Multi-Science Journal, v. 1, n. 9 (2017) 28-32

Conteúdo disponível em: https://www.ifgoiano.edu.br/periodicos/

Multi-Science Journal

Website do periódico: https://www.ifgoiano.edu.br/periodicos/index.php/multiscience

Original Article

Impact of anthropic action on physical attributes of the soil in different physiology of Cerrado

Raylla Pollyana Barbosa de Sousa[1]*, Marco Antonio Moreira de Freitas[2], Marcos Pereira Costa[1], Lucas Felisberto Pereira[2], José Victor Alves Gomes[1]

[1]*Instituto Federal Goiano, Posse, Goiás, Brazil.*
[2]*Professor at the Instituto Federal Goiano, Posse, Goiás, Brazil. *Autor para correspondência: rayllapollyana@gmail.com.*

I N F O   A R T I C L E

Histórico do artigo
Recebido: 25 maio 2017
Aceito: 23 outubro 2017

Palavras chaves:

Stolf impact penetrometer
Compression
Agricultural activity

A B S T R A C T

This paper was made using the Stolf impact penetrometer to identify different levels of soil compaction and evaluate the impact of human activities on physical soil attributes by comparing areas with native vegetation and areas in which it practiced agricultural activity. For compression analyses were assessed four areas with different condition soil characteristics and/or uses. Subsequent to those assessments, data collection and analysis were proposed solutions and measures to soften the negative effects of anthropological activities undertaken in the tested areas.

1. Introduction

The soil anthropic compaction leads to changes in their physical properties, promoting increased soil density due to volume reduction, once the air present in the micro and macro pores is expelled and culminates in substantial increases in mechanical resistance, thereby providing, difficulties in developing, particularly, the root system of plants.

The current production matrix highly dependent on inputs derived from non-renewable sources comes burdening production systems and impacting increasingly the environment. Thus, the current cultural practices must be rethought in order to install at the properties integrated farming systems economically viable, socially equitable and culturally acceptable, according to the specificities of each region (Lima & Carmo, 2006).

Therefore, the monitoring of soil attributes becomes of great importance. Among these stand out from those of physical order, such as soil compaction, in which misuse by means of incorrect handling such as conventional preparation, transit of machines and agricultural implements lads to the formation of denser environments and with this, more resistant to root penetration (Stone & Silveira 1999). The result of the compaction is catastrophic for the growth of the culture of agronomic interse, that for not having acces to water in depth, has its growth limited (Freddi et al., 2007).

Another attribute of soil quality is that of chemistry order, which in turn is greatly influenced by compaction processes, because once compacted the soil, not even a good fertilization can reverse slow growth and low productivity. This is justified by the law of the Law of Minimum that says that all factors are in their proper portions, the existence of a limitation to a vital process, such as the absorption of water , may reduce the growth os this individual, even if the other factors are present in satisfactory quantities (Kreuz et. al., 1995; Araújo et. al., 2007; Gomes e Filizola 2006). Biological attributes may also be impaired, as the deposition of organic matter in depth by the roots can be compromised, like the growth of these is (Buck et. al., 2000; Canbolat et. al., 2006).

Thus, soil compaction becomes harmful to the maintain a favorable agroecosystem to the production of agronomic cultures, since water is of paramount importance for the maintenance of vital processes such as the turgescence of plants, transport of nutrients in the soil to the roots by mass flow and within the plant (Calonego et. al., 2011). Beutler et. al. (2006) show that when in severe water deficit agronomic cultures such as soybean, corn, cotton and rice, for example, show significant decreases in productivity, which in the great majority of cases can be explained by the reductions in the photosynthetic rates provided by stomatal closure (Kramer & Boyer, 1995).

When compacted, the soil drainage capacity reduces substantially, as the rains in the cerrado is mostly concentrated and torrential (Mazurana et al., 2013), that water that does not percolate the soil can accumulate and according to local altitudes, can also carry soil particles and nutrients, thus triggering erosive processes in soils (Mazurana et al., 2011). Thereby, in properties that have compacted soils, it is common to find signs of soil degradation, such as erosive processes like as grooves, ravines and even gullies (Mazurana et al., 2011).

In conditions of soil compaction, losses such as those provided by drought events can be enhanced, especially in regions of the country that have extremely concentrated rains such as the northeast of the state of Goias, where the Brazilian Cerrado is located (Piccolo et al., 2011). Still, because it is a region in full development and agronomic growth together with the West of the state of Bahia, studies are necessary carry aimed at the practice of a non-predatory agriculture that respects the limitations imposed by the environment (Heredia, 2010).

In this way, the study of the behavior of the soils in their state of compaction, in places where there is or not anthropic action, becomes a valuable tool to understand the dynamics of the soils and also, to prospect management methodologies that aim at its conservation. Thus, the objective of this study is to identify different levels of soil compaction and measure the impact of human activities on soil physical properties.

2. Material and Methods

The study was conducted on the property of the Instituto Federal Goiano located at 14º06'29.9 "S and 46º19'39.6" W in the city of Posse, northeast of the state of Goiás. The treatments were conducted between March and May 2016. The data collected were obtained with Stolf impact penetrometer in four areas with different characteristics of condition and / or use of soil, in which each represents a treatment: Cerrado Intact (A); Cerrado Discovered (B); Clayey Spot (Clay) (C) and Cerrado Deforested + a past grid 18 (IF Goiano Meshed) (D) (all four belongings the future farm IF GOIANO Campus Posse) thus, each condition of soil cover and / or management constituted a treatment, and all treatments were arranged in the field according to a completely randomized delimitation (CRD) with ten replications in each treatment.

The area that was denominated as Intact Cerrado is characterized as an area in which there is no history of anthropic agricultural activity or any other strativist activities. The area called Discovered Cerrado, is characterized as an area where native vegetation existed and was removed, however, in this area there was no agricultural activity until then. The area designated as IF Goiano Meshed has as a background a conventional preparation, in which a soil glebe was revolved through successive plowing and harrowing operations that took place 18 months before the evaluation. Finally, soil patches of Argilous soil were analyzed in the IF Goiano Campus Posse area. These soil patches were collected in areas that were deforested adjacent to the native area, which at the time of the land was not used for agriculture or for preservation remained idle , thus suffering inclements which led to symptoms of degradation.

In each of the treatments was previously defined a representative plot of the characteristics of each area and within this plot were taken 10 measures with an impact penetrometer in the following depths: 0-15; 15-30; 30-45; 45-65 cm. Were withdrawn 10 single soil samples at 0-20 cm depth which later formed a representative composite sample that was sent to a laboratory and characterized physically. Each point taken was obtained through a completely random walk along each area that represented the treatments, and throughout this, soil penetration resistance data were taken.

The data collected from the impact penetrometer model Stolf were converted to resistance (R) of soil from mounted equations in Excel spreadsheets whose details are described in Stolf et al. (2014). First, data were obtained in practical units of equipment, defined as N (impacts / dm) = 10 × number of impacts / penetration (cm). The data were then converted to technical units, defined as R (kgf / cm 2) = 5.6 + 6.89 × N (impacts / dm). Also, for purposes of publication data are converted into R MPa (MPa) = 0.56 + 0.689 × N (impact / dm). The above parameters were analyzed based on the data collected in each of the four treatments previously provided and subjected to analysis of variance, and the averages of each depth for each treatment were submitted to the Tukey test at 5% probability.

Soil moisture samples were not taken from the treatments. The soil used in the first three treatments have deep horizon with 85% sand, according to the analysis. While clayey spot has about 55% clay.

3. Results and discussion

In table 1, it was observed higher resistance values for the initial 15 cm of the treatment Clay (C), 6.38 MPa, whereas for IF Goiano Meched (D), only 0.56 MPa, lower average among the four treatments analysed. For the depth of 15-30 cm, the treatments Cerrado Discovered (B) and Clay (C) presented the highest penetration resistance averages (4.92 MPa and 6.22 MPa respectively), not statistically different from each other; for this depth the IF Goiano Meshed (D) was presented the lowest average (1.25 MPa). At the depth of 30-45 cm, the Discovered Closed treatment (B) presented the highest mean (5.7 MPa), while Cerrado Intact (A) (2.7 MPa) and IF Goiano Meshed (D) (1.71 MPa) presented the lowest values. In the last layer analyzed, 45-65 cm, the Discovered Cerrado (B) continued to present the highest average penetration resistance, 6.36MPa.

Table 1. Penetration Resistance Averages (in MPa) for the four land use and/or management methodologies**.

Depth (cm)	Intact Cerrado	Discovered Cerrado	Clay	IF Goiano Meched
0-15	2,01 A cb	3,24 A b	6,38 A a	0,56 A c
15-30	2,78 A b	4,92 A a	6,22 AB a	1,25 B c
30-45	2,7 A c	5,7 AB a	4,46 BC b	1,71 BC c
45-65	2,51 A b	6,36 B a	2,97 C b	1,94 C b

**Capital letters compare within each management treatment the resistance at various depths, lower case letters compare the resistance to penetration at a depth for each of the soil management treatments. Treatments followed by the same capital letter or lower case letter do not differ from each other to 5% probability by the Tukey test.

In Cerrado Intact treatment was low levels of compression, these being between 2 and 3 MPa as can be seen in Figure 1 A. The degree of compaction ranged along the profile and reached its peak in the 15-30 cm layer. Already in cerrado discovered treatment, Figure 1 B, penetration resistance levels demonstrated higher ranging from 3-7 MPa. There was a gradual increase in resistance over the soil profile. The 45-65 cm layer has a higher degree of compaction. In contrast, clay treatment, in Figure 1 C, there is resistance in the layer 0-30, but this gradually regresses when they are hit greater depths. The degree of compression started at 6.37 MPa to 15 cm deep and reached 3 MPa at 65 cm depth. This was the only treatment that the initial degree of compression is greater than the final study. In the Cerrado Deforested + a past grid 18 treatment, shown in Figure 1 D, the degree of compression was found to be the lowest, its peak was lower than the initial compaction treatment Cerrado Intact. Its pattern is similar to Cerrado Discovered treatment, with gradual increase in resistance over the soil profile; they are differentiated by the values of the degree of resistance.

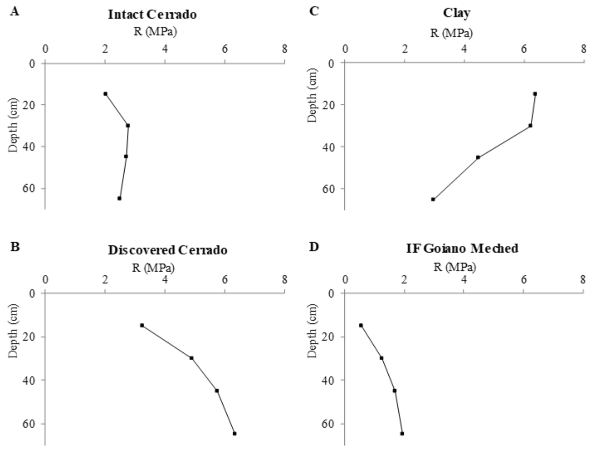

Figure 1. Soil Resistance degree in MPa as a function of depth in cm.

Garcia (2012) states that root development is influenced by the physical characteristics of the soil such as compaction, which to a high degree makes it difficult to aeration which restricts the growth zone of the rhizosphere. Therefore, it can be concluded that the native cerrado soils have a low degree of compression, as well as the results obtained in this experiment. In their work, Reinert et. al. (2008) show that in compacted soils with penetration resistance greater than 2 MPa, the growth of various cultures is already impaired. Furthermore, the results demonstrate the importance of management to support agricultural activities and the possible recovery of degraded areas, in which different strategies should be adopted for each treatment.

The soil of the Cerrado while native, intact and without any anthropic influence is usually porous and well drained with little resistance to penetration (Figure 1A) (Oliveira et al., 2008). These features facilitate the root system growth at depth (Oliveira et. Al. (2005), however, there is a series of variations in the superficial layers, which may increase the soil resistance (Figure 1 B and C) or reduce it (Figure 1.D). In fact, as clarified by Centurion et. al. 2006, the increase in penetration resistance is directly related to the success rate of different species of plants, mainly in areas destined for recovery and often the conditioning of the soil is necessary before the implantation of these species destined for recovery.

On the other hand, it is common to find degraded areas in depth, as found in Figure 1B, where a normal initial establishment of the culture is usually noted which may not express its maximum productive potential due to depth impediments (Foloni et al. 2003). Agronomic cultures and native species may be influenced equally by depth compaction, since drought events may limit their growth by causing these species to seek water in depth (Freddi et al., 2009). However, once compacted the soil in depth the cultivated plants may demonstrate some signs caused by lack of water, such as low growth, chlorosis and death (Letey 1985). In agro-ecosystems, these problems are usually bypassed and easily solved by breaking these compacted layers with the use of machines, especially submersibles (Drescher et al., 2011). But this artificial and mechanical solution does not work for natural environments, and thus, anthropic activity will result in damages that will naturally take decades or centuries to recover (Mazurana et al., 2011 and 2013).

When the Cerrado is deforested and the soil is discovered, it becomes susceptible to compression, because there is no vegetation to reduce the force of impact of drops of water on the ground, then the density of the same increases. Furthermore, the absence of vegetation can increase the amount of soil lost through rains and winds, which can culminate in rivers silting, formation of erosions of various types, and destruction of the soil in all its layers (Mazurana et. al., 2011).

According to studies conducted by Mendonça (2001), it was found an increase in the density of the soil and a reduction in organic matter, moisture, porosity and conductivity, in preserved areas in the National Forest Araripe (Flona). This description is similar to that found in the treatment Cerrado Deforested and Clay (Figure B and C). These results corroborate with those found by Freddi et. al. (2009), demonstrating that under these conditions agronomic cultures are harmed, thus having their productivity hampered since they can not break the compacted barriers in the soil and have access to the amount of water necessary to complete their cycle. Even native species that have slow initial growth may be harmed as they will find a completely different environment that constitute an impediment to their establishment.

In studies of variability in the clayey soil profile made by Iaia (2006), there was gradual reduction of mechanical resistance to penetration (RMRP) with increasing depth where the highest levels of RMRP were verified to 25 cm. The same occurred in the clay treatment of the present study, where there was resistance check in 0-30 layer and gradual reduction of this behavior after the 30 cm deep. These results can be explained by the superficial sealing provided by the rain impact, animal trampling and sporadic transit of machines and implements that over time can make the most superficial layer compacted and resistant to penetration (Mazurana et al., 2011). Further, the penetration resistance may decrease according to depth, Drescher et. al., 2011 explain that the pressure applied to the soil distributes along its profile, causing greater compaction problems in the surface layers, which can keep the subsurface layers free of compaction and any resistance to root growth. However, for these specific cases, mechanical intervention may be required to decompress the surface layers of the soil.

According to Santiago (2007), the conventional tillage of soil is the disturbance of the surface layers to reduce compaction. It was the situation of the Cerrado deforested + a past grid 18 treatment, made in the area of IFGoiano campus Posse, where there was practically no resistance to penetration. Since most of the soils of the Cerrado are classified as Dystrophic Latosol, and still with low content of clay and sandy by nature, conventional soil preparation activities such as plowing and grazing are currently questionable (Mazurana et al.). Among the points that can be mentioned the numerous reports of the benefits of conservation management of soils such as no-tillage, which guarantees productivity identical to conventional management methods, preserving the soil structure, without exposing the organic matter to oxidation, allowing increase of the biological activity in the soil and also, preserving the productive activity even when under dry conditions (Matsuoka et al., 2003; Oliveira et al., 2008).

The results obtained in this work confirm that the soils of the Brazilian Cerrado need careful and detailed studies before any activity is implemented, since when comparing A and B, a similar penetration resistance curve is observed, differing only in the layer of 0-15 cm, that is, an effect only of soil preparation, which according to Mazurana et. al. (2011) is dispensable, since the culture can be developed and produced using no-tillage.

In this way, by comparing the four treatments, it can be stated that the ideal condition from a conservation point of view is the one closest to the one found in the native Cerrado, thus other preparations that aim to condition the soil for the development of the plant become negligible, since under tropical conditions the spraying of soil aggregates, exposure of organic matter and soil compaction caused by inadequate management can only transform agriculture into a predatory and unsustainable activity over time.

4. Conclusions

The results obtained were as expected, known the physical characteristics of the soil. Because of this behavior, this soil will require a management aiming at its conservation and structure. For this, it should be prioritized the increase of organic matter, especially in meshed soil because this is an area that will be used later. This addition of organic matter will help improve the physical chemical and biological composition of this area and improvement in soil moisture retention and fertility, will favor the activity of microorganisms, among other factors, which will require other studies so that dynamics of the use of Cerrado soils is understood, and thus, its use is done in a conscious and sustainable way.

5. Acknowledgment

CNPq, FAPEG and the Instituto Federal Goiano.

6. References

BEUTLER, A.N., CENTURION, J.F., CENTURION, M.A.P.C., Silva, A. P., (2006). Efeito da compactação na produtividade de cultivares de soja em latossolo vermelho. R. Bras. Ci. Solo, 30:787-794.

BUCK, CORINNA; LANGMAACK, MARCUS; SCHRADER, STEFAN (2000). Influence of mulch and soil compaction on earthworm cast properties. Applied Soil Ecology, v. 14, n. 3, p. 223-229.

CANBOLAT, M.Y., BILEN, S., ÇAKMAKCER, R., ŞAHIN, F., AYDN, A., (2006). Effect of plant growth-promoting bacteria and soil compaction on barley seedling growth, nutrient uptake, soil properties and rhizosphere microflora. Biology and Fertility of Soils, v.42, p.350–357.

CENTURION, J.F., CENTURION, M.A.P.C., BEUTLER, A.N., ROSSINI, L.A., FREDDI, O.S., NETO, E.L.S., (2006). Compactação do solo no desenvolvimento e na produção de cultivares de soja Científica, Jaboticabal, v.34, n.2, p.,203-209 203.

DRESCHER, M. S., ELTZ, F.L.F., DENARDIN, J. E., FAGANELLO, A., (2011). Persistência do efeito de intervenções mecânicas para a descompactação de solos sob plantio direto. Bras. Ci. Solo, 35:1713-1722.

FOLONI, J.S.S., CALONEGO, J. C., LIMA, S. L., (2003). Efeito da compactação do solo no desenvolvimento aéreo e radicular de cultivares de milho. Pesq. agropec. bras., Brasília, v. 38, n. 8, p. 947-953, ago. 2003.

FREDDI, O. S., CENTURION, J. F., BEUTLER, A. N., ARATANI, R.G., LEONEL, C. L., (2007). Compactação do Solo no Crescimento Radicular e Produtividade Da Cultura do Milho. R. Bras. Ci. Solo, 31:627-636.

FREDDI, O. S., CENTURION, J. F., DUARTE, A. P., PERES, F. S. C., (2009). Compactação do solo e produção de cultivares de milho em latossolo vermelho. II - Intervalo hídrico ótimo e sistema radicular. R. Bras. Ci. Solo, 33:805-818.

GARCIA, E. A., MARASCA, I., CAMPOS, F. H., ASSIS, R. L. de, LANÇAS, K. P. (2012). Índice de cone de um latossolo vermelho e um nitossolo vermelho em áreas de pousio. Tékhne In Lógos, v. 3, n. 2, p. 1-9.

IAIA, A. M., MAIA, J. C. S., KIM, M. E. (2006). Uso do penetrômetro eletrônico na avaliação da resistência mecânica do solo cultivado com cana-de-açúcar. Revista Brasileira de Engenharia Agrícola e Ambiental. Campina Grande-PB, v.10, n.2, p.523-530.

KREUZ, C.L., LANZER, E.A., PARIS, Q., (1995). Funções de produção Von Liebig com rendimentos decrescentes. Pesquisa Agropecuária Brasileira. 30 (1): 95-106.

LETEY, J., (1985). Relationship between soil physical properties and crop production. Adv. Soil Sci., 1:277-294.

LIMA A. J. P. & CARMO M. S. (2006). Agricultura Sustentável e a Conversão Agroecológica. Desenvolvimento em Questão, Editora Unijuí, n. 7.

MATSUOKA, M., MENDES, I.C., LOUREIRO, M.F., (2003). Biomassa microbiana e atividade enzimática em solos sob vegetação nativa e sistemas agrícolas anuais e perenes na região de primavera do leste (MT). R. Bras. Ci. Solo, 27:425-433.

MAZURANA, M., LEVIEN, R., MÜLLER J., CONTE. O., (2011). Sistemas de preparo de solo: alterações na estrutura do solo e rendimento das culturas. R. Bras. Ci. Solo, 35:1197-1206.

MAZURANA, M., FINK, J.R., SILVEIRA, V.H., LEVIEN, R., ZULPO, L., BREZOLIN, D., (2013). Propriedades físicas do solo e crescimento de raízes de milho em um argissolo vermelho sob tráfego controlado de máquinas. R. Bras. Ci. Solo, 37:1185-1195.

MENDONÇA, L. A. R. (2001). Recursos hídricos da Chapada do Araripe. 193 p. (Tese de doutoramento) - Centro de Tecnologia da Universidade Federal do Ceará, Fortaleza.

NETO, M. S., PICCOLO, M. C., JUNIOR, C. C., CERRI, C. C., BERNOUX, M., (2011). Emissão de gases do efeito estufa em diferentes usos da terra no bioma cerrado. R. Bras. Ci. Solo, 35:63-76.

NARDOTO, G.B., SOUZA, M.P. & FRANCO, A.C., (1998). Estabelecimento e padrões sazonais de produtividade de Kielmeyera coriaceae (Spr) Mart. nos cerrados do Planalto Central. Revista Brasileira de Botânica, 21(3): 313-319.

OLIVEIRA, J. T., MOREAU, A. M. S. S., PAIVA, A. Q., MENEZES, A.A., COSTA, O. V., (2008). Características físicas e carbono orgânico de solos sob diferentes tipos de uso da terra. R. Bras. Ci. Solo, 32:2821-2829, 2008, Número Especial.

OLIVEIRA, R. S.†, BEZERRA, L., DAVIDSON, E. A., PINTO, F., KLINK, C. A., NEPSTAD, D. C., MOREIRA, A., (2005). Deep root function in soil water dynamics in cerrado savannas of central Brazil. Functional Ecology 2005 19 , 574–581.

PALMEIRA, B. H. M., LEITE, S. P., (2010). Sociedade e Economia do "Agronegócio" no Brasil. Revista Brasileira de Ciências Sociais - VOL. 25 N° 74. RBCS Vol. 25 n° 74 outubro/2010.

REINERT, D.J., ALBUQUERQUE, J.A., REICHERT, J.M., AITA, C., ANDRADA, M.M.C., (2008) Limites críticos de densidade do solo para o crescimento de raízes de plantas de cobertura em argissolo vermelho. R. Bras. Ci. Solo, 32:1805-1816.

TOLF, R., MURAKAMI, J.H., BRUGNARO, C., SILVA, L.C.F., MARGARIDO, L.A.M. (2014). Penetrômetro de impacto Stolf – programa computacional de dados em Excel-VBA. Revista Brasileira de Ciência do Solo, v. 38, n. 3, p. 774-782.

SANTIAGO, A. D., ROSSETTO, R. (2007). Preparo Convencional. AGEITEC. Available in: <http://www.agencia.cnptia.embrapa.br/gestor/cana-de-acucar/arvore/CONTAG01_84_22122006154841.html> Access in: 15/06/2016.

STONE, L. F & SILVEIRA, P. M. (1999). Efeitos do Sistema de Preparo na Compactação do Solo, Disponibilidade Hidrica e Comportamento do Feijoeiro. Pesq. agropec. bras., Brasília, v.34, n.1, p.83-91.