Leaching of nitrate to the fertilization with litter of swine bed depping, liquid swine manure and chemical fertilizer

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Abstract

The successive application of high doses of pig manure can lead to contamination of nitrate, due to the high nitrogen concentrations in these wastes, related primarily to the composition of the diet of pigs. This study evaluated changes in levels of $N\text{-NO}_3$ in an Ultisol, typical in the city of Braço do Norte, SC, during the cycle of culture of the maize in a tillage system, in function to the fertilization with litter of swine bed depping, liquid swine manure and chemical fertilizer, with application of the appropriate dosage of N and twice the recommended dosage for the maize. The evaluations were made at depths of 0-15, 15-30, 30-45 and 45-60 cm at six dates during the maize cycle. There were increases in the levels of NO3$^-$ in the soil, with variation of values during the cycle of the culture. The highest value was observed in the treatment fertilized with pig slurry 2x in the depth of 45-60 cm. The results indicate the occurrence of leaching of NO3$^-$, but these elements are not yet present at critical levels in the soil.

Key Words

Swine, percolation, fertilization.

Introduction

Santa Catarina is the largest producer of pork, where like in other countries, the activity is typical of small farms. Often the land available for disposal of waste generated in production is insufficient, leading to successive applications in small areas. The fertilization of the agricultural cultures with swine manure can be an important source of nutrients, which when properly managed provides an increase in productivity. However, current practices and incorrect handling of these wastes contribute to the degradation of the soil, water and air quality, mainly by the potential of contamination of the groundwater. Thus the swine culture in confinement is considered by the agencies of environmental fiscalization as an activity of high polluting potential (Pereira 2006).

The chemical characteristics of wastes are related to the nutritional composition of alimentary diets of the swine, that among other nutrients, is rich in N, P and K, resulting in 60 to 70% of the N ingested by the animals been excreted in their faeces and urine (Oliveira 2000).

Among the macronutrients present in the manure, N is usually the element in highest concentration and also the one that causes the largest environmental problems, caused by changes that can be submitted to the soil and may result in losses, mainly by leaching. The process of nitrification of the ammoniac nitrogen of the manure applied at the ground occurs quickly, in speeds that can exceed the capacity of absorption by plants and microorganisms, decreasing the potential of fertilization of the waste and / or increasing their pollution potential (Franchi 2001; Aita and Giacomini 2008; Giacomini and Aita 2008). Giacomini and Aita (2008) observed that with the application of pig slurry, mainly in a dose of 80 m3 ha-1, the quantities of N-and NO3- and its leach in the soil increased rapidly after the application of manure.

Therefore, knowing the destination of these elements in the ground is essential for assessing the environmental impact caused by the use of the manure and its impact directly related to the soil's ability to retain the NO3-.. This study aims to evaluate the levels of ammonium in the soil and leaching of the nitrate, at depths of 0-15, 15-30, 30-45 and 45-60 cm, in an Ultisol Red-Yellow fertilized with overlapped bed, liquid swine manures and chemical fertilization in SPD, since 2002, in the city of Braço do Norte, SC.

Methods

The experiment was installed in the year of 2002 in an Ultisol Red-Yellow, cultivated under system of no-tillage with the succession oats / maize without the use of pesticides in rural property located at the Watersheds River Cachorrinhos, in the city of Braço do Norte, SC, in the coordinates 28° 15 'S and 49 ° 15' W. The climate of the city is a Cfa type, according to the classification of Köppen (Epagri, 2000).

The treatments were applied in experimental units (parcels) with 4.5 x 6.0 m (27 m²), constituted of: control (T) no fertilization, fertilization with swine bed depping (CS), fertilization with pig slurry (DL), nitrogen...
soluble (AS) with urea application. All the fertilization treatments were applied with doses related to one (1x) and two (2x) times the N recommended for cultures of oats and maize. The applied values were calculated based on the Chemical Commission and Soil Fertility (CQFS RS / SC 2004). The amount of N recommended for the cultures (30 kg ha$^{-1}$ for oats and 90 kg ha$^{-1}$ for maize) was defined in function of the soil analysis and productivity expected of maize. The swine bed depping was manually applied on the soil surface, five days before planting the maize. The application of liquid swine manure and soluble fertilization (urea) was parcelled according to the recommendation of the CQFS RS / SC (2004).

The liquid manures were collected in midden system to create full course located in the same property. The volume of manure applied, determined from the estimated concentration of nutrients by the densimeter calibration, was 50.9 m$^3$ ha$^{-1}$ for the treatment once (1x) the need of N in the cultures, distributed in three applications (01 / 10, 05/11 and 23/12/2007). The total amounts of nutrients applied were 89 kg N ha$^{-1}$, 79 kg P$_2$O$_5$ ha$^{-1}$ and 63 kg K$_2$O ha$^{-1}$ for the treatment with liquid manure once the recommendation of N for the cultures, and the double for the treatment two times the recommended N of the cultures.

The total amounts of 89 applied nutrients were of kg N ha$^{-1}$, 79 kg P$_2$O$_5$ ha$^{-1}$ and 63 kg K$_2$O ha$^{-1}$ for the treatment with liquid dejection a time recommended of N of the cultures and the double for the treatment two times the recommended one in N of the cultures. It was applied 10.7 Mg ha$^{-1}$ of overlapping swine bed on 01/10/2007 for the treatment once (1x) the recommended N and 21.4 Mg ha$^{-1}$ for double the recommendation. The total quantities of N, P$_2$O$_5$ and K$_2$O represented in the overlapping bed, respectively 90, 88.6 and 74 kg ha$^{-1}$ for the recommendation of one dose of N and 180, 177.2 and 148 kg ha$^{-1}$ for the double of the recommendation.

The levels of N-NO$_3$ were evaluated in four soil layers (0-15, 15-30, 30-45 and 45-60 cm) on 0, 7, 35, 53, 73 and 142 days after the application of the overlapping bed and the first application of liquid swine manure and urea. In each plot, were taken 6 sub-samples of soil, with help of a Dutch auger, to form a composite sample. The material was transported to a laboratory, dried and then harrowed, thus obtaining the fine dried in air soil (TPSA). Of this, was removed a sub-sample for extraction with KCl 1 mol L$^{-1}$ and the determination of N-NO$_3$ was to distillation of drags to the vapor with equipment of the type semi-micro Kjeldahl (Tedesco et al. 1995).

The results in each ground layer from the different sampling dates were submitted to the analysis of variance and treatment means compared by the Tukey test at 5% of significance level.

**Results**

The analysis of variance found that the application of swine manure promoted significant modifications in the levels of N-NO$_3$ in the soil, in depth and in the different sampling seasons. The levels of N-NO$_3$ at 7 days after the application were higher in the treatments DL2x on the surface layer (Figure 1). At 35 days there have been increases in the depth of 30-45 cm, which reinforces the hypothesis of rapid nitrification of the liquid swine manure, as the demand of maize still is small. This result may be related to the fast infiltration of NO3-in soil where urea is hydrolyzed and the ion formed ammonium is quickly converted to nitrate, resulting in the increase of its concentration (Costa 2001). The N losses by leaching occur mainly in the early stages of crop establishment, when the root system is not yet sufficiently developed, related to the rapid nitrification of ammoniac nitrogen from the swine manure in the soil and the low adsorption of N-NO$_3$.

The rate of mineralization of the waste is extremely important in the nutrients availability to the plants and may vary depending on the type of manure, the attributes of soil moisture, the humidity. At 73 days after the first application of pig slurry it was observed that a higher level of the NO$_3$ in the treatment DL2x in the layer 45 to 60 cm, thus confirming the occurrence of leaching, that leads to an increased risk of groundwater contamination.

At day 142 toward the end of the culture cycle, it was revealed there were lower levels of nitrate in the surface layer and high levels in the 45-60 cm layer, mainly in the treatment DL2x, this demonstrates that the applied values are higher than those assimilated into the culture, even under parcelled applications of the liquid manure.

Another important factor for the increase in depth of nitrate, may have been due to the high occurrence of rain observed in this period, which probably favoured the leaching of NO$_3$. Aita and Giacomini (2008) found in RS that with the application of 0, 40 and 80 m$^3$ ha$^{-1}$ of pig manure occurs a rapid increase in the leaching of NO$_3$, especially after the implementation of the highest dose of manure.
Figure 1. Levels the N-NO$_3^-$ in layer to 0-60 cm to soil during the cycle of culture of the maize.
The lowest value of N-NO$_3^-$ observed in dealing with litter of swine bed depping in relation to the slurry, the 142 days at 60 cm depth can be related to the bed had stayed on the surface, causing to the present N a slower processing. In studies of fertilization with slurry and litter of swine bed depping in Paleudalf in Rio Grande do Sul, Giacomini and Aita (2008) found a temporal variation of the quantities of N-NO$_3^-$ in the soil until the depth of 90 cm, where the slurry present a higher amount of N-NO$_3^-$ in the soil in relation to treatments with litter. Oliveira (1993) observed that in soils submitted to applications of high levels of liquid swine manure for several years (160 m$^3$ ha$^{-1}$), the levels of NO$_3^-$ in groundwater were ten times higher than those found in untreated soils.

**Conclusion**

In general, increases in levels of nitrate had occurred in the soil, added via swine manure, but they were not considered critical to the environment. The duplicate fertilization of liquid swine manure has superior nutrients compared to those assimilates from the culture and over the time may present risks of leaching of NO$_3^-$. The highest levels were observed in the layer of 60 cm at the end of the culture cycle. Criteria should be considered as dosages, range of application of manure and the adoption of SPD to minimize environmental impact due to losses of nitrate by leaching.

**References**


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