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SECTION: AGROECOLOGY

Master Thesis

Optimising faecal sludge co-composting in the semiarid Tropics

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SUMMARY

In Ghana soils are generally poor in organic matter and nutrient content, agricultural productivity is low and there is little use of mineral fertiliser. This research aimed at developing a composting process apt to sanitise faecal matter from public toilets in a simple way that can be easily adopted by local communities. Therefore, the compost as a product must be able to increase soil organic matter and nutrient content, while being hygienically and environmentally safe in its production and use.

To facilitate the initial building of the compost piles, a sandwich setup of faecal sludge and plant materials (*Panicum maximum, Azadirachta Indica* and the leaves and twigs of *Mangifera Indica*) was chosen. The experiment was carried out at Valley View University (VVU) with a pseudo-replicate at Orphanage Africa (OA) in Greater Accra. The layout was constituted of 9 treatments at each site. Treatments differed in the plant material to faecal sludge ratio and/or turning frequency. Ratios 1:1, 1:2, 1:3, were categorised as Low Sludge (LS), Medium Sludge (MS) and High Sludge (HS) respectively. Each pile in these categories was turned every 3rd, 5th and 10th day, starting 14 days after pile building; respectively classified as High Turning Frequency (HTF), Medium Turning Frequency (MTF) and Low Turning Frequency (LTF).Temperatures in the core and 15cm depth of each treatment were recorded twice a day and the courses of pH and electrical conductivity (EC) were monitored as well. Die-off of faecal indicators (*Salmonella* spp., faecal *Streptococci* and *Escherichia coli*) was assessed from homogenised samples collected on days 27, 54 and 84 of composting and analysed at International Water Management Institute (IWMI) Accra, Ghana. The inactivation of helminth eggs was validated with *Ascaris suum* eggs that were inserted into the compost after the piles had been set up at two depths; core of the pile and ≤ 15cm depth. A plant bioassay with garden cress (*Lipidium sativum*) was carried out three times at a monthly interval to test phytotoxicity of compost at different stages. Above-root biomass yield of each treatment was expressed as a percentage of the control

(with garden soil). Changes in percentage nutrient nitrogen (N), phosphorus (P), potassium (K), and organic carbon (C_{org}) contents were also assessed, at Institute for Agricultural Chemistry at the University of Hohenheim, from air-dried compost material sampled three times during the trial.

Compost piles in the MS and HS categories recorded relatively higher temperatures at both sites. Temperature courses were slightly different at both sites with characteristic two peaks. Thermophilic temperatures were recorded earlier at OA than VVU. The pH of all categories at both locations decreased during the second month of composting and then increased during the third. However, it was in the range of 7.0 to 8.5 throughout the composting period. EC was distinctly higher at both sites for HS compost category though it decreased to slightly the same level in all treatments at the end of the trial. There was no clearly observed treatment or site effect on deactivation of faecal indicators. More than 99.9 % die-off of the initial load of *Salmonella* spp., and faecal *Streptococci* was achieved within 54 days of composting at temperatures less then 55 °C. *Escherichia coli* were more resistant at the attained temperature and pH. However, >75 % of the bacteria had been deactivated by the end of the trial. Slight re-growth for all bacteria was observed during the second month. Deactivation of *Ascaris suum* eggs was >90 % at the core of the compost and <30 % at 15 cm depth.

There was no observed influence of treatment on compost phytotoxicity. However, a significant reduction of toxicity was achieved after 54 days. All treatments at both locations achieved > 80 % above-root biomass yield of the control. Treatment effect on compost phytotoxicity was minimal. Nutrient balances indicated significantly higher percentage N and P at VVU while K and C_{org} were higher at OA. Lack of insulation and a proper mixture of the composts piles might have negatively affected the temperature increases during composting and the consequent effect on pathogen deactivation rate.