The Effects of Composting on Swine Manure Nutrients and Hormones

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ABSTRACT

There is concern about the direct application of raw manure to fields as a soil amendment due to its relatively high concentration of ammonia, pathogens, and volatile organic compounds, which give rise to adverse odors and environmental concerns. In addition, not much is known about the fate and transport of reproductive hormones that can be present in the manure. Composting may be a method to reduce the potentially harmful effects of manure application. Composting is the process of biodegradation by aerobic microorganisms, which destroys pathogens and converts organic compounds into a more stable form, resulting in a humus-like material better suited for application as a soil amendment. Two piles of swine manure with bedding (corn stalks) were constructed to allow for the monitoring of internal temperature and were sampled periodically for nitrate-, ammonium-, and total-N, total-P, pH, EC, and the hormones 17β-estradiol (E2), estrone (E1), and testosterone (T). One pile (compost) was mixed periodically throughout the study, resulting in temperature increases within the pile to the thermophillic range (>40ðC) after each mixing. The other pile (static manure) was not mixed and the temperature of the manure stayed very close to ambient throughout. After 92 d, the compost had a pH closer to neutral, lower EC, and lower total-N content than the static manure pile. Both piles showed greatly reduced ammonium-N concentrations from the initial material at all depths with time, while the static manure pile showed more signs of nitrate leaching than the compost pile. Estradiol was similar for both piles while estrone concentrations were lower as a result of composting. After 92 d, the compost was a humus-like material with very little odor, while the static manure pile had maintained much of its original physical characteristics.

METHODS

Two piles of fresh manure plus bedding from a farrowing barn were placed on a concrete base. Thermocouple probes were inserted at 30-cm increments. The internal temperature was logged hourly.

A skid-steer loader was used to mix the compost material at 36, 50, 65, and 78 d after the piles were made (29 July).

Horizontal core samples were taken from each pile at the locations of the temperature probes prior to turning of the compost. The samples were frozen until analysis.

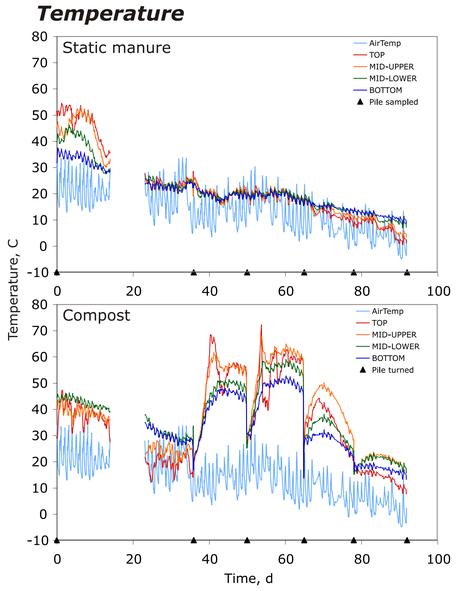
Hormone extraction method

- Sample solvated in H_2O and stirred, centrifuged and decanted.
- Repeat with methanol 2x-and combine with H_2O extract
- Filter combined extract
- Extract the H_2O/methanol extract with hexane
- Spike hexane extract with deuterated E2 and T
- Blow dry and resolvate with H_2O/methanol
- Apply sample to C18 SPE cartridge (elute steroids with 5:1 ethyl acetate/methanol)
- Extract against 5% NaCl in H_2O
- Apply organic residue to Florisil SPE cartridge-(elute steroids with 95:5 methylene chloride/acetone)
- Reconstitute sample and submit for LC/MS analyses

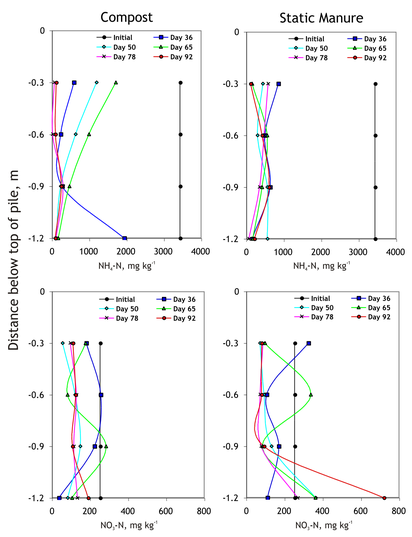
Close-up of temperature probes in both piles. The probes extended to the center of the pile. Notice the difference in appearance of the two materials after 92 days.

RESULTS

Temperature



Thermophillic temperatures were reached after the compost pile was turned while the internal temperature of the unturned manure pile remained near ambient.



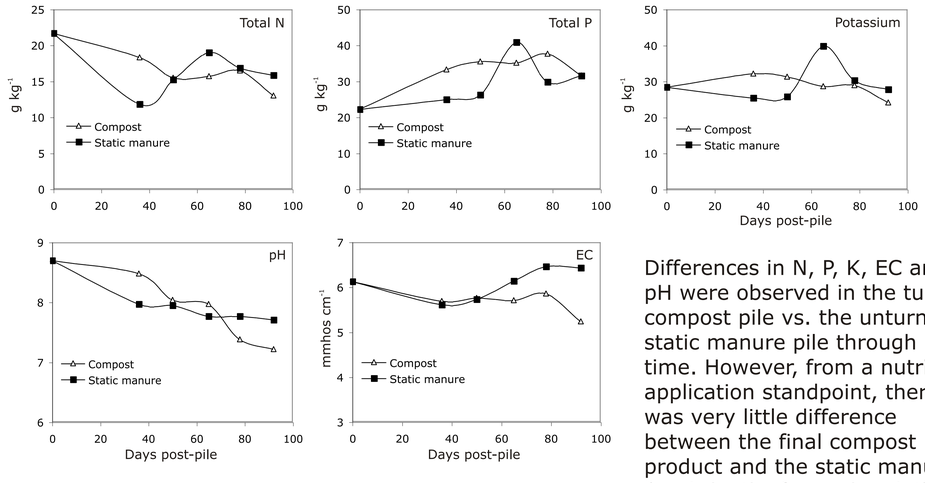
Inorganic Nitrogen

Initial ammonium (NH_4-N) concentration was initially very high but decreased rapidly in both piles.

The nitrate (NO_3-N) peak at 0.6 m on Day 65 and the elevated concentrations at 1.2 m, especially on Day 92, may be an indication of leaching within the static manure (not-turned) pile.

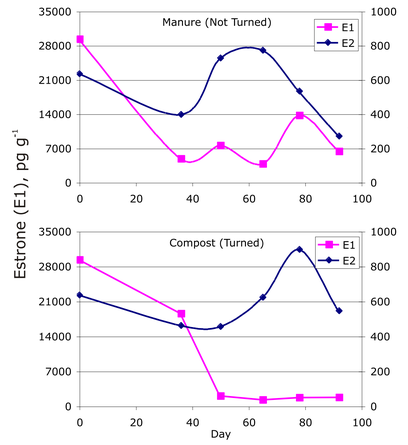
After 92 d, the physical appearance of the composted pile (right) was very different from the unturned static manure pile (left), indicating breakdown of the organic material.

Nutrients, pH, EC



Differences in N, P, K, EC and pH were observed in the turned compost pile vs. the unturned static manure pile through time. However, from a nutrient application standpoint, there was very little difference between the final compost product and the static manure. (n=4 depths for each point)

Hormones



Estrone (E1) was initially over 29,000 pg g^{-1} (dry weight basis), but averaged about 1800 pg g^{-1} after Day 50 in the turned compost pile while only decreasing to an average of 7300 pg g^{-1} after Day 36 in the static manure.

Estrone (E1) was found in much higher concentrations than E2. Estrone is considered to be between 0.5-0.1 times the toxicity of E2. The E1 was between 2-46 times the concentration of E2 in this study, indicating that both could cause adverse affects in the environment, since as little as 10 ng E2 L^{-1} has been shown to to cause feminization of male trout.

It is recognized that E2 metabolizes to E1. In this study, however, there is no direct relationship observed between the two hormones. Ongoing research of glucuronide conjugated E2 (E2G) indicates that it is possible for E2G to hydrolyze to E2, lending a possible explaination for the erratic E2 increases. Further research related to E2-E2G transformations needs to be conducted.

Different microorganism populations between the piles (i.e. thermophillic vs. mesophillic and aerobic vs. anaerobic) may lead to different fates of E2 and E1, for example, E2-humin incorporation.

Thermophillic and aerobic conditions of the turned compost pile enhanced the reduction of E1.

Pharmaceuticals

No sulfonamides were detected in either pile. Historically, only the liquid manure storage pond at the site (nursery waste) was found to have any detectable sulfonamides (sulfamethoxazole at 38 ng L^{-1}).

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