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PHYSICAL QUALITY OF THE SOIL IN A DIRECT AND CONVENTIONAL PLANTING SYSTEM

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Abstract: The no-tillage system is defined as a conservationist management system, which involves techniques with the objective of physical, biological and chemical soil conservation, based on the absence of disturbance and permanent soil cover through crop rotation. With this, this work aims to gather information obtained through bibliographic reviews that are associated with the physical quality of the soil under the no-tillage and conventional system. The no-tillage system has improvements in soil physical attributes such as reduced penetration resistance (Rp) by improving soil aggregates, soil density (Ds), mycopores and macropores, as there is no greater soil disturbance during use. of the system, thus increasing the oxidation of organic matter, which, consequently, favors the increase in C stocks, Power Mean Diameter (MPD). Differing from the conventional planting system, which has greater traffic and soil disturbance, thus breaking more the structure of the aggregates, reducing soil moisture because there is no deposit of cultural residues and greater resistance to penetration by soil compaction by the weight and use of agricultural machinery.
Keywords: Physical attributes, Conservation, Soil management.

INTRODUCTION

DIRECT PLANTATION

The implementation of the No-tillage System (SPD) before arriving in Brazil had already started for a long time in other countries such as England, the United States and also in several regions of Europe, however, the introduction of this system in Brazil happened at the end of the decade. 1960, which began in small areas as a resource for academic studies on conservation soil management (MOTTER; ALMEIDA, 2015).

Agricultural production in southern Brazil in the years 1950 to 1960, farmers were based solely on a model of soil preparation (conventional planting), but this management practiced excessive use of equipment such as disc plows and heavy harrows, which were pulled by tractors for the incorporation of plant biomass and control of weeds (TORRES; PEREIRA; FABIAN, 2008). However, the extension of agricultural frontiers and the use of conventional soil preparation for cultivation led to soil degradation by erosion, affecting productivity, regardless of advances in genetic improvement, use of chemicals and heavy machinery (CASÃO JUNIOR et al., 2012).

The no-tillage system is defined as a conservationist management system, which involves techniques with the objective of physical, biological and chemical soil conservation, based on the absence of disturbance and permanent soil cover through crop rotation (HECKLER et al., 2002; LAL, 2004; NUNES et al., 2015). Historically, SPD has been appreciated as an important practice for the sustainability of intensive agricultural production systems, for the benefits, for example, increased infiltration and availability of water for plants; lower rate of soil and nutrient loss due to erosion, reduced machine working time, reduced fuel consumption and reduced pollution of water resources, compared to conventional planting (LAL, 2004; SOANE et al., 2012).

According to the experiment by Sá et al. (2014) it is observed that the no-till system (SPD) has an accumulation of cultural residues in the soil, providing an increase in carbon, contributing to a better absorption of water, increasing the sortivity, total porosity and macroaggregates.

EXPANSION AND MANAGEMENT WITH PD AND PC SYSTEM

The replacement of natural vegetation causes variations in soil properties, such as density, porosity and penetration resistance, and these vary with climate conditions, plant species and soil, but little is known about the intensity and causes of these variations. Thus, a detailed comparative study between soil layers, in which the effect of vegetation cover is felt with greater intensity, can contribute to the understanding of changes and their influences on the soil-plant system (KATO et al., 2010).

Cultivation areas under SPD are expanding considerably due to the benefits it provides to the soil and cultivation, with no soil disturbance and the covering of the soil with straw avoid erosion, leaching, in addition to promoting greater water infiltration and keeping the soil moist. however much the SPC has, as well as improving agricultural productivity operability (DIAS et al., 2015). In 2017, the IBGE census indicated that the North region had 1.1 million/ha, the Northeast had 3.3 million/ha, the Midwest had 13.6 million/ha, the South East had 2.9 million/ha and the South had 11. 9 million/ha planted with the no-tillage system. In 2018, the Brazilian Federation of the No-tillage System (Febrapdp) reported that Brazil had a total of 33.06 million/ha planted with the no-tillage system.

According to Soares et al. (2016) knowing the damage caused by the different management systems is essential to improve the physical and chemical qualities of the soil, since the improper use of the soil, such as the excessive use of machinery or the use of poor conservation practices, can lead to an increase in density., decreased macroporosity and total porosity, among other damages.

On the other hand, some soil attributes are more sensitive to mechanical action, especially the stability of aggregates, soil density, organic carbon content and carbon stock, which are indicators used to measure these changes, as well as regulate the infiltration, retention and availability of water in the soil and favoring gas exchange (LIMA et al., 2003; VASCONCELOS et al., 2010; VIEIRA et al., 2011).

The effectiveness of the no-till system is linked, among other conditions, to the quantity and quality of residues generated by cover crops and the permanence of these on the soil. These residues, in tropical climate regions, have a faster decomposition than in temperate climate regions, due to microbial action and temperature (ANDRADE et al., 2018). However, this statement does not mean that the PD system is a solution for any region or type of soil. According to Bertoni and Lombardi Neto (2008), the soil must present minimum structural conditions that allow good infiltration and absence of an impediment layer that hinders permeability.

SOIL TYPES

Latosols are present in most of the Cerrado, with 46% of the area. Latosols under Cerrado vegetation present acidity and low natural fertility (LEPSCH, 2011). Oxisols, according to their origin, follow subsequent characteristics of intense weathering, such as high depth and profile homogeneity, low cation exchange (CTC) and low natural fertility (EMBRAPA, 2013), low soil density, high volume of macropores and high friability, which favors its management (OLIVEIRA et al., 2004).

The Ultisols occupy the second largest extension of area in Brazil. They are characterized by the presence of a subsurface horizon of clay accumulation, classified as textural B (SANTOS et al., 2018).

According to the Brazilian Soil Classification System - SiBCS, the Planosols class is defined as mineral soils that have low-efficiency drainage, with a superficial horizon, contain a lighter texture that abruptly contrasts with the immediately underlying B horizon, with the density, in general large amounts of clay, low permeability, occasionally instituted by a flat horizon, forming an overlapping (suspended) water table, with periodic existence and unstable presence throughout the year (EMBRAPA, 2013).

With this, this work aims to gather information obtained through bibliographic reviews that are associated with the physical quality of the soil under the no-tillage and conventional system.

METHODOLOGY

Research was carried out on websites: Google Scholar, Scielo, Science direct and Elsevier. In the period from 1997 to 2020, using keywords such as: conventional planting system, no-tillage system, soil physical quality between SPD and SPC.

Keywords were used such as "physical quality of soil in PD", "physical quality of soil in PC", "physical quality of soil in latosol with PD and PC", "physical quality of soil in planosol".

RESULTS

For Oliveira et al. (2015) the physical attributes of the soil change depending on the management to which they are subjected, and may be aggravated by the constant use of implements and machine traffic used in conventional soil preparation. On the other hand, some physical attributes of the soil may vary in a short period of time or in a simple practice of preparation, others will only be visible or measurable with continuous use (OLIVEIRA et al., 2014).

PENETRATION RESISTANCE

In a Planosol with SPD system, the organic fragments in the soil profile by the cultural residues present in the free light fraction of the soil (FLL) that enter the decomposition process incorporated the organic matter (OM) to the soil matrix (Occluded Light Fraction and Fraction heavy) thus reduces penetration resistance (Rp) and soil density (Ds) throughout the use of the system, since there is no soil disturbance that would increase the oxidation of organic matter, which, consequently, favors the increase in C stocks, aggregation, power mean diameter (DMP) and total porosity (Pt) (REIS; LIMA; BAMBERG, 2016).

The high values of carbon management index (BMI) in SPD with 5 years and SPD with 7 years in a Planosol showed that the system became efficient in maintaining carbon stocks and improving the physical quality of the soil. In uncultivated fields, Rp values were lower, but studies by Reis et. al., (2006) disclose that the effect of conventional planting system (CP) on the soil can be improved with the time of implementation of the SPD, mainly by the accumulation of organic matter on the soil surface, which improve the structure of the soil and its physical quality.

In a Yellow Latosol, areas with penetration resistance in 34-year-old cotton plantations showed greater horizontal continuity under conventional than no-till. A study with years of cotton cultivation in the conventional tillage system indicates the presence of a plow tray medially below the cultivated layer due to the long-term disc plow and historical moldboard plowing. This may be a reason for lower hydraulic conductivity and cotton yield under conventional tillage than under no-tillage system. In contrast, the irregular distribution of zones with resistance to penetration in the PD may be related to the increase in machine traffic and rupture of densified soil peds by the activity of the root system and soil macrofauna (DORNER et al., 2010; MARTINO; SHAYKEWICH, 1994).

It is known that the greatest soil compaction in the SPD system is in the surface layer, because of the passage of machines in the area, without the subsequent plowing and harrowing, causing a decrease in the volume of the soil, consequently increasing the apparent density. In relation to Rp, in plots under SPC in a Yellow Latosol, it is lower in the surface layer (0–20 cm) and higher in soil depth, while in plots under SPD the opposite occurs. The increase in Rp values, in the layer of 20–25 cm, for the SPC, may indicate the beginning of the formation of a grid foot, caused by the continuous preparation of the surface layer (ARATANI et al., 2009; BERTOL et al., 2004; GOZUBUYUK et al., 2014).

MACROPOROSITY AND MICROPOROSITY

According to Blanco-Canqui and Lal (2008), the removal of residues at the end of the harvest influences the physical properties of the soil at macro and micro scale. Thus, the residues that become soil cover are of great importance to aggregate functions and properties in the soil at different scales.

According to the work carried out by Tormena et al., (2002), in soil classified as Dystrophic Red Latosols, with the implementation of black oat (Avena strigosa, Schreb) in the period 1999/2000 in two systems consisting of: no-tillage and conventional tillage system showed higher microporosity in no-tillage with a value of 0.296 m3m-3 while conventional tillage was 0.285 m3m-3 in the layers of 0.0-0.10.

In no-tillage and conventional systems in a Red Argisol, the macroporosity is below the critical value in all layers 0.0-0.10 cm, 0.10-0.15 cm and 0.20 to 0.25 cm, with macroporosity of 0.08 m3m-3, 0.08 m3m-3, 0.07 m3m-3, in PD and the PC that presented 0.14 m3m-3, 0.09 m3m-3, 0.09 m3m-3 respectively, the soil has a low volume of macropores, a restriction that must be considered in the planning of soil and crop management operations to avoid further degradation (FLORES et al., 2008; REICHERT et al., 2003).

The PD, compared to the PC, had greater stability of aggregates in a Red Argisol of the class from 4.76 to 8.0 mm, from 0 to 0.05 m (73 versus 25 %), it did not differ from 10 to 0.15 m (45 versus 51 %) and lower in the layer from 20 to 0.25 m (28 versus 52 %) The PC has higher productivity in the first two years, while the PD produces more in the last three crops. Thus, the DP, after its consolidation as a system, will be able to produce more than the PC (FLORES et al., 2008).

According to Reis et al., (2016), high values of macroaggregates were observed in a planosol in the years of SPD with 3 years (0.03 m3m-3), SPD with 5 years (0.04 m3m-3) and SPD with 7 years. years (0.06 m3m-3), which differed from the 1-year SPD (0.01m3m-3) in the 0.00 to 0.03 m layer and showed an effect of the SPD implantation time on the physical attribute of the soil. The longer implantation time also increased the weighted mean diameter (WMD) of the aggregates from 2.6 to 3.6 mm. According to Silva et al. (2008), the 8-year SPD is sufficient to promote improvements in the physical quality of the soil.

Soil organic carbon has the potential to increase aggregate stability and stimulate macroaggregation by improving the binding forces between soil particles (BLANCO-CANQUI et al., 2013).

SOIL POROSITY AND DENSITY

For the work of Secco et al., (2005) the physical attributes of the soil were evaluated, such as: soil density and Total Porosity in areas with soybean, wheat and corn crops with a soil classified as Latosol Vermelho Argiloso, from 1995 to 1997 with cultivation under continuous no-tillage (PDC) and conventional tillage system with scarification and leveling harrow (PCEG) at a depth of 0.14 to 0.21 cm. The results showed that the soil density presented higher values in the PDC system that presented 1.29 Mg m-3, 1.33 Mg m-3, 1.32 Mg m-3 than in PCEG 1.18 Mg m-3, 1.27 Mg m-3, 1.15 Mg m-3 for the 3 years respectively, while the total porosity presented for the PDC 0.50 dm3 dm-3, 0.49 dm3dm-3, 0.50 dm3dm- 3 and for PCEG 0.54 dm3dm-3, 0.52 dm3dm-3, 0.56 dm3 dm-3 for the 3 years respectively.

Nogueira et al. (2016) observed that the SPD in a three-year-old Oxisol showed lower total porosity in relation to the SPC, but it will persist only in the first years of cultivation, ceasing to exist over the years, since the frequent deposition of organic residues on the soil surface provided by the no-tillage system will result in improved physical characteristics and increased porosity.

Regarding the cultivation of sugarcane in clayey, the changes in the physical indicators of the soil occurred only at the depth of 0-0.10 m between the rows, in which no-tillage showed higher apparent density (BD) in relation to conventional planting only. in the cane-plant cycle, while soil penetration resistance (SRP) values were higher during ratoon cane (BARBOSA et al., 2019).

According to Sales et al., (2016), crops such as corn and brachiaria provided higher porosity value in the SPD, because of their roots, which at the time of crop removal, their decomposition favors the production of biopores that help increase macroporosity and total porosity, in addition to contributing to soil carbon, SPC does not have soil cover, which leaves it unprotected and prone to degradation.

WEIGHTED AVERAGE DENSITY (DMP) AND GEOMETRIC AVERAGE DENSITY (DMG)

According to Silva and Mielniczuk (1997) they observed a decrease in the weighted average diameter (WMD) of the aggregates of 71 % in a Red Argisol (220 g kg-1 of clay) and of 47 % in a Purple Latosol (680 g kg-1 clay), when it left a native field condition for conventional tillage with annual crops and plowing and harrowing, while for no-till there was a stabilization.

According to Costa et al. (2003), the DMP of aggregates in an Latosol has values of 0.61 mm in an Argisol and 1.76 mm in conventional tillage, for values of 0.91 and 1.90 mm., respectively, in no-tillage. The largest geometric mean diameter (DMG) of the aggregates was observed in the surface layer of the soil under no-tillage (3.7 mm), compared to the soil under conventional planting (1.6 mm), indicating a positive effect of the non-revolving of the soil. soil and accumulation of plant residues on the surface on the stability of aggregates.

SOIL MOISTURE

According to Fernández-Ugalde et al., (2009) in their experiment, they observed that higher moisture content under no-tillage than under conventional tillage was more evident at lower water potentials. Soil that increase moisture has generally been related to improved soil aggregation (ABID; LAL, 2009).

In semi-arid regions with irrigation system provides soil compaction, one of the factors for this occurrence is the soil preparation with moisture above friability, which consequently occurs the density of soil particles (RADFORD et al., 2007). With the deposition of soil cover in the semi-arid region, there is an increase in soil organic carbon, due to the decomposition of waste and its mineralization, improving the formation of aggregates (GIUBERGIA; MARTELLOTTO; LAVADO, 2013).

In soils in South Africa, soil moisture content was measured in drier periods of the growing season. However, the study showed that there was higher moisture content with the no-till system than conventional at both depths (0-10, 10-20), long-term no-till increased initial and cumulative infiltration, and Kfs by 47% to 100%, respectively, compared to conventional (NOURI et al. 2019).

CONCLUSION

The no-till system improves physical attributes of the soil throughout its implementation, attributes which are of great importance for the development of plants such as resistance to penetration, macroporosity and microporosity, total porosity and greater availability of water. However, there is still a need for more work that develops more physical aspects of the soil in different soil conditions.

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