ABSTRACT

Cattle manure available to farmers is of low value as a fertilizer N and generally contains less than 1% N, which cannot sustain N requirements for high yielding crops like maize. The purpose of the study was to develop methodologies and practical interventions for improving quality and efficient utilisation of cattle manure. The study evaluated the effect of pit storage of manure (anaerobic decomposition), conventional heaping storage method (aerobic composting), crop residue incorporation and duration of storage on NH_3 volatilisation and quality of the manure. Mineralisation-immobilisation studies were carried out to determine nutrient release patterns from the resultant manures. Maize crop responses to N availability from the manures were investigated.

Maize straw mixed at a rate of 4.8kg straw to one tonne manure was the most effective in reducing N losses up to 88% in cattle kraals. Higher losses of up to 40 ugN g^{-1} manure were measured under aerobic manure composts compared to only 8 ugN g^{-1} under anaerobic storage. Low pH values below 7 and high moisture content explained for negligible N losses under anaerobic storage conditions. Most of the N in anaerobic manures was in the form of NH_4-N while there was $N0_3$-N accumulation in aerobic manures.

The dynamics of N mineralisation were described by first order kinetics with high rate constants of up to 0.068 day^{-1} for anaerobic manures. The course of N turnover for anaerobic manures suggested two phases, an initial exponential immobilisation phase lasting between 4 and 6 weeks followed by a mineralisation phase. The decomposition of aerobic manures in soil followed a slow linear immobilisation pattern with rate constants of up to 0.038 day^{-1}. Less than 28 kg ha^{-1} of N were taken up by the crop from aerobic manures compared with 35 kg in the control, resulting in depressed grain yields in the year of application. Increased N availability from aerobic manures leading to high N recoveries and grain yields were observed in subsequent seasons. Synchrony between N release and plant uptake was best achieved in treatments receiving anaerobic manures composted without straw for 3 months. Subsequently, higher grain yields were measured in treatments with anaerobic manures in the year of application. Overall, the cumulative yields were greatest with anaerobic manures. Losses from broadcast applications were 25kg N t^{-1} and 19.3kg N t^{-1} manure for anaerobic and aerobic manures respectively. Banding placement method reduced volatile N losses by 80% and grain yields were subsequently increased by 32% over conventional broadcasting.

It was concluded that the addition of straw with manure during handling and anaerobic storage for 3 months, enhances quality. By improving N concentration of manure by 0.1% N, anaerobic storage may provide an equivalent of 30kg of AN (ammonium nitrate), which reduces fertiliser costs required to offset the N deficit in aerobic manures. Placement of manure in bands improves efficient utilisation of the manure. Whilst aerobic manures may not improve crop yields in the year of application, regular application of the manure could improve soil quality in the long term, through soil organic matter build up which enhances soil physical properties, buffering capacity and microbial activities.

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