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Soil Cover Plants and Physical and Hydric Attributes of a Rhodic Haplustox in Organic Production System

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1 Introduction

Soils in central Brazil have several favorable conditions for its use in intensive agricultural activities, especially for annual crops. However, some agricultural systems practiced are of low level of productivity and efficiency, mainly due to inadequate soil and water management, in addition to the insufficient level of planning and sustainable management of the production process (Urchei et al., 1996). In general, the tillage systems in these soils are characterized by high revolving degree by plow and harrow discs use, which carry negative impacts on soil attributes and environmental sustainability (Silveira et al. 1997).
The conventional tillage system, in general, causes an intense revolving in the soil surface layer which can promote the organic matter decomposition affecting the soil structural quality. The compacted layers presence in the subsurface reflects a structural deterioration, with increasing soil bulk density and reducing soil aggregate size, macroporosity, water infiltration rate and plants root development (Silva & Mielniczuk, 2000). As an alternative to systems that degrade the soil, the conservation systems, such as no-tillage, constitute a practice that gives sustainability to agriculture. In Brazil Oxisols the adoption of management practice to maintain the soil protection and organic matter continuous supply is essential to the maintenance of a good soil structure (Lal & Greenland, 1979). Agricultural systems involving soil cover plants and no-tillage have been shown to decrease erosion and increase water infiltration rate, aggregates diameter, microbial activity and crops productivity (Campos et al., 1995).
This work had the objective to evaluate the effect of different soil cover plants on the physical and hydric attributes of a Rhodic Haplustox in an organic production system, under two tillage systems, no-tillage (NT) and conventional tillage (CT).

2 Material and Methods

The experiments were carried out in a no-tillage and conventional tillage at the experimental area of Embrapa Rice and Beans, in Santo Antônio de Goiás, Goiás State, Brazil. The experimental design was a randomised block, in 2×5×3 factorial scheme, with four replications. The soil used was a Haplustox, clay, with 473 g kg^{-1} of clay, 190 g kg^{-1} of silt and 336 g kg^{-1} of sand in the layer of 0-30 cm in depth. The soil cover plants management was done at flowering. The cover plant straw stayed on the soil in NT and it was incorporated at soil profile in CT. In each soil tillage system the following cover plants were evaluated: velvet bean (*Mucuna aterrima*), sunn hemp (*Crotalaria juncea*), pigeon pea (*Cajanus cajan*), sorghum (*Sorghum technicum*), and fallow. Soil physical and hydric attributes and soil aggregation status was analysed in the profile soil layers. As a comparison between the physical and hydric attributes and aggregation status, trenches were open and soil samples were collected at the same depths in native forest areas located adjacent to the experimental area.

The physical and hydric attributes and soil organic matter were evaluated through the soil samples collected in 0-10 cm, 10-20 cm and 20-30 cm deep layers, with deformed structure for the soil organic matter and soil aggregation and undeformed structure collected in 0-30 cm deep to water retention curves (Embrapa, 1997). The water retention curves at 6, 8, 10, 33, 60, 100 and 1500 kPa were determined by the centrifugal method. The soil aggregates classes were determined by methodology according to Yoder (1936). After prepared, the samples were transferred to the Yoder equipment, adapted to mesh with sieves of 2.0, 1.0, 0.5, 0.25 and 0105 mm opening. The mean weight diameter of soil aggregates (DMP) was calculated and the percentage of stable aggregates with diameter > 2.00 mm.

3 Results and Discussion

The soil water retention, evaluated by retention curves, was affected by soil tillage systems and cover plants. In No-tillage at 0-30 cm deep (Fig. 1) the soil cultivated with leguminous showed higher soil water retention than that cultivated with sorghum or in fallow. This difference probably can be credited to the input soil biomass offered by cover plants and corn crop cultivated in succession to cover plants. For the soil under fallow, with lower biomass production, that statement can be consistent, due to lower water holding capacity of the soil. However, when analyzing the soil under sorghum, this culture produced the highest amount of biomass among the species tested (Rigo, 2006). A positive response in water retention was expected, which did not happen. It is known that the grasses have a high ratio C/N, so it is possible that the sorghum crop residues lasted for longer time on the soil surface and did not produce the desired effect in subsurface layers. Increase in soil water holding capacity cultivated with vegetables has been observed by several authors (Carvalho, 2005). In all cases, soil under no-tillage retain more water that soil under conventional system, independent of plant cover (Figs. 1 and 2).

The differences observed occurred only between the depths, which were expected, since in most soils, the trend is the organic matter to decrease in content with depth (Table 1). These results agree with Rigo (2006) who showed that, even with a similar biomass production by cover plants in the two systems of production, soil management incorporating the crop residues in the CT, or leaving them on the soil surface, the NT was not sufficient to substantially alter the content of organic matter in the soil profile.

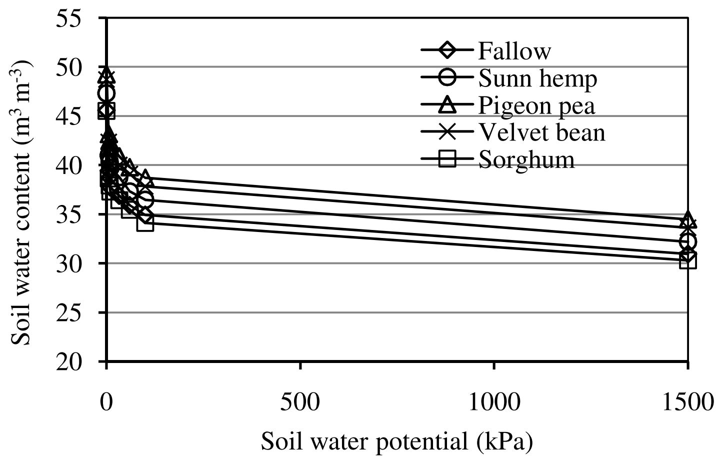

Figure 1. Soil water retention of a haplustox, 0-30 cm layer depth, under no-tillage (NT).

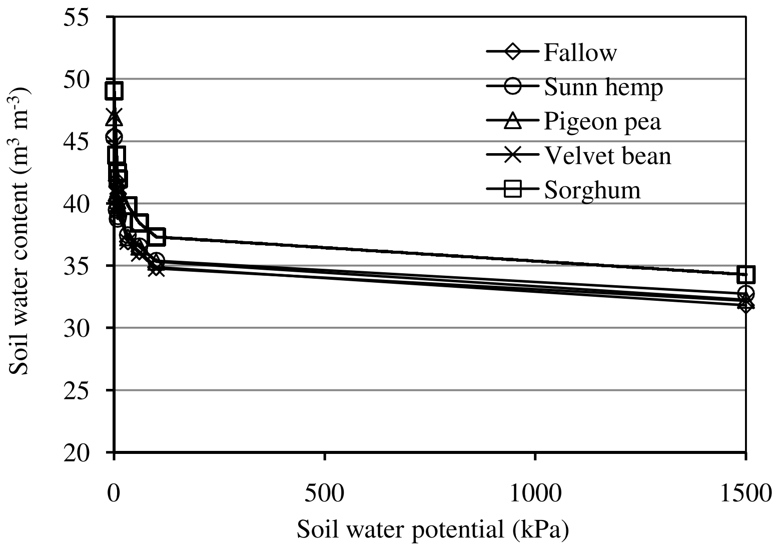

Figure 2. Soil water retention of a haplustox, 0-30 cm layer depth, under conventional tillage (CT).

Table 1. Physical soil attributes and organic matter average of a Haplustox in no-tillage (NT), conventional tillage (CT) and forest (FR) in different soil depths.

	depth(cm)	2mm	DMP	MO
		%	mm	$g\ m^{-3}$
	0-10	68,28a[1]	3,64a	20,75a
NT	10-20	46,89b	2,74b	19,45b
	20-30	35,39c	2,35b	17,45c
	0-10	39,48a	2,36b	20,60a
CT	10-20	43,88a	2,57b	19,45b
	20-30	37,11a	2,31b	17,20c
	0-10	85,99	4,39	26,00
FR	10-20	91,88	4,60	25,00
	20-30	87,28	4,46	23,00

2mm-aggregate>2mm, DMP-aggregate diameter and MO-organic matter. [1]average followed by same letter, in column, do not differ by Tukey test at 5% probability.

The soil aggregation status was influenced only by soil tillage system. The percentage of aggregates with diameter higher than 2 mm and the mean weight diameter of aggregates was higher in NT than in CT, at 0-10 cm and 10-20 cm soil layers (Table 1). For soils under NT, this behavior is expected because crop residues remain on the soil surface giving to the profile first layers a better soil structure development. Table 1 also shows aggregate with diameter greater than 2 mm and DMP values to the CT. It is observed that the values of these variables are lower in profile when compared to the one obtained in the NT. This behavior can be credited to the distribution of the remains of plants of cultural coverage along the profile, by the action of incorporation provided by mouldboard plows. Thus, unlike the NT, where the crop residues are maintained on the soil surface, the biomass in the CT diluted in a large volume of soil, with a lesser effect on soil profile aggregation.

4 References

CAMPOS, B. C.; REINERT, D. J.; NICOLODI, R.; RUEDEL, J. & PETRERE, C. Estabilidade estrutural de um latossolo vermelho escuro distrófico após sete anos de rotação de culturas e sistemas de manejo. **Revista Brasileira de Ciência do Solo**, Campinas, v.19, p. 121-125, jan/abr. 1995.

BERTOL, I.; COGO, N. P. & LEVIEN, R. Erosão hídrica em diferentes preparas de solo logo após a colheita de milho e trigo na presença e ausência de resíduos culturais. **Revista Brasileira de Ciências do Solo**, Campinas, v.21, p.409-418, 1997.

CARVALHO, M. T. M. de. **Influencia de um sistema de produção agroecológico sobre os atributos físico-hídricos do solo, crescimento e produtividade do milho (*Zea mays* L.)** 2005. 47 f. Dissertação mestrado em Agronomia, Escola de Agronomia e Engenharia de Alimentos, Universidade Federal de Goiás. Goiânia, 2005.

EMBRAPA. Centro Nacional de Pesquisas de Solos. **Manual de métodos de análises de solo.** 2ª.ed. Rio de Janeiro, 1997. 212 p

LAL, R. & GREENLAND, B. J. **Soil physical properties and crop production in tropics.** Chischester: Jonh Willey, 1979. p.7-85.

RIGO, E. **Plantas de cobertura de solo e atributos físico-hídricos de um Latossolo Vermelho distrófico em sistema de produção orgânico.** 2006. 38 f. Dissertação mestrado em Agronomia, Escola de Agronomia e Engenharia de Alimentos, Universidade Federal de Goiás. Goiânia, 2006.

SILVA, I. F. da & MIELNICZUK, J. Avaliação do estado de agregação do solo afetado pelo uso agrícola. **Revista Brasileira de Ciência do Solo,** Campinas, v.21, p.313-319, 2000.

SILVEIRA, P. M.; SILVA, J. G.; STONE, L. F. & ZIMMERMANN,F. J. P. Efeito de sistema de preparo na densidade do solo. in: CONGRESSO BRASILEIRO DE CIÊNCIA DO SOLO, 26. 1997, Rio de Janeiro**. Resumos**... Rio de Janeiro, Sociedade Brasileira de Ciência de Solo. 1997, (CD ROM)

YODER, R.E. A direct method of aggregate analysis of soil and a study of the physical nature of erosion losses. **Journal of America Society of Agronomy**, v.28, p.337-357, 1936.

URCHEI; M. A.; RODRIGUES, J. D.; STONE, L. F. & CHIEPPE JÚNIOR, J. B. Efeitos do plantio direto e do preparo convencional sobre alguns atributos físicos de um latossolo vermelho-escuro argiloso, sob pivô central. **Irriga**, Botucatu, v. 1, n. 3, p. 8-15, 1996.