







## SCIENTIFIC ARTICLE

## Nitrogen doses in the development of Discovery™ Bermudagrass during winter

Adrielle Rodrigues Prates<sup>1\*</sup> , Patrick Luan Ferreira dos Santos<sup>1</sup> , Matheus Vinícios Leal do Nascimento<sup>1</sup> ,  
João Victor Costa<sup>1</sup> , Philippe Solano Toledo Silva<sup>1</sup> , Roberto Lyra Villas Bôas<sup>1</sup> 

<sup>1</sup> Universidade Estadual Paulista (UNESP), Faculdade de Ciências Agrônomicas,  
Departamento de Ciência Florestal, Solos e Ambiente, Botucatu-SP, Brazil

### Abstract

Discovery™ bermudagrass has been used in ornamental and sporty low-traffic turfgrass, due to its intense green coloring and slow growth, as an alternative in the search to reduce maintenance costs, such as cutting and nitrogen fertilization. However, little is known about fertilization recommendations in winter seasons, especially nitrogen fertilization. In this sense, the objective was to evaluate different doses of N in the development of bermudagrass Discovery™ in winter. The experiment was carried out during the winter, in an area with Discovery™ lawn already implemented. The design was entirely causalized, with 5 doses of N (0, 15, 30, 45 and 60 g N m<sup>-2</sup>) through the application of urea, with four repetitions, using 20% of the doses, according to crop requirement for winter, in a single application. The evaluated parameters were green color index (GCI), (Scout CM-1000 and Scout TCM 500), height, dry mass, traction and analysis by digital image of the lawn. It was observed that with the increase of N doses there was an increase in biometric assessments, however the analysis by digital image showed uneven results, and the traction of the lawn did not differ between treatments. Larger doses provided a better visual aspect of the lawn, but for the economic aspect, it is concluded that the use of 20% of the doses between 30 and 40 g N m<sup>-2</sup>, applied only once during the winter, is more recommended for the development of the Discovery™ bermudagrass.

**Keywords:** nitrogen fertilization, nutritional management, ornamental lawn, turfgrass.

### Resumo

#### Doses de nitrogênio no desenvolvimento de grama Bermuda Discovery™ durante o inverno

A grama bermuda Discovery™ tem sido utilizada em gramados ornamentais e esportivos de baixa tráfego, pelas suas características de coloração verde intensa e lento crescimento, como alternativa na busca de reduzir os custos com manutenção, como corte e adubação nitrogenada. Entretanto, pouco se sabe sobre as recomendações de adubação em épocas de inverno, principalmente a adubação nitrogenada. Nesse sentido, objetivou-se avaliar diferentes doses de N no desenvolvimento da grama bermuda Discovery™ no inverno. O experimento foi realizado durante o inverno, em uma área com gramado Discovery™ já implementada. O delineamento foi inteiramente causalizado, com cinco doses de N (0, 15, 30, 45 e 60 g de N m<sup>-2</sup>) por meio da aplicação de ureia, com 4 repetições, sendo usada 20% das doses, de acordo com a exigência da cultura para o inverno ano em aplicação única. Os parâmetros avaliados foram: índice de cor verde (ICV), (Scout CM-1000 e Scout TCM 500), índice de cor verde escuro, índice de cor verde G, brilho, matiz, saturação, altura, massa seca e tração do gramado. Observou-se que com o aumento das doses de N houve um aumento nas avaliações biométricas, porém a análise por imagem digital mostrou resultados desiguais, e a tração do gramado não diferiu entre os tratamentos. Doses maiores proporcionaram um melhor aspecto visual do gramado, mas pelo aspecto econômico, concluiu-se que o uso de 20% das doses entre 30 e 40 g N m<sup>-2</sup>, aplicado apenas uma vez durante o inverno, é mais recomendado para o desenvolvimento da grama bermuda Discovery™.

**Palavras-chave:** adubação nitrogenada, gramados ornamentais, gramados, manejo nutricional.

\*Corresponding author: [adrielle.prates@unesp.br](mailto:adrielle.prates@unesp.br)

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## Introduction

Bermudagrass (*Cynodon* spp.) show rapid growth and development, which is essential for use in high performance sports fields (Godoy *et al.*, 2012; Mateus *et al.*, 2017), however, its use ends up being unfeasible for landscaping, since due to these characteristics, it increases the cost of maintaining the cut (Santos and Castilho, 2018). Thus, as an alternative, it would be the use of a variety that shows slow growth, to be used for ornamental purposes and in low traffic sports fields.

Discovery™ bermudagrass (*C. dactylon*) is a new variety, which has good morphological characteristics such as soft leaves, homogeneous formation and slow vertical growth, where maintenance is reduced, as it requires 75% less cutting frequency compared to other Bermudagrass (Qually Gramas, 2020). Thus reducing maintenance costs, since a large part of the budget is dedicated to cutting equipment, fuel and hours worked (Kowalewski *et al.*, 2014; Santos and Castilho, 2018).

However, the proper development of the turfgrass requires correct nutritional management, this is because bermudagrass are highly demanding in fertilization, requiring a high amount of nitrogen, a nutrient that is directly related to the growth of the turfgrass, in addition to quality and aesthetics (Godoy *et al.*, 2012; Oliveira *et al.*, 2018).

In this way, nitrogen can provide high density (closed lawn, without flaws) and high green color, which is desirable from an aesthetic point of view (Gazola *et al.*, 2016). However, technical information is still incipient in relation to maintenance fertilization of already established turfgrass, mainly in relation to nutrient N (Mateus and Castilho, 2012; Godoy *et al.*, 2012; Gazola *et al.*, 2019), during the winter, where grass development is hampered due to low temperatures, and turfgrass tends to slow its growth (Lima *et al.*, 2015). Thus, this work was conducted to evaluate the response in the development of the Discovery™ bermudagrass in function of nitrogen doses during the winter.

## Material and Methods

The experiment was installed on July 3, 2019 in an area with turfgrass Discovery™ already implemented, in Botucatu-SP, Brazil. The region's climate is characterized as a humid subtropical climate with abundant and well-distributed rainfall throughout the year, according to the Koppen climate classification. The soil is characterized as "Latossolo vermelho distrófico" (LVd), using the Brazilian Soil Classification System, and in the experimental area, soil samples were collected for chemical analysis according to the methodology of Raij *et al.* (2001) (Table 1).

**Table 1.** Result of chemical analysis of the soil in the experimental with Discovery™ Bermudagrass during winter

pH	M.O.	P <sub>resina</sub>	H+Al	K	Ca	Mg	BS	CEC	V%
CaCl <sub>2</sub>	g dm <sup>-3</sup>	mg dm <sup>-3</sup>		mmol <sub>c</sub> dm <sup>-3</sup>					
5.6	20	108	14	2.9	26	8	37	50	73

For the installation and development of the study, the lawn already established, the turfgrass was cut at a height of 13 mm, where the experiment was arranged in a completely randomized design, with 5 doses of N, these being: 0, 15, 30, 45 and 60 g N m<sup>-2</sup> (corresponding to 0, 150, 300, 450, and 600 kg ha<sup>-1</sup>) (Lima *et al.*, 2015) and 4 repetitions, totaling 20 experimental units, with a dimension of 1.5 m<sup>2</sup>. For the experiment, 20% of the doses were used, because the turfgrass is less demanding in nitrogen fertilization in winter, and the application was in a single dose. The urea mineral fertilizer (45% N) was used as a source of N, spreading evenly over the turfgrass and then watered. The experiment was irrigated daily through a sub-superficial drip installed at a depth of 10 cm, replacing the previous day's evapotranspired lamina. After 34 days after fertilization (average temperature of 17.1 °C, with maximum and minimum averages of 22.7 and 12.2 °C respectively and 101.82 mm of accumulated precipitation), the following parameters were evaluated:

- *Green color index (GCI)*: Field Scout CM-1000, whose operating principle is based on light reflectance, making three readings in each plot, and their averages are

calculated. Samples were obtained parallel to the surface of the turfgrass, at the same height (1.0 m).

- *Green color index (GCI)*: Light reflectance meter, which consists of the use of a device called Field Scout TCM 500 Turf Color Meter, which measures the reflection of light by the grass in the red, green and blue spectrum. The device was placed in contact with the grass and pressed so that there is no light penetration, which generates a lawn index (0 to 9.9).

- Analysis of the visual aspect by digital image - Photographs of the area were taken with an 12Mp camera, fixed in a structure called "light box", similar to that produced by Peterson *et al.* (2011). This structure is a completely sealed box with lamps connected to a battery, in order to standardize the brightness and the area photographed in all treatments. These images were transferred to a computer, and with the aid of the Adobe Fireworks® program, the RGB value (Blue, Green and Red) of each image was verified. As only the green component (G) does not define the green color, also depending on the red (R) and blue (B) components, the RGB results were compiled into an electronic spreadsheet in MS Excel and converted to HSB

values, that is, hue, saturation and brightness, according to the methodology of Godoy et al. (2012). The lawn's luminosity value was also discovered by the HSL system. After obtaining the HSB values, the Dark Green Color Index (DGCI) was calculated, which varies from 0 - 1 (Karcher and Richardson, 2003).

- *Turfgrass height* - with the "Grass Height Prism Gauge" turfgrass height measuring instrument being measured three times per plot, in order to minimize the influence on the result of irregular areas.

- *Dry matter mass* - The cut was made using the GreenMaster 1000 Toro® machine leaving the turfgrass 13 mm high. Cuttings were collected in order to assess the dry matter mass of the aerial part of the turfgrass, after the samples were placed in an oven at 65 °C for 72 h, and weighed on a 0.01 precision scale.

- *Turfgrass traction* - For this measurement, a specific torque measurement device (Nm) was used, which simulates how much force is needed to tear the turfgrass, called Rotational Resistance Tester - Deltec Metaal®. Analyzes were made at 3 points within each plot.

The results obtained were submitted to analysis of variance and polynomial regression studies were also performed for the effects of N doses. The statistical analysis was performed using the SAS program.

## Results and Discussion

The results found in the present study (Tables 2), demonstrated that there was a statistical difference for most of the variables analyzed, except for GCI (Scout TCM500) and DGCI.

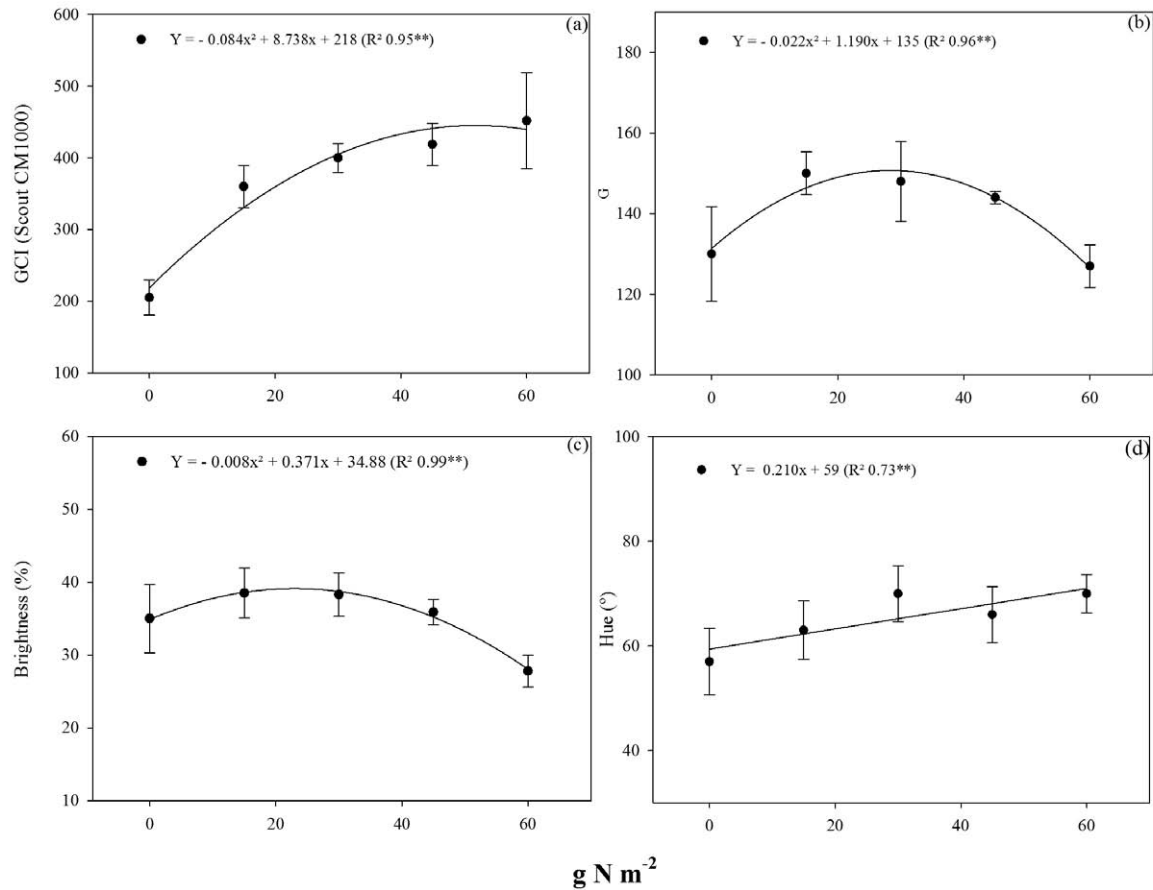
**Table 2.** Analysis of variance for biometric and digital imaging components of Discovery™ bermudagrass during winter.

Variable	F	Overall average	CV (%)
<i>Biometric</i>			
GCI - Scout CM1000	14.14**	367	14.01
GCI - Scout TCM500	0.88 <sup>ns</sup>	8.2	10.75
Height	3.48*	18.3	18.9
Dry mass	11.96**	3.6	13.15
Traction	0.44 <sup>ns</sup>	31	11.15
<i>Digital image</i>			
Green (G)	5.45*	140	6.12
Brightness	5.25*	35	10.79
Hue	3.79*	65	9.19
Saturation	5.21*	54	12.42
Luminosity	5.5**	108	7.66
DGCI	1.37 <sup>ns</sup>	0.33	10.44

\*, \*\* and <sup>ns</sup> – indicate significance at 5%, 1% probability, and not significant, respectively

Lawn traction showed no significant difference in relation to treatments (Tables 2), and considering sports lawns, this study showed an average value below the ideal traction values (between 35 and 45 Nm) established by FIFA (2016). Thus, it appears that during winter, regardless of the dose used, the lawn will be less resistant, possibly due to its slow growth during this period, showing the relevance of fertilization

For GCI (Scout CM1000), green component (G) and brightness with increasing doses of N verified a quadratic adjustment, with doses 52.0 g N m<sup>-2</sup>; 27.0 g N m<sup>-2</sup> and 23.2 g N m<sup>-2</sup>, obtaining the highest values of 445 Scout, 151 and 39.2%, respectively (Figure 1a, b and c), for hue there was a linear increase with the increase N doses (Figure 1d).

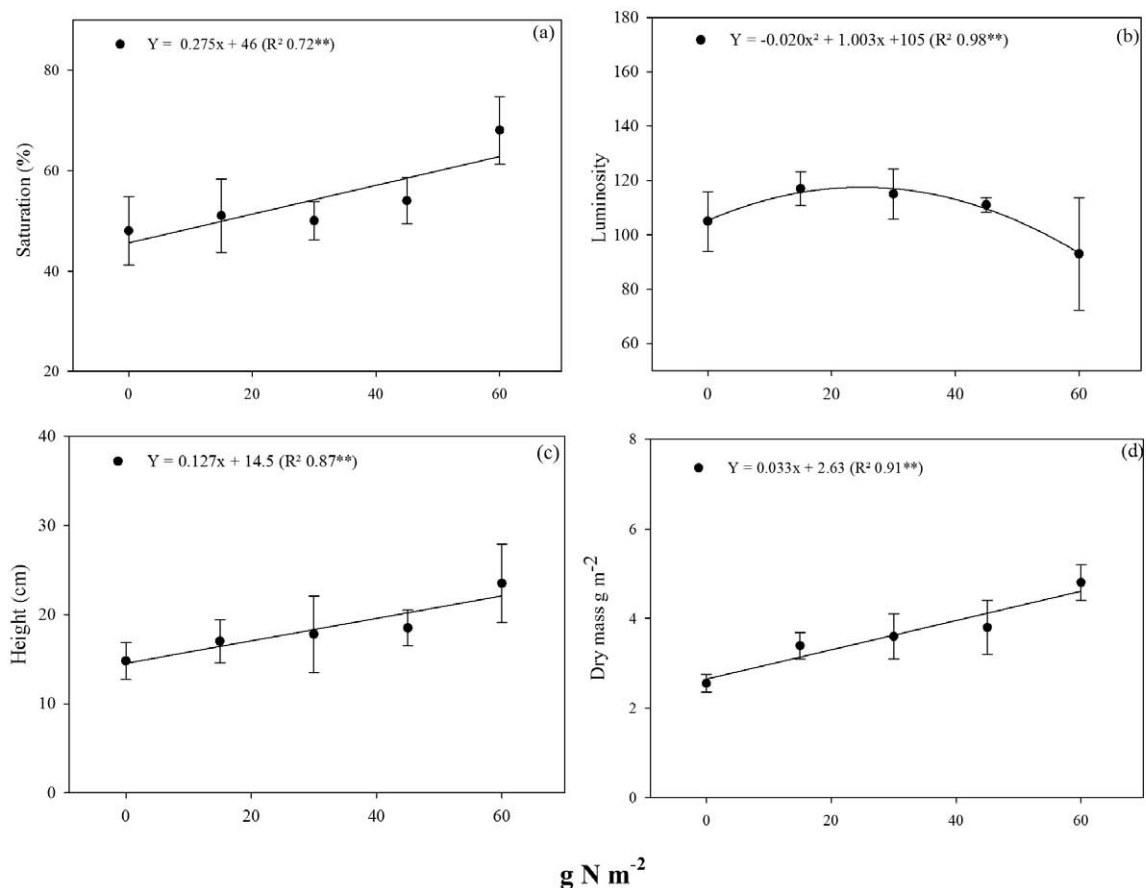


**Figure 1.** GCI, G, Brightness and Hue of Discovery™ bermudagrass in function of applied doses of N during winter, using 20% of the doses, according to crop requirement for winter. \*\* - Significant at 1% probability

In the study by Lima *et al.* (2012), with the production of bermudagrass 'Celebration' observed that the GCI (Scout CM1000), green component was influenced by the N dose, the first also having a quadratic adjustment depending on the N doses. The drop in the LCI index from the maximum dose of 52.0 g N m<sup>-2</sup>, may be related to a reduction in the concentration of N in the leaf, due to the dilution of this nutrient through greater growth, characterized by the increase of the dry mass, since maximum fertilizer absorption occurs (Lima *et al.*, 2012; Taiz *et al.*, 2017; Santos *et al.*, 2019). Thus, assessment elements such as green color intensity and hue in turfgrass, are indices that

can help assist in determining the most appropriate N dose for color conservation (Gazola *et al.*, 2016).

For saturation, height and dry weight, there is no increase in the N dose in a linear increasing adjustment (Figure 2a, c and d) and for the luminosity there was a quadratic adjustment in the dose 25.1 g of N m<sup>-2</sup> reaching the highest index of 117 (Figure 2b). In study by Dinalli *et al.* (2015), with Zoysia turfgrass applying herbicide as growth regulators fertilized with nitrogen, also found an increase in dry mass with increasing doses of N. And in work by Lima *et al.* (2015), with bermudagrass 'Celebration', there was a quadratic adjustment in the dry mass in the functions of the doses of N.



**Figure 2.** Saturation, Luminosity, Height, and Dry mass of Discovery™ bermudagrass in function of applied doses of N during winter, using 20% of the doses, according to crop requirement for winter. \*\* - Significant at 1% probability

It is important to note that an increase in N doses provides a high ICG (Scout CM1000) (Figure 1a), however, there is also an increase in height and dry mass (Figure 2d), which increases the maintenance cost due to the need for a greater number of cuts (Santos and Castilho, 2018). However, the species in the present study showed slow growth when compared with studies with other bermuda grass cultivars, such as ‘Celebration’ (Lima et al., 2015) and ‘Tifway 419’ (Mateus et al., 2017; Santos and Castilho, 2018). Even so, the low temperatures during the winter (16.8 °C) helped to maintain the slow growth of the lawn, which further reduced the need for intense maintenance during this period, which is desirable for ornamental lawns, that is, maintaining good aesthetic quality, intense green with slow growth (Gazola et al. 2016; Santos and Castilho, 2018).

Thus, the increase in N doses improved the biometric assessments of the present study (Figures 1a, 2c and 2d), however, for the analysis of digital images, with the exception of saturation, the components, brightness, green (G) and luminosity decreased after the dose 23.2 g N m<sup>-2</sup> (Figures 1b, 1c and 2b), besides the no significant difference in relation to the DGCI. The results, unlike the present study, differ from those mentioned by Godoy et al. (2012) who state that digital image analysis is a tool that helps to determine the state of N in the plant. Experiments such as those by Backes et al. (2010) and Gazola et al.

(2016) in emerald grass (*Zoysia japonica*) and Lima et al. (2012) in Bermuda ‘Celebration’ estimated N by means of digital images and obtained good responses, unlike the present study.

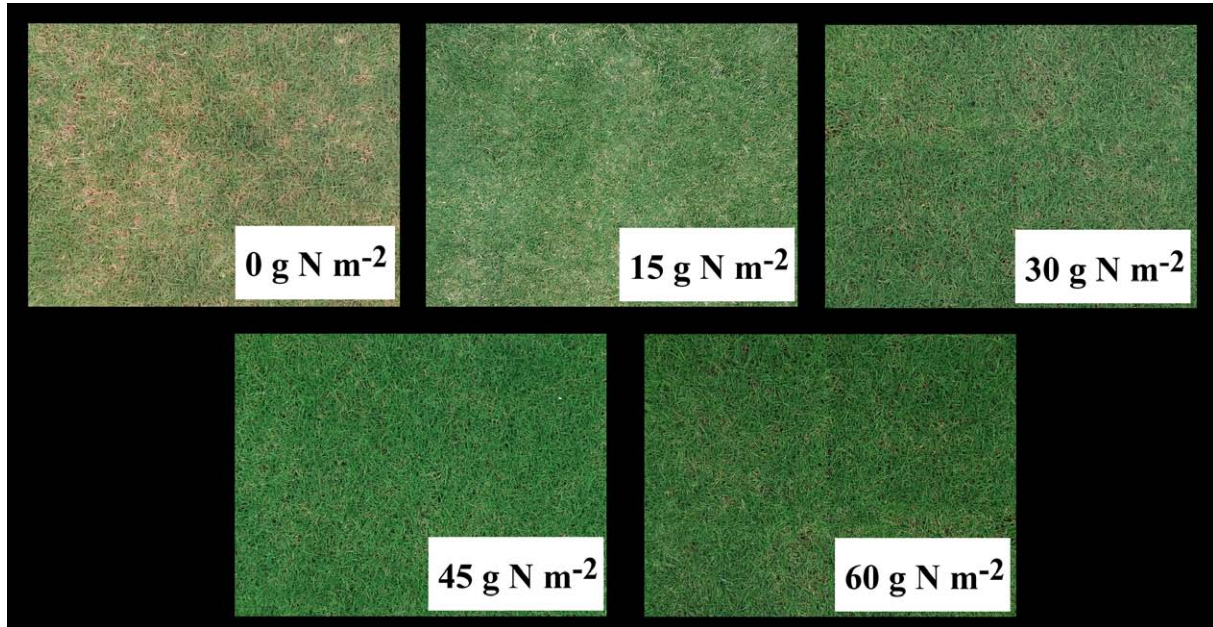
Another important factor to consider is the unnecessary expenses with fertilizer, due to the excess of nitrogen applied to turfgrass. In addition to spending on fertilizer, excess N can make the grass more susceptible to attack by pathogens, and losses can occur due to nitrate leaching and ammonia volatilization (Godoy et al., 2012; Souza and Fernandes, 2018), being that the latter can be enhanced with the application of the urea source. Souza and Fernandes (2018), say that although the use of nitrogen fertilizers increases the supply of reactive N to the soil-plant-atmosphere system, it also results in significant losses of N to the environment, one of the responsible for the main causes of pollution, because, in addition to leaching, we have eutrophication of water courses, and gas emissions from the manufacture of fertilizers from fossil fuels.

In Figure 3, it shows visually that with the increase of the doses of N there is a better closing of turfgrass and an increase of the green color. Gazola et al. (2016), in their study with emerald grass confirmed the statement that higher doses of N provide turfgrass with a more intense green color. Thus, the lower doses decrease the rate of ground cover by the turfgrass, as it limits growth, in addition to the

yellowing of the turfgrass (Godoy *et al.*, 2012; Santos *et al.*, 2019; Gazola *et al.*, 2019).

The increase in green color and aesthetic quality of the turfgrass may be related to the increase in chlorophyll content due to the greater availability of N, since the chlorophylls are formed with a central magnesium atom attached to 4 nitrogen atoms (Santos and Castilho, 2015;

Gazola *et al.*, 2016; Taiz *et al.*, 2017). Thus, the higher the leaf chlorophyll content, more intense the color of the turfgrass (Santos *et al.*, 2019). This fact confirms that the correct amounts of nitrogen provide aesthetic quality of the turfgrass (Godoy *et al.*, 2012; Gazola *et al.*, 2019). However, the nutritional requirement of lawn may vary according to species, cultivars, management and period.



**Figure 3.** Visual aspect of Discovery™ bermudagrass during winter after 34 days of application of N doses, using 20% of the doses, according to crop requirement for winter.

## Conclusions

Larger doses provided a better visual aspect of the turfgrass, but also considering the economic aspect, such as maintenance expenses, use of 20% of doses between 30 and 40 g N m<sup>-2</sup>, applied only once during winter is more recommended for the development of Discovery™ bermudagrass.

## Author Contribution

**ARP:** Interpretation, preparation and writing of the article, critical review, statistical analysis and translation **PLFS:** Experiment idea, field analysis, data collection and analysis, statistical analysis, critical review. **MVLN:** Field analysis, statistical analysis and data collection, critical review **JVC:** Field analysis and data collection, critical review **PSTS:** Field analysis and data collection. **RLVB:** Critical review, approval of the final version, work advisor.

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