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Association between the occurrence of mound-building termite in pasture with physical, chemical and biological characteristics of the soil

Associação entre a ocorrência de cupins de montículos em pastagem com características físicas, químicas e biológicas do solo

Asociación entre la aparición de termitas formadoras de montículos en pastos con características físicas, químicas y biológicas del suelo

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Abstract
The occurrence of mound-building termite *Cornitermes cumulans* (Kollar, 1832) (Termitidae) in pastures may be related to the chemical, physical and biological characteristics of the soil. However, little is known about these relationships. The objective of this study was to evaluate the relationship of the occurrence of mound-building termite in pasture with the chemical, physical and biological characteristics of the soil. The number of mounds and their circumference (cm) and height (m) were evaluated in three subareas present in the same pasture area. Soil chemical, physical and biological analyses were performed. Soil acidity and texture do not interfere with the occurrence of mound-building termites in the pasture. The lower CO_2 release in the soil contributes to a greater occurrence of mound-building termites and greater mound circumference. Therefore, it is important to improve the soil conditions in order to increase its biological activity and, consequently, to allow the development of microorganisms which reduce the development of mounds.
Keywords: Management; Cattle breeding; Mound; Poaceae; Sustainability.

Resumo
A ocorrência do cupim de montículo Cornitermes cumulans (Kollar, 1832) (Termitidae) em pastagens pode estar relacionada às características químicas, físicas e biológicas do solo. No entanto, pouco se sabe sobre essas relações. O objetivo deste trabalho foi avaliar a relação da ocorrência do cupim de montículo em pastagem com as características químicas, físicas e biológicas do solo. O número de montículos e sua circunferência (cm) e altura (m) foram avaliados em três subáreas presentes na mesma área de pastagem. Foram realizadas análises químicas, físicas e biológicas do solo. A acidez e a textura do solo não interferem na ocorrência de cupins formadores de montículos na pastagem. A menor liberação de CO2 no solo contribui para maior ocorrência de cupins formadores de montículos e maior circunferência

do montículo. Portanto, é importante melhorar as condições do solo para aumentar sua atividade biológica e, consequentemente, permitir o desenvolvimento de microrganismos que reduzam o desenvolvimento de sambaquis.
Palavras-chave: Manejo; Pecuária; Montículo; Poaceae; Sustentabilidade.

Resumen
La presencia de la termita *Cornitermes cumulans* (Kollar, 1832) (Termitidae) en los pastizales puede estar relacionada con las características químicas, físicas y biológicas del suelo. Sin embargo, se sabe poco sobre estas relaciones. El objetivo de este estudio fue evaluar la relación de la presencia de termitas formadoras de montículos en pastizales con las características químicas, físicas y biológicas del suelo. Se evaluó el número de montículos y su circunferencia (cm) y altura (m) en tres subáreas presentes en la misma área de pasto. Se realizaron análisis químicos, físicos y biológicos del suelo. La acidez y la textura del suelo no interfieren con la aparición de termitas formadoras de montículos en el pasto. La menor liberación de CO2 en el suelo contribuye a una mayor incidencia de termitas formadoras de montículos y una mayor circunferencia de montículos. Por tanto, es importante mejorar las condiciones del suelo para incrementar su actividad biológica y, en consecuencia, permitir el desarrollo de microorganismos que reduzcan el desarrollo de montículos.
Palabras clave: Administración; Ganadería; Montículo; Poaceae; Sustentabilidad.

1. Introduction

In developing countries, pasture is the main feed source for beef and milk cattle, and is the most practical and economical way for cattle farmers. However, most pastures have been degraded due to their incorrect use (Neto, et al., 2013), thus negatively affecting the sustainability of the livestock sector.

Among the factors related to pasture degradation, it is possible to highlight the large animal stocking in pickets, without adjustments for adequate support capacity, lack of nutrient replenishment and the occurrence of mound-building termites (Peron & Evangelista, 2004). Due to the smaller or larger number of mounds in the areas, the degradation process can be classified as initial and moderate (Santos, et al., 2007).

The infestation of mound-building termites in pastures is mostly related to different factors, such as chemical (acidity), physical (texture) and biological characteristics of the soil (microbial activity that can be determined by measuring the amount of CO_2 released from the soil) (Kennedy & Smith, 1995). However, few studies have been conducted to evaluate the relationship of these factors in the occurrence of mound-building termites, which is the objective of this study.

2. Methodology

This study was carried out in the municipality of Fama, Southern Minas Gerais (21°24′23″S and 45°49′43″W and 776 m altitude) in 2018. The climate of the region is subtropical with average annual temperatures between 18 °C and 20 °C. The average temperature of the coldest month is between 16 °C and 23 °C and, in the warmest month, it is between 36 °C and 37 °C. The average annual rainfall is 1516 mm with more intense rains in the summer compared to winter, according to the Köppen and Geiger classification.

A pasture area with approximately 55 ha was selected, with the same management history, without addition of fertilizers and soil correctives in the last 21 years, and classified as degraded according to indicators proposed by Oliveira et al. (2011). The area presented a flat topography, with a predominance of *Brachiaria decumbens* Stapf (1919) (Poaceae) and subareas at different infestation levels of mound-building termites of the species *Cornitermes cumulans* (Kollar 1832) (Termitidae).

Within the total area (55 ha), three subareas of five hectares each were separated with a distance of approximately 20 m from each other. Subareas were selected by visual contrast in the infestation of mound-building termites. Each subarea was divided into five parts of a hectare, each representing a replication, in which evaluations of mounds and soil sampling were carried out. In each part, the total number of mounds was counted, and 10 mounds were then randomly selected for the evaluation of the circumference at the base and height of the mound. The number, circumference and height of the mounds were considered the main components of the survey, being related to the explanatory variables: chemical (acidity), physical (texture) and

biological (CO_2 release) of the soil.

For the evaluation of the chemical, physical and biological parameters of the soil, 10 simple samples were collected, with a Dutch auger, in each part of the subarea, which were mixed for the composition of a composite sample. The samples were collected at a depth of 10 cm and at a distance of 1 m from each mound, where circumference and height were evaluated.

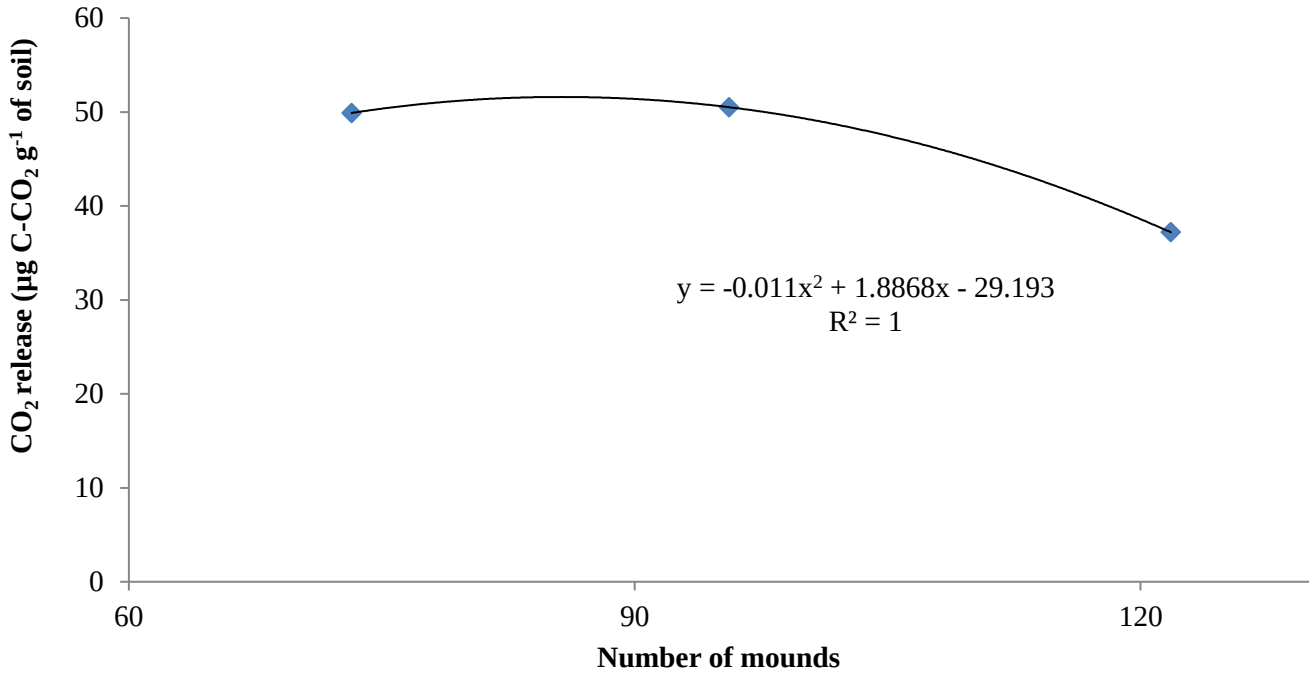
The soil samples were chemically analyzed, according to the methodology described by Silva (2009). The physical analysis was performed according to the methodology of Camargo (2009). Biological analysis was performed by measuring CO_2 release as a function of soil microbial activity, following the methodology described by Monteiro et al. (2002).

The data of the analyzed variables were submitted to the Shapiro-Wilk test for analysis of normality. The data presented normal distribution ($p > 0.05$). In order to verify the effects of the interrelations between the main variables (number, height and circumference of mounds) with the explanatory variables (chemical, physical and biological soil analysis), path analysis was performed (Wright, 1921). The interactions between CO_2 release x number of mounds; CO_2 release x circumference and circumference x height presented significant effects (value above + 0.75 or lower than - 0.75) and were submitted to regression analysis. The other interactions had no significant effect. All analyses were performed using the R software, version 3.2.4 (R CORE TEAM, 2016).

3. Results and Discussion

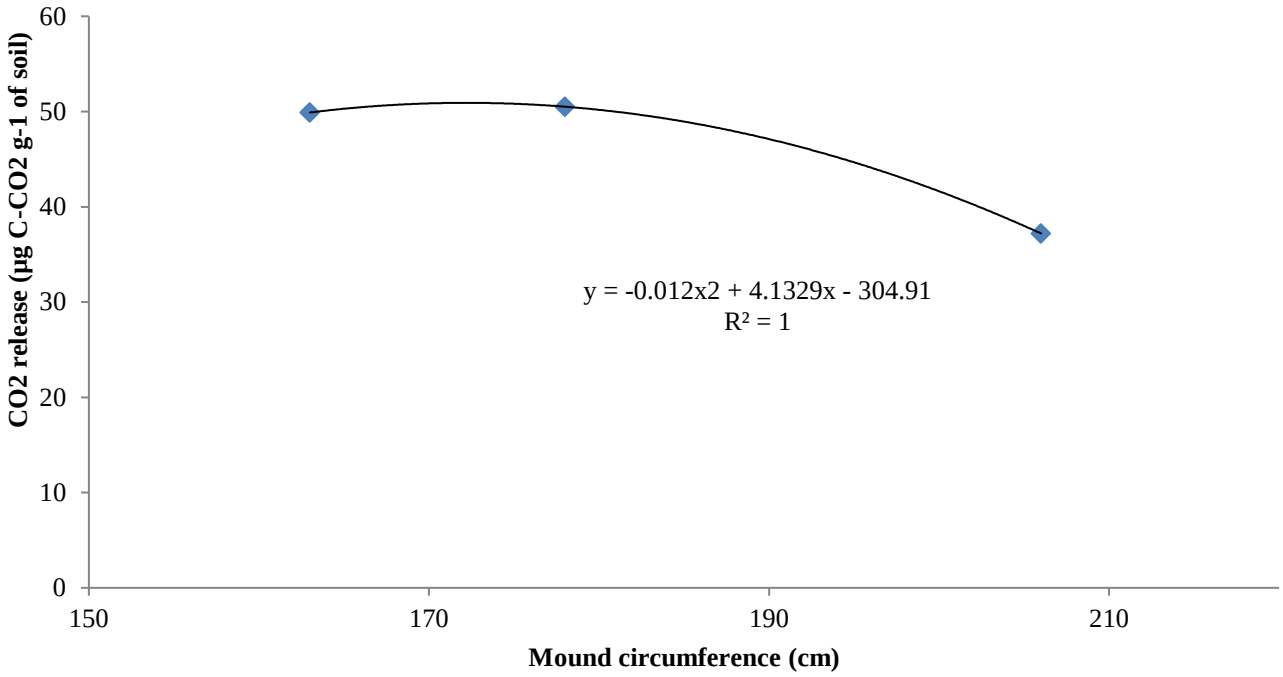
There was a significant effect of CO_2 release on the number and circumference of mounds ($p<0.05$) (Figs. 1 and 2). The highest number of mounds (121.8) was found in the subarea that presented less organic matter and lower CO_2 release (37.2 µg C-CO_2 g^{-1} soil) (Fig. 1). The same occurred with mound circumference, where the largest circumference (206 cm) was observed in the subarea that presented lower CO_2 release (37.2 µg C-CO_2 g^{-1} soil) (Fig. 2). The other explanatory variables (acidity and texture) did not show significant effects on the number, height, and circumference of mounds.

Figure 1. Relationship between CO_2 release and number of *Cornitermes cumulans* (Termitidae) mounds in pasture soils at different infestation levels.



Source: Authors.

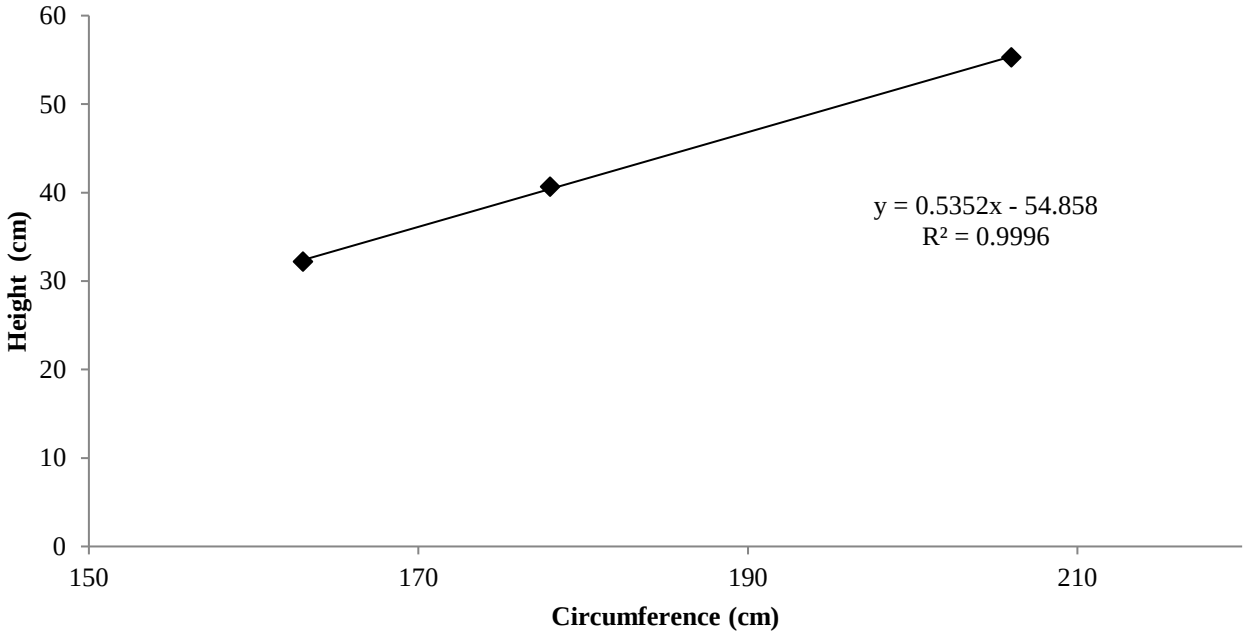
Figure 2. Relationship between CO_2 release and circumference of *Cornitermes cumulans* (Termitidae) mounds in pasture soils at different infestation levels.



Source: Authors.

Regarding the association between height and circumference, there was a significant effect ($p<0.05$) (Fig. 3). Higher mounds (55.3 cm) had larger circumferences (206 cm).

Figure 3. Relationship between height and circumference of *Cornitermes cumulans* (Termitidae) mounds in pasture soils at different infestation levels.



Source: Authors.

In this study, it was observed that CO_2 release is directly related to the respiratory activity of macro-and microorganisms present in the soil (Sabino, et al., 2015). The lower the organic matter content in the soil, the less CO_2 is released, implying a reduction in the activity of these organisms during the oxidation of organic compounds (Kennedy & Smith, 1995). Thus, in this study, it was possible to observe a greater mound infestation in areas where organic matter contents were lower (Pinheiro, et al., 2013; Lima, et al., 2011).

Regarding mound circumference, it should be observed that termite mounds with larger circumferences occupy a larger area, which provides less pasture available for the animals, difficult the movement of machines and implements and, therefore, an increase in the presence of venomous animals may occur (Embrapa, 1996). Thus, it is important to carry out the control of mound-building termites in pastures at the beginning of their development.

The results of this study demonstrate that pasture areas with higher microbial activity have lower infestation of mound-building termites. Entomopathogens are microorganisms commonly found in soils and, under suitable conditions, they can cause termite death (Vega, et al., 2012) and with pathogenicide on termites (Neves & Alves, 1999; Neves & Alves, 2000; Albuquerque, et al., 2005; Pinheiro, et al., 2013; Passos, et al., 2014). The conservation of microbial activity can be obtained through the appropriate pasture management and the accumulation of organic matter (through the correct cutting point of forages) (Garcia & Nahas, 2007).

4. Conclusions

In the conditions under which the study was carried out, it is concluded that soil acidity and texture do not interfere with the occurrence of mound-building termite *C. cumulans* in the pasture. The lower CO_2 release in the soil contributes to a greater occurrence and circumference of mounds. The biological characteristics of the soil can influence the occurrence of mounds, and the adoption of techniques that aim to improve the development conditions of microorganisms in the soil is necessary.

Thus, new studies must be carried out seeking to know the relationship between the cutting point of forages with the infestation of mound-building termites and identify possible microorganisms present in this interaction.

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