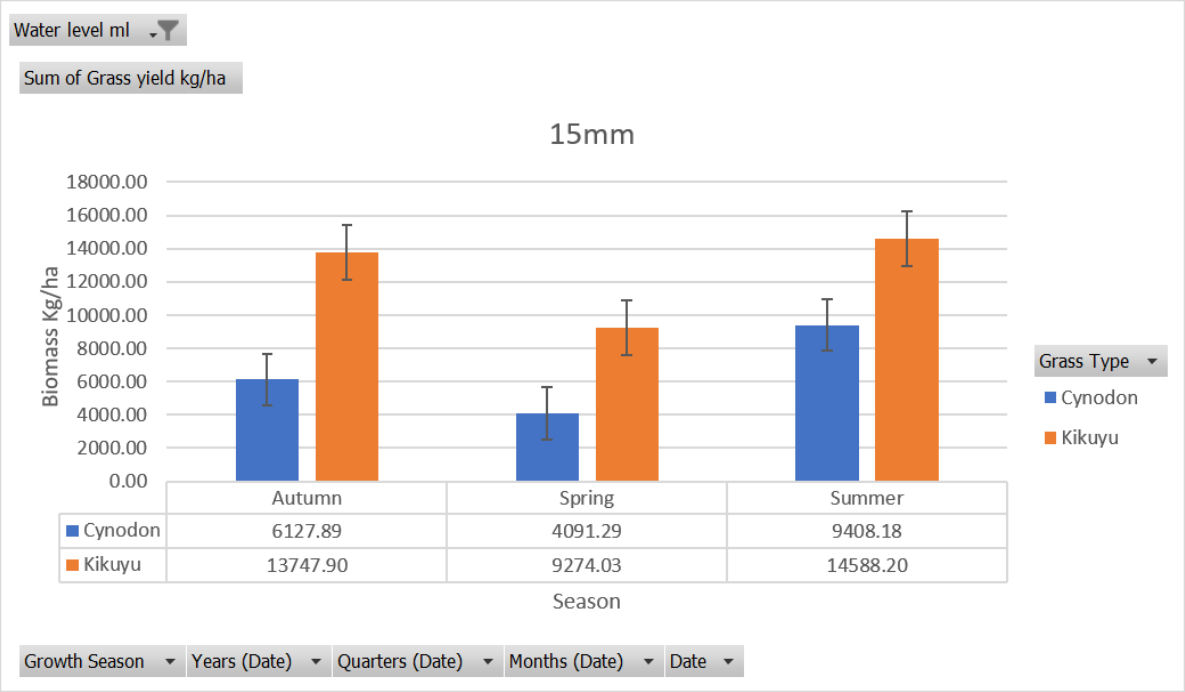


Fig. 4b Bar graph depicting the average biomass per hectare for *Cynodon* and Kikuyu under a 15 mm irrigation treatment regime, across three different seasons, measured using the clip and weigh method

Figure 4c indicates the biomass per kilogram for *Cynodon* and Kikuyu under the 20 mm irrigation treatment regime, at an application rate of 10 mm twice a week. It was discovered that *Cynodon* had the highest yield of 10 611.56 kg/ha, during the summer season surpassing the yield of Kikuyu (9975,36 kg/ha). It was evident that this regime was more favourable for *Cynodon* in the summer season than Kikuyu. The yield and water usage for Kikuyu was higher than that of *Cynodon* during the autumn and spring seasons.

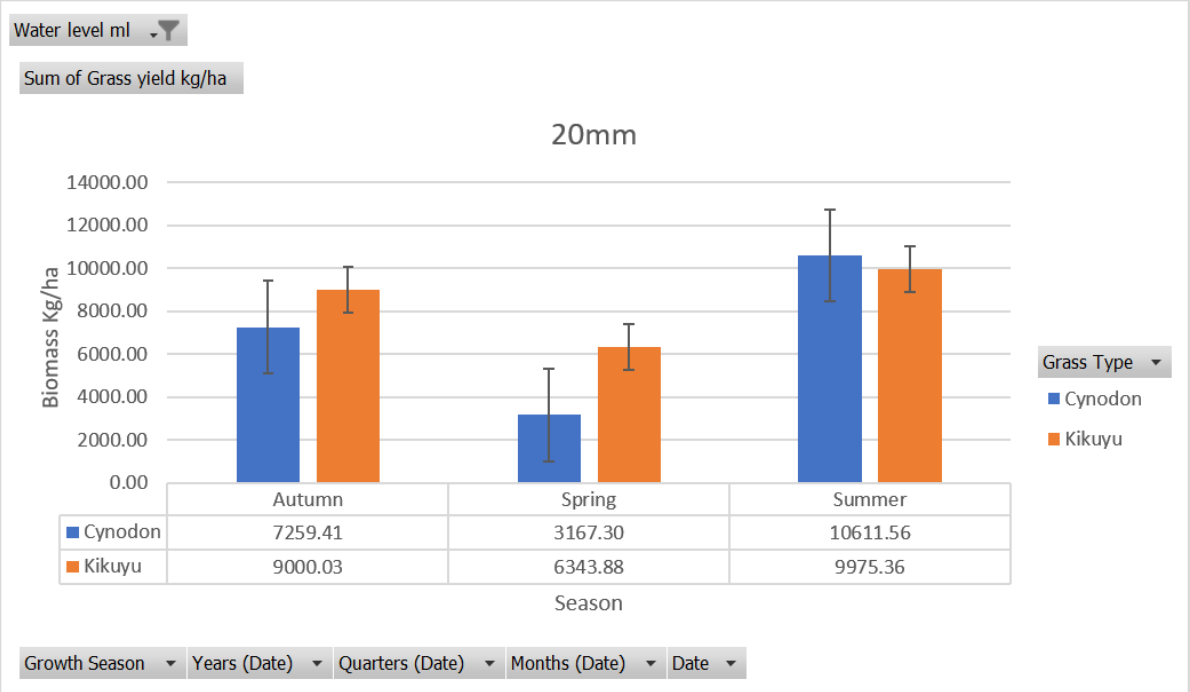


Fig. 4c Bar graph depicting the average biomass per hectare for *Cynodon* and Kikuyu under a 20 mm irrigation treatment regime, across three different seasons, measured using the clip and weigh method

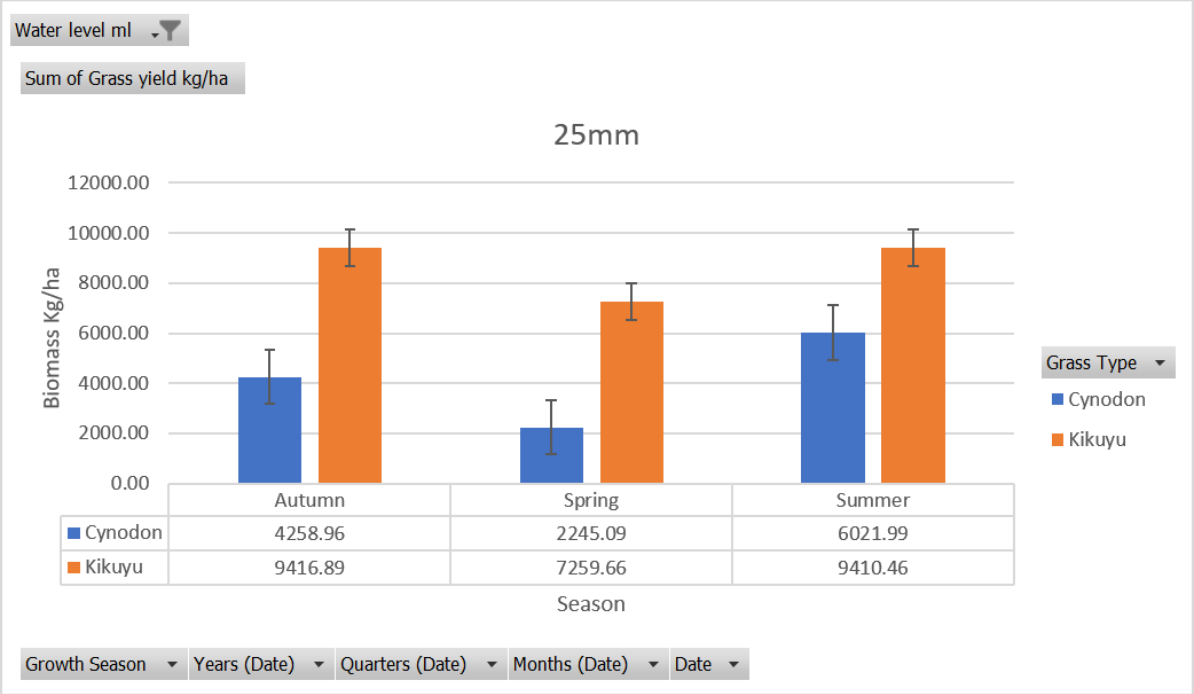
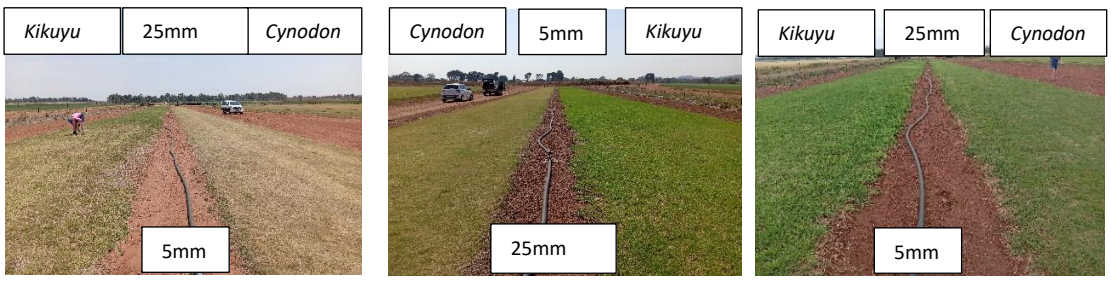


Fig. 4d Bar graph depicting the average biomass per hectare for *Cynodon* and Kikuyu under a 25 mm irrigation treatment regime, across three different seasons, measured using the clip and weigh method

Figure 4d indicates the biomass per kilogram for *Cynodon* and Kikuyu under the 25 mm irrigation treatment regime, at an application rate of 12.5 mm twice a week. The yield and water consumption at 25 mm are the highest for Kikuyu in all three seasons (autumn Kikuyu 9416,89; *Cynodon* 4258.96; spring Kikuyu 7259.66: *Cynodon* 2245.09 and summer Kikuyu 9410.46; *Cynodon* 6021.99 kg/ha).

Recovery period



a. 4 October 2024 b.11 October 2024 c.22 November 2024

Fig. 5 Photographic evidence of the different recovery periods for *Cynodon* and Kikuyu after the dormant winter period

From the photographic evidence Figures 5 a-c, it is evident that the recovery period for *Cynodon* after the dormant winter period is much slower than that for Kikuyu under the different irrigation regimes. Kikuyu appeared to exhibit a greener appearance at a faster rate than *Cynodon*. Accend Admin (2025) indicates that the recovery potential of Kikuyu can be ascribed to its deep root system (up to 3 m) that provides anchorage and access to moisture and nutrients from deep soil layers that other grasses cannot reach. It also spreads through above-ground

stolons and underground rhizomes that create a dense network, enhancing the rate of recovery period. This rapid recovery period of Kikuyu enhances the coverage of the bare soil, limiting the risk of soil erosion and the establishment of weeds.

Discussion

When a comparison was drawn between the results obtained from the electronic PM and the manual CW method the highest biomass production (yield) per season was obtained for Kikuyu at 15 mm (10 010.13 kg/ha PM; 14 588.20 kg/ha CW) for the summer season whereas the highest yield obtained for *Cynodon* was at 20 mm (8993.91 kg/ha PM; 10 611.56 kg/ha CW) for the summer season.

The tendencies obtained with the plate meter correlates with the results obtained by making use of the clip and weigh method to determine the total biomass production of Kikuyu and *Cynodon* turf grass under different irrigation regimes in three different seasons. These results correlate with the findings of Biran et al., (1981) and those of Jansen van Vuuren (1997), indicating that the water consumption of Kikuyu is higher than that of *Cynodon.* Biran et al., (1981) also indicated that water consumption is affected by mowing height, grass species and irrigation frequency.

According to the results obtained in this study 15 mm irrigation applied twice a week in 7.5 mm increments is recommended for Kikuyu and a 20 mm irrigation applied twice a week in 10 mm increments is recommended for *Cynodon* for optimal lawn conditions in autumn, spring and summer. These findings recommend a deduction in the irrigation of lawn as recommended by Accend Admin (2025) that suggests a 15-20 mm of water 3 times a week in spring (September to November) and 20-25 mm every second day in summer (December to February). They also indicate a deduction to delivering 15-18 mm of water per application in autumn (March to May).

Conclusion

This study aimed to provide scientifically based evidence concerning irrigation practices and water requirements of two turfgrass species extensively used as lawns in South Africa. The results obtained confirm the general perception that the water requirement of *Cenchrus cladestinus* (Kikuyu) exceeds that of *Cynodon dactylon* (Couch grass). From the literature, it is evident that the water consumption of lawn is affected by mowing height, irrigation practices as well as grass species. There is a need to inform and educate homeowners on the correct irrigation and maintenance practices concerning lawns and how to implement them. The results from this study demonstrate that applying irrigation at 25 mm/week should be adapted and reduced to 20 mm/week for *Cynodon* and 15 mm/week for Kikuyu. This could result in water conservation. Research should be extended to native South African grass species, and their water use for the application as lawn. It should also be extended to determine if deep watering once a week, at full amount of 25 mm, 20 mm, 15 mm and 5 mm is sufficient to sustain the two lawn species.

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Authors contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by M.S Deutschlander and E.M van Staden. The first draft of the manuscript was written by M.S Deutschlander and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Statements and Declarations

Competing Interests and funding

Authors A declare that they have no relevant financial or non-financial interests to disclose or competing interests.

Authors B are employees of Rand Water but have not received any personal financial support in executing this research project, they acted in an advisory role.

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Data availability

All datasets used and/or analysis during the current study are available from the corresponding author on reasonable request.

REFERENCES

Accend Admin (2025 July 31) Year-round care: seasonal irrigation settings for Randburg's climate. https://lawnking.co.za/year-round-lawn-care-seasonal-irrigation-settings-for-randburgs-climate/

Bartholomew PE (1985). Beef production from kikuyu and Italian Ryegrass. PhD Thesis, University of Natal, Pietermartizburg.

Bartman S (2024) Discovering South Africa's grasses: *Cynodon dactylon.* MyFarm 15: Magazine Editions - Farmspace | Ons Praat Boer.

Beard JB, Green RL (1994) The Role of Turfgrasses in Environmental Protection and Their Benefits to Humans. J Environ Qua 23:452-460.

Bigelow CA, Soldat DJ (2013) Turfgrass root zones: Management, construction methods, amendment characterization, and use. Turfgrass: Biol. Use Manag 56: 383–423. https://doi.org/10.2134/agronmonogr56.c11

Biran I, Bravdo B, Bushkin-Harav I, Raeitz E (1981) Water consumption and growth rate of 11 turfgrasses as affected by mowing height, irrigation frequency, and soil moisture. Agron J 73: 85-90.

Bormann FH, Balmori D, Geballe GT (2001) Redesigning the American Lawn: A search for environmental harmony. Yale University Press. New Haven.

Braun RC, Mandal P, Nwachukwu E, Stanton A (2024) The role of turfgrasses in environmental protection and their benefits to humans: Thirty years later. Crop Sci 64:2909-2944. DOI:10.1002/csc2.21383

Colmer TD, Barton L (2017) A review of warm-season turfgrass evapotranspiration, responses to deficit irrigation, and drought resistance. Crop Sci 57 98-110. DOI:102135/cropsci2016.10.0911

Conradie DCU (2012) South Africa's climatic zones: Today, Tomorrow. International Green Building Conference and Exhibition, July 25-26 2012, Sandton, South Africa.

De LC (2017) Lawn grasses-a review. Int J Hortic 7(11): 82-94. DOI:10.5376/ijh.2017.07.0011

Evergreen Turf (Pty/Ltd) (n.d) Lawn Care. https://evergreenturf.co.za/lawncare/

Fraser D,Sharp P, Morris B, Tethowan R (2017) Abiotic stress tolerance of kikuyu (*Chenchrus cladestinus*) and some related grasses and potential of kukuju for agricultural and urban environments. Crop & Pasture Sci 68 :285-296. http://dx.doi.org/10.1071/CP15380

Gross CM, Angle JS, Welterlen MS (1990) Nutrient and sediment losses from turfgrass. J Environ Qual 19: 663-668.

Helfgott SF (1994) *Pennisetum clandestinum* Hochst. ex Chiov. In 'Weed management for developing countries'. (Eds R Labrada, JC Caseley, C Parker) pp, 72–73. (FAO: Rome)

Hoy LH (2018) Modelling amenity landscape plant water use in South Africa. PhD Dissertation. University of South Africa, Pretoria. South Africa.

Jansen van Vuuren JD (1997) Optimal water use of turf grass. Water Research Commission Report 417/1/97. ISBN 186845 231 X. Department of Plant and Soil Sciences. Potchefstroom University.

Kjelgren R, Rupp L, Kilgren D (2000) Water conservation in urban landscapes. HortScience 35: 1037–1040. https://doi.org/10. 21273/HORTSCI.35.6.1037

Krans JV, Morris K (2007) Determining a profile of protocols and standards used in the visual field assessment of turfgrasses: A survey of national turfgrass evaluation program-sponsored university scientists. Online. Appl. Turfgrass Sci. (4)1. doi:https://doi.org/10.1094/ATS-2007-1130-01-TT.

Leinauer B, Van Leeuwen DM, Serena M, Schiavon M, Sevostianova E (2014) Digital Image Analysis and Spectral Reflectance to Determine Turfgrass Quality. Agron J 106: 1787-1794. https://doi.org/10.2134/agronj14.0088

Limaye U (1996) Analysis of residential water demand using multispectral videography and other electronic databases. PhD Dissertation, Dept. Biol. and Irr. Eng., Utah State Univ.,Utah.

Lindsey AJ, Schiavon M, Unruh JB, Kenworthy K (2025) Urban Landscapes: Turfgrass Benefits. Grasses 4(1): 3; https://doi.org/10.3390/grasses4010003

Monteiro JA (2017) Ecosystem services from turfgrass landscapes. Urban For. & Urban Green., 26:151-157. https://doi.org/10.1016/j.ufug.2017.04.001

Morris B (2009) Variation and breeding of kikuyu grass (*Pennisetum clandestinum*). PhD Thesis, Plant Breeding Institute, The University of Sydney, NSW, Australia

Mucina L, Rutherford MC (eds). (2006) The Vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19.

South African Biodiversity Institute, Pretoria.

Nic (2023) Lawn Care Plus. Kikuyu Grass – A Resilient Lawn Choice for South Africa. Kikuyu Grass – The Practical Lawn Choice for South Africa (lawncareplus.co.za)

Radhakrishnan M, Waisel Y, Sternberg M (2006) Kikuyu grass: a valuable salt-tolerant fodder grass. Commun. Soil Sci. Plant Anal. 37: 1269–1279. doi:10.1080/00103620600623590

Rand Water (n.d) Wonderful Water Wise Gardening. Johannesburg: CTP WEB Printers.

Serena M, Velasco-Cruz C, Friell J, Schiavon M, Sevostianova E, Beck L, Sallenave R, Leinauer B (2019) Irrigation scheduling technologies reduce water use and maintain turfgrass quality. Agron. J. 112:3456–3469, https://doi.org/10.1002/agj2.20246.

Simmons M, Bertelsen M, Windhager S, Zafian H (2011) The performance of native and non-native turfgrass monocultures and native tirfgrass polycultures: An ecological approach to sustainable lawns. Ecol. Eng. 37: 1095-1103.

Sherratt P (2011) The Benefits of Turf and its management. Department of Horticulture and Crop Science. The Ohio State University. Ohio.

Skerman PJ, Riveros F (1990) 'Tropical grasses.' FAO Plant Production and Protection Series. (FAO: Rome)

Trenholm LE, Unruh JB Cisar LJ (2017) Watering your Florida Lawn. Environmental Horticulture Department, The Institute of Food and Agricultural Sciences [UF/IFAS] Extension. http://edis.ifas.ufl.edu.

United States, Environmental Protection Agency (EPA) (2025) Turfgrass and Water Efficiency https://www.epa.gov/watersense/turfgrass-and-water-efficiency

United State Department of Agriculture (USDA) (2016) Bermudagrass for Turf. Agricultural Research Service, Crop Genetics and Breeding Research: Tifton, GA. U.S Department of Agriculture. (Bermudagrass for Turf : USDA ARS)

Water Wise (n.d.) Welcome to Water Wise Water Wise - Water Conservation and Education Campaign by Rand Water – what type of media was the information extracted from?

Weather and Climate (2025) online. Eikenhof, Gauteng, South Africa Climate https://weatherandclimate.com/south-africa/gauteng/eikenhof#t1 (Access date 8/9/2025)