AN INVESTIGATION OF COMPOSTING POULTRY MANURE IN RELATION TO NITROGEN CONSERVATION AND PHOSPHATE ROCK DISSOLUTION

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ABSTRACT

Gaseous losses of nitrogen (N) through ammonia (NH_3) volatilization and denitrification diminish the fertilizer value of animal and poultry manures and form atmospheric pollutants. Appropriate methods of composting can improve the fertilizer value by conserving manure N and minimise the risk of environmental pollution. Additionally, acids produced during composting and nitrification of conserved N in manure, provide a source of protons (H^+) which have the potential to dissolve phosphate rock (PR) when composted with manure. The objective of this research was to examine the methods of composting poultry manure with different amendments in relation to N conservation and PR dissolution.

Firstly, the methods for preserving and measuring N in manure samples were evaluated. The results suggested that freeze drying and inclusion of a strong oxidizing agent ($KMnO_4$) prior to routine Kjeldahl digestion were required to achieve complete recovery and accurate measurement of N in manure samples.

Methods for reducing the loss of N through NH_3 volatilization and denitrification during aerobic and anaerobic composting of poultry manure with different amendments were investigated in controlled 'flow through' incubation experiments. The amendments included carbonaceous bedding materials (woodchip, paper waste, wheat straw and peat), acidifier (elemental sulphur-S°) and adsorbents (zeolite and soil).

The loss of N through NH_3 volatilization from aerobic composting was about 17% of the manure N which was reduced by 90-95% under anaerobic composting. Under aerobic composting the addition of various amendments reduced the volatilization loss by 33 to 60%. Although the rate of denitrification was negligible (<1μg kg^{-1} day^{-1}) in fresh manure, it increased enormously (3.7mg kg^{-1} day^{-1}) during composting. The presence of nitrate (NO_3^-) was found to be a rate determinant for denitrification in manure. Amongst the treatments, the addition of S° was very effective in reducing NH_3 volatilization and denitrification.

The dissolution of PR during composting with poultry manure was examined using radioactively (^{32}P) labelled synthetic francolite and North Carolina phosphate rock (NCPR). The use of ^{32}P labelled francolite indicated that PR dissolution in poultry manure/PR composts could be measured more accurately from the increases in NaOH extractable phosphorus (ΔNaOH-P) than from the decreases in HCl extractable P (ΔHCl-P). Low levels of francolite and NCPR dissolution (<16%) occurred when PR is mixed with poultry manure. This was attributed to the high concentrations ($4.8 * 10^{-2}$mol L^{-1}) of calcium (Ca^{2+}) in manure solution which inhibited the dissolution of PR through the Ca common-ion effect. Addition of S^{o} to poultry manure/PR compost reduced the pH and thereby enhanced PR dissolution.

A system for the dissolution of PR, using the acid (H^{+}) produced during the nitrification of NH_3 released from poultry manure, was developed. The inhibitory effect of manure Ca on PR dissolution is avoided if the NH_3 released from decomposing manure is absorbed in bark and soil materials containing PR, which are kept either as manure covers or in separate columns. Although both methods were found effective in the absorption of NH_3, the result demonstrated that bark absorbs more NH_3 than does soil.

Extensive PR dissolution occurred in the bark (82.3%) and the soil (33.2%) even in the absence of NH_3 absorption from poultry manure. Higher levels of PR dissolution in bark is attributed to its high exchangeable acidity (80.5cmol (+) kg^{-1}) and large Ca sink size (82.7cmol (+) kg^{-1}). However, when the bark and soil materials were kept as manure covers, accumulation of Ca in the covers due to the diffusion of manure Ca, reduced the PR dissolution. When the bark and soil materials were kept separately in columns, nitrification of absorbed NH_3 resulted in small increases in PR dissolution in bark (15%) and soil (5%). However, most of the protons (50-95%) released during nitrification are involved in the buffering of the bark and soil materials.

The laboratory studies showed that the addition of S^{o} to poultry manure during aerobic composting not only reduced the loss of N, but also enhanced PR dissolution. Based on this observation, sulphocompost (a blend of poultry manure, woodchip with S^{o} and PR) and phosphocompost (a blend of poultry manure, woodchip with PR) were prepared

and their agronomic effectiveness were compared with fresh manure mixtures and urea using field grown winter cabbage and summer maize crops. The crop yield, N use efficiency and N recovery were greater for sulphocompost than for phosphocompost. The sulphocompost and phosphocompost were approximately 60% and 12%, respectively, as effective as urea treatments for winter cabbage. Both composts were equally effective as urea for the second season's maize crop. The study has shown that poultry manure enriched with PR and S^{o} can be used as a source of N, P and S.

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