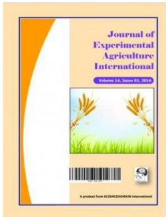

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Effect of Soil Preparation and Layers on the Weighted Mean Diameter and Geometric Mean Diameter of a Red Distroferric Latosol

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Authors' contributions

This work was carried out in collaboration among all authors. The authors PSXP, AB, MWR, ARBS and WMS performed the experiment and wrote the first draft of the manuscript. The authors PMC, DSP, FKP, TAXP and MAS discussed the results, corrected and improved the writing of the manuscript in Portuguese and English versions. All authors read and approved the final manuscript.

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ABSTRACT

The objective of this work was to study the influence of three management systems on the physical attributes and productivity of irrigated wheat, cultivar BRS-254, in the city of Tangara da Serra, MT. The soil physical attributes were: weighted mean diameter (DMP) and geometric mean diameter (DMG). The experimental design was in randomized blocks. The treatments for weighted average

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diameter (WMD) and geometric mean diameter (DMG) were arranged in a subdivided plot scheme, with eight replications. The tilting preparations obtained the highest DMPs compared to SD both in the 0-10 cm layer and in the 10-20 cm layer, a result possibly related to the incorporation of residues during the soil preparation associated with higher mucilage production promoted by higher activity of the root system of the crop, which found better soil physical conditions for its development. The PC presented a reduction in DMP when comparing the value in the 0-10 cm layer with the value in the 10-20 cm layer. The significant effect of soil preparation on DMG can also be a result of the incorporation of residues during the preparation, associated to the effect of higher root volume promoted by the higher root growth of the crop in these preparations, which, in turn, guarantee greater production of mucilages promoting greater soil aggregation and higher DMG. The use of the disk grid in the PC and PM interferes with the soil attributes. Soil inversion provided higher WMD and DMG.

Keywords: Aggregates; direct seeding; soil physics.

1. INTRODUCTION

Soil preparation systems aim to promote an adequate environment for the development and production of crops; however, factors such as soil genesis, climate and crop characteristics should be considered when choosing soil preparation method to avoid degradation of the soil.and the effects on the environment and crop productivity [1,2].

According to [3] the soil mobilization has been done in a disorderly way, since criteria that allow the maintenance of productive capacity are not adopted. Farmers and technicians forget that the techniques to be used in the management and preparation of the soil, must contemplate the various factors of production as a systemic set, which aims not only to promote the increase of production, but also to improve the desirable properties of the soil, without promoting degradation and pollution of the agroecosystem.

The soil structure is a physical property sensitive to soil preparation, its quality being analyzed by shape and stability [4,5].

Simultaneously, the formation and stabilization of the soil aggregate occurs in several physical, chemical and biological processes, acting through its own mechanisms in which they are involved by substances that act in aggregation and stabilization [6].

The organic matter (OM) is a powerful agent for the formation and stabilization of aggregates, and it is natural to find a positive correlation between these two variables [7,8].

According to [9,8] there is a highly significant correlation between the increase in OM content and the increase in aggregate stability up to 0.10 m depth.

In relation to the soil preparation [10] verified that the no-tillage system provides greater stability of aggregates in relation to conventional tillage. The use of agricultural implements in soil preparation causes changes in the distribution and stability of the aggregates, reducing the percentage of macroaggregates and increasing that of microaggregates [11]. [5] concluded that the no-tillage system provides aggregates with an average diameter about twice as large as in the tillage system in which plowing and weeding were used. This difference was associated with higher organic carbon content and higher microbial activity in the no-tillage system.

Silva and Mielniczuk [12] verified a reduction of the weighted average diameter of the aggregates of 71% in a Red Argissolo (220 g kg -1 of clay) and 47% in a Red Oxisol (680 g kg^{-1} clay) from a native field condition to conventional tillage with annual crops, plowing and harvesting. On the other hand, the authors verified an increase in the stability of aggregates of both soils when submitted to the no-tillage system. The DMG of the aggregates increased from 0.61 mm in the Argisol and 1.76 mm in the Latosol, in conventional tillage, to values of 0.91 and 1.90 mm, respectively, in no-tillage.

When comparing the management systems, conventional tillage and no-tillage, there is a relative increase of 74% for the weighted average diameter, 70% for the geometric mean diameter (DMG) and 10.4% for the index of stability of no-tillage aggregates in relation to conventional tillage [8].

The present work was developed with the objective of evaluating the weighted average diameter (DMP) and the geometric mean diameter (DMG) as a function of three different soil and layer treatments, evaluated at 97 after sowing irrigated wheat in Tangará da Serra, Mato Grosso, Brazil.

2. MATERIALS AND METHODS

2.1 Experimental Site Description

The experiment was carried out in the experimental field of the Mato Grosso Research, Assistance and Rural Extension Company (EMPAER), in the municipality of Tangara da Serra, located Southwest of the state of Mato Grosso, in the geographical coordinates, 14°04'38 "Latitude South, 57°03'45" West longitude and 427m altitude.

The climate of the region, according to the Köppen classification, is predominantly tropical - Awi, with two well-defined periods, that of the rains, which runs from November to March, with the highest index in December and January, and the dry season , which goes from April to October. Rainfall and annual mean temperature are 1.348 mm and 25.2°C, respectively.

The soil was characterized as a Distroferric Red Latosol according to the Brazilian System of Classification of Soil-SBCS [13], of clay texture, the chemical and granulometric characteristics are in Tables 1 and 2.

The experimental area was kept fallow for approximately one year (from when to when) after the cultivation of the wheat in the previous harvest, so that during the implantation of the management systems there was a large amount of organic matter on the surface.

The wheat crop was sown on June 4 and harvested on September 9,2011. Seeding was carried out on 15 sow lines with spacing of 0.17 m between rows and 0.05 m within rows. The sowing strips had 6 x 18 m, totaling 108 m^2 of area in each treatment. The cultivar BRS-254, of medium cycle (115-125 days) with seed density of 120 seeds.m^{-1} was used.

2.2 Soil Physical Attributes

The soil physical attributes evaluated were: weighted mean diameter (DMP) and geometric mean diameter (DMG).

For the analysis of the soil aggregates at 97 (DAS) days after sowing of the wheat, samples of semi-preserved structure were collected, one per plot at depths of 0 to 0.10 and 0.10 to 0.20 m, for this trenches of 0.4 x 0.4 x 0.4 m were opened with the aid of a hoe, a soil slice as intact as possible, was collected in a plastic container with a lid.

Laboratory analyzes were performed using the wet method described by [14]. The weighted mean diameter (DMP) and geometric mean diameter (DMG) were calculated according to the formula proposed by [8].

2.3 Experimental Design

The experimental design was in randomized complete blocks. The treatments for weighted average diameter (DMP) and geometric mean diameter (DMG) were arranged in a subdivided plot scheme, with eight replications.

Three types of soil preparation (conventional tillage (CP) with two gradations (one heavy and one mild) regulated to a depth of 0.17 m, minimum tillage (PM) with a light gradation regulated to 0.075 m and direct seeding (SD)); and as subplot: two layers of soil (0 to 0.10 m and 0 to 0.20 m) at 97 (DAS) days after sowing of wheat.

The 6 x 18 m sowing strips presented two passes of the machine, being considered as repetitions of the treatments within each plot. This was done so that the experiment reached the minimum degree of freedom required, following a statistic proposed by [15].

2.4 Data Analysis

The data were analyzed comparing layers 0 to 0.10 and 0.10 to 0.20 m at 97 (DAS) days aftersowing of the wheat.

The analysis of variance (Test F) was performed, and the means were compared by the Tukey test, with a probability of error of 0.05. All analyzes were performed using Assistat software.

3. RESULTS AND DISCUSSION

With the analysis of variance of the physical attributes of the soil DMP and DMG, comparing according to soil preparation systems and layers, evaluated at 97 days after sowing, it is possible to verify the significant effect of preparation for weighted average and geometric diameter. There was also significant interaction for weighted mean diameter (Table 3).

Table 1. Soil chemical analysis of the experimental area. Tangara da Serra, Mato Grosso, Brazil

Layer(cm)	pH($CaCl_2$)	P	K	Ca+Mg	SB	CTC	V	MOS
		mg dm^{-3}		cmol$_c$ dm^{-3}			%	g dm^{-3}
0-10	6.2	3.8	254	7.53	8.2	14.27	57.53	51.23
10-20	6.1	1.8	220.7	6.8	7.4	13.3	55.4	48

Table 2. Soil granulometric analysis of the experimental area. Tangara da Serra, Mato Grosso, Brazil

Layer (cm)	Sand	Silte	Clay
		%	
0-10	17,8	26,2	56
10-20	17,1	25,2	57,7

Table 3. Summary of analysis of variance of the weighted average diameter (WMD) and geometric mean diameter (DMG) as a function of the soil preparation and layers, evaluated at 97 after sowing. Tangara da Serra, Mato Grosso, Brazil

Attributes	Sources of Variation			Variation Coefficients(%)	
	Preparations	Layers	Interaction	Preparations	Layers
	Significance of F				
DMP	14.5954 **	0.2114 ^{ns}	4.1102 *	8.07	2.22
DMG	8.4479 **	0.5596 ^{ns}	1.4671 ^{ns}	11.17	1.77

*MAC: macroporosity (%); MIC: microporosity (%); PT: total porosity (%); DENS: density (kg dm-3); DMP: weighted mean diameter (mm); DMG: geometric mean diameter (mm). ns Not significant by the F-test at 0.05 probability. "**" "*" Significant at 0.01 and 0.05 of probability by the F test, respectively*

Table 4. Average data of weighted average diameter (WMD) and geometric mean diameter (DMG) as a function of soil preparation and layers, evaluated at 97 after sowing. Tangara da Serra, Mato Grosso, Brazil

Preparations	DMP (mm)			DMG (mm)		
	0-10 cm	10-20 cm	Average	0-10 cm	10-20 cm	Average
PC	2.39 aA	2.19 abB	2.29 a	1.93	1.75	1.84 a
PM	2.34 aA	2.35 aA	2.34 a	1.87	1.87	1.87 a
SD	1.96 bA	2.09 bA	2.03 b	1.58	1.64	1.60 b
Average	2.23 a	2.21 a	**2.22***	1.79 a	1.75 a	**1.77***

*PC = Conventional preparation, MP = Minimum preparation, SD = Direct seeding. Averages followed by the same lowercase letter in the column indicates no difference between readings, and upper case in the row, indicates no difference between layers, by the Tukey test at 5%. * Overall mean of treatments*

The data of weighted average diameter (DMP) and geometric mean diameter (DMG) as a function of soil preparation and layer at 97 days after sowing of wheat are shown in Table 4.

There was a significant interaction ($p < 0.05$) between soil and layer preparation for DMP and for DMG. There was a significant effect only of soil preparation ($p < 0.05$).

The interaction showed that the tilting preparations obtained the highest DMPs compared to SD ($p < 0.05$) in both the 0-10 cm layer and the 10-20 cm layer, a result possibly related to the incorporation of residues during the preparation of the soil associated with greater mucilage production promoted by the greater activity of the root system of the crop, which found better soil physical conditions for its development. This behavior contradicts the results of [10], where they describe that SD increased in this variable. Probably this opposite result may be common in first-year systems of direct seeding.

The PC presented a reduction in DMP when comparing the value in the 0-10 cm layer with the value in the 10-20 cm layer.

The significant effect of soil preparation on DMG can also be a result of the incorporation of residues during the preparation, associated to the effect of higher root volume promoted by the higher root growth of the crop in these preparations, which, in turn, guarantee greater production of mucilages promoting greater soil aggregation and greater DMG.

4. CONCLUSION

The use of the disk grid in the PC and PM interferes with the soil attributes. Soil shifting provided higher DMP and DMG.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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