Scientific Research Publishing

American Journal of Plant Sciences, 2023, 14, 845-856
https://www.scirp.org/journal/ajps
ISSN Online: 2158-2750
ISSN Print: 2158-2742

Sporting Usefulness Potential of Nine Local Taxa of Grasses for Lawns in the Agro-Ecological Zone with Bimodal Rainfall in Cameroon

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How to cite this paper: Lionel, M.Z.Y., Ntsefong, G.N., Carine, T.N., Brice, T.L. and Emmanuel, Y. (2023) Sporting Usefulness Potential of Nine Local Taxa of Grasses for Lawns in the Agro-Ecological Zone with Bimodal Rainfall in Cameroon. *American Journal of Plant Sciences*, **14**, 845-856.
https://doi.org/10.4236/ajps.2023.148056

Received: May 25, 2023
Accepted: August 11, 2023
Published: August 14, 2023

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Abstract

The Cameroonian flora has a very high biodiversity that remains largely unexplored. It contains many grasses that can be used for sports lawns, but are currently underutilized. In order to contribute to the improvement of the quality of sports lawns, nine local grass taxa from the agro-ecological zone with bimodal rainfall in Cameroon were evaluated for their potential for sporting use in natural lawns. The method of the Study and Control Group for Varieties and Seeds was used to evaluate the sports lawn characteristics of the taxa. The resistance to trampling and pulling, the density of the lawn, and the aesthetic appearance, which are factors in calculating the sports index, were monitored at two sites, including the experimental space at the University of Yaounde 1 in the Center region and Kagnol 2 in the East region, from January 2017 to January 2020. The monthly lawn characteristic data allowed for the differentiation between the means and the determination of the sports index of the taxa compared to commercialized lawn varieties. The sports index of the evaluated taxa varied: *Cynodon dactylon* (6.989), *Eleusine indica* (6.338), *Sporobolus natalensis* (6.301), *Cynodon* cf *Cynodon dactylon* (6.257), *Eragrostis tremula* (5.939), *Sporobolus pyramidalis* (5.583), *Agrostis rupestris* (5.335), *Axonopus compressus* (4.991), and *Digitaria* sp. (4.544). These results show that these grass taxa have potential for sporting use in lawn mixtures at different levels of sports disciplines.

Keywords

Sports Lawn Characteristics, Sports Index, Natural Sports Lawn, Local Grass

Taxa, Resistance to Trampling and Pulling

1. Introduction

Grasses, which have the ability to vegetatively multiply through tillering [1], promoting the formation of lawns, are used in sports activities for creating natural lawns. A sports lawn can be defined as a natural grass and soil environment managed for fast and aggressive sports activities [2]. A lawn is a vegetated surface composed of a mixture of grasses that are usually mowed, with each species in the mix having a specific function and aesthetic. It is difficult to imagine the practice of many lawn sports disciplines without natural grass. Many popular sports such as football, cricket, rugby, baseball, tennis, hockey, and golf are played on grass fields [3]. A sports lawn must offer a safe playing surface for athletes and comply with respective sports regulations. It is desirable for the grass to be strong enough to resist and quickly recover from the damage caused by sports events stress [4]. There are many estimates of the cost of lawn construction, but they are usually dependent on the elements involved in creating the "green rectangle", including substrate, seeds, water and mineral nutrition, and maintenance. The cost estimation of each element incorporates economic, environmental, geographical factors, and the desired quality of the lawn.

Natural grass, the green lung of Planet Earth, contributes to the reduction of carbon dioxide, provides oxygen, absorbs solar energy, reduces energy consumption, and contributes to the overall reduction of global warming [5]. Grasses reduce the risk of athlete injuries while acting as a natural cushion. They play a vital role in enabling better locomotion movements for players, better handling, and good ball rolling. The quality of the game is always influenced by grass height, texture, firmness, and growth pattern [3]. The selection of grasses for lawns is very strategic because they must meet the requirements of the game, perform well in the local climatic conditions, and not hinder player performance. The main characteristic of sport turf is its high resistance to repeated trampling and uprooting, in addition to a dense vegetation cover and an aesthetic appearance. Evaluation trials are conducted for at least 3 years at different locations to determine the lawn characteristics of the taxa under study, which are compared to those of control varieties chosen from the best varieties already on the market. The sports use corresponds to that of sports fields, subject to more intensive trampling during the sports season.

Ball speed, bounce, and rolling are influenced by the quality of the playing surface and the players [6]. Player performance depends largely on the quality of the grass surface, and all these considerations are related to three grass characteristics: traction, resistance, and regularity [4]. Lawn plant species, cultivars, biomass, density, coverage, mowing height, and root biomass are factors that directly influence lawn tolerance to trampling and playability [7]. It is established

that young players practicing on natural lawns can improve their performance and avoid possible injuries [8].

In Cameroon, football is very popular, and many young people and families have high motivations for it. Rugby, cricket, baseball, American football, and other lawn disciplines are gradually gaining ground. However, these disciplines are often practiced on spaces covered with sand, laterite, or very few lawns that exploit the natural advantages of local grass diversity. The territory is known for its diversity and richness of its floristic diversity [9]. In local climatic conditions, the significant endogenous genetic source is a potential basis for the selection and improvement of grasses for lawn sports. The objective of this work is to evaluate the lawn characteristics of nine local taxa of grasses for lawns from the agro-ecological zone with bimodal rainfall in Cameroon for their potential in sporting use in natural lawns.

2. Materials and Methods

2.1. Materials

The experimentation was carried out in the bimodal rainfall agro-ecological zone of Cameroon at two sites: the Kagnol 2 site in the Mboma district (3˚59"N and 13˚10'E) in the Haut-Nyong Division, and the experimental site of the University of Yaounde 1 in Ngoa-ékellé (3˚52'0"N and 11˚31'0"E) in the Mfoundi Division.

Nine local taxa of grasses for lawns from the zone were evaluated: *Agrostis rupestris*, *Axonopus compresus*, *Cynodon* cf *Cynodon dactylon*, *Cynodon dactylon*, *Digitaria* sp., *Eleusine indica*, *Eragrostis tremula*, *Sporobolus natalensis*, and *Sporobolus pyramidalis*. The vegetative propagation was used for the establishment of cultures (stolons and tufts).

2.2. Methods

The taxa were collected in the bimodal rainfall agro-ecological zone of Cameroon, mainly in Yaounde and Kagnol 2. A reserve collection was set up for preliminary observations, which allowed for a more precise idea of the taxa to be evaluated [10]. The experimental design was completely randomized blocks. Nine monospecific plots of 10 m × 10 m each were established. Maintenance consisted of daily removal of plant species other than the seeded taxa. The ideal lawn for sports activities is well-anchored to the substrate, dense, with a beautiful green color, and free of diseases. This requires good soil aeration, adequate mowing frequency, appropriate water and mineral nutrition, and possibly phytosanitary monitoring.

- Soil aeration: can be done by hoeing which promotes the availability of nutrients and better anchoring of the root system to the substrate.

- Water and mineral nutrition: depending on specific needs, watering and nutrient availability promote good growth and turf vigor. The supply is subject to the seasonal rhythm. A well-fed and hydrated lawn is dense and has good green

color.

- Mowing frequency and height: regularly mowed turf is vigorous. It is also subject to the seasonal rhythm. Mowing after 7 days may be more beneficial for sports turf.

- Sanitary monitoring: it should respect the environment and preferably be ecological.

In this study, the grass characteristics were evaluated using the method of the Study and Control Group of Varieties and Seeds [11]. The comparison of grass characteristics was made in relation to *Cynodon dactylon* and *Paspalum conjugatum*, commercially available varieties of Spanish and American origin, respectively. For each characteristic, a relative score was given to each taxon. Thus, each range of observation corresponds to a relative score, with the scale ranging from 1 (poor behavior of the plant for the characteristic) to 9 (very good behavior of the plant for the characteristic): 100 (9), <100% and >87.5% (8), <87.5% and >75% (7), <75% and >62.5% (6), <62.5% and >50% (5), <50% and >37.5% (4), <37.5% and >25% (3), <25% and >12.5% (2), and <12.5% and >0% (1).

2.2.1. Overall Aesthetic Aspect

This refers to the synthetic appreciation of the behavior of the plant cover; it results from the evaluation of the interaction of external factors (weather, pests, nutrition), the appearance of the lawn, soiling, the color and fineness of the foliage, and the density of the plant carpet [12] [13] [14]. Ratings were performed every month at each site. For each taxon, the averages of the different observations were calculated. Data was collected from 2017 to 2019 at both sites. The aesthetic aspects of rainy and dry seasons, which are used to calculate the sports index, were also calculated based on seasonal specificity.

2.2.2. Lawn Density

This is the state of soil coverage by the plant carpet appreciated one year after sowing. The sowings of 2017, 2018, and 2019 allowed the data for 2018, 2019, and 2020 to be obtained, respectively, for the calculation of taxon averages [11].

2.2.3. Tolerance to Trampling and Uprooting

It is evaluated from trampled trials by evaluating the abundance of remaining vegetation after treatment [15] [16]. A match of an average of 90 minutes with players wearing cleats was organized in each experimental site per month. Ratings were performed every month from 2018 to 2020, and then averages were calculated.

Sports index = (5 × tolerance to trampling and uprooting + 2 × lawn density + 1 × rainy season aesthetic aspect + 1 × dry season aesthetic aspect + 1 × general aesthetic aspect)/10 [11].

2.2.4. Organization and Statistical Analysis of Data

Data was organized in Excel, and R software 4.1.2 was used to establish differences between means. Similar data arranged in the same orientation and fol-

lowed by different letters present a significant difference in comparison.

3. Results and Discussion

3.1. Results

3.1.1. Aesthetic Aspect

The behavior of the plant cover in interaction with external factors (weather, pests, nutrition), soiling, the color, and fineness of the foliage is an essential characteristic for the orientation of a grass taxon for a given use. This parameter is evaluated in three aspects: the overall aesthetic aspect, the rainy season aesthetic aspect, and the dry season aesthetic aspect. The development of vegetation strongly depends on weather conditions. The life cycle of grasses is often highly seasonal. Observing phenological changes has shown a positive correlation between the amount of precipitation and the growth/development dynamics of taxa, with a simple and unique measure to evaluate the response. The seasonal dynamics of the bimodal rainfall agro-ecological zone of Cameroon depend on the precipitation during the year. Grass growth is positively influenced by the amount of rainwater and, more precisely, water availability. In the rainy season, the local grasses' growth is maximal, and the growth/development phases are optimal.

Our results show that there is a significant difference in aesthetic aspect among the taxa and depending on the seasons (Table 1). Table 1 shows the aesthetic aspects of different grass taxa evaluated in three aspects: overall aesthetic aspect (AEG), rainy season aesthetic aspect (AESP), and dry season aesthetic aspect (AESS). The data presented are mean values with standard deviations (±) based on observations made in 2017, 2018, and 2019.

Table 1. Aesthetic aspects of the taxa.

Taxa	AEG	AESP	AESS
Agrostis rupestris	5.05 ± 1.15c	5.5 ± 0.85bcd	3.36 ± 0.20h
Axonopus compressus	4.72 ± 1.17d	5.09 ± 1.00ef	3.31 ± 0.58h
Cynodon cf Cnodon dactylon	5.57 ± 0.42b	5.68 ± 0.41b	5.17 ± 0.14de
Cynodon dactylon	6.16 ± 0.67a	6.39 ± 0.56a	5.3 ± 0.21cde
Digitaria sp.	4.37 ± 1.22e	4.79 ± 1.00f	2.79 ± 0.47i
Eleusine indica	5.36 ± 0.73b	5.63 ± 0.52bc	4.33 ± 0.49g
Eragrostis tremula	4.06 ± 0.45f	4.24 ± 0.30g	3.39 ± 0.28h
Sporobolus natalensis	4.11 ± 0.41f	4.27 ± 0.28g	3.51 ± 0.29h
Sporobolus pyramidalis	3.92 ± 0.49f	4.22 ± 0.36g	3.25 ± 0.29h

(AEG: overall aesthetic aspect, AESP: rainy season aesthetic aspect, and AESS: dry season aesthetic aspect. Data from 2017, 2018, and 2019).

In Table 1, the different grass taxa are listed in the first column, while the mean values for the three aesthetic aspects (AEG, AESP, and AESS) are presented in the subsequent columns. The values are presented as mean ± standard deviation based on observations made in 2017, 2018, and 2019. The letters within the values indicate significant differences ($p < 0.05$) between the taxa and the different aesthetic aspects. Taxa with the same letter are not significantly different from each other, while those with different letters are significantly different. For example, *Agrostis rupestris* and *Axonopus compressus* are not significantly different from each other in terms of overall aesthetic aspect (AEG), but they are significantly different from *Cynodon dactylon*, which has the highest AEG value.

The overall aesthetic aspect resulted in the grouping of the taxa into two groups: those with a value greater than or equal to 5 and those with a value lower than 5. Thus, *Cynodon dactylon*, *Cynodon* cf *Cynodon dactylon*, *Eleusine indica*, and *Agrostis rupestris* are in group 1, while *Axonopus compressus*, *Digitaria* sp., *Sporobolus natalensis*, and *Eragrostis tremula* are in group 2.

As for the seasonal aesthetic aspects, they allowed to observe the behavior of each taxon according to precipitation. The seasonal effect is significantly noticeable in all taxa, revealing that water availability is a determining factor in the aesthetic aspect of the taxa. However, it should be noted that some taxa show greater sensitivity to the aesthetic aspect depending on the seasons, with values that can vary by more than one and a half units from one season to another, such as *Agrostis rupestris* (5.5 to 3.36), *Axonopus compressus* (5.09 to 3.31), and *Digitaria* sp. (4.79 to 2.79). Water availability is a determining factor in the aesthetic aspect of the grass. The beauty of lawn grasses is enhanced with water availability.

3.1.2. Density of Grass Taxa

The degree of soil coverage by the vegetative mat is the parameter for measuring the turfing power of the taxa. It refers to the speed of colonization of space and the establishment of the lawn. The taxa showed significant differences in terms of density (Figure 1).

In terms of colonization speed, the local taxon *Cynodon dactylon* was found to be fast with an average score of 7.67, followed by *Sporobolus pyramidalis* at 6.67, *Sporobolus natalensis* at 6.46, *Cynodon* cf *Cynodon dactylon* and *Eragrostis tremula* at 6.25, *Eleusine indica* at 6.08, and *Agrostis rupestris* at 5.67, which all revealed mean densities above 5. Based on the establishment of the vegetative mat over time, these taxa have a noticeable potential for turfing sports fields. As for the taxa *Axonopus compressus* and *Digitaria* sp., with respective scores of 4.92 and 4.67, additional measures would be necessary. Grasses occupy space by two means: vegetative multiplication and generative multiplication. The former is done by tillering, while the latter involves seed production. At the base of the primary leaves, buds develop that will give rise to new tillers. The number of tillers in a meadow is a balance that depends on seasonal trends, climatic conditions, and taxa.

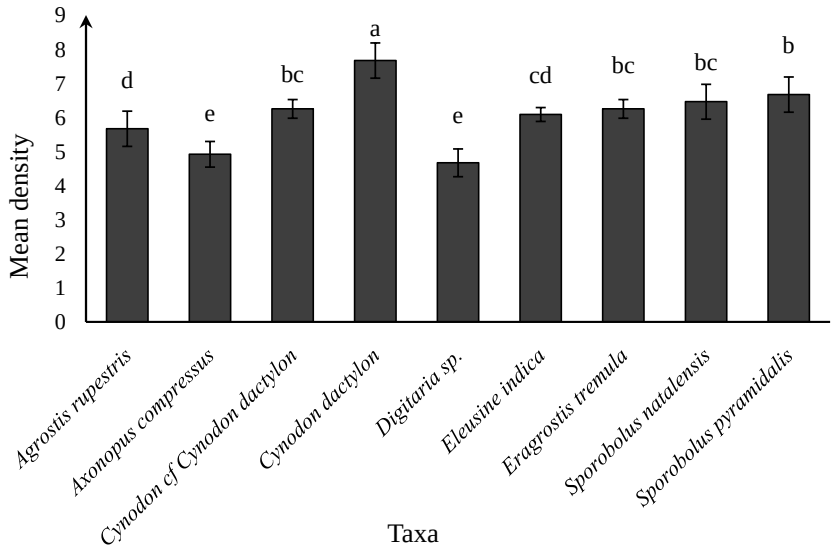

Figure 1. Mean densities of taxa (averages of data from 2018, 2019, and 2020).

3.1.3. Tolerance to Trampling and Uprooting

Resistance to trampling and uprooting refers to the potential of a turf grass to withstand the impact of cleats on the one hand, and the anchoring force of its roots in the substrate on the other hand. This characteristic reveals a significant difference between the taxa (**Figure 2**).

With the exception of the taxon *Digitaria* sp., whose average resistance is 4.83, all taxa show satisfactory resistance. *Sporobolus natalensis*, *Cynodon dactylon*, *Eleusine indica*, and *Eragrostis tremula* show very good resistance with scores of 7.64, 7.34, 7.18, and 7.04, respectively. *Cynodon* cf *Cynodon dactylon* and *Sporobolus pyramidalis* show good resistance with scores of 6.73 and 6.22, respectively. *Agrostis rupestris* at 5.62 and *Axonopus compressus* at 5.39 show fair and exploitable resistance in the creation and/or improvement of sports lawn resistance.

3.1.4. Sports Index

The choice of a grass for a lawn mixture with respect to its use in the establishment of a sports lawn refers to its sports index. This choice of a taxon depends on the intensity of use of the lawn, the climatic conditions of the environment, and its adaptability and availability. The time of use is proportional to the sports index and therefore the potential for sports use. The local turf grass taxa under study reveal a variability of the sports index, with satisfactory scores under local conditions (**Table 2**).

Based on their potential for sports use, *Cynodon dactylon*, *Eleusine indica*, *Sporobolus natalensis*, and *Cynodon* cf *Cynodon dactylon* stand out with very good sports indices of 6.989, 6.338, 6.301, and 6.257, respectively. These scores are exploitable at different levels of practice of sports disciplines on the lawn. *Eragrostis tremula*, *Sporobolus pyramidalis*, and *Agrostis rupestris* present fair values of 5.939, 5.583, and 5.335, respectively. *Axonopus compressus* and *Digitaria* sp. show significant sports index values of 4.991 and 4.544, respectively.

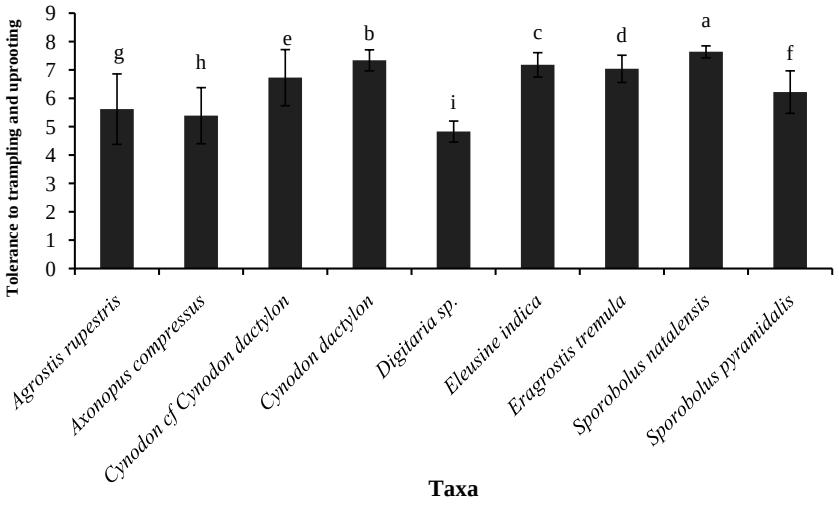

Figure 2. Tolerance to trampling and uprooting of taxa (data from 2017 to 2020).

Table 2. Sports indices of taxa (averages of data from 2017 to 2020).

Taxa	Sport Index	Potential for sports use
Digitaria sp.	4.544	Low
Axonopus compressus	4.991	
Agrostis rupestris	5.335	Good
Sporobolus pyramidalis	5.583	
Eragrostis tremula	5.939	
Cynodon cf Cynodon dactylon	6.257	Very good
Sporobolus natalensis	6.301	
Eleusine indica	6.338	
Cynodon dactylon	6.989	

3.2. Discussion

It is difficult to imagine sports disciplines performing on a lawn without natural grass. Many popular sports disciplines like football, cricket, rugby, baseball, tennis, hockey, and golf are played on grassy fields [3]. The local grass taxa of the agro-ecological zone with bimodal rainfall, which were the subject of this study, revealed variable lawn characteristics. Depending on the sports discipline and level of practice, this variability allows for the orientation towards the use of a given taxon. The selection of grasses for a lawn is very important for sports field preparation because the lawn characteristics of grasses vary from one species to another [3]. The choice of grasses for a sports lawn must meet more or less strong agronomic requirements depending on the usage and pedoclimatic conditions. Their ability to establish, develop, and regenerate is important.

Before establishing a natural lawn, it is important to know the different grass taxa that can be used, as natural lawns are favored by athletes. The players' per-

formance depends on the quality of the grass surface in terms of traction, resistance, and regularity [4]. The ratings for resistance to trampling and tearing, the density of the vegetative cover, and the aesthetic aspect guide the choice of a species for its use. However, in the choice of species, the speed of germination, resistance to trampling and tearing are given priority.

The main characteristic of a sports-type lawn is its high resistance to repeated trampling. The sports lawn must offer a safe playing surface for athletes. The grass must be strong enough to withstand and quickly recover from damage caused by sporting events [4]. The evaluated taxa presented varying levels of resistance. A first group of taxa with a resistance score above 7, including *Sporobolus natalensis*, *Cynodon dactylon*, *Eleusine indica*, and *Eragrostis tremula*, are potential species of good choice for sports lawns for sports such as football and rugby. These grasses provide a firm base, shock resistance, and tear resistance. Football fields are very exposed to grass damage; therefore, vigorous growth grasses are preferred because they allow for quick regeneration after damage [17]. Rugby involves intense trampling of the lawn and a generally sustained destruction by several pairs of cleats during the game [18]. *Cynodon* cf *Cynodon dactylon* and *Sporobolus pyramidalis* reveal resistance scores above 6, which are exploitable for sports lawns of satisfactory level. *Agrostis rupestris* and *Axonopus compressus* reveal scores slightly above 5. Their use for sports lawns would only require specific measures to be taken into account. The *Digitaria* sp. taxon showed a low score, requiring more particular attention to its use in sports lawns. Considering the lawn characteristics revealed by the evaluated taxa, their exploitation is possible and favorable for the establishment of lawns of satisfactory level, all the more so as they are in their natural ecosystem. The use of plant material in their original ecosystem can be an excellent treatment [19]. The use of local grasses would be preferable due to their reduced threat to indigenous ecosystems and their greater resistance. Local species represent an important source of genetic variability that can be used to support specific plant breeding programs. The genetic material of the selected turf ecotypes in potential use zones or in similar environments is much more likely to succeed in obtaining new turf cultivars [20]. Being endemic species, their expression presents scores similar to those of commercialized varieties whose data is contained in catalogs.

The selection of grasses for a lawn is very important because it must meet the characteristics of the game, be effective in the climatic conditions of the environment, and not hinder the players' performance, speed, bounce, and ball roll [6]. From the most favorable taxon for the establishment of lawns to the one requiring more specific measures, they are respectively *Cynodon dactylon*, *Eleusine indica*, *Sporobolus natalensis*, *Cynodon* cf *Cynodon dactylon*, *Eragrostis tremula*, *Sporobolus pyramidalis*, *Agrostis rupestris*, *Axonopus compressus*, and *Digitaria* sp. There are 9 species and 10 varieties of *Cynodon* in the world that are widely distributed, genetically diversified, and generally considered pioneer species for restoration [21]. *Cynodons* thrive in overgrazed pastures and other disturbed and degraded sites [22]. These local grass taxa for a lawn can be used

to varying degrees of importance. The variability of the aesthetic aspect of taxa during the seasons on the one hand and, to a lesser extent, their resistance to trampling on the other hand, would allow for better control of the potential lawns established like the already commercialized varieties. The lawn acts as a natural cushion and reduces the risk of injury [23]. Rhizomatous grasses such as *Cynodon dactylon*, *Cynodon* cf *Cynodon dactylon*, and *Digitaria* sp. are widely used due to their strong ability to form a natural cushion. Upright-growing taxa such as *Arostis rupestris*, *Eleusine indica*, *Eragrostis tremula*, *Sporobolus natalensis*, and *Sporobolus pyramidalis* reinforce the resistance and tear resistance of the lawn. Mixtures of different well-chosen local taxa thus allow for the establishment of sports lawns better adapted to their own ecosystem and the climatic conditions prevailing there. The selection of local grasses for a lawn and their scientific management is strategic for improving the quality of the game and the players' performance in grass sports disciplines [3].

4. Conclusion

Each of the studied taxa showed an exploitable and favorable score for use in the establishment of natural lawns for sports purposes. Being endemic grass species of the agro-ecological zone with bimodal rainfall in Cameroon, the local conditions allow for their more optimal agronomic expression.

Highlight

The article discusses the potential for nine local grass taxa to be used for sporting purposes in lawn development within the agro-ecological zone with bimodal rainfall in Cameroon.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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