

# Empire Turf® chemical fertilization grown on three substrates

## Abstract

Empire Turf® was the first national cultivar developed, compared to traditional Emerald grass, the Empire is characterized by fast establishment, high erosion control, tolerance to irrigation with non-drinking water, firmer carpets, good drought and salinity tolerance, shading and low demands on soil fertility. However, despite all these desirable characteristics, the development and establishment of the grass will depend on its handling and especially on the substrate in which it is installed. Thus, this study evaluated the development of Empire Turf® conducted on three substrates, with chemical fertilization. The experiment was carried out in containers (volume of 8.5 L) filled with the treatments: T1 - soil; T2 - soil + sand + soil conditioner (1v:1v:1v) and T3 - soil + sand (1v:1v), forming a completely randomized design with three treatments and three repetitions, considering each container as an experimental unit. On March 30, 2019, the first evaluation was carried out, then the treatments received chemical fertilization (NPK+S 13-5-13+14), using 20g of the commercial product diluted in 2L of water, being a single dose per container. After 15 days, in the 2nd evaluation, it was evaluated: foliar chemical analysis, the foliar chlorophyll index (FCI), fresh mass (FM) and dry mass (DM). The results indicated that Empire Turf® presents a rapid response of 15 days, after maintenance fertilization with 10g L<sup>-1</sup> of NPK+S (13-5-13+14), having better development when cultivated in soil + sand compound substrate (1v:1v).

**Keywords:** gramiculture, turfgrass, *zoysia japonica*

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## Introduction

It is estimated that Brazilian gramiculture moves about 500 million of the national agricultural sector, with the states of São Paulo and Paraná being the main producers.<sup>1</sup> In this scenario, Emerald grass (*Zoysia japonica*) is the main species of grass produced, representing 80% of the total production area in Brazil.<sup>2,3</sup>

Popularly known, Emerald grass is a species often used for ground cover for several purposes: landscaping, slope protection and sports fields, due to its stoloniferous-rizomatous growth habit, high resistance to trampling and high rate of ground cover.<sup>3,4</sup>

Due to these characteristics and good market acceptance, Empire Turf® was developed, the first national cultivar from traditional emerald grass. The new cultivar has slightly wider and longer leaves compared to traditional emerald grass, with the following advantages: faster establishment, better erosion control, tolerates irrigation with non-drinking water, firmer mats, good tolerance to drought and salinity, shading and little demand on soil fertility.<sup>5,6</sup>

However, despite all these desirable characteristics, the development and establishment of the grass will depend on its handling and mainly on the substrate in which it is installed, and the type of soil or substrate may affect the development of the lawn.<sup>7-9</sup>

This is important because of the frequency with which lawns are installed in compacted or nutritionally poor soils, which in addition to hindering development, can cause loss of colour, presence of weeds and formation of superficial roots. Therefore, when choosing the substrate, it is essential that it provides the necessary nutrients and has desirable chemical and physical characteristics, since the composition of the substrate directly affects its texture and may influence its predisposition to compaction.<sup>9-11</sup>

Another important aspect for the establishment and development of lawns is the nutrient availability. Lawns, like any other crop, have nutritional requirements so that they can express their exuberance and complete their development.<sup>12</sup> However, there is no official recommendation of fertilization for lawn implantation and maintenance in the State of São Paulo, a fact that hinders the proper fertilization of species and cultivars, often resulting in erroneous fertilization.<sup>4,13</sup>

Thus, this study evaluated the development of Empire Turf® conducted on three substrates, with chemical fertilization.

## Material and methods

The experiment was conducted from March to April 2019 and installed in full sun. The lawn was installed in September 2018, where Empire Turf® mats were cut and implanted in black polyethylene containers (volume of 8.5L; dimensions of 47.5cmx17.5cm mouth; 41.5cmx113cm bottom and 15.5cm height), and filled with the treatments: T1 - soil; T2 - soil + sand + soil conditioner (1v:1v:1v) and T3 - soil + sand (1v:1v). Thus, a completely randomized design was formed, in factorial scheme 3x2, with three treatments (substrates) and two collection dates (before and after fertilization), with three repetitions, considering each container as an experimental unit.

The soil used was Dystroferic Red Latosol, removed from the surface layer of 0-20cm of a cerrado region. The conditioner, according to the producer, is composed of naturally decomposed pine bark and ashes, of a physical barbed nature. And the washed medium sand, was acquired in local commerce. Chemical (Table 1) and physical analysis of the substrates (Table 2 & 3) were performed.

On March 30, 2019, the foliar chlorophyll index (FCI) was measured using ChlorofiLOG (Falker Automação Agrícola, Brazil),

that is, before maintenance fertilization, and on the same day the first mowing of the lawn took place. After the removal of the plant biomass, fertilization with NPK+S 13-5-13+14 was performed, using

20g of the commercial product diluted in 2L of water, per container. After 15 days (April 14, 2019), the FCI was checked again and the second mowing of the lawn was performed.

**Table 1** Chemical analysis of the soil for use in Empire Turf®

Substrate	P-resin	MO	pH	K	Ca	Mg	H + Al	Al	SB	CTC	V
	mg dm <sup>-3</sup>	g dm <sup>-3</sup>	CaCl <sub>2</sub>	-----	mmol <sub>c</sub> dm <sup>-3</sup> -----						%
T1	3	9	5.8	0.3	12	8	16	0	20.3	36.3	55
T2	12	8	5.3	0.9	1	2	9	0	3.9	12.9	30
T3	89	24	6.4	6.3	154	34	9	0	194.3	203.3	96

T1 - soil; T2 - soil + sand + soil conditioner (1v:1v:1v); T3 - soil + sand (1v:1v)

**Table 2** Granulometric analysis, density and porosity of substrates used in the implantation of Empire Turf®

Treatments	Clay	Sand Total	Silt	Density	Macroporosity	Microporosity
	----- g Kg <sup>-1</sup> -----			(Kg dm <sup>-3</sup> )	----- % -----	
T1	62	936	2	1,27	14	39,2
T2	36	961	3	1,52	24	20,9
T3	59	939	2	1,31	18,4	32,4

T1 - soil; T2 - soil + sand + soil conditioner (1v:1v:1v); T3 - soil + sand (1v:1v)

**Table 3** Potential water retention of substrates used in the implantation of Empire Turf®

Treatments	Water retention (cm <sup>3</sup> cm <sup>-3</sup> )			
	0h	24h	48h	72h
T1	0,487	0,506	0,487	0,464
T2	0,413	0,431	0,413	0,389
T3	0,461	0,492	0,461	0,440

T1 - soil; T2 - soil + sand + soil conditioner (1v:1v:1v); T3 - soil + sand (1v:1v)

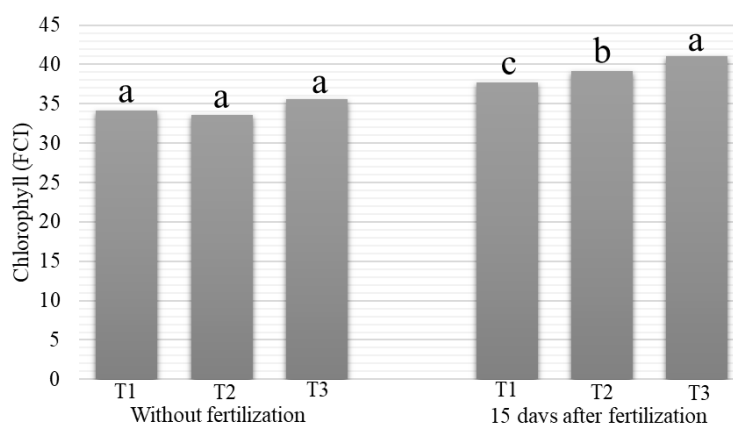
The leaves collected for both dates were weighed (Fresh Mass - FM) and then placed in a forced circulation oven at a temperature of 65°C for 72 hours to perform the drying. After drying, the leaves were again weighed (Dry Mass - DM) and crushed by knife mill. Foliar analysis (N, P, S, K, Ca, Mg, Cu, Fe, Zn and Mn) was performed according to Malavolta et al.<sup>14</sup> methodology.

The irrigation management was daily, where each container received 2L of water, until saturation, to avoid this factor interfering in the results. Weed control was done manually whenever necessary.

The data from FCI, FM and DM were submitted to analysis of variance ANOVA ( $p \leq 0.05$ ) and Tukey Test ( $\alpha = 0.05$ ), using the computer program: System for Analysis of Variance - SISVAR (Ferreira, 2019).

## Results and discussion

The results found in this study demonstrate that there was only a difference for the FCI after fertilization of the lawn (Figure 1). Before fertilization, the relative chlorophyll index provided values between 33.53 and 35.57 FCI, and did not differ from each other, with T3 presenting the highest result (35.57). After fertilization, the FCI values were higher than before, and T3 differed from the others, presenting FCI of 41.02, and T1 with the lowest result. So, Empire Turf® grass responded to the fertilization, being different for each substrate, inferring that soil + sand, provided a better quality to the plant.



**Figure 1** Foliar chlorophyll index (FCI) of Empire Turf® before and after 15 days of fertilization with (NPK+S 13-5-13+14). T1 - soil; T2 - soil + sand + soil conditioner (1v:1v:1v); T3 - soil + sand (1v:1v).

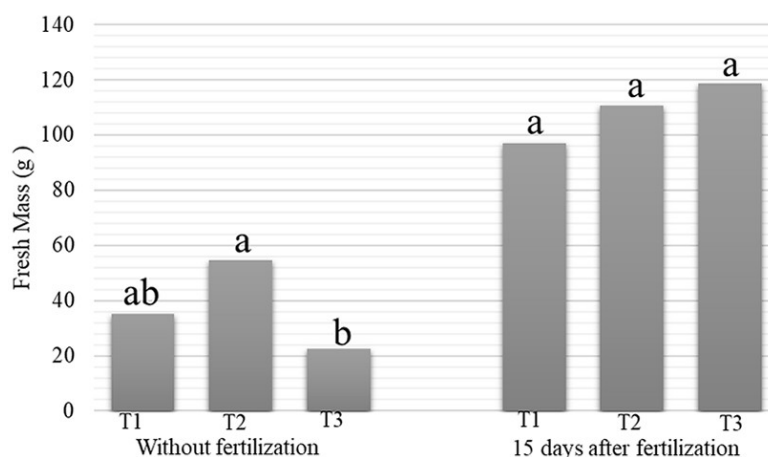
According to Santos & Castilho<sup>15</sup> the substrate is one of the factors that most influence the nutrition of the lawn, where they are strictly related to the capacity of water and nutrients retention. And so, after maintenance fertilization, the grass can respond in higher concentrations of foliar chlorophyll, depending on the material used as base.<sup>13</sup> Also, according to Taiz et al.<sup>16</sup> chlorophylls are composed of 4 nitrogen atoms attached to 1 atom of Mg, and with this, when nitrogen fertilization occurs, there is an increase in these molecules, where the substrate directly influences the amount found in the grass,<sup>17,18</sup> which may have occurred in this study, in T3 which showed the best result. Also, in the product used, it presents sulfur in its composition, which is one of the essential nutrients in the synthesis of chlorophyll molecules,<sup>16</sup> favoring the increase of FCI in the species of the present study.

Thus, there is a relationship between fertilization, substrate used and chlorophyll content, as observed in the work of Santos & Castilho<sup>13</sup> who after maintenance fertilization in emerald grass with NPK (10-10-10) on different substrates found difference in results, ranging from FCI between 17.44 and 20.81 units, however, these results are lower than in the present study. Oliveira et al.<sup>19</sup> put that emerald grass nutrition is essential to increase aesthetic quality, with nitrogen being the nutrient required in larger quantities by the species, and the grass presents a rapid response after its application with intense green coloring.<sup>20</sup> T3 has the best result after fertilization, so it is better nourished and with higher green intensity than the other substrates.

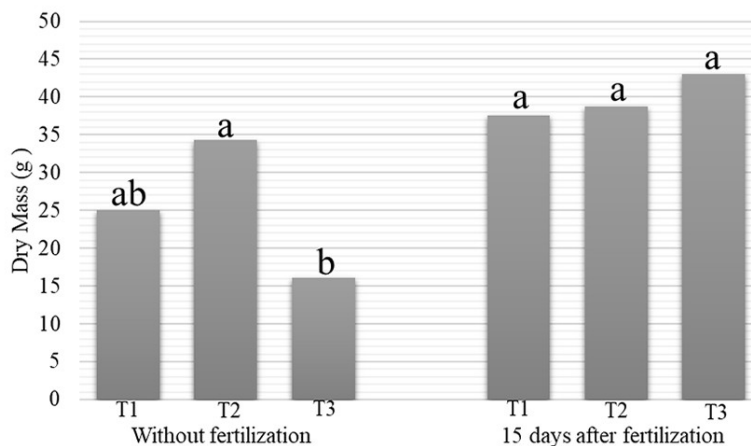
However, these results differ from those cited by Santos & Castilho<sup>15</sup> who observed that only the mixture of soil and sand is not sufficient to be used as a base for ornamental lawns, being essential the use of some organic compound for better development of the species. The same confirms Dias et al.<sup>7</sup> for Carpet grass (*Axonopus spp.*), and Amaral et al.<sup>9</sup> for Bermuda grass (*Cynodon spp.*).

However the species of study, Empire Turf®, according to Henriques<sup>5</sup> is a more rustic grass, so it can adapt to different types of environments, and there are no reports about the best substrate for its development. Still research on its development is scarce, given the small number of scientific articles found in the literature, being more and more necessary the search for information.

In relation to fresh and dry mass (Figure 2 & 3), similar behaviours of this biometric evaluation are observed. Before fertilization, T2 presented the best result, possibly due to the fact that it is the soil conditioner base, which can provide organic fertilization and thus maintain the development of the lawn a little larger than the other treatments. T3, on the other hand, obtained the lowest results for FM and DM, since having sand in its composition, the substrate is not able to retain water and nutrients in ideal conditions for lawn development.<sup>10</sup> However, after fertilization, there was a greater increase in T3 - soil + sand (1v:1v), showing that Empire Turf®, installed in that substrate is able to respond easily in biomass production in the fertilization carried out, compared to the first evaluation, despite this, there was no difference between the substrates.



**Figure 2** Empire Turf® fresh mass before and after 15 days of fertilization with (NPK+S 13-5-13+14). T1 - soil; T2- soil + sand + soil conditioner (1v:1v:1v); T3 - soil + sand (1v:1v).



**Figure 3** Empire Turf® dry mass before and after 15 days of fertilization with (NPK+S 13-5-13+14). T1 - soil; T2 - soil + sand + soil conditioner (1v:1v:1v); T3 - soil + sand (1v:1v).

Mateus et al.<sup>21</sup> recommends the use of sandy substrates for lawn installation, since they favor drainage and no water accumulation occurs, due to the higher porosity of the material, however, an adequate fertilization program should be maintained. However, this fact does not corroborate the results of Santos & Castilho<sup>13</sup> who observed a lower production of fresh and dry Emerald grass after fertilization in soil + sand compound substrate (2v:1v). The same is confirmed in an experiment with emerald grass performed by Silva et al.<sup>22</sup> who concluded that the substrate with organic matter showed better results when compared to the use of soil + sand mixture, different from the present study.

It is also noteworthy that greater accumulation of plant biomass increases the need for maintenance cutting to maintain the aesthetics of the grass,<sup>8</sup> however, there was no statistical difference in results after fertilization, thus inferring that T3 that showed an increase in FCI did not have great production of plant biomass, this characteristic being ideal for ornamental lawns.

In the same way that grass responds in growth and increased chlorophyll content after fertilization, foliar nutrition should be ideal. According to Godoy & Villas Bôas<sup>23</sup> emerald grass is of medium nutritional requirement, and in the results of macronutrient foliar analysis (Table 4) there was an increase in values after fertilization. Before fertilizer application, the grass was in nitrogen deficiency at T1 and T3, since it was outside the ideal values for the crop proposed by Godoy et al.<sup>24</sup> from 14 to 25g kg<sup>-1</sup>. T3 as the basis of organic compound, possibly managed to maintain the nutrition of the turfgrass, even without fertilization, as described above. These results corroborate with the FCI and FM and DM evaluations, with a relationship between the results. After fertilization, all substrates were already within the proposed by the same authors, showing the importance of correct nutritional management.

P and Mg showed values higher than the range of 1.9 to 2.2g kg<sup>-1</sup> and 1.3 to 1.5g kg<sup>-1</sup>, respectively, cited by Godoy & Villas Bôas<sup>23</sup> in work done with Emerald grass.

**Table 4** Foliar analysis of macro and micronutrients of Empire Turf® without fertilization and after 15 days of fertilization (NPK+S 13-5-13+14)

Treatments		N	P	K	Ca	Mg	S	Cu	Fe	Mn	Zn
		g kg <sup>-1</sup>						mg kg <sup>-1</sup>			
Without	T1	13.02	4.47	10.99	4.8	1.84	4.01	15	734	134	42
	T2	19.11	3.75	9.36	2.97	1.46	3.7	19	386	90	45
	T3	12.39	4.99	12.05	3.17	1.71	3.27	9	343	119	37
After 15 days of fertilization	T1	16.94	4.96	14.99	2.73	1.55	3.63	8	148	77	33
	T2	21.35	4.6	17.46	2.36	1.93	4.17	10	112	79	37
	T3	16.87	3.75	12.52	2.2	1.6	3.24	10	129	80	37

T1 - soil; T2 - soil + sand + soil conditioner (1v:1v:1v); T3 - soil + sand (1v:1v)

According to the same authors, for K levels only T3 before fertilization reached the ideal range of 11 to 13g kg<sup>-1</sup>; however, after fertilization, all substrates showed higher results than the ideal range, possibly because potassium was one of the nutrients applied in larger amounts (13%). According to Godoy et al.<sup>4</sup> after nitrogen, K is the most required nutrient by grasses, because although it has no structural function, it is strictly related to stress recovery, transpiration and consequently plant growth.<sup>16</sup>

For Ca there was a fall after fertilization, and the concentrations were not within the ideal range between 4 to 6g kg<sup>-1</sup>,<sup>23</sup> possibly due to the fact that with the growth of grass, there was a need to build new cells, and the nutrient has great structural function,<sup>16</sup> and previously was more concentrated in smaller plant biomass.

The micronutrients, on the other hand, fell in relation to Fe after fertilization, and this did not reach the ideal range of 188 to 318mg kg<sup>-1</sup>.<sup>23</sup> This fact may have occurred, given the greater synthesis of chlorophyll, where Fe represents expressive function in the construction of these molecules,<sup>16</sup> and with the increase in the FCI (Figure 1), there was a decrease in results (Table 4). For the nutrients Mn and Cu, both showed higher values than recommended by Godoy & Villas Bôas<sup>23</sup> for the culture, being between (25-34mg kg<sup>-1</sup>) for Mn and (2-4mg kg<sup>-1</sup>) for Cu before and after fertilization. Zn fell after fertilization, possibly because it is directly related to antioxidant enzymes.<sup>16</sup> Before fertilization the lawn was in a poor nutritional state, especially in N, and thus the amount of photosynthetic pigments were lower,<sup>18</sup> and because of this, the intensity of light ends up causing environmental stress (photodane), and Zn, which is a co-factor of antioxidative enzymes such as SOD and POD,<sup>16</sup> possibly had an

absorption in large quantities. However, after fertilization, this stress decreased and the need for absorption of Zn through the lawn was less intense.<sup>25</sup>

However, it is important to point out that this kind of study is new and that there is not much research on it and the information is deficient, being more and more necessary experiments to soften this fact.

## Conclusion

Empire Turf® has a rapid response of 15 days after maintenance fertilization with 10g L<sup>-1</sup> of NPK+S (13-5-13+14), having better development when grown on soil + sand compound substrate (1v:1v).

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## Conflicts of interest

The authors declare there are no conflicts of interest.

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