DETERMINATION OF HYDRAULIC CONDUCTIVITY OF A HAPLIC PLINTHOSOLS UNDER A CHRONOSEQUENCE OF AGRICULTURAL USE

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ABSTRACT: In the region of the plains in the state of Goiás, the microrelief in marshy fields, or fields of mounds, also called covais, cocorutos and monchões, are large areas where predominate Haplic Plinthosols. Many of these areas were incorporated into the agricultural systems of production, without the evaluating of the impact of their hydro-physical characteristics. Thus the objective of this study was to evaluate the impact of a chrono sequence of agricultural uses on the soil water movement in the field of mounds through the hydraulic conductivity parameter. For that four areas were selected, of which three are under chronosequence of agricultural use and one completely preserved. The permeameter constant load was used to determine the hydraulic conductivity. In areas without anthropogenic interference, the values of hydraulic conductivity were 0.4233 m h^{-1} for high mounds and 0.1297 m h^{-1} for low mounds. In areas with anthropogenic interference, the hydraulic conductivity values were 0.1395 m h^{-1} for five years of anthropic interference, 0.1338 cm h^{-1} for ten years of anthropic interference and 0.0579 m h^{-1} for fifteen years of anthropic interference. There was a reduction of the structural quality as assessed by hydraulic conductivity into the area with human interference in no-tillage system.
KEYWORDS: hydro-physical attribute, soil water movement, covais

DETERMINAÇÃO DA CONDUTIVIDADE HIDRÁULICA DE UM PLINTOSSOLO HÁPLICO SOB UMA CRONOSSEQUÊNCIA DE USO AGRÍCOLA

RESUMO: Na região dos chapadões no estado de Goiás, os microrrelevos em campos brejosos, ou campos de murundus, também denominados covais, cocorutos, morrotes e monchões, constituem áreas extensas onde predominam Plintossolos Háplico. Muitas destas áreas foram incorporadas aos sistemas agrícolas de produção, sem que os impactos nas características físico-hídricas fossem avaliados. Assim, o objetivo deste trabalho foi avaliar o impacto da cronossequência de uso agrícola no movimento da água no solo no campo de murundus através do parâmetro condutividade hidráulica (Ko). Para isso, quatro áreas foram selecionadas, das quais três estão sob cronossequência de uso agrícola e uma completamente preservada. O permeâmetro de carga constante foi usado para determinar os valores de Ko. Em áreas sem interferência antrópica, os valores de Ko foram 0,4233 m h^{-1} e 0,1297 m h^{-1}, para partes altas e baixas dos murundus, respectivamente. Em áreas com interferência antrópica, os valores de condutividade hidráulica foram 0,1395 m h^{-1}, 0,1338 m h^{-1} e 0,0579 m h^{-1}, respectivamente para cinco, dez e quinze anos de interferência humana. Houve uma

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redução da qualidade estrutural, avaliada pela condutividade hidráulica para a área com a interferência humana no sistema de plantio direto.
PALAVRAS-CHAVE**:** características físico-hídricos, movimento da água no solo, covais

INTRODUCTION

Micro-reliefs in marshy fields (murundus, covais, cocorutos and monchões, in Portuguese) of the savannah plateau of the state of Goiás, Brazil, form extensive areas predominantly featured as Haplic Plinthosols soil. The soil is highly relevant due to its role as a water recharge and supply for underground water and the maintenance of water levels in streams and rivers of one of the most important Brazilian hydraulic sources, or rather, the river Paranaíba basin.

During the last decades the above mentioned areas in the state of Goiás, Brazil, were incorporated to cash crop production systems. Landscape transformation in an agriculture-occupied process went beyond the loss of biodiversity and climate changes, with the modification of soil structure. The consequences, comprising soil compaction and erosion, accumulation of silt in waterways and liability in water resources, are perceptible, even though their evolution and economical and environmental consequences are still largely unknown.

Due to the region´s characteristics (high rates of organic materials and clay, land relief and possibility of mechanization), high productivity rates abounded throughout the last decades. Consequently, year by year producers have incorporated other areas to the production system without evaluating the effect of such incorporation on soil quality and environment. This is especially grave due to the importance of the region for the Brazilian hydrological system (Gomes Filho et al., 2011). According to Silva et al. (2012), the soil´s physical and hydraulic properties affect the hydrological processes which comprise infiltration, erosion, wetness redistribution and the transport of solved materials.

The hydraulic conductivity of a soil (surface and depth) is an essential parameter to determine or predict the hidric operating of different types of coverings. These results are important for evaluating the conditions of aquifer recharge, regulation of flow of watercourses surface water, contamination plumes behavior, determining rates of sprinkler irrigation systems, characterizing of the vulnerability that each soil type presents how much contamination of shallow groundwater or water table, among other applications (Fiori et al., 2010).

Therefore, the objective of this study was to evaluate the impact of a sequence of agricultural uses on the soil water movement in the field of mounds through the hydraulic conductivity parameter.

MATERIAL AND METHODS

Current assay was conducted on the Farm Boa Vista in the micro-basin of the river Claro in the municipality of Jataí GO Brazil, in 2010. The region has been characterized by micro-reliefs of earth mounds (murundus, covais, cocorutos and monchões, in Portuguese) with a predominance of Haplic Plinthosol soils.

Current analysis compared the areas during the period with agricultural usage (5, 10 and 15 years) and two areas without any agricultural usage, of which one was on the upper section of the mound and the other on the lower section. Since all areas were close to one another, with the same Haplic Plinthosol soil type, the environmental conditions were homogeneous.

The sampling points were chosen within each area and tested prior to analysis of variance to check homogeneity of variance between them. The data were analyzed as a completely randomized design with 30 sampling points for the analysis of hydraulic conductivity.

Through the layout of chronosequence of anthropic usage, the impact on hydraulic conductivity was evaluated, according to the treatments below: Treatment 1 – natural conditions exist in the lower section of the earth mound, with no anthropic intervention in the area. The area lies on the lower section of the mounds, flooded most of the year, with no termite activity and covered by crawling graminoid vegetation. Treatment 2 – natural conditions on the higher section of the earth mound, approximately 2 m high, without anthropic intervention, which remains dry most of the year, formed by termites. It has typically savannah vegetation, with a great diversity of shrubs and graminoids. Treatment 3 – Area occupied for 5 years by no-tillage system. Cash crops consisted of soybean in the harvest; maize (or millet or sorghum) in the winter harvest; fallow state in the interim harvest. Treatment 4 – Area occupied for 10 years by no-tillage system. Successive cash crops consisted of soybean in the harvest period; maize in the winter harvest; fallow land. Treatment 5 – Area occupied for 15 years by no-tillage system. Successive cash crops consisted of soybean in the harvest period and maize in the winter harvest.

Thirty samples with undeformed structures were collected to determination of the hydraulic conductivity of soil saturated (K_o). Six samples were collected by area, using volumetric rings 0.30 m height and 0.10 m diameter.

The equation (1) below was applied for determining the saturated hydraulic conductivity.

$$K_o = \frac{V \; x \; L}{A \; x \; t \; x \; (L+h)} \quad (1)$$

Where: K_o = hydraulic conductivity of saturated soil, m min^{-1}; V = volume of water collected, m^3; L = thickness of the soil layer, m; A = cross-sectional area of the soil sample, m^2; t = time of collection the volume of water, min, and h = height of the water depth, m.

The results were subjected to analysis of variance using the F test at 1% and 5% probability and the treatment means were compared by Tukey test at 5% probability.

RESULTS AND DISCUSSION

The largest value for hydraulic conductivity was observed in the area corresponding to the upper mound, area without human intervention and with extensive termite activity (Table 1).

Table 1. Average values of soil hydraulic conductivity depending on the study areas with their respective coefficients of variation*

Area	hydraulic conductivity (m h^{-1})	CV (%)
Area without anthropic intervention (upper part of the mound)	0.4233 A	25.33
Area without anthropic intervention (lower part of the mound)	0.1297 B	27.73
Area with 5 years of use (no tillage system)	0.1395 B	26.24
Area with 10 years of use (no tillage system)	0.1338 B	25.38
Area with 15 years of use (no tillage system)	0.0579 C	26.92

(*) Means followed by the same letter do not differ at 5% probability by Tukey test.

There was no significant difference in values for Hydraulic Conductivity between the inferior part of the mound, area with five years of use on tillage system and area with ten years of on-tillage system. The area in soil with no-tillage system for fifteen years, it showed lower values of hydraulic conductivity, even with significant differences in relation to other anthropic areas (Table 1).

Scherpinski et al. (2010) studied the spatial variability of the saturated hydraulic conductivity and water infiltration in the soil, in an area of 20 ha, characterized by intensive grain production, using the Guelph Permeameter. They found the value of 110.24% for the coefficient of variation of the saturated hydraulic conductivity.

Santos et al. (2012) studied the spatial variability of physical attributes of soil in alluvial valley of semiarid region of Pernambuco state, they found that the hydraulic conductivity showed high variability, with CV value of 261%, indicating a high heterogeneity of soils on the study area.

The random variation of hydraulic conductivity of saturated soil, probably due to stratification typical of hydromorphic soils and soil management. The results agree with those obtained by Eguchi et al. (2003), in which the high variability of the data of hydraulic conductivity of saturated soil can be explained by the presence of plant roots, microbial activity, localized cracks caused by the times of drought and other factors.

The soil of upper mound presents high hydraulic conductivity. The destruction of these mounds and subsequent incorporation to enable productive activity cause changes in soil structure and therefore significant changes in the conductivity of the soil water.

The areas with anthropic intervention had a significant impact on the ecosystem, evidenced by the high rate of hydraulic conductivity. The removal and incorporation of these areas reduced the minimum values in other areas, and after fifteen years of anthropic intervention, the index was significantly lower. Problems for watersheds and agricultural production will be evident with frequent and heavy rains because all natural cycle of water transport in these areas was significantly modified.

CONCLUSIONS

The values of hydraulic conductivity were significantly higher than in the area without anthropic intervention, upper part of the mound. The area without anthropic intervention, lower part of the mounds showed no significant difference compared to areas with five and ten years incorporated on the no-tillage system. The area with fifteen years of incorporation in the tillage system was the one with the lowest value of the hydraulic conductivity, differing from other areas.

There was a reduction in the structural quality assessed by hydraulic conductivity for area with fifteen years of use in the tillage system.

The impacts caused by anthropic interference in the attribute evaluated, imply a significant change in the flow of water that naturally exist in the field of mounds. So, especially considering the connection of these areas to the perpetuation of source of water and watercourses, it is concluded that these areas should not be incorporated into the agricultural production process.

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