Report for 2003DC35B: Effect of Pelletized Poultry Manure on Vegetable Production and Vadose Zone Water Quality

Publications

- There are no reported publications resulting from this project.

Report Follows

Effect of Pelletized Poultry manure on Vegetable Production and Vadose Zone Water Quality

Annual Progress Report for FY 2005

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Effect of Pelletized Poultry manure on Vegetable Production and Vadose Zone Water Quality

Introduction

Poultry produced from the Delaware, Maryland, and Virginia (DELMARVA) poultry industries in applied on farmland along with chemical fertilizer for crop production. However, a significant amount of unused manure is stored for future usage or remains to be disposed of. Perdue AgriRecycle Inc. has cleaned, sterilized, and pelletized poultry manure for easy handling and movement in crop and vegetable production. This material has been analyzed for nutrient content; however, not much data is available to demonstrate its effectiveness in crop and vegetable production as well as its effect on ground water quality or pfeisteria proliferation. Residents of Washington DC grow vegetables in their backyard and could potentially use this material as a soil amendment. Therefore, this experiment is designed to determine the effectiveness of pelletized poultry manure as a soil amendment in vegetable production and its potential effect on DC water resources. Information generated will be used for extension and outreach to benefit the residents of Washington DC. This project will impact both our sustainable agriculture project of recycling waste as a soil amendment and our efforts in enhancing environmental quality.

The Chesapeake Bay Agreement signed by leaders of Delaware, Maryland, Washington DC, and Virginia promises a 40% reduction in the Bay's nitrogen and phosphorus level by the year 2010. This reduction campaign was initiated particularly because of a chemical fertilizer and poultry manure in crop production areas. Eutrophication, caused by excess nitrogen and phosphorus, has also reduced the Bay's sub-aquatic vegetation significantly. The most recent Chesapeake Bay report, July 2002, indicates no improvement in the Bay's water quality. On a scale of 100, the Bay's environmental quality was graded as 27, which is extremely low. In fact, this grade did not change from the previous year regardless of clean up efforts.

Objectives:

1. To determine the extent to which pelletized poultry manure affects water quality when used as a soil amendment in growing vegetables.
2. To determine the feasibility of using pelletized poultry manure as a substitute for commercial fertilizer in the growing of vegetables in urban areas.

Progress Toward Achieving Objective 1

To achieve experimental objectives, an experimental plot has been established with soil of silt loam. The experimental design is a randomized block with three replications per treatment. This design has six blocks with each block representing one of six treatments. This six treatments being used are:

1. 2,000 kg ha^{-1} of chicken manure pellets + 500 kg ha^{-1} of commercial fertilizer (10-10-10).
2. 500 kg ha^{-1} of commercial fertilizer (10-10-10) only.
3. 1,000 kg ha^{-1} of chicken manure pellets + 500 kg ha^{-1} of commercial fertilizer (10-10-10).
4. 2,000 kg ha^{-1} of chicken manure pellets.
5. 1,000 kg ha^{-1} of chicken manure pellets.
6. No chicken manure pellets or commercial fertilizer. (Control or check plots).

In the experimental design, main plots are the six above named treatments and the crop varieties are butterbeans and collards as subplots. After clearing seed beds of surface debris, chicken manure pellets were added by broadcasting over the field surface with a manually operated garden seed spreader. Each main plot is 60ft. x 15ft. and subplot 15ft. x 10ft.

After treatments were added (Nov 20, 2004), two lysimeters were added to sample the water of vadose layer in each main plot at the distance of 20ft. apart. These lysimeters were each placed at two different depths, one 18 inches and the other 36 inches (Figs. I, II, III). The lysimeters installed were model 1920 FI pressure/vacuum soil water sampler. Each lysimeter at the 36 inch depth had a 1.5ft. long PVC pipe 1.5 inches in diameter. They both had a 2 bar porous ceramic cup at the bottom end and two ¼ inch tubes protruding from the top (area about one foot above the soil surface) which was otherwise sealed. One of the tubes is connected to a 2006 G2 pressure/vacuum hand

Figure I. **Lysimeters being installed in the poultry pellet amended plot by William Hare and James Allen.**

Figure II. **Lysimeter in place at a depth of 18 inches.**

pump which will be used to collect water samples. The lysimeters were put in place on November 20, 2004.

Figure III. Lysimeter placement at the experimental site being reviewed by James Allen.

To protect the field from erosion, and ordinary cover crop variety of rye was broadcasted on the field plot at about a rate of four bushels per acre. They were planted on December 10, 2004 and the field plot is now well covered with the rye vegetation.

Water sampling of the Vadose layer of each plot will begin in mid-January, 2005 and continue on a regular basis from that time onward. Collards were planted from seedlings on April 15, 2005 and butterbeans from seeds on the same date. The two crop varieties will be planted in each main plot. These main plots will each have six subplots 15ft. x 10ft. with 36 inches wide rows. Collards were planted 18 inches apart within rows from seedlings approximately 4.0 inches high while butterbeans will be planted from seeds within rows about 12 inches apart. During the growing season plots were kept well cultivated with the use of a garden cultivator or by hoeing.

Data collected during the growing season were Vadose water samples at 18 in. and 36 in., soil bulk density, soil porosity, seed yield of butterbeans and biomass data of both butterbeans and collards. Vadose water samples were be analyzed for nutrients such as phosphorus, nitrogen and heavy metals where feasible. Data collected will be statistically analyzed, using the analysis of variance (ANOVA) to correlate the amount of chicken pellet manure added to crop yield and water quality (amount of the above named chemicals in the soil water samples).

Research findings will be communicated by paper presentations in professional meetings and the publications of journal articles.

<u>Progress Towards Achieving Objective 2</u>

Experimental plots seeded to rye as a cover crop in November, 2004 are now well covered with lush vegetable growth (Fig. I). Soil samples were taken from experimental plots on April 26, 2005. Sampling techniques included the following:

a) Sampling at depths 0-6", 6-12" and 12-18".
b) The field was divided into sections and duplicate soil samples were taken from each treated section in order to increase accuracy of analysis. (Figs. IV, V, VI, VII, VIII, IX).

Figure IV. Experimental plots covered with rye showing early lush spring growth.

Soil samples are now being air dried and will be sent to analytical labs for analysis to determine concentration of N, P and organic matter (OM) content of the soil given the palletized poultry manure compared to that amended with commercial fertilizer.

Figure V. **Student Assistant Raphil Billy take soil samples at the 0-6” depth.**

Figure VI. **William Hare taking soil sample at the 6-12" depth.**

Figure VII. **Soil samples being collected by researchers James Allen and William Hare.**

Figure VIII. **Soil Sample being examined before sent off to a laboratory for chemical analysis.**

Water samples from Lysimeters located in each treatment block at depths of 18 and 36". In addition to the N and P concentrations mentioned for the soil samples, the water samples will also be tested for coliforms.

Figure IX. **Student intern, Mary Farrah, taking water samples.**

Preliminary Results

Highest organic matter concentration was in plots given the highest rate of poultry pellets (Table I). The lowest concentration was in plots given 0.45 g/Kg of soil and no fertilizer. This may be explained by the fact that a cover crop of rye might not produce as

Table I. Nutrient accumulation in soil based on sample depth and application of poultry pellets.

Treatments & Application Rates	**Sample Depth** (in.)	**P** (kg/ha)	**K** (kg/ha)	**Mg** (kg/ha)	**Ca** (kg/ha)	**pHw**	**pHg**	**CEC**	**% OM**
1 Pellet: 2,000 kg/ha 10-10-10: 500 kg/ha	0-6	37.0	117	90.7	880	5.40	7.55	6.05	1.65
	6-12	4.48	58.2	76.2	670	4.95	7.55	5.45	–
	12-18	11.8	77.8	113	963	4.90	7.38	7.65	–
2 Pellet: 0 kg/ha 10-10-10: 500 kg/ha	0-6	23.0	95.8	86.8	861	5.30	7.58	5.65	1.50
	6-12	5.60	65.5	85.1	642	5.00	7.55	5.40	–
	12-18	3.36	71.1	104	766	4.85	7.43	6.75	–
3 Pellet: 1,000 kg/ha 10-10-10: 500 kg/ha	0-6	33.6	105	102	1,210	5.75	7.65	6.00	1.65
	6-12	5.04	97.3	101	882	5.35	7.60	5.60	–
	12-18	3.36	70.6	104	952	5.05	7.48	6.8	–
4 Pellet: 2,000 kg/ha 10-10-10: 0 kg/ha	0-6	65.5	110	113	2,103	6.45	7.70	7.60	1.60
	6-12	7.84	65.5	84.0	1,151	5.70	7.68	5.60	–
	12-18	3.36	77.8	102	1,075	5.20	7.50	6.85	–
5 Pellet: 1,000 kg/ha 10-10-10: 0 kg/ha	0-6	40.3	95.8	114	1,505	5.90	7.68	6.50	1.35
	6-12	5.60	77.8	128	1,084	5.35	7.58	6.65	–
	12-18	3.92	81.8	127	1,012	4.90	7.48	7.00	–
6 Pellet: 0 kg/ha 10-10-10: 0 kg/ha	0-6	37.5	104	123	1,558	5.95	7.70	6.45	1.50
	6-12	6.16	71.7	119	1,122	5.30	7.53	6.85	–
	12-18	3.92	89.0	116	1,041	4.85	7.43	7.45	–

Table II. Average nutrient accumulation in soil based on rates of application of poultry pellets.

Treatments & Application Rates	P (kg/ha)	K (kg/ha)	Mg (kg/ha)	Ca (kg/ha)	pHw	pHg	CEC	% OM
1 Pellet: 2,016 kg/ha 10-10-10: 448 kg/ha	17.7	84.2	93.3	838	5.08	7.49	6.38	1.65
2 Pellet: 0 kg/ha 10-10-10: 448 kg/ha	10.6	77.5	92.1	739	5.05	7.52	5.93	1.50
3 Pellet: 1,008 kg/ha 10-10-10: 448 kg/ha	14.2	79.2	103	1,015	5.38	7.58	6.13	1.65
4 Pellet: 2,016 kg/ha 10-10-10: 0 kg/ha	25.8	84.8	99.7	1,444	5.78	7.63	6.68	1.60
5 Pellet: 1,008 kg/ha 10-10-10: 0 kg/ha	16.8	85.5	123	1,244	5.38	7.60	6.72	1.35
6 Pellet: 0 kg/ha 10-10-10: 0 kg/ha	16.5	88.5	120	1,241	5.37	7.54	6.92	1.50

much organic as plants in the other plots. However, at this point we cannot say why concentration of 1.50% OM in the control (treatment 6 in Table I) was more than 1.35% OM found in treatment 5 (0.45 g/Kg and 0.0g/Kg).

As expected, the highest concentration of total phosphorous was found in plots given the highest rate of poultry pellets (0.9 g/Kg of soil). However, when treatments 1 and 4 were compared, it appears that the absence of 10-10-10 did contribute significantly to phosphorous accumulation. Nutrients K, Mg, and Ca were relatively lower in plots given treatment 1 and 2 and that may be due to the pH levels of 5.08 and 5.05 in these plots (Table I).

Water sampling was somewhat difficult due to low accumulation of water in the lysimeters. The poor accumulation may be due to low rainfall resulting in little soil moisture. Another factor that may have had an impact on soil moisture accumulation was the soil compaction or high bulk density of the soil. This may have caused a significant amount of the rain to runoff rather than percolate through the soil, resulting in soil water accumulation only after significant rain events.

Both nitrogen and total phosphorous concentration in the soil was highest in plots given the highest rate of poultry pellets and 10-10-10 fertilizer (Table II). However, treatment 5 had the highest rate of nitrate/nitrite. This result cannot be explained at this point since treatment 5 had only half as much of the pellet as treatments 1 and 4 (Table II), but both still accumulated more nitrate/nitrite.

Table III. Nitrogen accumulation in soil water.

Treatments	Sampling Date	Lysimeter Depth (in.)	NO_3^-/NO_2^- (mg N/L)	Total P (mg P/L)	Total Kjeldahl Nitrogen (mg N/L)	Total Nitrogen (mg N/L)
1: Pellet: 2,016 kg/ha 10-10-10: 448 kg/ha	5/25/05	18	0.80	1.20	—	—
		36	0.65	0.85	7.6	8.25
2: Pellet: 0 kg/ha 10-10-10: 448 kg/ha	5/25/05	18	—	—	—	—
		36	0.20	<0.10	1.65	1.85
3: Pellet: 1,008 kg/ha 10-10-10: 448 g/ha	5/25/05	18	<0.10	—	—	—
		36	0.35	0.20	0.80	1.15
4: Pellet: 2,016 kg/ha 10-10-10: 0 kg/ha	5/25/05	18	0.60	—	—	—
		36	0.10	0.35	5.25	5.35
5: Pellet: 1,008 kg/ha 10-10-10: 0 kg/ha	5/25/05	18	0.15	0.10	1.90	2.05
		36	1.90	0.30	3.50	5.40
6: Pellet: 0 kg/ha 10-10-10: 0 kg/ha	5/25/05	18	0.20	<0.10	—	—
		36	0.10	0.15	—	—

In water samples collected so far, the presence of fecal Coliform has been found only in plots receiving the highest rate of pellet application (Treatment 1), given 0.9 g/Kg of poultry pellets l and 0.2 g/Kg of 10-10-10. Lack of soil moisture and clay content of soil, resulting in low water accumulation in the lysimeters, may cause difficulty in sampling. In many cases, lysimeter water samples were so low that they could not be analyzed.

There was no yield data for limas and collard greens due to poor stands.

Table IV. Presence of fecal Coliform in soil water as related to application of composted poultry pellets.

Treatments	Rate of Amendment Application	Sampling Date	Sample ID	Total Coliform (P/A Colilert)	E. Coli (P/A Colilert)
1	Pellet: 0.9 g/Kg 10-10-10: 0.2 g/Kg	10/13/05	T1A18”	Present	Present
			T1A36”	Present	Present
			T1B18”	Present	Absent
			T1B36”	Present	Absent
2	Pellet: 0 g/Kg 10-10-10: 0.2 g/Kg	10/13/05	No Water in Lysimeter	–	–
3	Pellet: 0.45 g/Kg 10-10-10: 0.2 g/Kg	10/13/05	No Water in Lysimeter	–	–
4	Pellet: 0.9 g/Kg 10-10-10: 0 g/Kg	10/13/05	T4A18”	Absent	Absent
			T4A36”	Present	Absent
			T4B18”	Absent	Absent
			T4B36”	Present	Absent
5	Pellet: 0.45 g/Kg 10-10-10: 0 g/Kg	10/13/05	No Water in Lysimeter	–	–
6	Pellet: 0 g/Kg 10-10-10: 0 g/Kg	10/13/05	T6A18”	Absent	Absent
			T6A36”	Absent	Absent
			T6B18”	Present	Absent
			T6B36”	Present	Absent

PLANS FOR FY 2006-2007

1. Yield data will be collected from the two test crops, sweet corn and lima beans. Harvesting of sweet corn and of lima beans is expected to occur by the end of July. Data to be collected and analyzed will be exclusively fresh market sweet corn and lima beans.
2. Water samples will be taken when significant rain events permit during the year. Soil sampling may be done before planting. Both water and soil sampling will be done again at the end of August when harvesting is expected to be ended.
3. In the fall of 2006, plots will be lightly disked and poultry pellets will be added prior to crop planting. The amount to be added will double based on preliminary soil and water test results.
4. Soil and water sampling data will be analyzed statistically and correlated to fresh weight of marketable yield of sweet corn and lima beans to determine how well

the pelletized poultry manure does as a soil amendment in the growing of fresh vegetables.

5. As mentioned before, in the fall, plots will again be seeded to cover crop rye.
6. All fresh market yield and soil and water analytical data will be analyzed using ANOVA along with appropriate test of significance techniques.
7. Test crops for FY 2006-2007 will be changed to sweet corn and lima beans. To further institute a rational rotation system, the crops will be changed to sweet corn and black-eyed peas in FY 2007-2008.