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RETENTION OF NITROGEN AND PHOSPHOROUS FROM LIQUID SWINE AND POULTRY MANURES USING HIGHLY CHARACTERIZED PEATS

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ABSTRACT

This paper reports on research designed to test the hypothesis that differences in peat composition will cause differences in amounts of N and P retained during contact with liquid swine manure (LSM) and liquid poultry manure (LPM). Peat types representing a wide range of properties were tested in order to establish which chemical and physical properties might be most indicative of their capacities to retain N and P from LSM and LPM. Eight-percent slurries (peat/LSM and peat/LPM) were measured for total nitrogen (TKN) and total phosphorous (TP) after 6, 24 and 96 hours. Tests were done to determine the TKN and TP contents of these peats, the LSM, and the LPM, both before and after they were mixed together.

The N and P retention results revealed that most peats worked reasonably well at retaining N and P from either LSM or LPM. However, some peats were more effective than others. These peats also decreased the N and P levels in the liquid portion of the LSM. Peats with higher N retention capacities tended to have lower ash contents, but higher macroporosities and total cellulose contents. Peats with higher P retention capacities tended to

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have lower bulk densities, ash contents, total guaiacyl lignins contents, fulvic acids contents, but higher microporosities, macroporosities, H contents, and total cellulose contents. Peats with higher N and P retention capacities also had humic acid contents between 5–7%. The results of this study suggest that if these peats are used to reduce odors and N and P contamination, possible byproducts could be the production of odorless fertilizers.

Key Words: Peat; Swine; Poultry; Nitrogen; Phosphorous

INTRODUCTION

Nutrients derived from swine and poultry manures can be potential environmental contaminants. Factory size swine and poultry farms produce large quantities of liquid swine manure (LSM) and liquid poultry manure (LPM). In addition to causing severe odor problems and posing the risk of transmitting disease, these manures have high Nitrogen (N) and Phosphorous (P) contents which can pollute local water supplies. The most direct method of contamination occurs as a result of applying the manures as fertilizers.

Most of the literature on this subject focuses on the problem of high N content. Although some of this literature deals with preventing N pollution caused by LSM and LPM, the majority of it is concerned with preventing N loss, caused mainly by ammonia volatilization. Manures are a valuable source of N, but their value is affected by significant losses of N due to volatilization of ammonia.[1–4] Both LSM and LPM are highly susceptible to N loss through ammonia volatilization. Ammonia volatilization in manures can exceed 50% of the total N content because ammonification occurs throughout the entire manure handling process.[5,6] Various organic and inorganic amendments have been studied as possible solutions to the problem. Witter and Kirchmann[7] found that *Sphagnum* moss peat was better at reducing ammonia losses from poultry manure than zeolite or basalt. A study done by Mahimairaja et al.[8] concluded that wheat straw and peat were superior to wood chips or paper waste in reducing ammonia loss. Al-Kanani et al.[9] found that *Sphagnum* moss peat was better at reducing ammonia loss in LSM than the other amendments that were tested (sulfuric acid, phosphoric acid, monocalcium phosphate monohydrate, elemental S, and calcium carbonate). A study by Barrington and Moreno[10] confirmed the results of the other studies by once again finding that *Sphagnum* moss peat worked well at reducing ammonia volatilization.

Regarding the problem of the high P content associated with LSM and LPM, very little research has been done. Lindemann and Cromwell[11] found that changing swine diets to reduce P levels in manure does show some promise. However, the authors state that, for female swine intended for breeding, more research is needed because mineral reductions may have long-term impact on longevity and reproductive performance. A study by Canizares-Villanueva et al.,[12] found that *Phormidium sp.* grown in anaerobically digested LSM can aid in reducing P levels. Some studies have determined that peat soils work fairly well at taking up or removing P.[13,14] Although this is so, both studies indicate that these soils are limited as to how much P can be sorbed at once or over time. In addition, other studies have stated that peat-containing wetlands are not very good at sorbing P, due to low levels of inorganic minerals capable of sorbing P.[15,16] The Heikkinen study[16] stated that the ability of the peat to retain P increased with increasing concentrations of oxalate extractable Fe and Al. A study done by James[15] showed that P sorption by peat and sand increased when amended with iron oxides or steel wool. Overall, the existing literature tends to suggest that peat is more effective at sorbing N than P.

In nearly all of the previous studies, only *Sphagnum* moss peat was tested. Although *Sphagnum* peat is available commercially in many parts of the country, it is not necessarily the indigenous or cheapest peat type in regions where swine or poultry production is common. In North Carolina, for example, where swine production has increased dramatically in recent years, many kinds of peat are found. However, *Sphagnum* moss peat is not a particularly common one of these.[17,18] Additionally, previous studies with a variety of other contaminants have shown that the type of peat used can strongly affect its sorption/desorption properties (e.g., gasoline-derived hydrocarbons,[19–25] metals,[20,22,25–27] nitrates,[21,27] and odorous LSM compounds[28,29]).

Thus, the primary objective of this study was to test the hypothesis that differences in peat composition will cause differences in amounts of N and P retained during contact with LSM and LPM. A secondary objective was to assess the effect of contact time on the amounts of this retention.

MATERIALS AND METHODS

Selection of Peat Samples

The University of South Carolina's Department of Geological Sciences has a unique collection of peat samples, which consists of a large assortment of bulk samples of natural peats from various parts of the United States. Representative splits of these samples have already been analyzed in great detail for their chemical, physical, and biological properties.[30] Some of these measured properties include: 1) porosity (micro-, macro-, and total); 2) hydraulic conductivity; 3) water-holding capacity; 4) fiber content; 5) bulk density; 6) pH; 7) carbon, hydrogen, oxygen, nitrogen, chlorine, and sulfur; 8) major and trace element inorganic content and mineralogy (by INAA, XRF, and XRD); 9) botanical composition; 10) organic chemical compounds by chemical fractionation and combined pyrolysis GC/MS and pyrolysis GC/FT-IR/FID analysis; and 11) proportions and types of humic and fulvic acids. Selections of these peat samples have been used in the past by us for various sorption/desorption experiments, including experiments on gasoline-derived hydrocarbons,[19–25] metals,[20,22,25–27] nitrates,[21,27] and odorous LSM compounds.[28,29]

The advantage of using these highly characterized samples over peat samples tested by others is that, at minimal expense, the results of our odor tests can be correlated with the already known compositional properties of these peats to determine: 1) which parameters are most likely to be controlling our results and 2) more importantly, which parameters can be used by us or by others to predict whether a particular untested peat from some other part of the country, or some other type of material with similar parameters, would be good candidates for this kind of use.

Table 1. Peat Samples Used in Our Studies

Sample Designation	ASTM Classification #D4427-92	Location	Dominant Botanical Components
Maine *Sphagnum* peat	Fibric	Maine	*Sphagnum*
Loxahatchee *Nymphaea* peat	Hemic	Loxahatchee Wildlife Refuge, FL	*Nymphaea* (water lily) and *Sagittaria* (arrowhead)
Loxahatchee Sawgrass peat	Hemic	Loxahatchee Wildlife Refuge, FL	Grass-sedge, *Sagittaria* and *Nymphaea*
Minnesota Hemic peat	Hemic	Minnesota	Spruce and woody dicot
Okefenokee *Nymphaea* peat	Hemic	Okefenokee Swamp, GA	*Nymphaea*, *Sagittaria*, and grass-sedge
Shark River (*Rhizophora*) peat	Hemic	Everglades National Park, FL	*Rhizophora* (red mangrove)
New York peat	Sapric	Fort Drum, NY	Spruce, woody dicot and fern
North Carolina peat	Sapric	First Colony Farms, NC	*Persea*, woody dicot, grass and fern
Okefenokee *Taxodium* peat	Sapric	Okefenokee Swamp, GA	*Taxodium* (cypress) and *Persea* (bay)
Snuggedy Swamp peat	Sapric	Snuggedy Swamp, SC	*Myrica*, *Persea*, and *Lyonia*

For this study, ten different peat types were tested. These were designated Maine *Sphagnum* peat, Loxahatchee *Nymphaea* peat, Loxahatchee Sawgrass peat, Minnesota Hemic peat, Okefenokee *Nymphaea* peat, Shark River (*Rhizophora*) peat, New York peat, North Carolina peat, Okefenokee *Taxodium* peat, and Snuggedy Swamp peat. These peats were selected because they represent a wide range of physical and chemical properties (Table 1).

Collection of LSM

LSM was collected at a commercial nursery-pig farm in North Carolina from the effluent being flushed into a holding lagoon from a hog barn. The LSM was then stored in a refrigerator at 4°C prior to use. It had a pH of approximately 7.0 and its total solids measured 0.25%. This undiluted LSM was used as the standard in all tests.

Collection of LPM

LPM was collected at a commercial egg-producing hen farm in South Carolina from the effluent being flushed into a holding lagoon from a hen barn. The LPM was then stored in a refrigerator at 4°C prior to use. It had a pH of approximately 8.0 and its total solids measured 1.1%. This undiluted LPM was used as the standard in all tests.

Laboratory Methods and Experimental Design

LSM study

The 10 peat types used in this study were slurried with LSM for 6, 24 and 96 hours and compared with a standard consisting of LSM without peat addition. Eight-percent slurries were prepared by combining 3.73 grams (dry weight—using wet weight equivalent) of peat with 53.3 grams of LSM in 150ml polyethylene vials. The vials were sealed, and shaken vigorously by hand for approximately one minute. These vials were then left undisturbed for 24-hours. After this time period, the samples were centrifuged for 30 minutes at 2000 rpm. Solid and liquid samples were then separated and sent to the USDA-ARS in Florence, SC for analysis. These samples were analyzed for total nitrogen (TKN) and total phosphorus (TP) using a Technicon Auto Analyzer II. The method used to do these analyses was Technicon Method No. 334-74W/B.

LPM study

In this study, the same 10 peat types were slurried with LPM for 24 and 96 hours and compared with a standard consisting of LPM without peat addition. Procedures and analytical methods used in the LSM study were repeated in this section.

RESULTS

LSM Study Results

The results from this study are shown in Table 2. This data represents both the solid sample results, and the results for the residual liquid samples. For both sets of data, the amount of contact time (6, 24, or 96 hours) appears to have had no significant effect on the amount of N and P retained by the peats tested. One possible explanation for this could be that all ten peats reached their maximum N and P sorption potential quickly and could not retain any more N or P. Another possibility could be that all ten peats quickly sorbed certain forms of N and P and were not capable of sorbing the remaining forms of N and P. The answer to this question may determine how effective and how long these peats could be used for fertilizer purposes. Data from all three contact times (6, 24, or 96 hours) were averaged for all samples. These average numbers are used for discussion and evaluation throughout this paper.

Solid Sample Results

The results for the solid samples (Table 2) indicate that nine out of the ten peats (Loxahatchee *Nymphaea*, Loxahatchee Sawgrass, Maine *Sphagnum*, North Carolina, New York, Okefenokee *Nymphaea*, Okefenokee *Taxodium*, Shark River, and Snuggedy Swamp) retained small to significant amounts of N (from New York at 19% to Maine *Sphagnum* at 105%), while one peat (Minnesota Hemic) retained and lost very small

Table 2. TKN and TP Results for Peats in Contact with LSM and LPM (Results Represent Both Solid and Residual Liquid Samples)

Peat Sample	TKN% Increase (LSM, Solid)	TKN% Decrease (LSM, Liquid)	TP% Increase (LSM, Solid)	TP% Decrease (LSM, Liquid)	TKN% Increase (LPM, Solid)	TP% Increase (LPM, Solid)
Maine *Sphag.*						
6 hrs.	103	65	1600	−2		
24 hrs.	107	70	1500	8	103	1400
96 hrs.	104	75	1600	−1	85	1600
Average	105	70	1567	2	94	1500
Snug. Swamp						
6 hrs.	77	52	1600	10		
24 hrs.	87	52	1700	13	89	1900
96 hrs.	78	45	1600	14	78	1700
Average	81	50	1633	12	84	1800
North Car.						
6 hrs.	75	26	1300	−34		
24 hrs.	77	28	900	−27	95	1300
96 hrs.	74	28	1200	−38	82	1300
Average	75	27	1133	−33	89	1300
Lox. *Nymph.*						
6 hrs.	62	47	1250	22		
24 hrs.	57	46	950	34	37	1100
96 hrs.	54	54	900	17	40	900
Average	58	49	1033	24	39	1000
Oke. *Nymph.*						
6 hrs.	46	55	1000	23		
24 hrs.	46	57	600	23	20	750

96 hrs.	40	61	650	13	39	900
average	44	58	750	20	30	825
Lox. Sawgrass						
6 hrs.	28	46	1000	37		
24 hrs.	42	51	1050	35	7	100
96 hrs.	40	53	1000	28	16	1200
average	37	50	1017	33	12	1100
Shark River						
6 hrs.	38	32	256	13		
24 hrs.	40	34	233	17	9	189
96 hrs.	34	29	200	19	20	189
average	37	32	230	16	15	189
Oke. *Tax.*						
6 hrs.	24	46	120	5		
24 hrs.	22	48	110	11	14	110
96 hrs.	24	52	80	−4	17	120
average	23	49	103	4	16	115
New York						
6 hrs.	3	47	171	35		
24 hrs.	25	53	243	48	20	271
96 hrs.	30	53	243	38	14	243
average	19	51	219	40	17	257
Minn. Hemic						
6 hrs.	−16	40	200	22		
24 hrs.	10	46	283	35	−8	333
96 hrs.	6	52	267	26	−10	300
average	0	46	250	28	−9	317

amounts of N. All ten peats retained significant to very significant amounts of P (from Okefenokee *Taxodium* at 103% to Snuggedy Swamp at 1633%).

Residual Liquid Results

The results for the residual liquid samples (Table 2) indicate that all ten peat samples removed significant amounts of N (from North Carolina at 27% to Maine

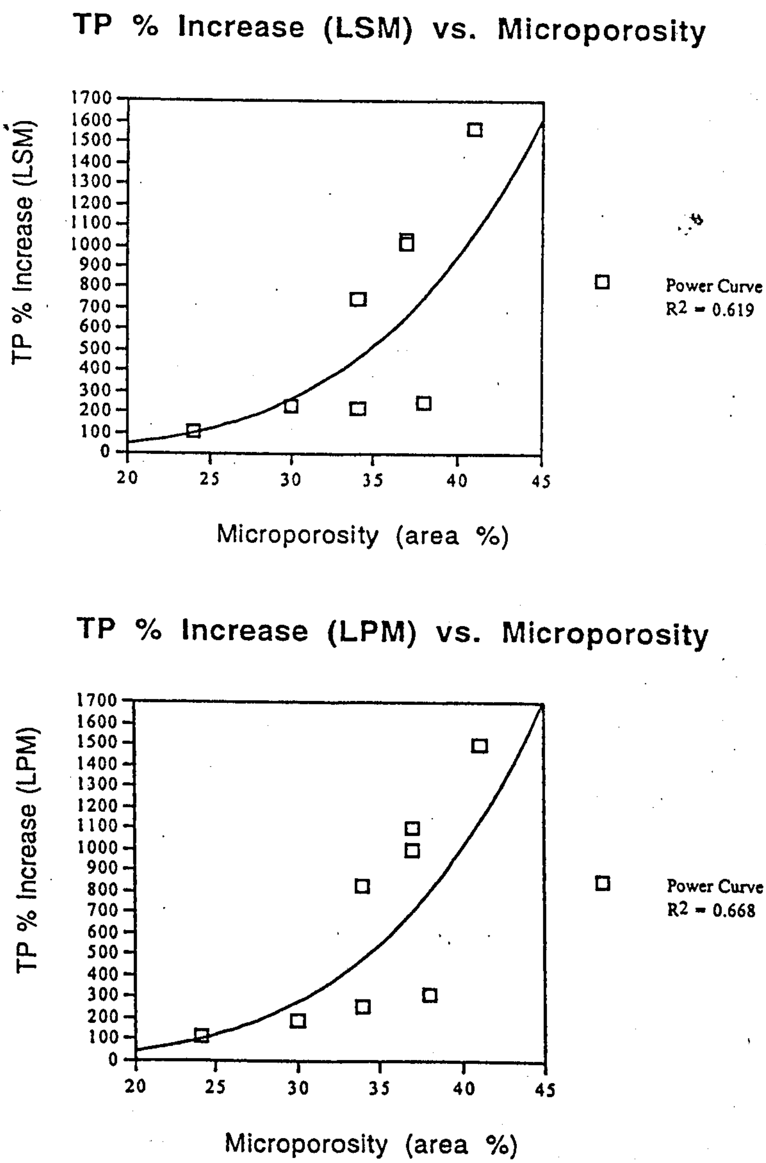


Figure 1. TP% increase (using LSM and LPM) vs. microporosity.

Sphagnum at 70%) from the liquid portion of the LSM. In addition, seven of the ten peats tested (Loxahatchee *Nymphaea*, Loxahatchee Sawgrass, Minnesota Hemic, New York, Okefenokee *Nymphaea*, Shark River, and Snuggedy Swamp) removed fair amounts of P from the liquid LSM (from Snuggedy Swamp at 12% to New York at 40%), while two of the peats (Maine *Sphagnum* and Okefenokee *Taxodium*) both increased and removed small amounts of P from the liquid LSM. The North Carolina peat added to the amounts of P in the liquid LSM by a fair margin (33%). One interesting fact about these results is that the amount of N and P retention in the LSM

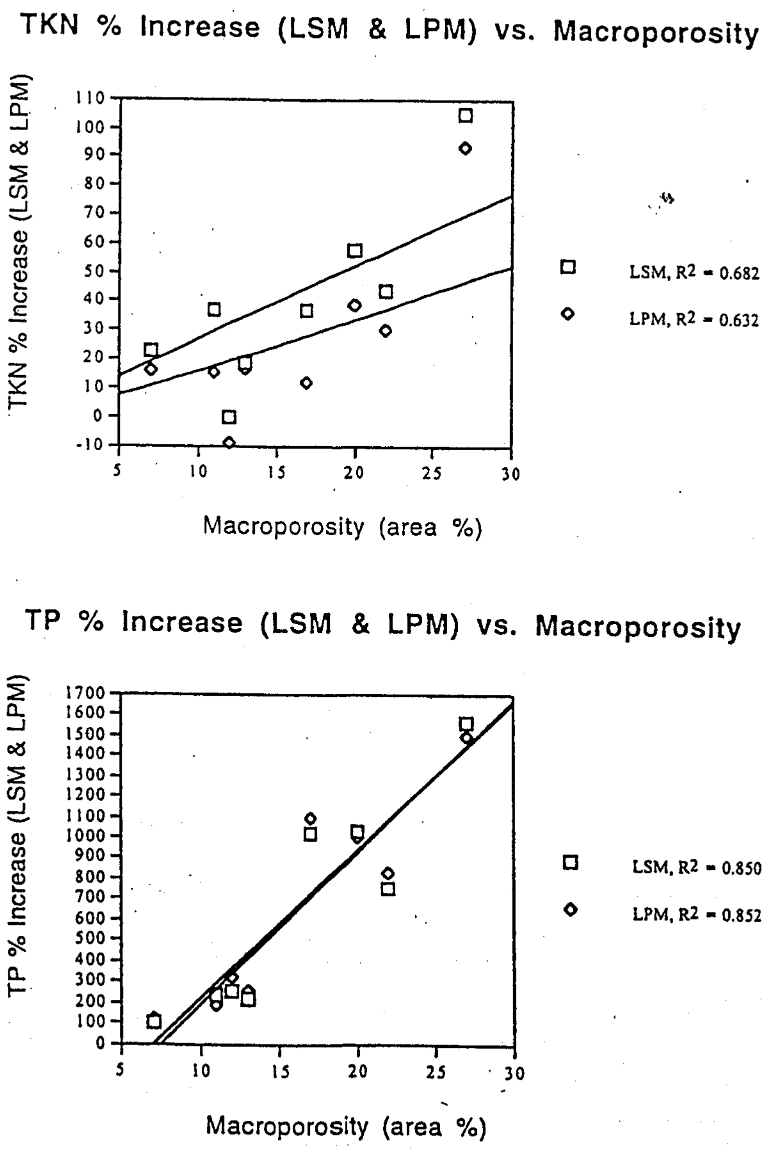


Figure 2. TKN and TP% increase (using LSM and LPM) vs. macroporosity.

solid peat samples does not equal the decrease in N and P in the residual liquid. This is especially true for P. One explanation for this is that most of the P and some of the N found in LSM may be contained within the very small total solids portion of this manure (0.25%).

LPM Results

The results from this study are listed in Table 2. In this study, only solid samples were tested (solid treated peats and the same solid peats in their untreated states). As in the LSM study, the amount of contact time (24 or 96 hours) appears to have no significant effect on the amount of N and P retained by the peats. Thus, data from both

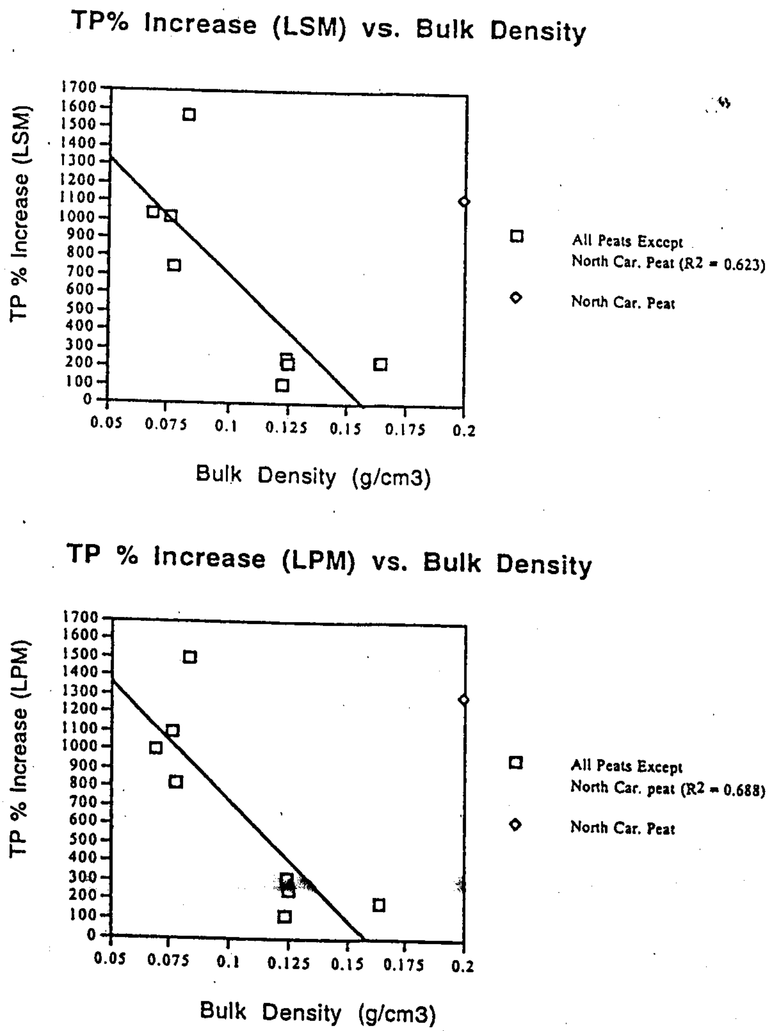
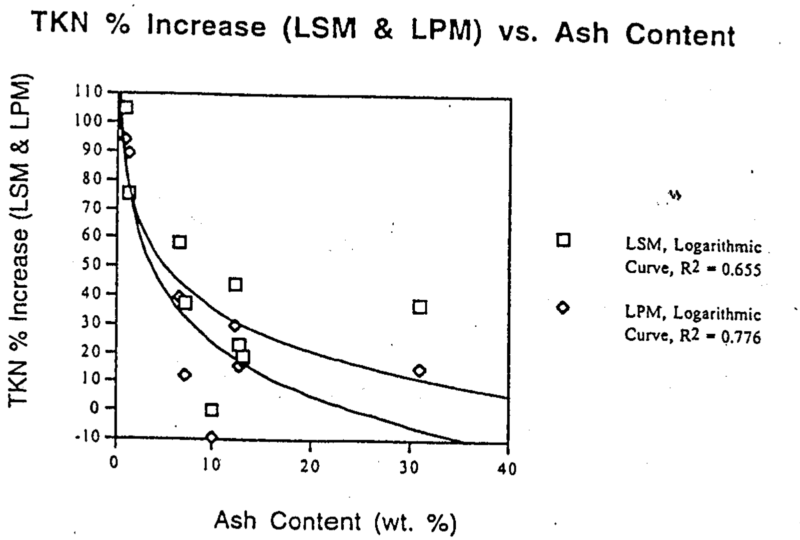


Figure 3. TP% increase (using LSM and LPM) vs. bulk density.

contact times (24 or 96 hours) were averaged for all samples tested in this study and these average numbers were used for discussion and evaluation purposes throughout this paper. Nine out of the ten peats (Loxahatchee *Nymphaea*, Loxahatchee Sawgrass, Maine *Sphagnum*, North Carolina, New York, Okefenokee *Nymphaea*, Okefenokee *Taxodium*, Shark River, and Snuggedy Swamp) retained small to significant amounts of N (from Loxahatchee Sawgrass at 12% to Maine *Sphagnum* at 94%), while one peat (Minnesota Hemic) retained and lost very small amounts of N. All ten peats retained significant to very significant amounts of P (from Okefenokee *Taxodium* at 115% to



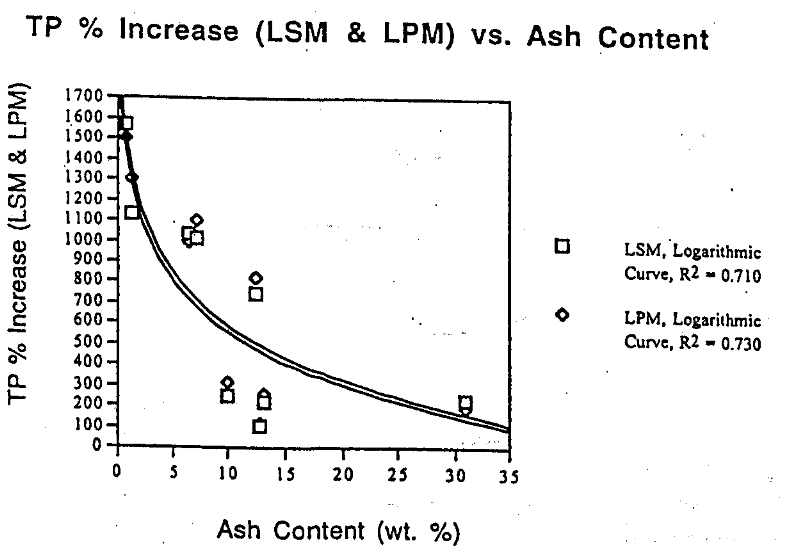
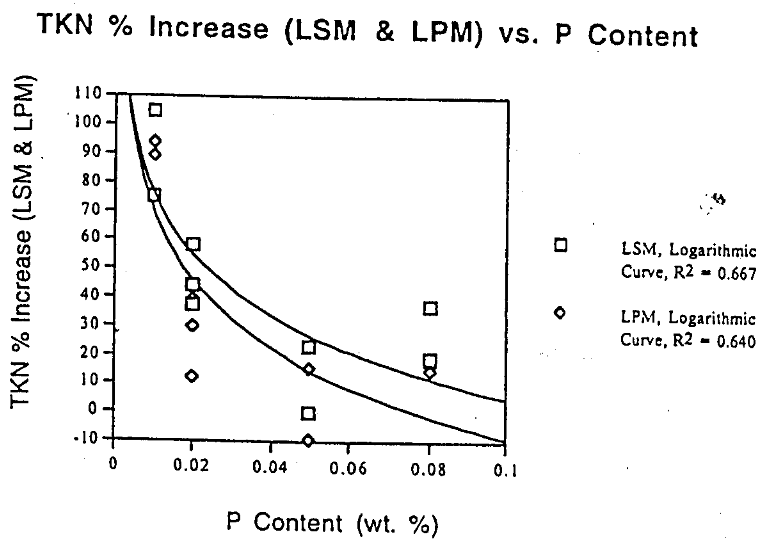


Figure 4. TKN and TP% increase (using LSM and LPM) vs. ash content.

Snuggedy Swamp at 1800%). These results are almost identical to the LSM solid sample results.

In order to determine which physical or chemical characteristics of these peats might be related to their N and P retention capacity, some parameters of these samples that had previously been determined[30] were plotted against both the LSM and LPM results. Out of the thirty-three parameters used, eighteen did not correlate well with either set of results. These parameters included: fiber content, water holding capacity, pH, and hydraulic conductivity; C, N, Cl, S, and O contents; Mg, Ca, and



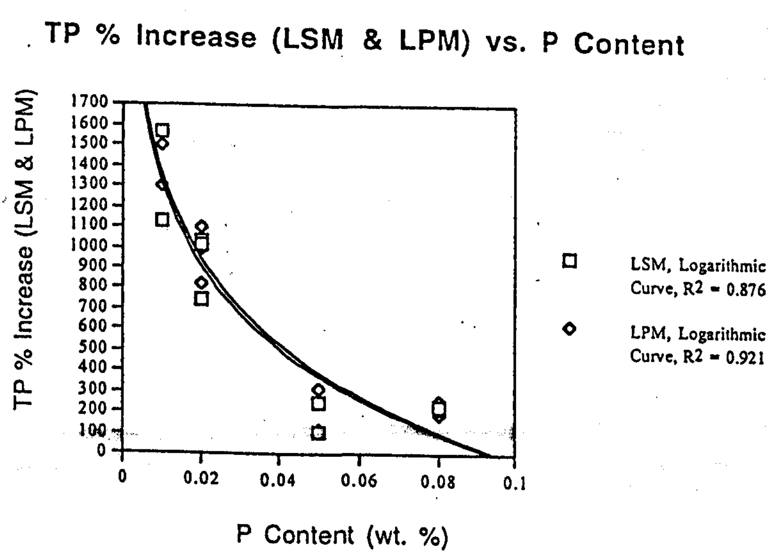
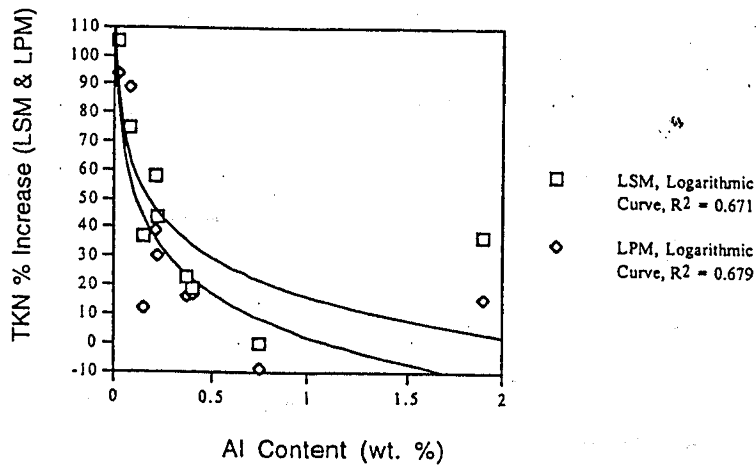


Figure 5. TKN and TP% increase (using LSM and LPM) vs. P content.

Na contents; total aldehydes, total furans, total furanones, total pyranones, total other ketones, total other lignins, and total all lignins contents. The remaining fifteen parameters (microporosity, macroporosity, bulk density; ash, Al, Fe, K, Si, Ti, and P contents; H, total cellulose, total guaiacyl lignins, fulvic acids, and humic acids contents) correlated very well with both the LSM and LPM results (Figures 1–15). In addition, correlations made with the solid sample results were almost identical for both studies. Overall, all fifteen of these parameters correlated very well with the P retention results and nine of the parameters correlated very well with the N retention results. This was true for both studies.

TKN % Increase (LSM & LPM) vs. Al Content



TP % Increase (LSM & LPM) vs. Al Content

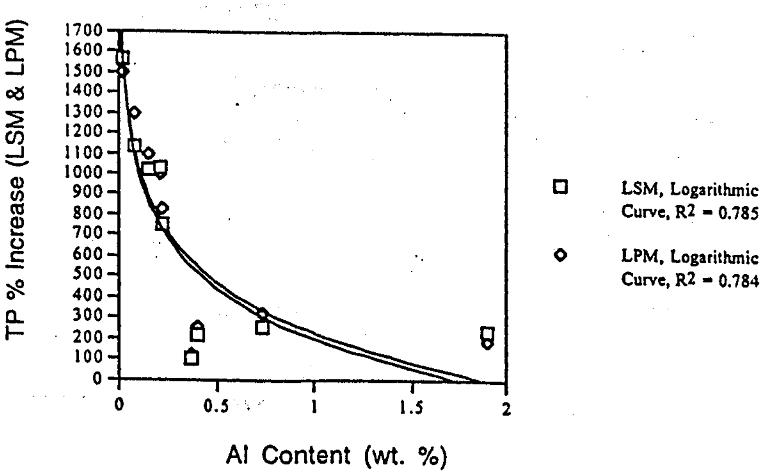


Figure 6. TKN and TP% increase (using LSM and LPM) vs. Al content.

Of the physical characteristics measured, microporosity, macroporosity, and bulk density exhibited fairly strong correlations with both the LSM and LPM results (Figures 1–3). The peats with higher bulk density (Figure 3) tended to retain less P, while the peats with higher microporosity (Figure 1) and macroporosity (Figure 2) tended to retain greater amounts of P. The peats with higher macroporosity (Figure 2) also tended to retain greater amounts of N.

Of the inorganic chemical characteristics measured, ash content, Al content, Fe content, K content, Si content, Ti content, and P content exhibited fairly strong correlations with both the LSM and LPM results (Figures 4–10). The peats with higher

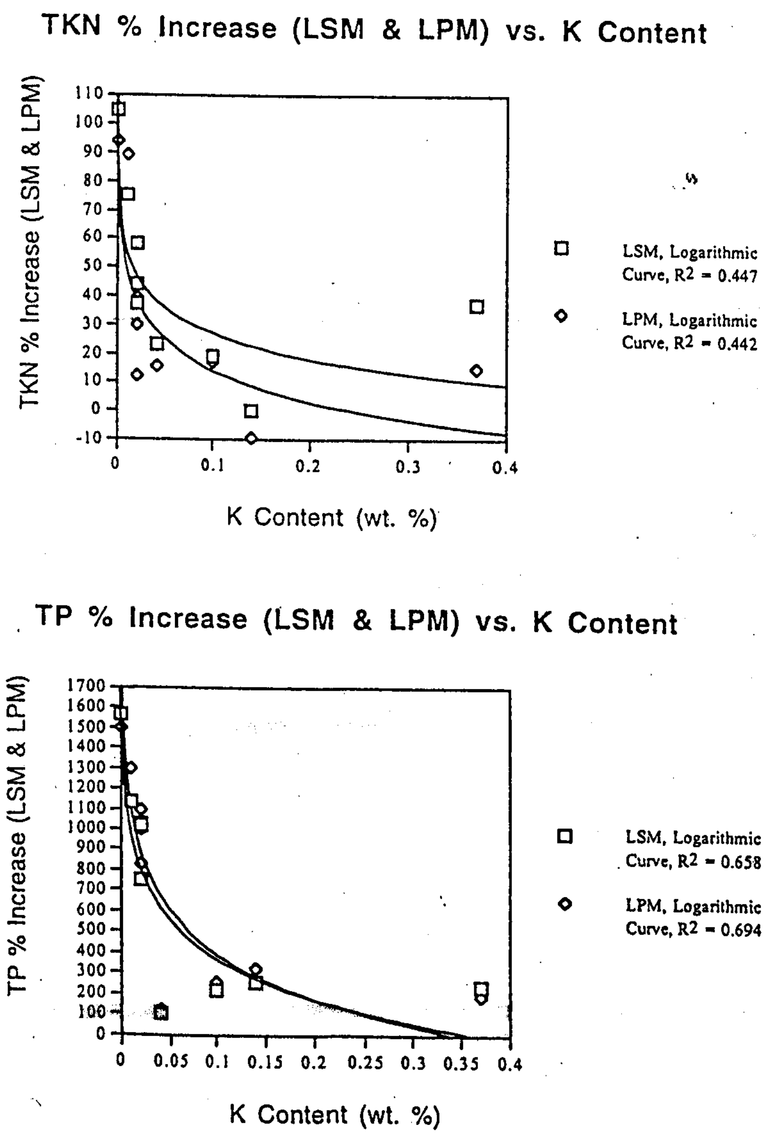


Figure 7. TKN and TP% increase (using LSM and LPM) vs. K content.

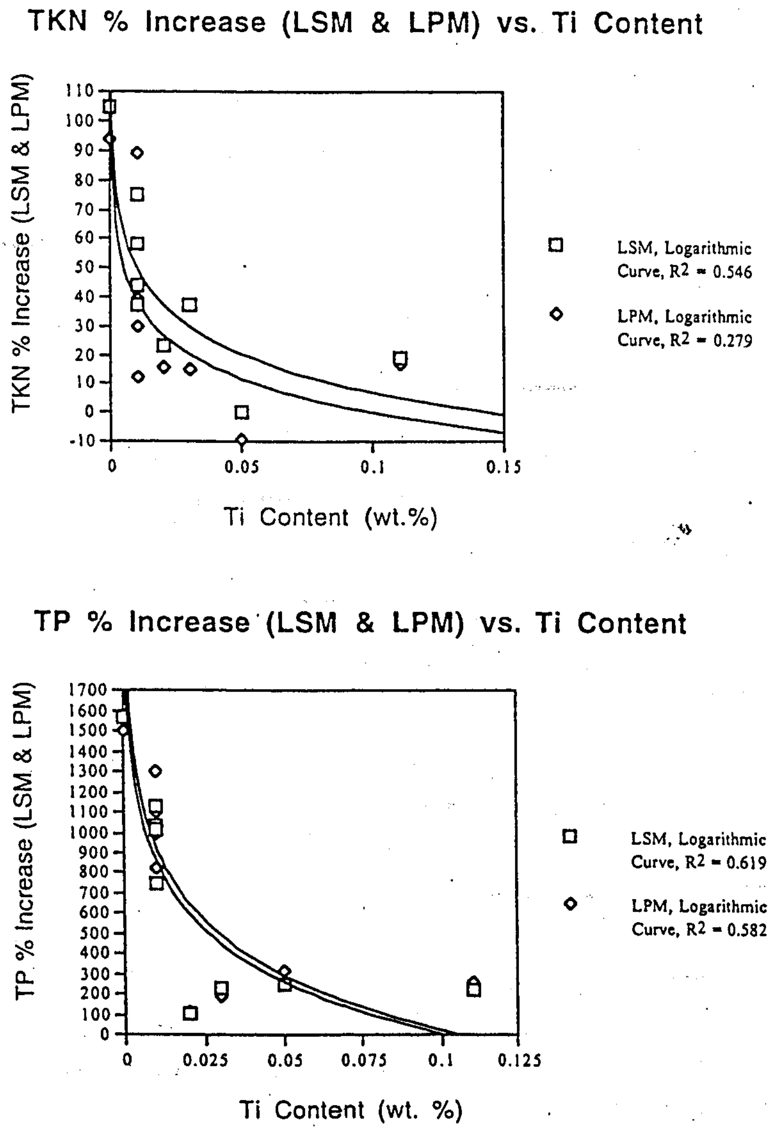


Figure 8. TKN and TP% increase (using LSM and LPM) vs. Ti content.

concentrations of ash and, consequently of inorganic elements, tended to retain less N and P. Peats with extremely low concentrations of these inorganic elements tended to retain a lot more N and P (Fe content did not correlate well with the LSM and LPM N retention results and Si content did not correlate well with the LPM N retention results). These results are interesting in that they contradict the studies done by Heikkinen et al.[16] and James et al.[15] The Heikkinen study stated that the ability of the peat to retain P increased with increasing concentrations of oxalate extractable Fe and Al, while the James study showed that P sorption by peat and sand increased when amended with iron oxides or steel wool. The results from this study show just the opposite.

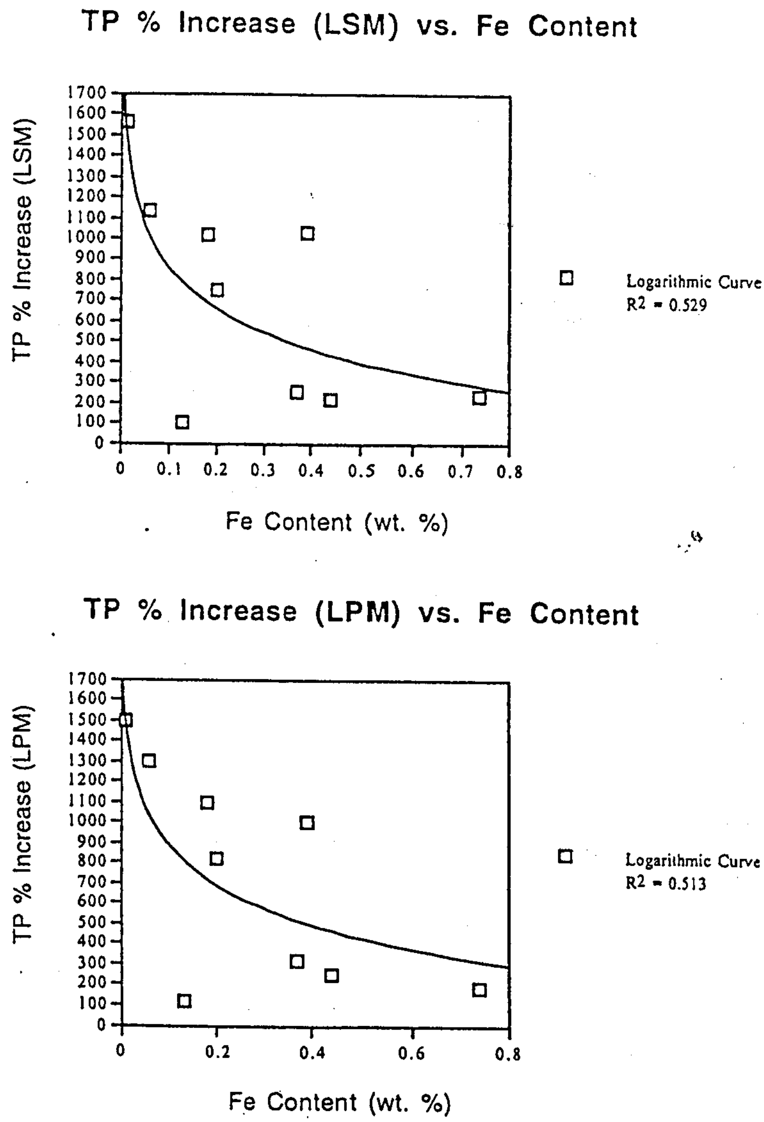
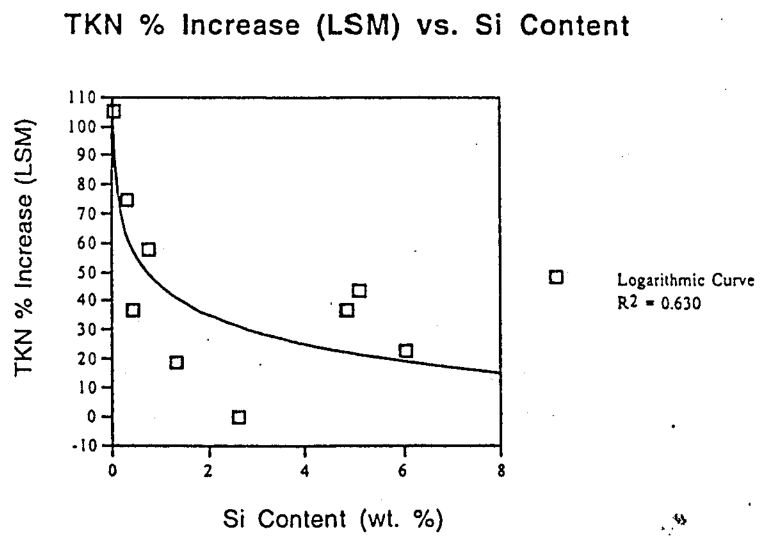


Figure 9. TP% increase (using LSM and LPM) vs. Fe content.

Of the organic chemical characteristics measured, H content, total cellulose content, total guaiacyl lignins content, fulvic acids content, and humic acids content exhibited fairly strong correlations with both the LSM and LPM results (Figures 11–15). The peats with higher H content (Figure 11) and total cellulose content (Figure 12) tended to retain more P, while the peats with higher total guaiacyl lignins content (Figure 13) and fulvic acids content (Figure 14) tended to retain much less P. With humic acids content (Figure 15), it appears as though peats with humic acids content between 5–7% work best at retaining both N and P (6%



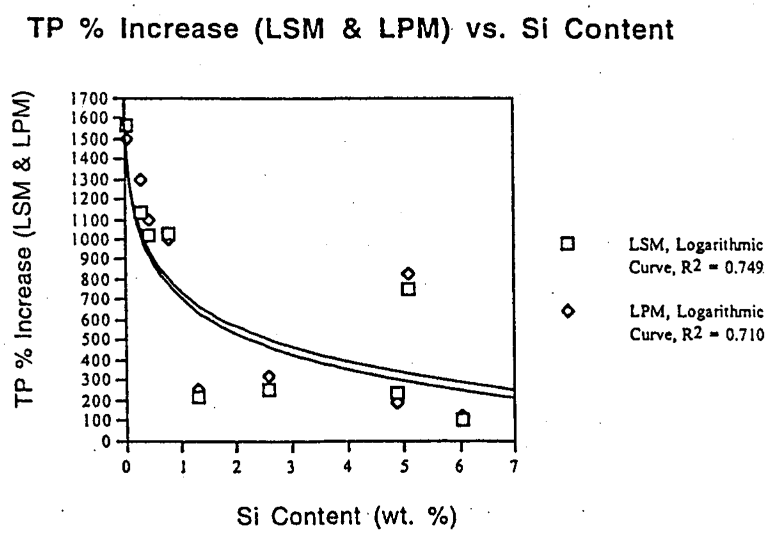


Figure 10. TP% increase (using LSM and LPM) vs. Si content.

content worked the best). The peats with higher total cellulose content (Figure 12) also tended to retain more N.

In examining the correlations made, the peats with higher N retention capacities tend to have lower ash contents, higher macroporosities, and higher total cellulose contents. Peats with higher P retention capacities tend to have lower bulk densities, ash contents, total guaiacyl lignins contents, fulvic acids contents, but higher microporosities, macroporosities, H contents, and total cellulose contents. Peats with higher N and P retention capacities also have humic acid contents between 5–7%.

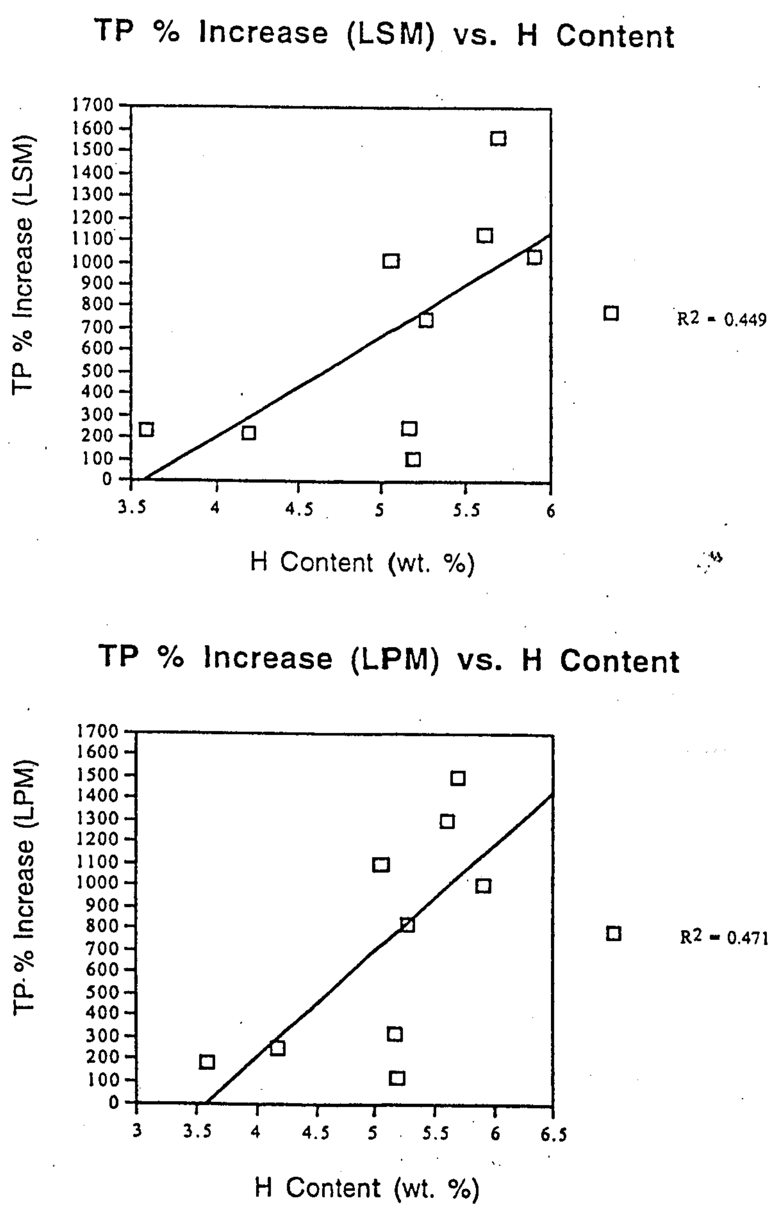
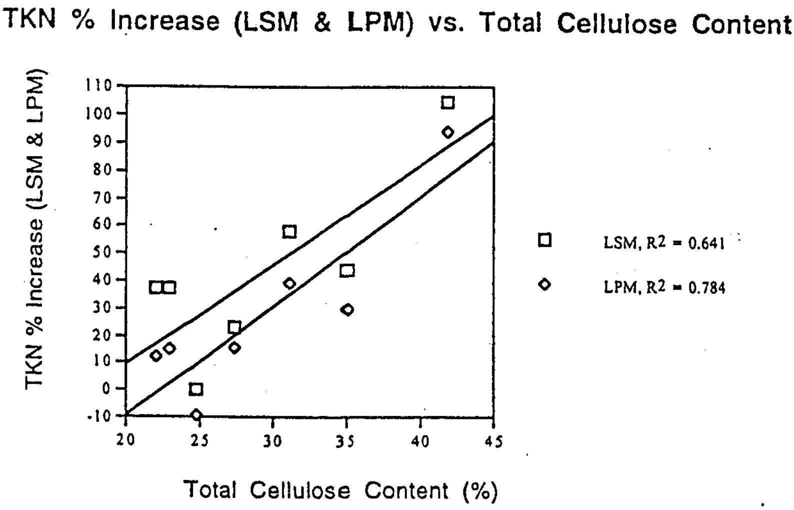


Figure 11. TP% increase (using LSM and LPM) vs. H content.

These results are very similar to our previous study that examined odor removal from LSM.[29]

DISCUSSION

Overall, the results of this study show that most peats work fairly well at retaining N and P and from LSM and LPM. In addition, they also reduced the N and



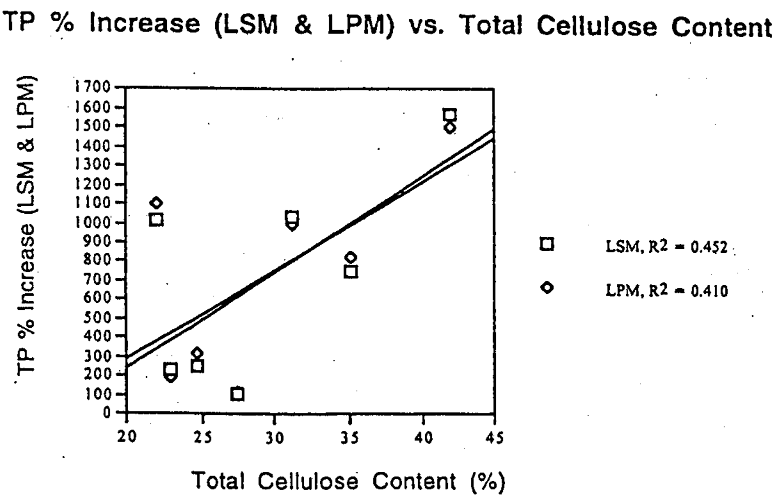


Figure 12. TKN and TP% increase (using LSM and LPM) vs. total cellulose content.

P levels from the liquid portion of the LSM. Further testing at a swine or poultry farm is needed to determine how effective and long these peats could be used for this purpose. Comparing the results of this study to a previous study done by us,[29] which evaluated the capacity of these same peats to remove odorous compounds from LSM, leads to the possibility of producing odorless fertilizers. Our previous study demonstrated that after 24 hours of mixing with LSM, seven out of ten peats removed all odors from the LSM, while the other three peats reduced the odors quite significantly, but not entirely. Additional tests using LPM indicated that mixing peats with LPM for 24 hours also reduced the odors significantly, but not nearly as well as when the peats were mixed with LSM. One possible explanation for this could be that the total solids content in the LPM was greater than the total solids in the LSM (1.1% vs. 0.25%). If this explanation is valid, than diluting the LPM until its total solids

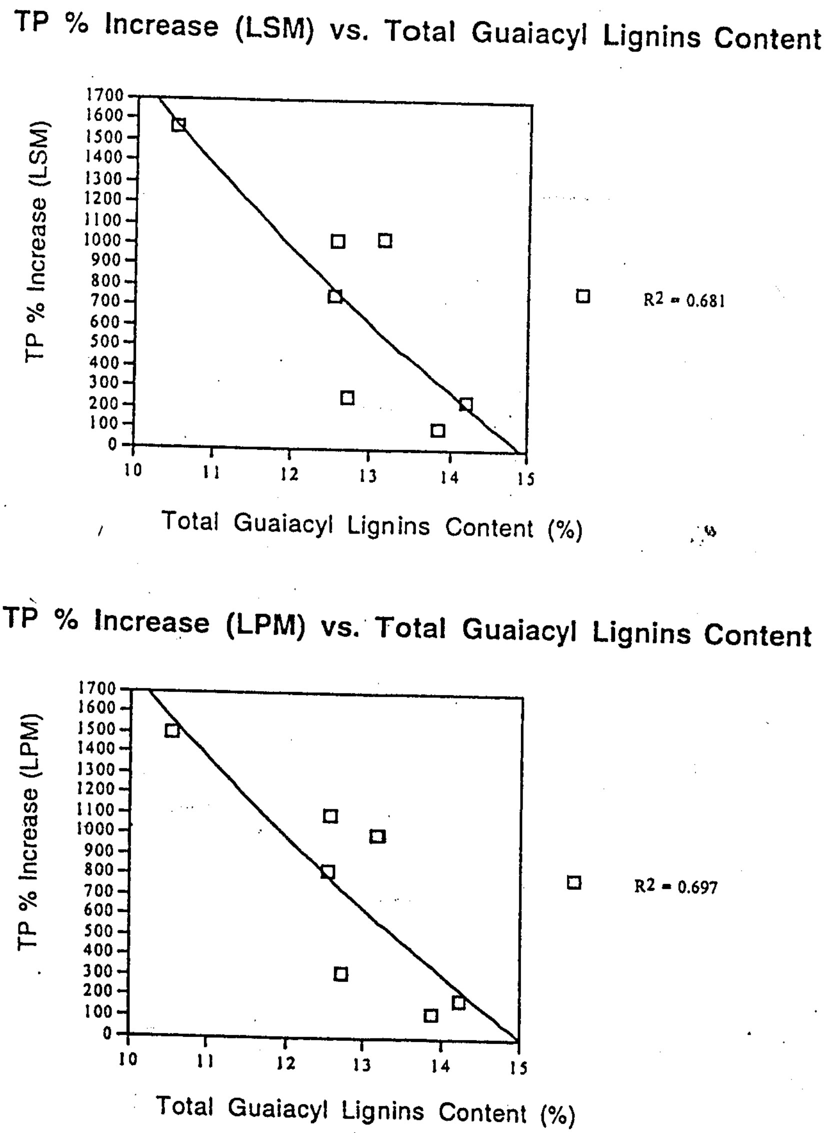
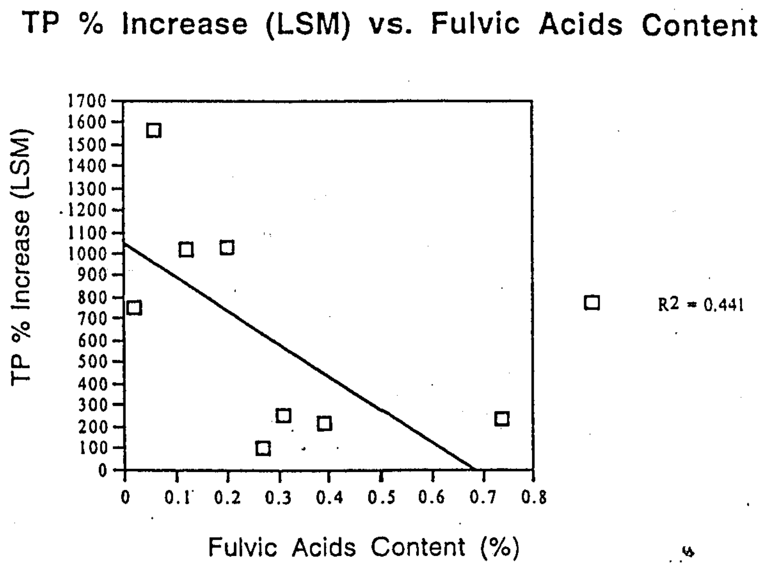


Figure 13. TP% increase (using LSM and LPM) vs. total guaiacyl lignins content.

measures around 0.25% should solve this problem. The results of this study demonstrate that if peats are to be used as media for reducing odors in LSM and/or LPM, they also will retain N and P from these manures and at the same time reduce the N and P levels in the liquid portion of the LSM. The end result of using these peats for this purpose is the reduction of N and P contamination caused by LSM and LPM, while at the same time possibly producing odorless fertilizers. One question that remains unanswered is whether or not these peats will retain the N and P over time. In order to answer this question, five of the ten peats tested in this study (Maine *Sphagnum*, Okefenokee *Nymphaea*, Minnesota Hemic, North Carolina, and Snuggedy



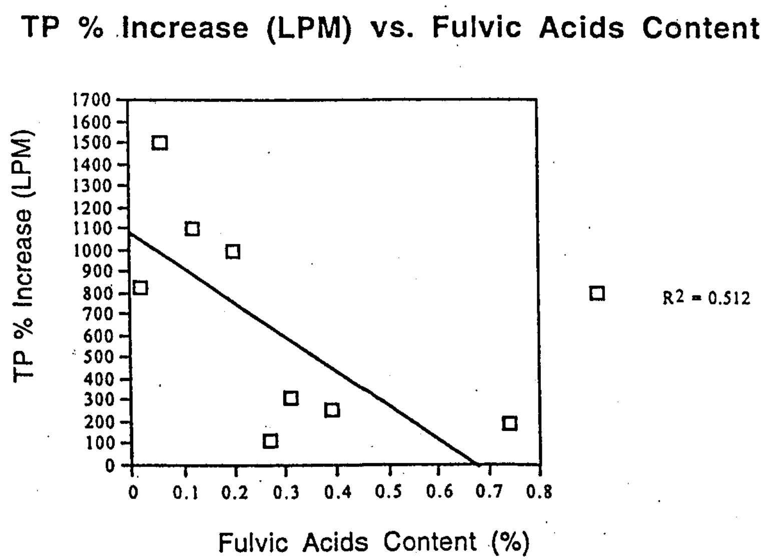
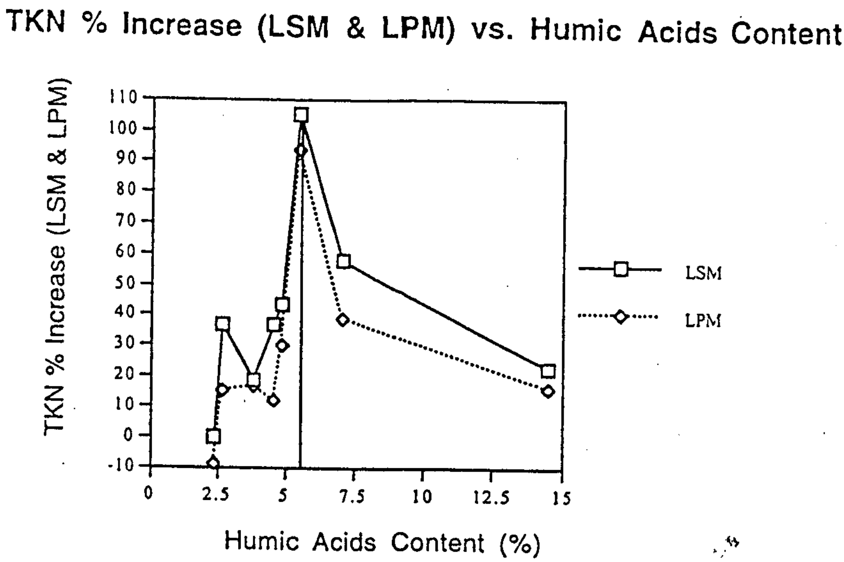


Figure 14. TP% increase (using LSM and LPM) vs. fulvic acids content.

Swamp) were tested for N and P retention after a two-year period. These peats were mixed with LSM for 24 hours, then centrifuged and separated into liquid and solid samples. The solid samples were set aside for two years, then analyzed for N and P retention.

Table 3 demonstrates that four out of the five peats (Maine *Sphagnum*, Minnesota Hemic, North Carolina, and Snuggedy Swamp) held on to most or the entire N originally retained from the LSM. The other peat type (Okefenokee *Nymphaea*) lost a



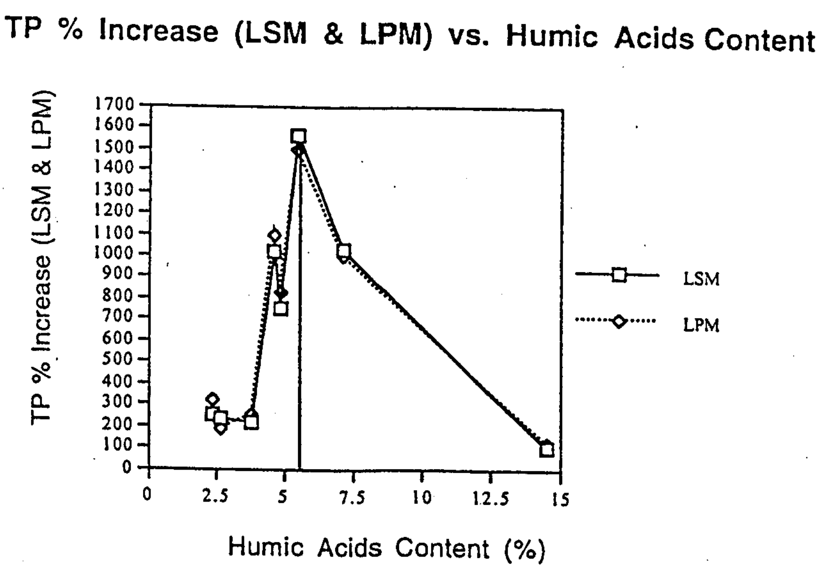


Figure 15. TKN and TP% Increase (using LSM and LPM) vs. humic acids content.

fair amount of N over time (66%). Two peat types actually increased their N content over the two-year period (North Carolina, 11% and Minnesota Hemic, 7%). With P, all five peats retained some to most of the P originally retained from the LSM. Okefenokee *Nymphaea* and North Carolina peats lost the most P over time (70% and 65%, respectively), while Minnesota Hemic peat lost the least amount (30%). These results demonstrate that these peats work fairly well at retaining N and P over time. Overall, these peats worked better at retaining N than P over time. Okefenokee

Table 3. Average TKN and TP % Increases for Peats That Were in Contact with Fresh LSM and Analyzed Immediately vs. Those That Sat for Approximately 2 Years Before Being Analyzed[a]

Peat Sample	TKN % Increase	TKN % Increase[a]	% Decrease	TP % Increase	TP % Increase[a]	% Decrease
Maine Sphag.	105	88	16	1567	950	39
Oke. Nymph.	44	15	66	750	225	70
Minn. Hemic	0	7	−7	250	175	30
North Car.	75	83	−11	1133	400	65
Snug. Swamp	81	75	7	1633	900	45

All samples were mixed w/ LSM for 24 hours; analyzed solid samples only.
[a]Samples were in contact with fresh LSM than sat for approximately two years before being analyzed.

Nymphaea peat worked poorly at retaining both N and P. In order to determine how effective these peats will work for these purposes, further testing needs to be done on a larger scale at a swine and/or poultry farm.

CONCLUSIONS

Overall, most peats in this study worked reasonably well at retaining N and P from either LSM or LPM. However, some peats were more effective than others at retaining N and P. Maine *Sphagnum* peat was best at retaining N, while the Minnesota Hemic peat was the worst. Snuggedy Swamp peat worked best at retaining P, while the Okefenokee *Taxodium* peat worked the worst. The peats tested in this study also decreased the N and P levels in the liquid portion of the LSM.

Peats with higher N retention capacities tend to have lower ash contents, but higher macroporosities and total cellulose contents. Peats with higher P retention capacities tend to have lower bulk densities, ash contents, total guaiacyl lignins contents, fulvic acids contents, but higher microporosities, macroporosities, H contents, and total cellulose contents. Peats with higher N and P retention capacities also have humic acid contents between 5–7%. These results are very similar to a previous study that examined which physical and chemical characteristics of peats are most indicative of their capacities to remove odorous compounds from LSM.

Combining the results of this study with our previous LSM and LPM odor reduction study, suggests that if these peats are used to reduce odors and N and P contamination, possible byproducts could be the production of odorless fertilizers.

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Part B

Pesticides, Food Contaminants, and Agricultural Wastes

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