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Behavior of Soil Carbon in Amended Areas with Sewage Sludge

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1. Introduction

The Greenhouse Effect, an Earth's natural and essential phenomenon, lately has been increased by the anthropogenic intervention, by fossil fuel burning, deforestation, and mostly wrong agricultural tillage, leading to an increase in the atmospheric gases that causes this effect.

Correct soil tillage and forestry practices are considered important tools to promote decrease of emissions of GHG and mitigating of Greenhouse Effect through soil carbon sequestration. Soil represents is the third greater pool of carbon in the planet. It is estimated that there is approximately 2300 Petagrams of carbon in soils, which represents nearly three times the atmospheric carbon concentration.

Sewage sludge (SS) plays an important role as soil fertility improver because it contains high levels of organic matter and nutrients [1]. However, its application requires careful monitoring to avoid soil contamination and changes in organic matter that could cause serious implications for the crop where it is applied.

It is related that SS plays an important role as soil fertility improver, hence it is a wastewater treatment product and has the potential to enhance soil productivity, as it contains high levels of organic matter and nutrients [1].

In this way, the purpose of the following study is to evaluate the SOM of SS amended areas, comparing to no amended area, analyzing about the sustainability of its use in forestry systems as a tool for mitigating GHG emissions and sequestrating atmospheric carbon.

2. Materials and Methods

The experimental field under eucalyptus plantation is installed in two different farms (Entre Rios and Areona) in the city of Itatinga, São Paulo state. Each farm was divided in two

different areas, according to the SS amendment. The soil profile in the Entre Rios farm was characterized as an Oxisoil, with a clay content varying between 16 and 20%, while the Areona farm soil is characterized as Quartzarenic Neosoil, with a clay content varying between 5 and 12%. The sample identification according to the SS amendment was performed as it follows: ER 60 (Entre Rios farm and SS amended), ER 228 (Entre Rios farm and no SS amended), AN 254 (Areona farm and SS amended) and AN 36 (Areona farm and no SS amended).

In December, 2009, soil samples were collected in three repetitions in the depths 0–10 and 10–20cm. They were dried at room temperature and subsequently sieved at 0.5 mm mesh. The SS amendment occurred ten days before the plantation, at a volume between 1500 and 2000 kilograms per hectare.

Carbon content measurements were carried out by an elemental analyzer Carlo Erba EA-1110 instrument. The measurements were made in triplicate, taking into account depth and condition analyzed in both farms.

3. Results and Discussion

The carbon content results for Entre Rios and Areona farm, as well as some soil physical characteristics and eucalyptus plantation beginning, are shown in Table 1.

In the case of the Entre Rios Farm, probably SS amendment increased the microbial activity in soil by high availability of fresh organic matter [4] what, in a second stage, must have triggered a soil carbon decrease by degradation of stable fractions [3].

According to [3], in their study about stability of organic carbon in soils, increasing of fresh organic matter at depth, could lead to a loss of ancient soil carbon, which leads a decreasing of total soil carbon content as a function of time, promoting the priming effect in soil.

This situation in the Entre Rios farm is worrying since represents, among other factors, loss of soil organic matter by microbial activity, which may cause limitations in soil fertility and structure, and possible carbon loss as CO_2, causing increase in atmospheric GHG concentration, negatively contributing to the global warming scenario.

The results obtained for the samples of the Areona farm showed an inverse behavior comparing to the samples of the Entre Rios farm. It was observed that in the SS amended area the values of carbon content were higher than in the no amended area, in all analyzed depths.

Table 1: Carbon content results obtained for soil samples from Entre Rios and Areona Farm. ER 228: no SS amended, ER 60: SS amended, AN 36: no SS amended and AN 254: SS amended

SAMPLE	C Content	Soil Profile	Clay Content	Eucalyptus Plantation
ER 228 0–10 I	1.85±0.02	Oxisoil	16 – 20 %	Nov/2004
ER 228 0–10 II	0.90±0.01	Oxisoil	16 – 20 %	Nov/2004
ER 228 0–10 III	0.98±0.03	Oxisoil	16 – 20 %	Nov/2004
ER 228 10–20 I	1.21±0.01	Oxisoil	16 – 20 %	Nov/2004
ER 228 10–20 II	0.80±0.04	Oxisoil	16 – 20 %	Nov/2004
ER 228 10–20 III	0.67±0.02	Oxisoil	16 – 20 %	Nov/2004
ER 60 0–10 I	0.84±0.03	Oxisoil	16 – 20 %	Apr/2004
ER 60 0–10 II	0.84±0.02	Oxisoil	16 – 20 %	Apr/2004
ER 60 0–10 III	1.18±0.04	Oxisoil	16 – 20 %	Apr/2004
ER 60 10–20 I	0.37±0.02	Oxisoil	16 – 20 %	Apr/2004
ER 60 10–20 II	0.45±0.01	Oxisoil	16 – 20 %	Apr/2004
ER 60 10–20 III	0.60±0.03	Oxisoil	16 – 20 %	Apr/2004
AN 36 0–10 I	0.57±0.03	Quartzarenic Neosoil	5 – 12 %	Mar/2008
AN 36 0–10 II	0.67±0.02	Quartzarenic Neosoil	5 – 12 %	Mar/2008
AN 36 0–10 III	0.70±0.01	Quartzarenic Neosoil	5 – 12 %	Mar/2008
AN 36 10–20 I	0.41±0.05	Quartzarenic Neosoil	5 – 12 %	Mar/2008
AN 36 10–20 II	0.46±0.01	Quartzarenic Neosoil	5 – 12 %	Mar/2008
AN 36 10–20 III	0.45±0.02	Quartzarenic Neosoil	5 – 12 %	Mar/2008
AN 254 0–10 I	0.71±0.01	Quartzarenic Neosoil	5 – 12 %	May/2008
AN 254 0–10 II	0.74±0.03	Quartzarenic Neosoil	5 – 12 %	May/2008
AN 254 0–10 III	0.75±0.02	Quartzarenic Neosoil	5 – 12 %	May/2008
AN 254 10–20 I	0.53±0.03	Quartzarenic Neosoil	5 – 12 %	May/2008
AN 254 10–20 II	0.61±0.04	Quartzarenic Neosoil	5 – 12 %	May/2008
AN 254 10-20 III	0,54±0,01	Quartzarenic Neosoil	5 – 12 %	May/2008

Anyway, these results showed an interesting behavior. The soil in Areona is characterized as Quartzarenic Neosoil (a recently generated soil with amounts of quartz in its composition). This kind of soil has a major fraction of sand and low carbon concentration in your profile. This way, it was not expected strong interaction between SS and the organic matter of this soil. However, it was noted that soil tillage with SS amendment in the Areona farm leads to a better carbon accumulation when compared with the same tillage in the Entre Rios farm.

It is important to note that the decrease in the carbon content in the Entre Rios farm is potentialized and accentuated by the SS amendment, probably, due to an increase in the microbial activity in soil.

However, it is important to evaluate if this difference was due to different soil properties for each farm or if may be attributed to period of the experiment. Eucalyptus plantation began in 2004 in Entre Rios Farm and in 2008 in the Areona farm.

4. Conclusion

Studies of soil amendment using SS are very important to avoid negative environmental consequences, as soil contamination or decreasing of carbon content in soil. This kind of residues management can be positive depending on the situation, and for this reason each case needs to be carefully studied.

Thus, field experiments must continue in both farms to confirm and validate the initials tendencies detected. New alternatives for soil tillage in forestry systems can be suggested to make possible SS soil amendment in sustainable conditions with environmental benefits.

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