Nitrous oxide emission in potato cropping systems

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Abstract:

The potato is a strategic crop in Mauritius in which the aim is to reach self-sufficiency in production. The average area under potato cultivation in Mauritius is 822.4 ± 39.2 hectares and the production figures is 18,857 ± 704 tons per year. The potato is the most cultivated crop in the non-sugar sector. In order to obtain better tuber size and quality, the implementation of mechanical tillage and use of synthetic fertiliser is a critical requirement. However, those practices were seen to have adverse effects on several ecosystem level and ecotype such as the soil, streams, lagoons and the atmosphere. The use of fertilisers in agriculture contributes to the emission of greenhouse gases such as nitrous oxide (N_2O), methane (CH_4) and carbon dioxide (CO_2). Nitrous oxide, being emitted less than carbon dioxide, is 273 times more potent as a greenhouse gas compared to carbon dioxide. This study has been carried out at the University of Mauritius farm and focuses on the emission of nitrous oxide gas in potato cultivations and how practices like organic mulching, fertiliser application and tillage contribute the emission of nitrous oxide. Twenty four (24) subplots of 5m x 5m were setup in a randomized complete block design from April to July 2016 and the potato variety Spunta was used for the trial. Static chambers made of PVC were setup (one per subplot) with the headspace volume of 6.28 x $10^{-3}m^3$ and a basal area of 0.0314 m^2. The nitrous oxide emission was monitored using a portable handheld gas analyzer. Nitrous oxide monitoring was carried out twice a week for one hour at those following intervals T_0, T_{20}, T_{40} and T_{60}. The monitoring was initiated one week before the potatoes were planted until one week after the harvest. It was noticed that the rate of emission of nitrous oxide was greater in no tilled plots under maize stover mulch and nitrogen fertiliser use at a rate of 120kg/ha with a daily flux ranging from 17.61 ± 3.02 g N_2O-N/ha/day in dry soil (moisture content <10%) to 23.39 ± 44 g N_2O-N/ha/day in humid soil (moisture content >60%). The lowest recorded emission was in the control experiment with an average flux of 7.73 ± 0.34 g N_2O-N/ha/day. Several factors were seen to have an impact on the emission of N_20 mainly, soil organic carbon content, coverage (cover crops, mulching etc.), soil texture, soil moisture and temperature. A positive correlation was recorded between temperature, soil moisture and organic matter content to the nitrous oxide flux from the soil. During the plant's vegetative/tuber bulking stage, the nitrous oxide emission was seen to be stable in all plots except for plots with tillage treatments in combination with nitrogen fertiliser where fluctuations in nitrous oxide emission were recorded. A sharp increase in N_20 flux in all treatments was noted after the potatoes were harvested. Although the beneficial impacts of mulching are numerous, it provides a suitable microclimate for soil borne organisms to thrive leading to a higher soil respiration rate, leading to an increase in greenhouse gas emission. Therefore, it can be concluded that nitrous oxide emission in potato cropping systems is elevated and influenced by several biotic and abiotic factors, proper mulch material selection and application strategy can contribute in improving plant nitrogen absorption and thus, limiting N_2O emission.

Keywords: Agriculture, Mulching, Potatoes, Nitrous oxide, Greenhouse gas emission