# THE STABILITY OF AGGREGATES AND ORGANIC CARBON CONTENT AFTER THE APPLICATION OF GYPSUM, SOIL SCARIFICATION AND A SUCCESSION OF AGRICULTURAL CROPS

## ESTABILIDADE DE AGREGADOS E TEOR DE CARBONO ORGÂNICO, APÓS APLICAÇÃO DE GESSO, ESCARIFICAÇÃO DO SOLO E SUCESSÃO DE CULTURAS

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**ABSTRACT**: Studies related to the monitoring of soil quality by physical attributes are important for the evaluation and maintenance of the sustainability of agricultural systems, besides indicating the appropriate management of the environment, aiming at its conservation and productivity. The objective of this study was to evaluate the stability of aggregates and organic carbon after the application of gypsum, soil scarification and a succession of crops. The treatments consisted of an absence and addition of gypsum, absence and presence of soil scarification, and three systems of crops in succession. The experimental design was made of randomized blocks, in a 2x2x4 factorial scheme, with eight replications. The aggregates were evaluated as stabled in water and soil organic carbon content. The treatment where gypsum was applied, as well as the soybean/maize/brachiaria/fallow (SMBF) succession system, presented better results in soil aggregation and higher levels of organic carbon.

**KEYWORDS:** Soil management. Physical attributes. Soil degradation.

## INTRODUCTION

Agricultural practices, when performed improperly, result in changes of both physical and chemical soil attributes, such as aggregation, which is one of the most important factors for the conservation and maintenance of the environmental functions of the soil (LOSS et al., 2009; HANKE; DICK, 2017), and organic matter, involved in the processes of cementation and stabilization of aggregates. Moreover, the relationships between soil aggregates and organic matter content are related to mineral fraction, soil fauna, microorganisms, presence of roots, inorganic agents and environmental variables as the main factors involved in the formation and stability of soil aggregates (SALTON et al., 2008).

Aggregate stability is related to several soil physical properties, such as: water retention capacity, infiltration rate, erosion resistance (GARCIA; ROSOLEM, 2010; NASCENTE; LI; CRUSCIOL, 2015). The increase of the stability of aggregates provides the best structuring of the soil, supplying it with pore spaces and allowing a better

development of a root system for plants, airflow and water in the soil (SALTON et al., 2014).

Root exploration in the soil profile can accelerate the aggregation process of soil particles, by releasing exudates with the interweaving of small clods that, consequently, form larger structures. The cultivation of plants with abundant root systems combined with management practices that add organic matter in soils are essential for the formation and stability of aggregates larger than 2 mm, resulting in the restructuring of soil particles (RIBON et al., 2014).

The organic matter, in its turn, exerts great influence in the processes of formation and stabilization of aggregates. A greater amount of organic matter available to the soil provides a higher structural quality (VEZZANI; MIELNICZUK, 2011; MATAIX-SOLERA et al., 2011). Conservation systems of soil management result in an expressive increase of soil aggregation. The rotation, or crop succession, with frequent residue inputs, associated with other management practices that aim to reduce soil disturbance, typically results in a greater

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aggregate stability, which is revealed by higher values of weighted average diameter (WAD) of the aggregates, which, in large part, is related to the effect of management systems on soil organic carbon (BRAIDA et al., 2011).

However, it is still necessary to understand the influence of agricultural inputs and other management practices on aggregation and MOS levels. Among the most commonly used inputs, agricultural gypsum ($CaSO_4.2H_2O$) has been used mainly in no-tillage systems to minimize acidity problems. This happens because gypsum is an excellent source of Ca (20%) and S (15−18%). The increase of these nutrients may favor deep root growth and promote the carryover of other bases, such as $Mg^{2+}$ and $K^+$ to deeper soil layers (FOIS et al., 2018). In addition, when applied to the soil, gypsum reacts with $Al^{3+}$ and forms complex ionic pairs, making it less toxic ($AlSO^{4+}$) to the plants and providing exchangeable bases ($Ca^{2+}$ and S) in the subsoil, due to its movement, that is about 150 times higher than limestone (ZAMBROSI; ALLEONI; CAIRES, 2007; MASCHIETTO, 2009; NEIS et al., 2010). Thus, gypsum is considered a soil conditioner with little effect on pH, compensating for the surface effect of limestone, since it even acts underground, without the need for incorporation, increasing the volume of soil to be explored and the tolerance of plants to drought in the soil (ARF eet al., 2014; ZANDONÁ et al., 2015).

Another practice that has been employed, and indicated for soils suspected of compaction, is soil scarification, which generates immediate benefits with the rupture of thickened layers, such as density reduction, increased surface roughness,

hydraulic conductivity and water infiltration rate in the soil (MAZURANA et al., 2011). According to Tormena, Fidalski and Rossi Junior (2008), the adoption of a planned crop rotation system is essential for the maintenance of structural soil quality in no-tillage systems. Nevertheless, little is known about the benefits of using crops succession and input MOS in the soil aggregation, besides the influences caused by the use of gypsum and scarification in the soil.

Studies on soil quality monitoring by physical attributes are important for assessing and maintaining the sustainability of agricultural systems, as well as indicating the appropriate management of the environment, aiming at its conservation and productivity (MOTA; FREIRE; ASSIS JÚNIOR, 2013). Therefore, the objective of this study was to evaluate the stability of aggregates and organic carbon content, after the application of gypsum, soil scarification and a succession of crops.

**MATERIAL AND METHODS**

The experimental area was located at the Embrapa Rondônia headquarter, in the city of Porto Velho, capital of the state of Rondônia (RO), (08º 47' 42''S, 63º 50' 45''W), elevation of approximately 95 meters (Figure 1). The average annual rainfall is 2,200 mm, with a dry season from June to September; the average annual temperature is 24.9 °C and the average relative humidity is 89%. The climate of the region is defined as humid tropical, according to the Köppen classification. The soil of the experimental area was classified as a dystrophic Red-Yellow Latosol (EMBRAPA, 2013).
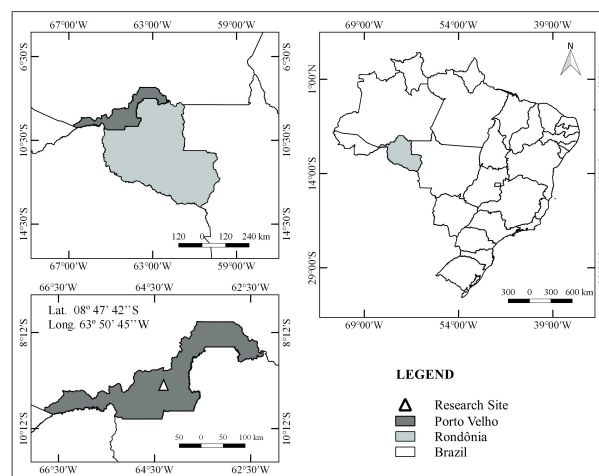


**Figure 1.** Location of the research site in the city of Porto Velho, RO.

Before the implementation of the experiment, the area was cultivated with *Brachiaria*

*brizantha* cv. Marandú for a period of eighteen years (1990 to 2008); after that, was kept in fallow

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during four years (2009 to 2013). The chemical characterization of the soil, before the

installation of the experiment, is presented in Table 1.

**Table 1.** Chemical analysis of the soil in the 0.00 – 0.20 m layer of the experimental area.

| pH em H$_2$O | Ca$^{2+}$+ Mg$^{2+}$ | K$^+$ | Al$^{3+}$ | H$^+$+Al$^{3+}$ | T | SB | OM | P available |
|---|---|---|---|---|---|---|---|---|
| | cmolc dm$^{-3}$ | | | | | | | mg dm$^{-3}$ |
| 5.0 | 1.7 | 0.12 | 2.2 | 5.9 | 7.7 | 1.73 | 3.2 | 1.4 |

pH: in water; SB: sum of bases; T: CTC at pH 7.0; OM: Organic matter

The experiment began in the year 2013, for the 2014 crop, with a randomized block design, composed of eight blocks, in a 2x2x3 factorial scheme. The following treatments were used: with and without mechanical soil scarification; absence and presence of agricultural gypsum; and four crop succession systems (soybean/fallow, soybean/maize/fallow, soybean/maize and brachiaria/fallow). Each experimental unit had a 4.5 m x 20 m dimension, and 27 m x 40 m for each block, totalizing 160 m x 54 m, excluding curbstones.

In the implementation of the experiment, the only mechanical practice introduced was soil scarification, with 2,000 kg ha$^{-1}$ of gypsum. Both treatments were conducted before soybean planting, in 2013, the first year of the experiment. The seeds available in the Cone Sul [Southern Cone] region of Rondônia were used for planting soybean, maize and brachiaria, according to the following planting density: 260 to 340 thousand plants ha$^{-1}$ for soybean; 50 to 70 thousand plants ha$^{-1}$ for maize and 16 kg ha$^{-1}$ of brachiaria.

The dates of soybean sowing were in November 2013, December 2014, December 2015 and November 2016; the maize and brachiaria sowing were always done thirty days after the soybean crop. Soybean and maize were cultivated with mechanized sowing and the brachiaria was cultivated by a manual sowing broadcast system.

NPK fertilizers were carried out with the following formulations: 400 kg$^{-1}$ of 0-30-15 formulation in soybean sowing, plus 300 kg ha$^{-1}$ of 4-30-10 formulation in maize cultivation (with or without brachiaria) and 150 kg ha$^{-1}$ of 25-0-25 formulation in side-dressing in maize crop (with or without brachiaria), 30 days after maize germination.

To determine the stability of aggregates, samples with preserved structure were collected in the 0.0-0.05, 0.05-0.10, 0.10-0.20 m layers. The sample collection was made with a spade, without destructing the clods, which were packed in plastic bags and, later, air-dried. In the preparation of the samples, the clods were hand-cut, taking care not to

destroy the aggregates; and then sieved in 9.5 mm and 4 mm sieves. The aggregates retained in the smallest sieve were selected for a wet laboratory analysis (EMBRAPA, 2011).

To determine the distribution of aggregate classes, we used the wet sieving, with the machine recommended by Yoder (1936), which was calibrated to run for 15 min with 32 oscillations per minute. The samples were moistened and transferred to the Yoder apparatus, adapted with 2.0, 1.0, 0.5, 0.25, 0.125, 0.063 mm cut-off mesh sieves (KEMPER; CHEPIL, 1965). After the end of oscillations, the content retained in each of the sieves was kiln-dried at 105 °C, for 24 hours, and then weighed. The class less than 0.060 mm was calculated by difference, taking into account the initial weight minus the residual moisture and the weight of the other classes as a basis.

The results are expressed as a percentage of the aggregates retained in each of the sieve classes and as the stability of the aggregates evaluated by the Weighted Average Diameter (WAD) obtained by the formula proposed by Castro Filho, Muzilli and Podanoschi (1998), and the Geometric Mean Diameter (GMD), according to Schaller and Stockinger (1953), cited by Alvarenga et al. (1986).

The organic carbon was determined by oxidation of the organic matter via wet with potassium dichromate in a sulfuric medium, using as energy the heat released from the sulfuric acid and/or heating process. The excess of dichromate after oxidation is titrated with a standard solution of Ammonium iron (II) sulfate (Mohr salt) (EMBRAPA, 2011).

The hypothesis of the normality of data was tested by the Shapiro-Wilk test. Data were submitted to analysis of variance, when significant through the F test, the means were compared by the Scott-Knott test at a 5% level of probability.

## RESULTS AND DISCUSSION

The higher concentration of organic carbon (OC) was observed in the 0.00 – 0.05 and

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0.05 – 0.10 m layers, in the treatments where the application of agricultural gypsum occurred (Table 2). Although no statistical differences were observed in the 0.10 – 0.20 m layer, the gypsum treatment continued to present a higher OC content, probably due to the reaction with exchangeable acidity and base levels increase, which favors the proliferation of soil macrobiota. However, in this layer the most significant treatment was the presence of scarification, presenting the highest OC content (5.4 g Kg$^{-1}$). These results may be related to the increase of Ca along the soil profile, which may have favored the development of the root system in depth, resulting in a greater efficiency of the plant to increase dry matter. The effect of gypsum as a soil conditioner for root growth may play an important role in the increase of

organic matter through the deposition of organic residues in depth. It is known that around 27 to 37% of the soil carbon input originates from the roots (SANTOS et al., 2011). Higher OC levels in the soil, due to the application of gypsum, are a good indication that the use of this technology increases crop yield due to a more efficient use of water and nutrients (ROSSETTO et al., 2013).

The treatment with scarification in the 0.00 – 0.05 and 0.05 – 0.10 m layers was not significant. However, the 0.10 – 0.20 m layer presented a higher OC content in the soil scarification treatment (Table 2). Scarification results in the preparation with less revolving and, therefore, less incorporation of the straw, remaining, on the surface, a greater cover for soil protection (CARVALHO FILHO et al., 2007).

**Table 2.** Mean values for in-balance soil carbon levels, due to the effect of agricultural gypsum, soil scarification and crop succession systems, in the 0.00 – 0.05, 0.05 – 0.10 and 0.10 – 0.20 m layers.

| TREATMENTS | | Organic carbon (g.kg$^{-1}$) | | |
| | | Layer (m) | | |
| | | 0.00 – 0.05 | 0.05 – 0.10 | 0.10 – 0.20 |
|---|---|---|---|---|
| Gypsum | With | 7.8 a | 6.9 a | 5.3 |
| | Without | 7.1 b | 6.3 b | 4.8 |
| F TEST | | * | * | ns |
| Scarification | With | 7.6 | 6.7 | 5.4 a |
| | Without | 7.3 | 6.5 | 4.7 b |
| F TEST | | ns | ns | ** |
| Succession | SMBF | 8.2 a | 7.7 a | 4.9 |
| | SMF | 7.6 b | 6.8 b | 5.1 |
| | SF | 7.2 b | 6.3 b | 4.2 |
| F TEST | | * | * | ns |

SMBF = soybean/maize/brachiaria/fallow; SMF = soybean/maize/fallow; SF = soybean/fallow; ** significant at the 1% probability level (p <.01); * significant at the 5% probability level (.01 = <p <.05); ns not significant (p> = .05). Means followed by the same lowercase letter in the column do not differ from one another by the Scott-Knott test at the 5% probability level.

Among crop succession systems, the soybean/maize/brachiaria/fallow (SMBF) system showed the highest amount of OC in the 0.00 – 0.05 and 0.05 – 0.10 m layers, the other systems did not differ among themselves (Table 2). Similar results were observed by Oliveira et al. (2010) and by Portela et al. (2010), who verified a significant improvement in the physical attributes of the soil due to the continuous supply of plant material to the soil, mainly through the roots of the crops. The increase of organic matter in the soil acts positively in the recovery process since it proves nutrients from the mineralization and in a better soil structure, in its physical quality, that will interfere in soil porosity and aeration (BONINI; ALVES; MONTANARI, 2015). The products derived from this organic matter are sources of nutrients and specific energy for soil microorganisms that play an

important role in aggregation, since the products of microbial decomposition, such as polysaccharides and mucilage, are cementing agents of soil macroaggregates (INAGAKI et al., 2016; SILVA et al., 2016).

Regarding the OC, regardless the evaluated treatments, it can be observed that it decreases when depth increases. This process occurs more strongly in soils under no-tillage, since the residues deposited on the surface are not incorporated into the soil (BRIEDIS et al., 2012).

Evaluating the effect of gypsum, it may be noted that the in the 0.00 – 0.05 m layer, gypsum application provided a higher percentage of aggregates, in the class > 2 mm, and larger values of WAD and GMD, indicating that the structure of the soil may have been influenced by the agricultural gypsum in the topsoil surface layer (Table 3).

**Table 3.** Mean values of the class size of aggregates (GMD, WAD) due of the effect of agricultural gypsum, in the 0.00 – 0.05, 0.05 – 0.10 and 0.10 – 0.20 m layers.

| Treatment | > 2 | 1 – 2 | 1 – 0.5 | 0.5 – 0.25 | 0.25 – 0.125 | 0.125 – 0.063 | < 0.063 | GMD | WAD |
|---|---|---|---|---|---|---|---|---|---|
| | ------------------------------------ % | | | | ------------------------------------ | | | ----- mm ----- | |
| | 0.00 – 0.05 m | | | | | | | | |
| With | 94.4 a | 1.3 b | 1.1 b | 0.7 b | 0.4 b | 0.1 b | 1.6 b | 2.9 a | 3.3 a |
| Without | 91.2 b | 2.2 a | 1.6 a | 1.1 a | 0.7 a | 0.3 a | 2.6 a | 2.7 b | 3.1 b |
| F TEST | ** | ** | ** | ** | * | * | * | ** | ** |
| | 0.05 – 0.10 m | | | | | | | | |
| With | 94.2 | 2 | 1 | 0.7 | 0.5 | 0.1 | 1.3 | 2.9 | 1.2 |
| Without | 93.3 | 1.7 | 1.3 | 0.6 | 0.3 | 0.3 | 1.9 | 2.8 | 3.2 |
| F TEST | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| | 0.10 – 0.20 m | | | | | | | | |
| With | 93.6 a | 2.0 b | 1.1 b | 0.8 b | 0.3 | 0.2 | 1.7 | 1.8 | 3.2 |
| Without | 91.3 b | 3.1 a | 1.9 a | 1.1 a | 0.3 | 0.1 | 1.8 | 1.7 | 3.1 |
| F TEST | ** | ** | ** | * | ns | ns | ns | ns | * |

GMD = geometric mean diameter; WAD = weighted average diameter; ** significant at the 1% probability level ($p < .01$); * significant at the 5% probability level ($.01 = < p < .05$); ns not significant ($p > = .05$). Means followed by the same lowercase letter in the column do not differ from one another by the Scott-Knott test at the 5% probability level.

Gypsum can act indirectly in the formation of aggregates processes, by favoring the development of the root system. The roots act in the formation and stabilization of soil aggregates processes by physical or biochemical processes. In aggregation, both physical and biochemical processes are involved: the first, due to the approximation of mineral particles, caused by the pressure exerted during the growth of these roots; and the latter, due to the release of organic substances in the rhizosphere because of their decomposition, activating microorganisms that exude organic compounds and/or emit hyphae (mycorrhizal fungi), that are temporary cementing agents of soil macroaggregates (COSTA JÚNIOR et al., 2012).

Working with different doses of gypsum, Rosa Junior et al. (2006) concluded that gypsum can act as a conditioner of soil structures, favoring aggregation, and a consequent improvement in soil structure. Stable aggregates in water contribute to improved porosity and, consequently, higher infiltration and resistance to erosion (MATOS et al., 2008). Unstable aggregates, when on the surface, tend to disappear and disperse under the impact of raindrops (ASSIS; BAHIA, 1998).

In the 0.05 – 0.10 m layer, no significant differences were observed in the classes of aggregates with the application or no application of gypsum (Table 3). However, in the 0.10 – 0.20 m layer, the application of agricultural gypsum presented higher value of aggregates in the class larger than 2 mm. Inversed results were found in the

2-1, 1-0.5 and 0.5- 0.25 mm classes. The highest WAD value was observed in the application of agricultural gypsum treatment (Table 3). In order to increase aggregate stability, it is necessary to reduce soil nutrient losses (SPIGEL; MENTLER, 2003), while increasing the amount of larger aggregates and total porosity (SHAVER et al., 2002).

In the soil management with or without scarification, in the 0.00 - 0.05 m layer, it was possible to observe that in the soil scarification treatment, the class of aggregates smaller than 0.063 mm presented a higher percentage. In the same layer, it was also observed that a greater concentration of GMD occurs in the treatment where scarification was not performed. In the other layers, no significant differences were observed (Table 4). These results corroborate the tendency presented by the distribution of the aggregate size in water, indicating that scarification of the soil managed under a no-tillage system may have influenced GMD values. The mechanical action of the scarify stems, despite not revolving the soil, promotes the rupture of its structure and intensifies the disintegrating action with the use of the ripper roller, which breaks the clods to reduce the roughness of the ground and facilitate the sowing process (CALONEGO; ROSOLEM, 2008).

**Table 4.** Mean values of the class size of aggregates (GMD, WAD) due to the soil scarification effect in the 0.00 – 0.05, 0.05 – 0.10 and 0.10 – 0.20 m layers.

| Treatment | > 2 | 1 – 2 | 1 – 0.5 | 0.5 – 0.25 | 0.25 – 0.125 | 0.125 – 0.063 | < 0.063 | GMD | WAD |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | % | | | ------ mm ------ | |
| **0.00 – 0.05 m** | | | | | | | | | |
| With | 92.2 | 1.6 | 1.3 | 0.9 | 0.6 | 0.2 | 2.6 a | 2.7 b | 3.1 |
| Without | 93.4 | 1.9 | 1.3 | 0.9 | 0.4 | 0.3 | 1.6 b | 2.9 a | 3.1 |
| F TEST | ns | ns | ns | ns | ns | ns | * | * | ns |
| **0.05 – 0.10 m** | | | | | | | | | |
| With | 93.2 | 2.0 | 1.2 | 0.7 | 0.3 | 0.2 | 2.0 | 2.8 | 3.1 |
| Without | 94.2 | 1.8 | 1.1 | 0.7 | 0.5 | 0.2 | 1.5 | 2.9 | 3.1 |
| F TEST | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| **0.10 – 0.20 m** | | | | | | | | | |
| With | 92.6 | 2.4 | 1.5 | 0.9 | 0.4 | 0.1 | 1.8 | 1.9 | 3.1 |
| Without | 92.3 | 2.6 | 1.6 | 1.0 | 0.3 | 0.1 | 1.7 | 1.8 | 3.1 |
| F TEST | ns | ns | ns | ns | ns | ns | ns | ns | ns |

GMD = geometric mean diameter; WAD = weighted average diameter; ** significant at the 1% probability level (p <.01); * significant at the 5% probability level (.01 = <p <.05); ns not significant (p> = .05). Means followed by the same lowercase letter in the column do not differ from one another by the Scott-Knott test at the 5% probability level.

It was observed that in the soil surface, the SMBF succession system presented a significantly larger amount of soil constituting large aggregates, in the class larger than 2 mm, in relation to the other succession systems (Table 5). According to Basso and Reinert (1998), the values of larger aggregates tend to increase over time in systems with increased organic carbon, due to the use of cover crops under a no-tillage system (TORRES et al., 2015), resulting in a higher geometric and weighted aggregate diameter (PEREIRA et al., 2011). The higher the amount of plant material deposited in coverage, the higher will be the aggregation and lower the susceptibility to erosive processes caused by the impact of raindrops (FERREIRA; SCHWARZ; STRECK, 2000).

**Table 5.** Mean values of the class size of aggregates (GMD, WAD) due to crop succession systems in the 0.00 – 0.05, 0.05 – 0.10 and 0.10 – 0.20 m layers.

| Treatment | > 2 | 1 – 2 | 1 – 0.5 | 0.5 – 0.25 | 0.25 – 0.125 | 0.125 – 0.063 | < 0.063 | GMD | WAD |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | % | | | ------ mm ----- | |
| **0.00 – 0.05 m** | | | | | | | | | |
| SMBP | 94.0 a | 1.4 b | 1.1 b | 0.6 b | 0.3 b | 0.1 | 2.2 | 2.8 | 3.2 a |
| SMP | 92.6 b | 2.0 a | 1.3 b | 1.1 a | 0.4 b | 0.3 | 2.1 | 2.8 | 3.1 b |
| SP | 91.8 b | 2.0 a | 1.7 a | 1.2 a | 0.8 a | 0.3 | 2 | 2.7 | 3.1 b |
| F TEST | * | * | ** | * | ** | ns | ns | ns | * |
| **0.05 – 0.10 m** | | | | | | | | | |
| SMBP | 94.1 | 2 | 1.1 | 0.6 | 0.4 | 0.2 | 1.2 b | 2.9 | 3.1 |
| SMP | 92.9 | 1.9 | 1.2 | 0.7 | 0.4 | 0.3 | 2.3 a | 2.8 | 3.1 |
| SP | 94.3 | 1.8 | 1.1 | 0.7 | 0.5 | 0.1 | 1.3 b | 2.8 | 3.2 |
| F TEST | ns | ns | ns | ns | ns | ns | * | ns | ns |
| **0.10 – 0.20 m** | | | | | | | | | |
| SMBF | 92.4 | 2.8 | 1.6 | 0.9 | 0.4 | 0.1 | 1.4 | 1.4 | 3.1 |
| SMF | 92.3 | 2.5 | 1.5 | 1.0 | 0.4 | 0.2 | 1.9 | 1.9 | 3.1 |
| SF | 92.7 | 2.3 | 1.4 | 0.8 | 0.3 | 0.2 | 1.9 | 1.9 | 3.1 |
| F TEST | ns | ns | ns | ns | ns | ns | ns | ns | ns |

SMBF = soybean/maize/brachiaria/fallow; SMF = soybean/maize/fallow; SF = soybean/fallow; GMD = geometric mean diameter; WAD = weighted average diameter; ** significant at the 1% probability level (p <.01); * significant at the 5% probability level (.01 = <p <.05); ns not significant (p> = .05). Means followed by the same lowercase letter in the column do not differ from one another by the Scott-Knott test at the 5% probability level.

For the 2-1 and 0.5-0.25 mm classes, the reverse occurred. In that case, SMF and SF systems demonstrated the highest values, indicating that the soil mass of large aggregates, larger than 2 mm, came from smaller classes (Table 5). These results are probably due to a greater distribution of roots in the superficial layer, contributing to a better soil structure, especially in the SMBF crops system with more waste input, where the root stocks of crops produce stable aggregates by supplying organic residues to decomposition, promoting high microbial proliferation in the rhizosphere (OADES, 1984). In addition, results indicate that the succession of crops involving maize, soybean and brachiaria made the formation and stabilization of larger diameter aggregates possible.

According to Santos et al. (2012), the contribution of organic material to the soil surface, through a no-tillage system, associated with the development of the root system of different cover crops, can contribute to the stability increase of larger diameter aggregates, improving the structural quality of the soil in the evaluated areas. Thus, it is assumed that this model of succession may have facilitated the activity of microorganisms, as well as a higher content of organic matter, factors that favor the larger diameter of the stable aggregates in water.

## CONCLUSIONS

The treatment in which agricultural gypsum was applied presented better results in soil aggregation and higher levels of organic C.

Soil scarification did not influence organic C contents and did not alter the stability of soil aggregates.

The system of succession of SMBF crops influenced the stability of aggregates in a positive way only in the soil surface. The same system presented a higher organic C content.

**RESUMO:** Estudos relativos ao monitoramento da qualidade do solo pelos atributos físicos são importantes para a avaliação e manutenção da sustentabilidade dos sistemas agrícolas, além de sinalizar o manejo adequado do ambiente, visando à sua conservação e produtividade. Este trabalho teve por objetivo avaliar a estabilidade de agregados e teor de carbono orgânico, após a aplicação de gesso, escarificação do solo e sucessão de culturas. Os tratamentos consistiram na ausência e adição de gesso agrícola, ausência e presença de escarificação do solo, e três sistemas de sucessão de culturas. O delineamento experimental foi em blocos casualizados, em esquema fatorial 2x2x3 com oito repetições. Sendo avaliada a estabilidade dos agregados estáveis em água e teor de carbono orgânico do solo. O tratamento onde foi aplicado gesso agrícola e o sistema de sucessão SMBP apresentaram melhores resultados na agregação do solo e maiores teores de carbono orgânico.

**PALAVRAS-CHAVE:** Manejo do solo. Atributos físicos. Degradação do solo

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