DEVELOPMENT OF SWINE WASTEWATER DEWATERING/COMPOSTING FACILITY AND END PRODUCT USE

By

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INTRODUCTION

Swine production in North Carolina is second only to Iowa of hogs on farms (Graham, 1995) with 8.3 million head. Cash receipts from 1994 sales exceeded 980 million dollars representing 15.4 percent of total agricultural cash receipts. Using the underfloor flush-lagoon treatment system of manure management is reported to produce 950 gallons per year per pig capacity for growing-finishing operations. Disposal of such large volumes of wastewater containing 0.5-3.0% solids from these production facilities in an environmentally safe and economically sound manner is a current concern. The current method of handling these wastewaters is by land application which has many limitations including risks of ground and surface water contamination by leachates and runoff from overflowing lagoons during inclement weather and excess rainfall.

Existing and pending regulations for handling swine manures may require new handling systems and reduce agricultural acreage due to buffer zones by rivers and streams.

Composting is a natural biological process which can be utilized for processing manures into a beneficial product but requires an integrated approach consisting of (1) enhancement of the solids content of wastewater, (2) composting using sawdust-woodchips as bulking materials and (3) development of guidelines for use of the final product for various crop production systems.

OBJECTIVES

The project is an endeavor to develop and demonstrate an integrated program for handling swine manures which assures compliance with all regulatory requirements, produces a beneficial product and develops potential uses for the product.

The specific objectives were:

1. Evaluate systems for enhancement of the solids content of swine lagoon liquids.
2. Develop an aerated bin (in-vessel) composting facility
3. Characterize the chemical and physical properties of the compost.
4. Establish beneficial use criteria for utilization of the compost.

PROCEDURES

Aerated compost bins. The composting study was conducted at the Northpork Porcine Composter, Bowen Farms, Inc. in Belhaven, North Carolina. Existing 8' x 16' x 6' compost bins located at this facility were divided into 8' x 8' and fitted with BioPlates™ (Fiberstone Technical Affiliates Inc.) which are used for aeration of the bins (Cunniff and Edwards, 1996). Squirrel cage fans with 500 cfm capacity were installed as an air supply.

Solids separation. A Key Dollar™ Model 100 separator was supplied by the Key Dollar Co., Inc. of Milton-Freewater, Oregon. The separator was fitted with a screen having 1/16 inch openings.

Following an initial trial with the 1/16 inch screen, a 1/32 inch screen was installed for further evaluation.

Compost feedstock blends. Three feedstock combinations used for composting evaluations were:

1. Manure solids from separator (straight)
2. Manure solids + woodchips - equal parts by volume mixed (1:1)
3. Manure solids woodchips - equal volumes layered approximately 3 inch depth.

These blends were placed in bins to a depth of approximately 4 ft. Temperatures were monitored with a Campbell Scientific CR 10 data logger.

Compost analyses. Compost was analyzed for C, N, P, K, Ca, Mg, Mn, Zn, Cu, Pb, Ni, and Cr by the Analytical Services Laboratory-Department of Soil Science, North Carolina State University. C and N were analyzed using a Perkin Elmer Model 2400 CHN Elemental Analyzer (Perkin Elmer Corp., Norwalk, Connecticut). P, K, Ca, Mg, Mn, Zn, Cu, Ph, Ni, Cd, and Cr were determined by ICP using a Perkin Elmer Plasma 2000 emission spectrometer following a dry ashing in a muffle furnace at 500°with dissolution in HCl.

Greenhouse studies. Two plant species. Dwarf nandina cv. Fire Power and Dipladenia are being grown in the following 5 mixes a) compost only (SW), b) commercial media (CM), c) 75% SW + 25% CM, d) 50% SW + 50% CM, e) 25% SW + 75% CM. Fertility rates of 0, 5 or 10 lb yd^3 of 14-14-14 Osmacote was mixed with each mix, 4 replicates of Dipladenia, 5 replicates of Nandina.

RESULTS AND DISCUSSION

Separator results. An initial trial with the Key Dollar Model 100 separator using the 1/16 inch screen to which pit discharge waste containing 2.08% solids was pumped at 100 gpm resulted in removed solids of 20% solids. Replacement of the screen with 1/32 inch screen resulted in 74% solids removal from a pit discharge of 2.85% solids. The solids content of material from the 1/32 inch screen was 24.2%. The primary effluent from the separator contained 0.75% solids and the secondary effluent (after the roller press) contained 1.24% solids.

Composting results. The temperature regimes for the three bins are shown in Figure 1. The bin containing no wood waste reached a maximum temperature of 130°F, slightly below PFPR requirements, and was maintained for about 1 week followed by a general decline until turned mechanically after which temperature increased to 115°F before being terminated. This material with a high moisture content settled increasing density and limited aeration. Larger fan with higher static pressure capability may have overcome this problem and should be tested further. Composting of straight material would be desirable because of less labor requirement and increased efficiency of the bin capacity. Both bins containing wood waste as a bulking material achieved PFPR requirements. These bins required several loading days to fill the bin and thus a drop in temperature at each loading. There was some evidence here of inadequate fan capacity which may have limited maximum temperatures achieved in other composting projects.

Compost analyses. Chemical analyses and bulk density of the two wood amended composts were comparable and only the analyses of the 1:1 mixed feedstocks are shown in Table 1. This was the product used for the greenhouse studies. The pH of the samples ranged from 7.2 with wood swine solids layered to 7.8 with the straight swine waste. Bulk density ranged from 860-931 lbs/yd^3 in the wood amended compost as compared to 1303 lbs/yd^3 where only swine waste was used. Soluble salts ranged from 128-182 mhos x 10^{-5} in the three composts as compared to 220 mhos x 10^{-5} in the uncomposted raw waste.

Table 1. Characteristics of Swine Waste Compost from 1:1 mixed feedstock.

Parameter	%	Parameter	mg kg^{-1}
C	48.6	B	8.0
N	1.25	Mn	343.2
P	0.76	Zn	289.0
K	0.42	Cu	92.3
Ca	0.96	Ph	16.0
Mg	0.23	Ni	4.6
S	0.39	Cd	<1
Fe	0.89		
		Na	146.0
		Cl	289.3
Soluble Salts		128 mhos x 10^{-5}	
pH (2:1)		7.6	
Bulk Density		931 lbs/yd^3	

Cucumbers, a salt sensitive crop, were seeded in each of the composted materials and in uncomposted manure. Cucumber germination and growth were inhibited in the uncomposted manure but normal growth occurred in all of the compost products.

Early growth of dipladenia shows a positive response to the compost at low fertilizer rates but high rates of compost resulted in a decrease in growth at 75 and 100% compost.

Growth response of nandina was similar to that with dipladenia but plants growing in high compost rates are exhibiting symptoms of iron deficiency which may be due partially to the relatively high salt content and the competitive effects of zinc and copper contained in the compost. Final growth quality analyses will be presented at the conference.

REFERENCES

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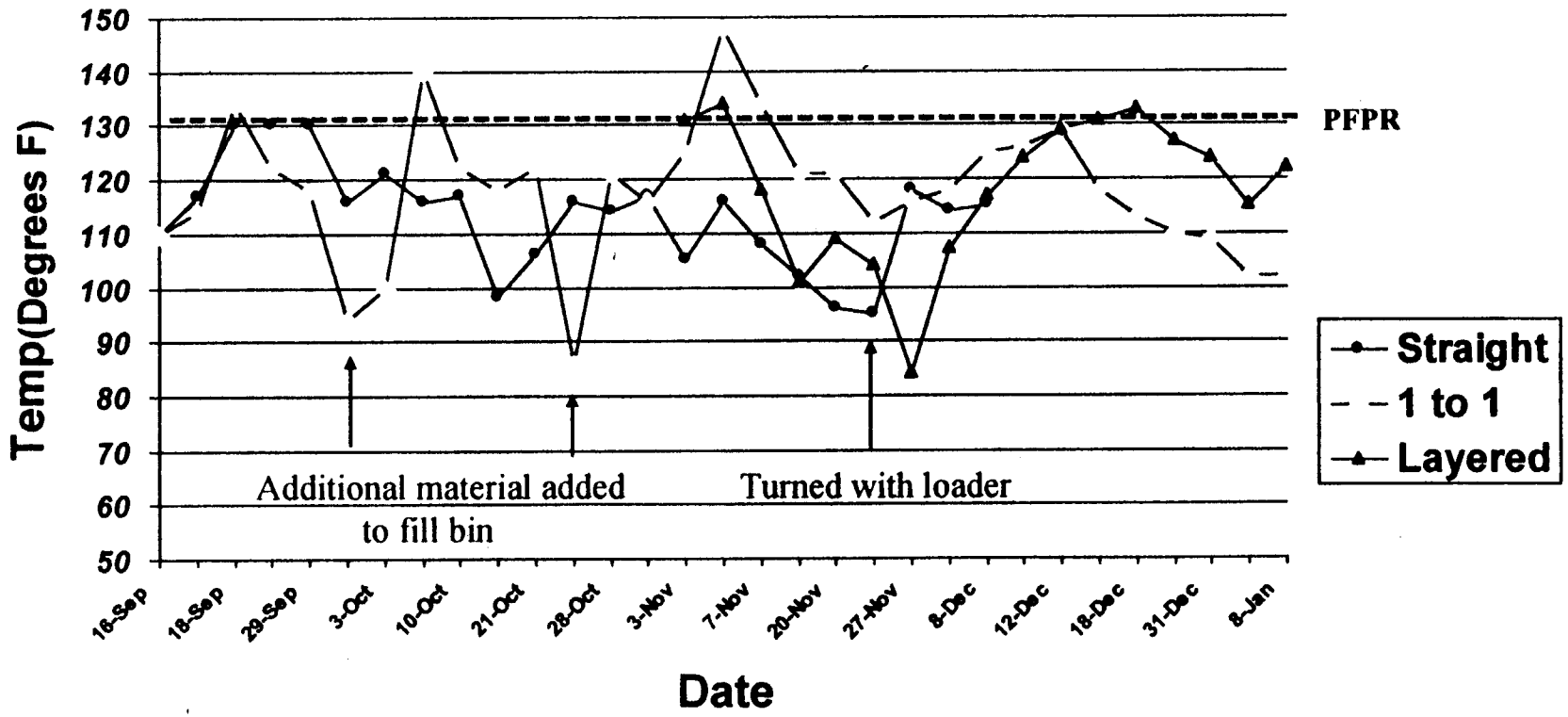
Fig. 1. Northpork Swine Wastewater Compost Temp. Regime