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SITE-SPECIFIC N_2O EMISSION FROM SOIL RELATED TO FERTILIZATION AND SUGARCANE TRASH ADDITION

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Introduction

Better information on greenhouse gas (GHG) emissions and mitigation potential in the sugarcane sector is necessary to manage these emissions and identify responses that are consistent with the status of economically and environmentally friendly source of energy (do Carmo, et al., 2012).

In the sugarcane sector, GHG emissions from the agricultural system can be originate from several sources, the most important being: a) conversion or land use change and its effects on C and N stocks of ecosystems; b) fertilization and irrigation; c) management of waste, including burning before harvesting; and d) operations in planting. Decomposition of industrial and agricultural waste such as straw and sugarcane vinasse contribute to 29% of GHG emissions resulting from the formation N_2O and CO_2, while another 10-20 % correspond to emissions of CO_2 and N_2O by the use of nitrogen fertilizers (Figueiredo, et al., 2010). The inefficient use of fertilizers by crops is regarded as an important factor controlling N_2O flux from soil (Bouwman, 1998).

Fertiliser application alters the concentration of N in different soil compartments, causing leaching of nitrogen compounds and the emission of N_2O or N_2, by the action of soil microorganisms that govern the processes of nitrification and denitrification (Smith, 1997). The most important factors affecting N_2O emissions from fertilizers are the climate, the carbon (C) organic soil, soil texture, soil drainage, plenty of NO3-N and soil pH, plus the related to management factors, which are the rate of application of N fertilizer by type, rate and technique of application of these fertilizers and crop type (Wrange et al., 2001; Snyder et al, 2009; Carmo et al, 2012). Generally, the longer the time in which the compounds from N fertilizers, organic wastes, crop residues etc. are available for the microbes in the soil and without competition absorption by plants, the higher should be the emission of N_2O from the nitrification and denitrification process.

In Brazil, as manual harvesting is been gradually substituted by mechanized methods, the sugarcane crop residue (trash) left on the soil surface is increasing (do Carmo et al., 2012). The maintenance of the crop trash in the field, increase the organic matter content of the soil and creates favorable conditions for the establishment of a microclimate in those areas, since no abrupt changes occur in the temperature and humidity of the soil, favoring the establishment of a biological community that decompose straw, allowing the reuse of nutrients (Huang et al., 2013).. Focusing conservationist management practices, the ideal amount of crop residues to be left on the field is still unknown, which can differ regarding soil characteristics, environment, and variety. However, the maintenance of the straw in the field can change the GHG flow, which may have important reflection on global carbon and nitrogen equivalent system.

Despite the importance of the subject, data are still limited and controversial related to the interaction between sugarcane trash left on the field and the emission of N2O from fertilized soil (Figueiredo, et al., 2010). Thus, the understanding of how fertilization and different levels of trash interfere in the GHG emissions, to report a consensus emission factors for the sugarcane sector, become vital to the overall carbon balance in ethanol production and can be decisive for an international acceptance of this fuel in the short and medium term.

Methods

The samples were collected during the sugarcane season 2012/2013 in commercial area located in Iracemápolis City, São Paulo, Brazil (coordinates 22 ° 34’ S and 47 ° 31’ W). The sugarcane variety used was the CTC -14 in the second ratoon cane grown on soil classified as loamy Oxisol. Three treatments were evaluated, no trash (T0), 50 % (T1) and 100 % (T2) of straw left on the field. Therefore, after mechanized harvesting the trash left on the field was 6.0 and 12.26 ton ha^{-1}. After the trash material was placed onto the soil, the experimental plots were fertilized with 100 kg N ha^{-1} (ammonium nitrate). Fixed PVC chambers to collect the GHG samples were installed in the experimental plots, and remained in the same location throughout the experiment (Davidson & Schimel, 1995; Varner et al., 2003). A total of eight chambers were installed in each treatment, divided in 2 subplots with and without fertilizer. The GHG fluxes were sampled every other day, from the 1st to the 46th day after the fertilizer application, since January 2013. The gas samples were analyzed by gas chromatography (Shimadzu model GC 2014). Final flow was determined by linear regression of the curve. Soil samples were collected from the 0-10 cm layer, ground and sieved to 100 mesh for determination of total carbon (C) and nitrogen (N) by dry combustion in an elementary analyzer (LECO Tru-Spec CN analyzer).

Results and discussions

As expected, daily fluxes of N_2O in plant cane varied among treatments (Figure 1), increasing in the first month after the fertilizer application, decreasing exponentially to near background after this period. The N_2O flux reaches higher values around the 20th day after fertilization. The treatment that left all the trash (100 %) a higher N_2O flux from the nitrogen fertilizer applied. This increase may have been due to accelerating microbial nitrification and denitrification processes with the coupling of mineral N, available carbon, and favorable temperatures and soil moisture**.** On the other hand, the treatment with no trash and the 6.0 ton ha^{-1} presented similar emission. Despite the difference in the amount of dry matter left on the field, the CO_2 emissions were constant for all treatments in the same order of magnitude. Also, there were no increases in concentrations of N and C in soils for the treatments.

Conclusions

As expected, higher N_2O emission are associated with fertilizer application and all the harvesting trash left on the soil surface (100 %). However, low fluxes found for 6.0 ton ha^{-1}, similarly to the no trash treatment, are good information for managing amount of trash to be left on the sugarcane field for soil conservation and restoration. Although the results presented an information for the sugarcane sector, more studies are needed to provide information for managing trash accumulation in fields.

Keywords: Sugarcane trash, ammonium nitrate, nitrous oxide emission

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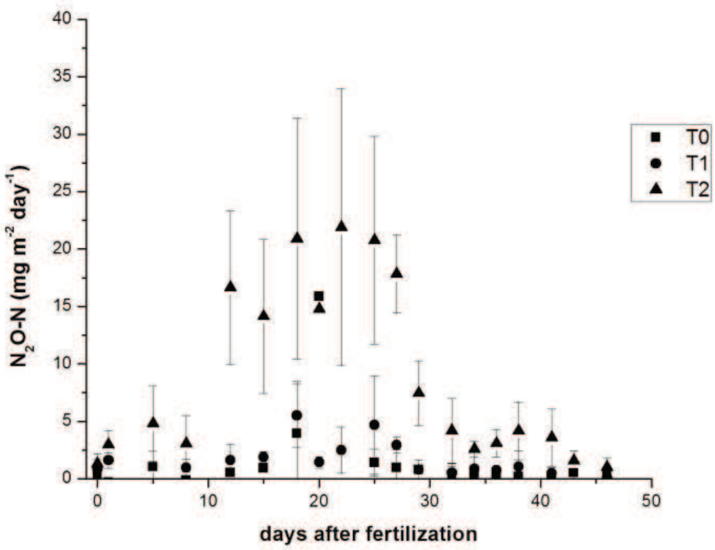

Figure 1. Daily mean fluxes of N_2O-N (mg m^{-2} day^{-1}) measured in a ratton cane with crop trash left on the soil surface, with (T0) no crop trash, (T1) 6.0 ton ha^{-1} and (T2) 12 .3 ton ha^{-1} of crop trash. The values represent the average of four replications