

The Effects of Wastewater Treatment Sludge on the Decomposition of Yard Waste

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ABSTRACT

Composting is used to describe the biological anaerobic auto-heated decomposition and transformation process of organic material (Ylva). The desired operating temperature for composting ranges from 50 degrees to 70 degrees Celsius. The temperature is important because it describes different phases of the composting processes (Ylva). Decomposition rate drops if the bacteria deplete the nitrogen. Adding sludge to compost piles provides nutrients such as phosphorus, potassium, and most importantly nitrogen. This experiment consisted of six compost piles. Two piles received 1,300 gallons of sludge. Two piles received 1,900 of sludge, and two piles were used as a control. No sludge was applied to the control group. Temperatures and carbon dioxide readings were taken approximately every three days. The results revealed that compost pile temperatures were higher in the sludge-applied piles. Temperatures and carbon dioxide readings rose in the first week and stayed at constant readings about four weeks.

INTRODUCTION

Compost piles are composed of branches, trees stumps, leaves, flowers and broken hay bales (Hawk). Composting is used as a recycling tool and provides fertilizer for gardens and crops. Composting is used to describe the biological anaerobic auto-heated decomposition and transformation process of organic material (Ylva). The desired operating temperature for composting ranges from 50 degrees to 70 degrees Celsius (Ylva). The temperature is important because it describes different phases of the composting processes (Ylva). The process is performed by microorganisms such as bacteria, fungi and actinomycetes (Ylva). As compost decomposes, bacteria growth increases and the levels of nitrogen decrease through the bacteria's consumption. It is suggested by Coyne that if more nitrogen was introduced into the compost piles, then bacteria would have more to feed on building their amino acids and protein levels, and finally increasing the decomposition rate. This nitrogen could be introduced through liquid sludge.

Sludge produced by the McPherson Wastewater Treatment Plant, McPherson, Kansas is classified as Class B (Gorszcyk). Class B sludge is limited by the EPA to have less than two million colonies of Coliform bacteria per one hundred milliliters. Seven samples of sludge are taken quarterly and analyzed, to find trace metals, nutrients, and bacteria levels. Adding sludge to compost piles provides nutrients that are unavailable in the amount needed to decompose compost piles. Microbes decompose plants and vegetation (Coyne). The decomposition produces bacteria growth but the bacteria need nitrogen. With more bacteria there is less nitrogen available.

The decomposition rate drops if the bacteria deplete the nitrogen. Adding sludge supplies important fertilizing nutrients such as phosphorus, potassium, and most importantly nitrogen. Sludge is suspected to increase the decomposition rate by providing a better

living environment for the bacteria (Coyne). If the bacteria are well fed, the heat will rise and the compost will break down.

Composting reduces the bulk, improves physical characteristics and makes the material easier to handle. Also it reduces land use for landfills and for surface application of waste (Coyne). The purpose of this project was to determine the effects of wastewater treatment sludge on the decomposition of yard waste.

MATERIALS AND METHODS

The EPA requires monitoring of municipal sludge. Testing is required quarterly. Test results on sludge from the McPherson WasteWater Treatment Plant in milligrams per liter were as follows: arsenic 1, cadmium 0.3, chrome 53.7, copper 60.6, lead 3.5, mercury 0.1, molybdenum 4.3, nickel 4.0, selenium 1.0 and zinc 43.5. Nutrient levels are also analyzed. Results in milligrams per liter were as follows ammonia 780, nitrate 1, total Kjeldahl nitrogen (TKN) 3,190, total phosphorus 1,200, available phosphorus 810, total potassium 430, available potassium 122.4, nitrogen 919, and available organic nitrogen 723 (Gorszcyk).

Six compost piles each were constructed. The compost piles were composed mainly of leaves, branches and hay. Each pile was five feet tall, ten feet wide and fifty feet long. Two piles had a low-level (1,300 gallons) of sludge applied. Two piles had a high level (1,900 gallons) of sludge applied. Two control piles were used to compare the decomposition rate between non-sludge compost and sludge-applied compost.

The compost piles were laid with a compost turner. The turner controlled the volume of each pile. The sludge was provided by the McPherson Wastewater Treatment Plant and brought to the site by tractor with a sludge tank attached. The tank held 4,000 gallons of sludge.

By monitoring the temperature and carbon dioxide levels it is possible to judge the bacteria growth. An increase in temperature and carbon dioxide means an increase in bacteria growth and decomposition. A carbon dioxide tester was used to find carbon dioxide levels. A thirty-six inch thermometer was used to take the temperatures. The compost piles were established October 27, 2000. The first application of sludge was October 31, 2000. Another sludge application occurred November 14, 2000. The high level piles received a total of 2,000 gallons each. They were the only two piles retreated with sludge. The temperatures and carbon dioxide measurements were taken every day for the first two weeks then every three days until

Table 1. Average temperature and carbon dioxide readings.

Week	High Sludge	CO ₂	Low Sludge	CO ₂	Untreated	CO ₂
1	118.80	3.800	112.80	2.500	88.60	0.900
2	119.60	1.500	115.50	2.100	104.60	0.900
3	120.40	3.000	108.50	1.250	89.90	0.000
4	124.00	3.100	122.30	2.750	98.50	0.375
5	94.20	0.942	93.60	0.000	85.50	0.000
6	63.60	0.330	63.10	0.000	54.80	0.000
7	72.25	0.000	65.50	0.000	34.00	0.000
8	32.50	0.000	22.50	0.000	20.00	0.000

December 31, 2000. The project began on October 31, 2000 and ended on December 31, 2000.

RESULTS

The compost pile temperatures revealed higher temperatures in the sludge-applied piles. Temperatures of the piles ranged from 70 to 82 degrees Celsius. After application of sludge temperatures rose over 30 degrees Celsius. Temperatures of sludge treated piles ranged from 116 to 124 degrees Celsius. It took one day for the temperatures to rise. The control group was 70 degrees Celsius and after a day of sitting rose to 82 degrees Celsius (Table 1).

Carbon dioxide readings also rose. Before sludge application the piles were at 0 percent. On the second day carbon dioxide readings rose to between one and six percent in the sludge treated piles. The control groups stayed at zero (Table 1).

During the first four weeks of the experiment the sludge treated piles ranged as high as 120 to 138 degrees Celsius. These temperatures represent all four sludge treated piles. The control group ranged from 90 to 112 degrees. There were noticeable differences between the sludge treated (ST) piles and controls (Table 1).

In addition carbon dioxide readings also varied from the beginning to end of the study. Carbon dioxide

readings in the sludge treated groups ranged from 0 to six percent. The control group readings ranged from 0 percent to four percent carbon dioxide (Table 1).

The last four weeks temperatures and carbon dioxide readings began dropping in both groups. The temperatures of sludge treated ranged from 40 to 92 degrees Celsius. The control group temperatures ranged from 19 to 68 degrees Celsius. Carbon dioxide dropped in both the control and ST piles. In both groups the carbon dioxide readings were at zero (Table 1).

The end temperatures in the sludge treated piles averaged 25 degrees Celsius with carbon dioxide readings at 0 percent. The control groups were also low at 20 degrees and 0 percent carbon dioxide (Table 1).

DISCUSSION

The success of this experiment provides a more efficient way to compost, helping to reduce waste. The Wastewater treatment plant has an over abundance of sludge. This would give them an outlet to use it. The McPherson Solid Waste plant has adopted a recycling program including composting in large quantities. If successful the McPherson Solid Waste Plant will have an outlet to discharge more sludge.

The main objective of this study was to speed up the decomposition rate and turn each pile over faster. Most composting piles take about eight weeks to turn over without sludge applications. When adding the sludge my main objective was to decrease the time needed to about six weeks. Secondly to have a higher and more constant temperature in the piles where sludge was added. At the end of my experiment only one of these two objectives was accomplished. The temperatures in the sludge treated group stayed between ten and twenty degrees higher than the control. The time it took to turn over didn't decrease very much.

The piles had not completed decomposing. Instead they had dropped down to temperatures as low as 20 degrees Celsius on the sludge applied piles and 19 degrees Celsius on the control group. These temperatures occurred due to the low air temperatures. When the experiment began daily temperatures were as high, as 21 degrees Celsius. Kansas had a harsh winter and the temperatures fell on December 8, 2000 to as low as -12 degrees Celsius. These air temperatures made it very difficult for the piles to generate heat. Due to the air temperatures the piles regardless of sludge application temperatures dropped and so did activity in the piles. It is my opinion that this experiment if repeated during spring or summer would be very successful and worthwhile. Temperatures would be higher and more constant, thus the piles would decompose at a more rapid rate. We were not able to keep temperatures above 124 degrees Celsius for seven days to classify it as Class A sludge, which would have enabled use of the compost by the public. The compost will be disposed of by adding it to the

landfill as a cover.

ACKNOWLEDGEMENTS

Thank you to John Hawk, Darin Klingensmith and Rick Kleinschmidt at the McPherson Solid Waste Utility for providing a facility, equipment and extensive knowledge in composting.

I would also like to thank Steve Gorszyk, Mike Wagner, Dale Vanderhoof and Eddie Bonham at the McPherson WasteWater Treatment Plant for providing municipal sludge and information on the contents of the sludge. Also for the usage of their time, equipment and knowledge involving sludge

I would like to thank Alfred Dutrow for his help in writing, editing, advisement and knowledge. Lastly Jonathan Frye for helping design and organize my senior research project. He also provided me with connections to the McPherson Solid Waste Utility and WasteWater Treatment Plant.

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