Scientific Article

# Substrates in the development of a sports turfgrass "Tifton 419"[1]

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**ABSTRACT**

Bermuda grass are the most widely used today in high performance sports fields, the cultivar "Tifton 419" is widely indicated for installation in these areas, however, there is no official a recommendation in the literature of the best substrate for the implantation of this species, and research is needed to meet this demand. In this way, the objective of this study was to evaluate the influence of substrates in the development of the "Tifton 419" sporting lawn. The experiment was conducted in field with grass carpets implanted in black plastic containers (volume 8.46 L), in a completely randomized design with five substrates and 12 replicates, with treatments: soil (100%), medium sand (100%), soil (50%) + medium sand (50%), soil (33%) + medium sand (33%) + organic compost (33%) and medium sand (50%) + organic compost (50%). Macro and microporosity, total porosity, density, chlorophyll content ($a + b$) and fresh and dry leaf mass were evaluated. The results showed that there was influence of the substrate on the development of the turfgrass, with the medium sand (50%) + organic compost (50%) presenting greater increases of fresh and dry mass (1.09 and 0.44 kg $m^{-2}$), which may lead to higher maintenance costs of the cut, and soil (33%) + medium sand (33%) + organic compost (33%) presented good results of the analyzes performed, being the one recommended for the development of the cultivar "Tifton 419" in sports fields.

**Keywords:** *Cynodon* spp., bermuda grass, organic compost, physical properties

**RESUMO**

**Substratos no desenvolvimento de gramado esportivo "Tifton 419"**

As gramas bermudas são as mais utilizadas atualmente em campos esportivos de alta performance, sendo o cultivar "Tifton 419" amplamente indicado para instalação nessas áreas, contudo, não existe na literatura uma recomendação oficial do melhor substrato para implantação dessa espécie, sendo necessárias pesquisas para suprir essa demanda. Dessa forma objetivou-se avaliar a influência de substratos no desenvolvimento do gramado esportivo cultivar "Tifton 419". O experimento foi conduzido a campo com tapetes de grama implantados em recipientes de plástico preto (volume 8,46 L), em delineamento inteiramente casualizado com cinco substratos e 12 repetições, sendo os tratamentos: solo (100%), areia média (100%), solo (50%) + areia média (50%), solo (33%) + areia média (33%) + composto orgânico (33%) e areia média (50%) + composto orgânico (50%). Foram avaliados: macro e microporosidade, porosidade total, densidade, teor de clorofila ($a + b$) e massa fresca e seca das folhas. Os resultados demonstraram que houve influência do substrato no desenvolvimento do gramado, sendo que a areia média (50%) + composto orgânico (50%) apresentou maiores incrementos de massa fresca e seca (1,09 e 0,44 Kg $m^{-2}$), o que pode ocasionar em maiores gastos de manutenção do corte, e solo (33%) + areia média (33%) + composto orgânico (33%) apresentou bons resultados das análises realizadas, sendo esse o recomendado para desenvolvimento do cultivar "Tifton 419" em campos esportivos.

**Palavras-chave:** *Cynodon* spp., grama bermuda, composto orgânico, propriedades físicas

## 1. INTRODUCTION

Since the beginning of the decade in Brazil, there has been a great increase in the market for production and maintenance of turfgrass, including sports ones (SILVA-KOJOROSKI et al., 2012). Thus, it is estimated that there are currently 238 producers producing approximately 20 varieties of grass (ANTONIOLLI, 2015). Together with this economic growth, the realization of the World Cup in 2014 and the 2016 Olympics have allowed, second Kuhn (2015) to make updates to the technologies of production, maintenance and development of sports fields.

A species with wide use in these events were the Bermuda grass (*Cynodon* spp.), that can be adopted in fields for practice of soccer, polo, golf, tennis and baseball (ALDAHIR, 2012). They are hot-season species, originating in the African continent with high growth rate and strong recovery after cutting (LORENZI, 2015). According to Gurgel (2012) several hybrids, such as the cultivars "Celebration" and "Tifton 419", were installed in Brazil in the last years, and they are widely recommended for sports fields. They are plants that present stoloniferous-rhizomatous growth habit, which allows greater resistance to trampling, as well as softness, which facilitates the ball

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bearing and cushion the impact of the players (GODOY et al., 2016).

However, grassy areas need to be installed on substrates suitable for their development, and at the same time provide a good practice of the sport (KUHN, 2015). The substrate must have good aeration and drainage, because when it rains, there may be flooding on the turfgrass or even nutrient unavailability due to compaction (SANTOS and CASTILHO, 2016). In soccer fields, according to Mateus et al. (2017), the compaction is a factor that maximizes the occurrence of knee and ankle injuries, being essential, substrates with low density for a good practice of the game, with better ball bearing, allowing a greater percentage of correctness of the passes and preserving the integrity physics of the players. According to Aldahir (2012), several studies are being conducted, aiming at the best type of substrate for installation of sports fields, based on soil, sand and organic compost.

According to Mateus et al. (2017) sand is the main component due to its high drainage capacity, already the organic compound has the role of supplying the physical needs (porosity and density) and chemical, since it provides increase of pH, and consequently greater availability of nutrients and neutralization of toxic aluminum (SANTOS and CASTILHO, 2016), while the soil works to better support the species. However, according to Godoy et al. (2012) in Brazil, there is no official recommendation for implementation and maintenance of the turfgrasses, and all information is based on international standards of USGA (UNITED STATES GOLF ASSOCIATION) for golf course *greens* (MATEUS et al., 2017), thus, there is a need for research to solve this demand. Thus, the objective was to evaluate the influence of substrates in the development of a sports turfgrass of Bermuda grass “Tifton 419”.

## 2. MATERIAL AND METHODS

The work was conducted in the field, from April 14th to June 16th 2017, with average data of 23.5 ºC air temperature and 81% relative humidity (DADOS CLIMÁTICOS, 2017). The species used was Bermuda grass cultivar “Tifton 419” (interspecific hybrid of *C. dactilon* x *C. transvalensis*), obtained from the company “Itograss Agrícola Alta Mogiana Ltda”, acquired in carpet format, and cut into pieces of size 0.4 x 0.15 m and implanted in black plastic containers (47.5 x 17.5 cm nozzle, 41.5 x 11.3 cm deep, height equal to 15.5 cm, volume equal to 8.46 liters) with drainage holes at the bottom. The experimental design was completely randomized with five substrates and 12 replicates. The treatments were: soil (100%), medium sand (100%), soil (50%) + medium sand (50%), soil (33%) + medium sand (33%) + organic compost (33%) and medium sand (50%) + organic compost (50%).

The soil used was the Dystroferric Red Latosol (layer 0-20 cm), from a University Experimental Farm. The organic compost was decomposed for one year, consisting of Bahiagrass leaves and corral manure (1:1) and the medium sand (whose particles have diameters between 0.2 and 0.6 mm) was acquired in local commerce and later washed.

Irrigation management was carried out manually daily, and the containers received water until saturation, that is, until they were filled in order to ensure that the water factor did not interfere with the results of the experiment. Weed management was performed manually whenever necessary.

In order to meet the nutritional requirements of the grass, as occurs in sports turfgrass (MATEUS et al., 2017), a commercial fertilizer was applied at a dose of 125 g $m^{-2}$ (manufacturer’s recommendation). The fertilizer was spread on each treatment and then watered until the filling (saturation) of the containers, the fertilizer having the following composition: 13% N, 5% $P_2O_5$, 13% $K_2O$, 1% Ca, 1% Mg, 5 % S, 0.04% B, 0.05% Cu, 0.2% Fe, 0.08% Mn, 0.005% Mo and 0.15% Zn.

Was performed physical analysis of the substrates, evaluating macro and microporosity, total porosity, macroporosity ratio by total porosity and density. Samples were taken from each of the five substrates on the day of the experiment installation (April 14th, 2017) and they were deformed, and determinations were performed according to EMBRAPA (1997) methodology.

For the development of the turfgrass was evaluated: a) The chlorophyll content of the leaves according to the methodology described by Lichtenthaler (1987), for the determination of total chlorophylls (*a* + *b*), being randomly collected from each treatment 5 g of vegetal material and extracted with acetone 80%, for that, it was realized an average of the four collections made on the days: April 28th, May 12th and 26th and June 15th 2017; b) Fresh mass and dry mass of the leaves: all the leaves of the turfgrass of each container were cut and placed in previously tared and identified paper bags, then weighed and the fresh mass checked, the dry mass being determined after the samples were allocated in drying oven, at 60 °C, and weighed after 72 h (ARRUDA, 1997). The weighings were performed in balance of 0.01 precision and the cut of the treatments carried out on June 15th 2017.

The results were submitted to analysis of variance (ANOVA) and Tukey test at the 5% probability level for comparison of means, using the SISVAR program (FERREIRA, 2014).

## 3. RESULTS AND DISCUSSION

According to the analysis obtained for the substrates, the highest macroporosity results occurred in medium sand (50%) + organic compost (50%), which presented an average of 16.07%, not statistically differing only in medium sand (100%) (11.57%). The treatments soil (100%), soil (50%) + medium sand (50%) and soil (33%) + medium sand (33%) + organic compost (33%) presented values of 6.83%, 7.03% and 6.97%, respectively, being statistically the same among themselves (Table 1).

**Table 1.** Average values of Macroporosity (Ma), Microporosity (Mi), Total Porosity (TP), Macroporosity ratio by Total Porosity (Ma /TP) and Density (D) of substrates.

| Substrate | Ma (%) | Mi (%) | TP (%) | Ma/TP | D (g cm$^{-3}$) |
|---|---|---|---|---|---|
| S (100%) | 6.83 b | 44.0 a | 50.83 a | 0.13 a | 1.21 c |
| MS (100%) | 11.57 ab | 38.30 a | 49.87 a | 0.28 a | 1.51 ab |
| S (50%) + MS (50%) | 7.03 b | 34.70 a | 41.73 a | 0.17 a | 1.54 a |
| S (33%) + MS (33%) + OC (33%) | 6.97 b | 38.23 a | 45.17 a | 0.18 a | 1.30 bc |
| MS (50%) + OC (50%) | 16.07 a | 33.07 a | 49.10 a | 0.33 a | 1.20 c |
| C.V.C. (5%) | 6.11 | 37.40 | 32.21 | 0.24 | 0.23 |
| CV (%) | 23.43 | 36.94 | 25.31 | 41.15 | 6.30 |
| F | 9.71** | 0.27$^{ns}$ | 0.302$^{ns}$ | 2.50$^{ns}$ | 10.97** |

Averages followed by the same do not differ at the level of 5% of significance by the Tukey test. ns- not significant;
* - significant at 5% by the F test;
** - significant at 1% by the F test. S- Soil, MS- Medium Sand, OC- Organic Compost. C.V.C. - Critical Value for Comparison. CV - Coefficient of Variation

According to Bigelow et al. (2013), values lower than 10% of macropores in the soil are detrimental to grass root growth. USGA (2018) recommend values of 15-30% macroporosity for installation of turfgrass in golf courses, with only medium sand (50%) + organic compost (50%) within this range. Second Reichert et al. (2009) the macropores are responsible for the aeration and contribution in the infiltration of water in the soil. For Genro Junior et al. (2009), the ideal ratio of macropores to total porosity is 0.33, and indicates a good relationship between aeration capacity and water retention in the soil; thus, according to Table 1, only the medium sand (50%) + organic compost (50%) presented such value, however, there was no statistical difference between the treatments.

Santos et al. (2016) working with turfgrass of *Zoysia japonica* (emerald grass), found value of macropores in the soil evaluation of 8.68%. Arrieta et al. (2009) in a golf course composed of Bermuda grass, observed macroporosity of 9.11% and 10.10% in different areas. Also, in a study with soil physical characterization for the development of emerald grass, Santos and Castilho (2016) observed the value of 12.67%, being only medium sand (50%) + organic compost (50%) above that mentioned, and the other treatments, below.

For the values of microporosity (Table 1), it was observed that soil (100%) had a higher percentage (44%) and medium sand (50%) + organic compost (50%) had the lowest value (33.07%), however there was no statistical difference between any of the substrates. USGA (2018) considers values between 15% to 25% of ideal microporosity in the installation of sports fields. Therefore, all the treatments presented results above the above.

Arrieta et al. (2009) evaluating the physical properties of the soil in a golf area for the development of *Cynodon* spp. found values of 40.52% and 40.75%, results close to that of the present study and Santos and Castilho (2016) observed 36.67% of micropores in the soil where the emerald grass was implanted.

When evaluating the total porosity data (Table 1), it is observed that there is no statistical difference between the substrates, with soil (50%) + medium sand (50%) and soil (100%) being the extreme average (41.73% and 50.83%).

The USGA (2018) considers values between 35-55%, suitable for total porosity, so that there is adequate growth and development in sports turfgrass, and in the present work, all substrates are within the mentioned. Lewis et al. (2010) showed a value of 44% in the first year of the installation of a golf course, and Dhanalakshmi et al. (2018) recommend that the soil should have 50% total porosity for the establishment of Bermuda grass.

For the density of the substrates (Table 1), soil (50%) + medium sand (50%) showed the highest value (1.54 g cm$^{-3}$), being statistically equal only to medium sand (100%). The medium sand (50%) + organic compost (50%) presented the lowest density (1.20 g cm$^{-3}$), being equal to soil (100%) and soil (33%) + medium sand (33%) + organic compost (33%). According to Santos et al. (2016) in general, the higher the total porosity, the lower the density of a substrate, and this fact was observed in the present work (Table 1).

USGA (2018) states that for the appropriate range of total porosity cited previously, is expected a density range of 1.19-1.72 g cm$^{-3}$ for growth and development of sporting turfgrass, so only medium sand (100%) and medium sand (50%) + organic compost (50%) are outside the mentioned. Brandy and Weil (1989) considered ideal ranges of density values ranging from 1.3 to 1.6 g cm$^{-3}$, being densities greater than 1.7 g cm$^{33}$ restrictive to plant growth. Under these conditions, only the substrates, medium sand (100%), soil (50%) + medium sand (50%) and soil (33%) + medium sand (33%) + organic compost (33%) offer sufficient densities for the development of the species. Dhanalakshmi et al. (2018) observed that in soil with a density of 1.35 g cm$^{-3}$, Bermuda grass responded well to vegetative development. Bigelow et al. (2013) presented an even more restricted range for turfgrass development, between 1.4-1.6 g cm$^{-3}$ and according to this interval only medium sand (100%) and soil (50%) + medium sand (50%), would be able to provide adequate grass development.

**Table 2.** Average of chlorophyll content (*a* + *b*), fresh and dry mass of Bermuda grass leaves "Tifton 419"

| Substrate | Chlorophyll (*a* + *b*) | Fresh Mass | Dry Mass |
|---|---|---|---|
| | μg g$^{-1}$ MF | Kg m$^{-2}$ | |
| S (100%) | 479.19 d | 1.04 a | 0.43 a |
| MS (100%) | 481.26 d | 0.61 b | 0.26 b |
| S (50%) + MS (50%) | 560.32 c | 0.81 ab | 0.35 ab |
| S (33%) + MS (33%) + OC (33%) | 738.55 a | 1.01 a | 0.41 a |
| MS (50%) + OC (50%) | 716.21 b | 1.09 a | 0.44 a |
| C.V.C. (5%) | 14.18 | 0.34 | 0.14 |
| CV (%) | 2.07 | 32.74 | 31.41 |
| F | 1239.17** | 5.48** | 4.78** |

Averages followed by the same do not differ at the level of 5% of significance by the Tukey test. ns- not significant;
* - significant at 5% by the F test;
** - significant at 1% by the F test. S- Soil, MS- Medium Sand, OC- Organic Compost. μg g$^{-1}$ MF – microgram per gram of fresh mass. Kg m$^{-2}$ – kilogram per square meter. C.V.C. - Critical Value for Comparison. CV - Coefficient of Variation.

At Table 2, it is observed that the best result of chlorophyll (*a* + *b*) was obtained in soil (33%) + medium sand (33%) + organic compost (33%) (738.55 μg g$^{-1}$ MF), differing from the other treatments. The lowest value was obtained by soil (100%) (479.19 μg g$^{-1}$ MF) and was statistically equal only to medium sand (100%) (Table 2).

Barbosa et al. (2017) evaluating the concentration of pigments in an ornamental grass of Bahiagrass (*Paspalum notatum*), observed a average value of 2000 μg g$^{-1}$ MF, very high when compared to the present work, possibly because they are of different species. Rodrigues et al. (2006), working with physiological analyzes of five cultivars of *Cynodon* found a range of 2132 to 2812 μg g$^{-1}$ MF, results higher than those found in the present study. However, Brosnan et al. (2011) in *Cynodon dactylon* found values varying from 127.8 to 192.9 μg g$^{-1}$ MF, these concentrations were lower than those observed in this work (Table 2).

The substrate components may have influenced the results of the chlorophyll content of the leaves. The soil (33%) + medium sand (33%) + organic compost (33%), which presented good results in the physical analyzes, with good total porosity and density (Table 1) also showed a better result of chlorophyll. Soil (100%), which presented the lowest pigment value, presented a macroporosity result lower than 10%, which according to Bigelow et al. (2013) harms turfgrass growth, and below that suggested by USGA (2018) of 15-35%.

Santos and Castilho (2016), working with physical characterization of substrates and their influence on the development of emerald grass, observed that the treatment composed only of soil presented low values in the physical analyzes and this reflected the leaf chlorophyll content found by the authors. In the present work, the same occurs, because soil (100%) presented macroporosity below the recommended value and consequently the lowest result of chlorophyll concentrations, corroborating with the cited.

The chlorophyll content of a sports turfgrass is important due to its aesthetic aspect, that is, it must have good density and intense green coloration (LIMA et al., 2012). According to Godoy et al. (2012), chlorophylls are responsible for this green tonality in plants, and the higher the concentration in leaf contents, the more intense the color of a grass. Thus, it is expected that the soil (33%) + medium sand (33%) + organic compost (33%) present a greater green tone when compared to the other substrates.

These results of leaf chlorophyll concentrations indirectly reflect the amount of nitrogen and magnesium in leaves since, according to Taiz and Zeiger (2017) chlorophylls are molecules formed by complexes derived from porphyrin, having as the central atom the magnesium, linked to four others of nitrogen. Thus, there is a correlation between the chlorophyll index and the nutritional status of the plant (SANTOS and CASTILHO, 2015; OLIVEIRA et al., 2018) it was inferred that the soil (33%) + medium sand (33%) + organic compost (33%) more efficiently meets the nutritional requirements of N and Mg of the turfgrass than the other treatments.

Another factor that proves that the type of substrate influenced the development of the turfgrass is the fact that in all the treatments a fertilization was carried out on the day of installation of the experiment with a commercial fertilizer (125 g m$^{-2}$ dose). Being that the product contains N and Mg in its composition (Table 1), which are the main components of chlorophyll (TAIZ and ZEIGER, 2017), evidencing that substrate composed of soil (33%) + medium sand (33%) + organic compost (33%) best retained these nutrients, which were absorbed by the plant, and reflected in the chlorophyll results (Table 2). Santos et al. (2012) state that depending on the substrate, there may be difficulties in the absorption of nutrients by the grass, and less efficiency of the use of the same by the plant, occurring loss of chlorophyll molecules due to the unavailability of N and Mg in adequate quantities.

For the fresh and dry mass of the leaves (Table 2), it was observed that the medium sand (50%) + organic compost (50%) presented the highest values of the analyzes (1.09 and 0.44 kg m$^{-2}$), differing only from medium sand (100%) with the lowest results (0.61 and 0.26 kg m$^{-2}$).

Amaral et al. (2016), in working with substrates and shading in Bermuda grass "Tifton 419", observed that after 30 days of installation of the experiment on the full sun treatment, they were obtained values of 0.03 to 0.16 kg

$m^{-2}$ fresh mass and 0.01 to 0.05 kg $m^{-2}$ dry mass, results that differ from those found in the present work. Silva-Kojoroski et al. (2012) in working with the same cultivar “Tifton 419”, observed a mean of 0.31 kg $m^{-2}$ of dry mass, being this value closer to those found in Table 2.

It was also noted that the substrates exerted influence on the production of fresh and dry mass of the turfgrass, and the substrates, medium sand (100%) and soil (50%) + medium sand (50%) presented the highest densities in the physical analyzes (Table 1) and the lowest fresh and dry mass results (Table 2). According to Santos et al. (2012), the greater the density of a substrate, the greater the compaction, which reduces the drainage of the water near the root system, the respiration of the roots, and makes it difficult to transport the nutrients in the soil, damaging the plant growth.

Santos and Castilho (2016), working with different substrates in emerald grass, observed that the density levels found (0.99, 1.02, 1.23, 1.28 and 1.46 g $cm^{-3}$) influenced production of fresh and dry mass, and the higher the value, the lower the mass produced. In an experiment evaluating the responses of three species of grams submitted to compaction treatment with roller compactors, Carrow (1980) can observe that the increase of the soil density directly interferes with the growth of the plants, making it limited mainly by the change in the porous spaces. However, Silva-Kojoroski et al. (2002), using different turfgrass species (São Carlos, Emerald and Tifton 419) and two levels of compaction verified the absence of density effect on dry mass production, attributing the existence of genotype differences in soil compaction tolerance.

Mateus et al. (2017) in a study of substrate components for sports fields with “Tifton 419”, observed that there was influence on the results of dry mass produced in the plants conducted in the different compositions. Santos and Castilho (2016) observed that the substrate density influenced the production of fresh mass (1.09 to 2.4 kg m-2) and dry mass (0, 45 to 0.84 kg m-2) in emerald grass. Santos et al. (2016) also found influence of the substrate in the development of an ornamental turfgrass. The authors concluded that the higher the mass value produced, the greater the expense for the maintenance cut. In the present work there was a considered difference between the highest and lowest values of fresh and dry mass produced, which is not a desirable result for turfgrass with sports function, because with the increase of leaves production of the shoot, there is also an increase in the need of cuts for the maintenance of both the aesthetics of the grass and to provide good conditions for the game (MATEUS et al., 2017). Thus, it can be inferred that the cutting machine will have to operate more frequently on the substrate composed of medium sand (50%) + organic compost (50%) than on the medium sand (100%), due to the difference of mass produced by them.

## 4. CONCLUSIONS

There is influence of the substrate in the development of the sports turfgrass of Bermuda grass cultivar “Tifton 419”. The substrate, composed of soil (33%) + sand (33%) + organic compost (33%), propitious good total porosity and density, and resulted in the best chlorophyll content and fresh and dry mass of the grass, being this the recommended one for development of “Tifton 419” in sports fields.

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## AUTHORS CONTRIBUTIONS

**P.L.F.S.**: Idea of the experiment, field analysis, data collection and analysis, interpretation, preparation and writing of the article, critical review **R.M.M.C.**: Adviser of work, analysis and interpretation of data, critical review of the article, approval of the final version of the article.

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