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**Maps of Spatial Variability of soil Chemical Properties of Pastures
Fertigated With Swine Manure**

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ABSTRACT

The technology of precision agriculture focuses on the temporal and spatial variability of nutrients in soil quantified their distributions. In this work were collected from soil sampling in a commercial farm with application of swine wastewater to check how are the soil characteristics and their interactions. The evaluations were performed using geostatistics the spatial variability of nutrients and the distribution profiles of 0.00 to 0.20 cm and from 0.20 to 0.40 cm. The study was conducted at Bonsucesso's Farms, The farm is located in Uberlândia, in the state of Minas Gerais, in Brazil. Fertilization was performed with swine wastewater (ARS) from 6,000 animals in the fattening stage with an average volume of 110 m³ per day. Treatments consisted of doses of 8000 m³ ha⁻¹ applied over 46 months for Tifton85 (Tifton 1), 5000 m³ ha⁻¹ applied at 36 months for Tifton85 (Tifton 2) and 3200 m³ ha⁻¹ applied in 26 months in the cultivar MG5. The levels of Ca and Mg indicate that the application of ARS does not elevate the levels of these elements or the extraction of forage is higher than the replacement; The application of ARS does not replace the soil correction, because the base saturation is low and the Ca and Mg has a negative balance; Levels of Phosphorus and Potassium are fully catered with the application of ARS.

Keywords: Fertility, organic fertilizer, isolines, kriging.

1. INTRODUCTION

Adriane de Andrade Silva; Vinicius de Oliveira Rezende; Marcelo de Castro Barreto; Regina Maria Quintão Lana; Ednaldo Carvalho Guimarães. “**Maps of Spatial Variability of soil chemical properties of pastures fertigated with swine manure**”. EFITA-WCCA-CIGR Conference “Sustainable Agriculture through ICT Innovation”, Turin, Italy, 24-27 June 2013. The authors are solely responsible for the content of this technical presentation. The technical presentation does not necessarily reflect the official position of the International Commission of Agricultural and Biosystems Engineering (CIGR) and of the EFITA association, and its printing and distribution does not constitute an endorsement of views which may be expressed. Technical presentations are not subject to the formal peer review process by CIGR editorial committees; therefore, they are not to be presented as refereed publications.

Sustainable Agriculture through ICT innovation

The pig is one of the main activities of the Brazilian cattle industry. Its environmental impact is caused by the wastewater produced by confined production systems. For distribution of wastewater along with fluid replacement, irrigation systems are more suitable: spray fixed, conventional and mesh, and self-propelled center pivot. In spraying, the water is applied to the soil surface in the form of artificial rain. The use of wastewater, liquid animal manures and organic fertilizers as a practice is profitable and reduces the discharge of groundwater and watercourses. In this study were collected from soil sampling at a commercial farm with application of swine wastewater to check how are the soil characteristics and their interactions. The evaluations were performed using geostatistics the spatial variability and distribution of nutrients in the profiles from 0.00 to 0.20 and from 0.20 to 0.40 cm.

For distribution of wastewater along with fluid replacement, irrigation systems are more suitable: sprinkler fixed conventional and mesh, and self-propelled center pivot. In spraying, the water is applied to the surface of the soil in the form of artificial rain. This system is widely used because of the possibility of high distribution uniformity, adaptability to diverse cultures and soils, the possibility of application of fertilizers and other products through irrigation water and easy to control the volume of water applied. The system tolerates lower quality water, with less risk of clogging, because the sprinkler nozzles have diameters of the particles present in the water. (Fernandes et al., 2005).

Among those mentioned, there is the system of sprinkler irrigation mesh that has the following characteristics: wings, drifting and principal are buried, requiring only the change of the sprinklers. With this, the manpower is significantly reduced compared to conventional sprinkler irrigation system. Has high uniformity of water application, enables the fertigation and saves energy. In addition, equipment is a low cost, making it more accessible to producers, enabling increased productivity, which can be reflected mainly in increased income. (Drumond and Aguiar 2005).

The system allows precision agriculture know the spatial variability of soil productivity and controlling the excesses of the elements. Investigate the causes of variability clarifies important factors that enables the management decision-making on the quantities of fertilizer and lime to be applied in each location referenced (Amado et al., 2009). Use in area with application of swine wastewater permits better and better use of available resource minimizing environmental risks.

The technology of precision agriculture focuses on the temporal and spatial variability of nutrients in soil quantified their distributions. The contour maps is one of the ways used to represent the spatial variability of soil attributes (Burgess & Webster, 1980). However, to build these maps is necessary to know the distribution of the variable and its degree of spatial dependence using geostatistics (Vieira et al., 1983).

In this work were collected from soil sampling in a commercial farm with application of swine wastewater to check how are the soil characteristics and their interactions. The evaluations were performed using geostatistics the spatial variability of nutrients and the distribution profiles of 0.00 to 0.20 cm and from 0.20 to 0.40 cm.

C051

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2. MATERIALS AND METHODS

The study was conducted at Bonsucesso's Farms, The farm is located in Uberlândia, in the state of Minas Gerais, in Brazil, geographic coordinates: Lat. 19 ° 05'17 "S, Long. 48 ° 22'00" W.



FIGURE 1 - Division of the sampled areas available in Bonsucesso's Farm submitted in swine manure: the left one Tifton, Tifton 2 in the center and right MG5.

Fertilization was performed with swine wastewater (ARS) from 6,000 animals in the fattening stage with an average volume of 110 m³ per day. Treatments consisted of doses of 8000 m³ ha⁻¹ applied over 46 months for Tifton85 (Tifton 1), 5000 m³ ha⁻¹ applied at 36 months for Tifton85 (Tifton 2) and 3200 m³ ha⁻¹ applied in 26 months in the cultivar MG5.

At each point, was collected with the use of an auger Dutch type, five sub-samples of soil material to form a composite sample representing the sampling point, one in the center and the other at the four cardinal points spaced from the center point 5 m . The samples were taken at depths from 0.00 to 0.20 and from 0.20 to 0.40 m. 10 composite samples were collected at each depth per area totaling 60 points. The

C051

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Sustainable Agriculture through ICT innovation

experimental design was completely randomized split plot in space. Were determined in samples of soil P, Ca^{2+} , Mg^{2+} and K^+ .

The Student t test, 5% was applied to compare the means of the attributes between the soil depths. The spatial dependence of the attributes studied was evaluated using geostatistics (Vieira et al., 1983), by calculating the semivariance and data fitting to experimental semivariogram

3. RESULTS AND DISCUSSION

Areas with greater application of ARS Tifton (Tifton 1 and 2), differed MG5 in relation to phosphorus in the 0-20 cm depth. It is observed that the application time increases the concentration of phosphorus (P) on the ground, mainly in the surface layers where it may be inferred that there is a high leaching of phosphorus in the soil profile.

Regarding P concentrations (Figure 2), it was observed that the accumulation occurred in areas mainly due to the time of application. The highest concentrations occurred in the area of Tifton receiving applications to 48 months. The levels observed in different areas are all considered high, while the areas of Tifton, the levels are very high with levels reaching up to 209 mg dm^{-3} .

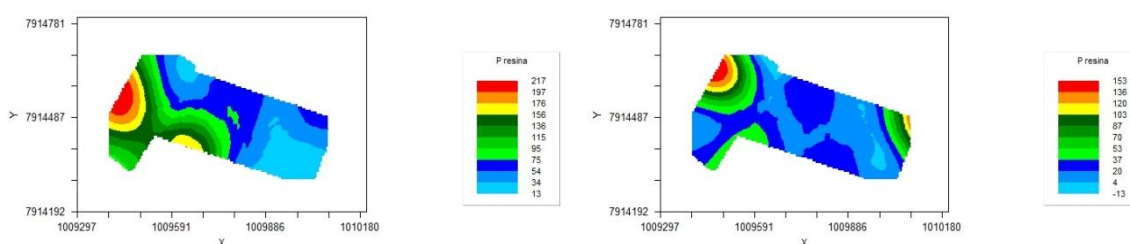


Figure 2 – Spatial variability of levels of P_2O_5 in the contour maps of the area with application of swine wastewater at a depth of 0-20 and 20-40.

It is known that P, by their characteristic high fixation in the soil is an element which has no significant increases in their availability with applications of conventional P, where the increases obtained are less drastically when observing the P content farm in this area of native forest, which never received fertilizer content is very low (9 mg dm^{-3}), ie, up to 23 times the original level in 4 years of manure application. On the one hand it is observed that a significant increase of P, on the other hand, it should monitor the accumulation, the same elements as traditionally limiting the production of fodder may cause toxicity. To date, in relation to productivity of forage, no reduction was observed due to the high levels of P.

Were also described by Ceretta et al., (2003) in a study on the use of liquid swine manure on natural pasture, changes in the concentration of P, these authors showed that high concentration of P in the topsoil, with increases 580% at 8.3 months and 6.710% at 48 months of application with liquid swine manure. These studies

C051

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Sustainable Agriculture through ICT innovation

indicate the importance of monitoring when the application is held constant in the same area.

When evaluating the content of P, with the exception of the area with the presence of MG5, significant differences ($P < 0.05$) between depths. It is observed that in the depth 20-40 cm, there was no increase in the level of P. This behavior is important because it is expected high mobility of this element in the soil profile. This same behavior was observed by Cunha (2009) to evaluate three different depths not observed percolation P at depths greater than 20 cm.

Mattias (2006) suggests that the accumulation of P in soil treated with ARS correlates with lower N / P ratio of waste, since to meet the required amounts of N by plants when applied ARS simultaneously apply quantities P greater than those necessary for the plants, resulting in accumulation of P and moves into the environment.

It is observed in Figure 2, at 20-40 cm depth that there is variability in the content of P in the different areas assessed, but this variability presents a range of levels considered, natural, close to those observed in areas where it was held application of animal manure. This behavior demonstrates that there is no leaching into the soil profile P in the conditions of the experiment.

Regarding the content of calcium (Figure 3), the depth 0-20 cm is the maximum observed in the range of $0.95 \text{ cmolc dm}^{-3}$, and 20-40 cm depth in the range of $0.77 \text{ cmolc dm}^{-3}$ ie the content is classified according to how low the CFSEMG (1999). According Furtini Neto et al. (2001) the application of organic waste to the soil increase the leaching of calcium. Cacea (2011) found that the calcium concentrations in the leachate increased with increasing rates of ARS, proving that organic waste increased leaching by the fact that wastewater can lead to the increasing release of CO_2 and consequently; leaching of Ca (HCO_3)₂ with water.

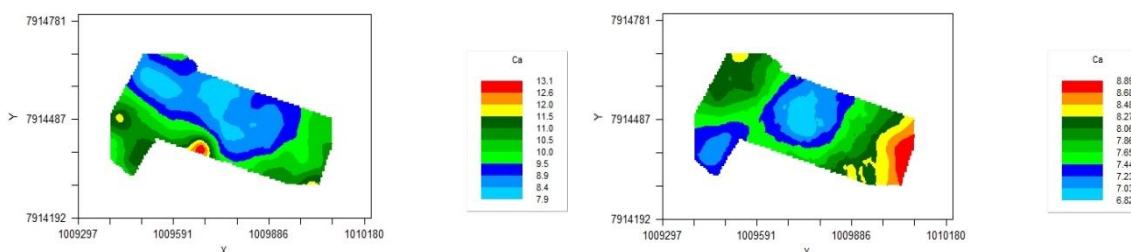


Figure 3- Spatial variability of levels of Calcium (Ca) in the contour maps of the area with application of swine wastewater at a depth of 0-20 and 20-40.

Regarding the magnesium content (Figure 4), the depth 0-20 cm is the maximum observed in the range of $0.44 \text{ cmolc dm}^{-3}$, and 20-40 cm depth in the range of $0.23 \text{ cmolc dm}^{-3}$, ie the content is classified according to how low the CFSEMG (1999). This behavior is expected due to the wastewater being poor in these elements because the calcium and magnesium tend to accumulate in the digester as they rush inside. The application of ARS is not contributing to elevated levels of Mg. It is observed that areas with less application time have the highest concentrations. There is a decrease in the

C051

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Sustainable Agriculture through ICT innovation

levels of these nutrients due to high extraction of MS and low or almost zero spare fertigation. Camargo et al (2011) also demonstrated a linear reduction in the levels of magnesium in the dry matter of shoots in function of increasing doses of manure. The Mg in the leachate were not significantly influenced by the application of ARS

Potassium did not differ between the treatment means. Regarding the depths, the highest average was found in the 0-20 cm layer. This indicates that there is a distribution of Potassium (K) in the soil profiles, characterized by the percolation of this element to the deeper layers. Their levels are considered good according to CFSEMG (1999). As the pH is lower in areas receiving higher amounts of ARS, the setting of this element is impaired.

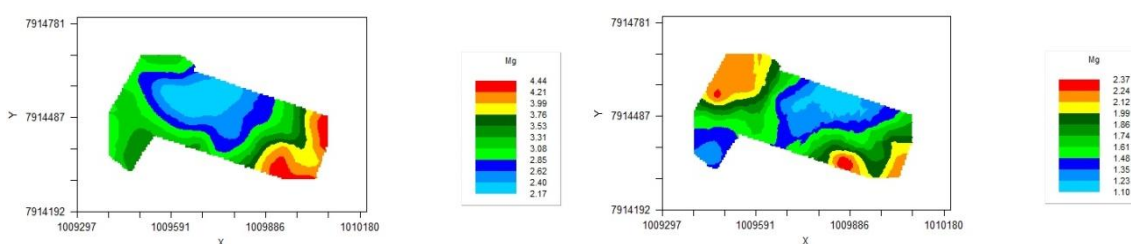


Figure 4 - Spatial variability of levels of Magnesium (Mg) in the contour maps of the area with application of swine wastewater at a depth of 0-20 and 20-40 cm.

According to Scherer (2001), potassium applied in the form of organic fertilizer acts as K applied as mineral, since it is not part of any stable organic compound, therefore, need not undergo the action of microorganisms becoming available soil quickly.

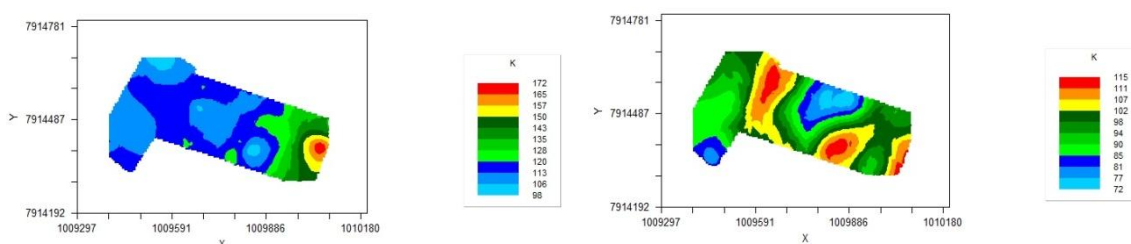


Figure 5 - Spatial variability of levels of Potassium (K) in the contour maps of the area with application of swine wastewater at a depth of 0-20 and 20-40.

4. CONCLUSION

The levels of Ca and Mg indicate that the application of ARS does not elevate the levels of these elements or the extraction of forage is higher than the replacement;

C051

Adriane de Andrade Silva; Vinicius de Oliveira Rezende; Marcelo de Castro Barreto; Regina Maria Quintão Lana; Ednaldo Carvalho Guimarães. “**Maps of Spatial Variability of soil chemical properties of pastures fertigated with swine manure**”. EFITA-WCCA-CIGR Conference “Sustainable Agriculture through ICT Innovation”, Turin, Italy, 24-27 June 2013.

Sustainable Agriculture through ICT innovation

The application of ARS does not replace the soil correction, because the base saturation is low and the Ca and Mg has a negative balance;

Levels of Phosphorus and Potassium are fully catered with the application of ARS.

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C051

Adriane de Andrade Silva; Vinicius de Oliveira Rezende; Marcelo de Castro Barreto; Regina Maria Quintão Lana; Ednaldo Carvalho Guimarães. “**Maps of Spatial Variability of soil chemical properties of pastures fertigated with swine manure**”. EFITA-WCCA-CIGR Conference “Sustainable Agriculture through ICT Innovation”, Turin, Italy, 24-27 June 2013.

Sustainable Agriculture through ICT innovation

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C051

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