Reducing NH3 and GHG emissions during poultry manure on-farm composting

Oudart Didier[1,2,3], Rafolisy Tovonarivo[4], Robin Paul[5], Hassouna Mélynda[5], Paillat Jean-Marie[2]

(1) Crête d'Or Entreprise - ZA des Sables - 97427 Etang-Salé, FR
(2) CIRAD – UPR Recyclage et Risque, BP 20, 97408 Saint-Denis Messagerie Cedex 9, FR
(3) Université de Toulouse, INSA, UPS, INP, LISBP, 135 avenue de Rangueil, 31077 Toulouse, FR
(4) LRI, Université d'Antananarivo, BP 3383, Antananarivo 101, MG
(5) INRA – Agrocampus Ouest, UMR SAS, 65 rue de Saint Brieuc, 35042 Rennes cedex 1, FR
oudart.didier@gmail.com

Introduction

Composting is notably used on farm to reduce the environmental impact during manure management. However this process leads to emissions of greenhouse gases (GHG) as methane (CH_4) and nitrous oxide (N_2O), and ammonia (NH_3) which is harmful [1]. NH_3 is emitted during thermophilic phase in conditions of high aeration rates with high nitrogen availability. CH_4 is produced under strictly anaerobical conditions influenced by the windrow size and turning frequency whereas N_2O emissions results from incomplete nitrification and denitrification for low oxygen level and temperature lesser than 45°C. Ways to reduce emissions of each gas are already known. We propose here to discuss a global composting strategy to reduce direct emissions of all these gases, combining effects of porosity, turning and humidification.

Material and methods

Six composting scenario were studied using a mix of poultry manure, wood shavings and water. Composting of a compacted heap (C) and non compacted heap (nC) was followed during 23 days. C was then turned and used to built another compacted heap (CtC) and a non compacted heap (CtnC), composted during 70 days. Finally composting of a wet (W) and a dry (D) heap was followed during 59 days. C, nC, CtC, CtnC and W had a higher humidity (55.6±1.5%) than D (46.2%). Internal temperature and emissions of CO_2, H_2O, NH_3, N_2O and CH_4 were measured continuously. Emissions of N_2O and CH_4 were converted in eqCO_2 to compare the total amount of emitted GHG and the proportion of each gas.

Results and discussions

D emitted 53% less GHG than W (respectively 63.6 and 133.9 kgeqCO_2 t^{-1} initial dry matter) with same proportion of N_2O and CH_4 (respectively 24.2% and 75.8% for D; 23.5% and 76.5% for W) for a similar CO_2 emission (14.9±2.5% of initial C). Same quantities of NH_3 were emitted (8.5±1.5% of initial N). C emitted 48% less NH_3 but 141% more GES than nC. CtnC emitted 64% more N_2O than CtC but less CH_4 (respectively 1.9 and 56.9 kgeqCO_2 t^{-1} IDM). However global GHG and NH_3 emissions were lower for CtC. To reduce initial N_2O and CH_4 emissions it is then recommended to have high initial porosity with a low humidity. Composting will then stop quickly on the surface of the heap. Then, a rapid turning of the windrow should limit NH_3 emissions. Turning coupled to water addition will homogenate the matter and reactivate biological reactions. After this, compaction will limit emissions of NH_3 and N_2O while maintaining the stabilization rate. More CH_4 will be emitted but global emission of GHG should be reduced.

Conclusion and perspectives

Global strategies can be proposed to reduce direct emissions of major pollutant gases. This experimentation also produced data that can be further used to validate and improve dynamic models of composting.

References

[1] Fukumoto Y., Osada T., Hanajima D. & Haga K., 2003. Patterns and quantities of NH_3, N_2O and CH_4 emissions during swine manure composting without forced aeration - effect of composting pile scale. Bioresource Technology, 89, 109-114.