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Temporary Storage of Poultry Broiler Litter

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Abstract: Transportation and storage of poultry broiler litter during the winter months is critical to implementing comprehensive nutrient/waste management plans, but acceptable temporary storage near the site of spreading can be difficult to arrange. Alternative, less expensive methods for temporary storage are needed to encourage more use of poultry litter on cropland, but these methods must be environmentally sound. Two separate studies were initiated to examine alternative methods of litter storage. Treatments included: No litter, litter covered with 6-mil polyethylene plastic, litter covered with commercially available HayGard® fabric, an uncovered pile, an uncovered, cone-shaped pile and an uncovered pile treated with a Polyacrylamide (PAM) to prevent water infiltration. Factors studied included litter quality and nutrient runoff. In both studies, the uncovered piles absorbed rainfall but also dried out on the surface rather rapidly in the spring. They also resulted in much higher runoff of ammonium-N, both total and soluble P and all other measured runoff parameters. Covered litter was wet on the surface from condensation under the cover, but generally resulted in less runoff of nutrients and maintained its fertilizer nutrient concentration. Exposed litter rapidly decomposed due to the wetting and drying effect. All litter apparently lost some mass although this was observed and not measured. Results indicate that dry broiler litter must be covered in order to protect litter quality and to prevent extensive nutrient runoff.

Key words: Poultry litter storage, nutrient runoff, fertilizer, temporary storage, PAM

INTRODUCTION

The greatest potential for non-point P contribution to surface waters usually occurs in watersheds with intensive animal production (Duda and Finan, 1983). Manure collected from Concentrated Animal Feeding Operations (CAFO) has traditionally been applied to fields near the operation because it is a practical means of providing needed plant nutrients for crop production. However, the highest potential of nutrient contribution to surface waters in watersheds is from non-point sources from the surface application of manures from intensive animal production (Kellogg and Lander, 1999; McFarland and Hauck, 1999; Sims *et al*., 2000). Non-point source pollution from agriculture has been identified as the leading source of water quality reduction by the USEPA (Parry, 1998).

In the intensive poultry broiler production region of Alabama, USA, the poultry litter has primarily been applied to pastures. Efforts are needed to move the poultry litter produced in Alabama into new areas of the state. Transportation and storage of poultry broiler litter during the winter months is critical to implementing comprehensive nutrient/waste management plans and to provide alternative areas for poultry litter utilization. Currently, the only acceptable Best Management Practice (BMP) for temporary storage of poultry litter by the USDA-NRCS in Alabama is for the poultry litter to be placed under plastic for 180 days or less on an impervious surface (USDA-NRCS, 2006). Row crop producers who utilize the poultry litter complain that 6 mil plastic used in the temporary storage of the poultry litter is difficult to handle, difficult to hold down, is inevitably torn and can become a problem if ripped plastic remains in fields. Cotton gins in particular have problems with pieces of plastic that get into cotton modules in the field and interfering with the cotton ginning process.

Row crop farmers have been reluctant to use poultry litter on their crops because of the difficulty getting it transported and spread at planting time in the spring. Temporary field storage near the site of spreading could help with this problem and encourage more row crop

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farmers to use poultry litter as a source of nutrients. Alternative, less expensive methods of storage would encourage more use of poultry litter on crop land and should be considered for shorter periods of time.

Very few efforts have been made to actually document the potential for runoff from temporarily stored broiler litter using different storage techniques. The objectives of this study were to: Evaluate conventional and alternative methods of temporary field storage of poultry broiler litter on litter quality and nutrient runoff; Demonstrate to local farmers the benefits of proper temporary winter storage and Encourage the transportation, storage and use of litter in areas where litter has traditionally not been used.

MATERIALS AND METHODS

Separate studies were conduced at E.V. Smith Research Station near Shorter, AL, in December, 2004-May, 2005 and again in January, 2006-June, 2006. In 2005, litter storage treatments were replicated using small piles (136 kg per pile) and all runoff was collected (Fig. 1). In 2006, larger piles of 5 Mg per pile were utilized, which were more representative of what producers would use and all runoff was collected (Fig. 1). However, because of their volume and size, the treatments were not replicated in this study. Treatments for both studies included: No litter, litter covered with 6-mil polyethylene plastic, litter covered with commercially available HayGard® fabric, an uncovered pile, an uncovered, cone-shaped pile and an uncovered pile treated with a synthetic polymer to prevent water infiltration. Below are the specific methods used in each of the separate studies.

Small pile study methods (2005): Mini-piles of dry, poultry broiler litter were placed inside wooden frames designed to collect all runoff and leachate (Fig. 1a). Each frame was lined with 6 mil polyethylene plastic with a drain attached at the lower corner to collect runoff. Each pile contained 136 kg (300 pounds) of dry poultry litter. Electronic moisture sensors were placed near the surface and near the center of each pile to monitor moisture inside the piles.

The treatments studied included polyethylene covered pile, a Western Hay Gard® covered pile, an uncovered pile, a cone-shaped uncovered pile, a pile with a sprayed-on latex polymer and a control. The polyethylene covered treatment is the standard USDA-NRCS recommended practice using 6 mil polyethylene for cover and the Western Hay Gard® covered pile was the same as the polyethylene, but covered with a heavy duty fabric. These two treatments were not replicated because no runoff was expected from the litter. All other treatments were replicated four times.

Fig. 1: Research sites: A) Research site with mini-piles of broiler litter and frames for collecting runoff, 2005; B) Research site with large boiler litter piles and flumes for collecting run off 2006

The uncovered pile was considered the worst way to store litter; it was dumped on the site and left. The cone shaped pile was an uncovered pile that was purposefully shaped into a cone to shed as much water as possible. This shape has sometimes been called the Delaware Cone. The latex polymer sprayed-on treatment was a cone-shaped pile sprayed with a commercially available polymer and allowed to dry. The control was an empty frame of the same size which was used to collect runoff water and any dust or particulate that blew into the area. The layout of the experiment is illustrated in Fig. 1.

Runoff samples were collected after each rainfall event from December 10, 2004 through May 10, 2005. Participation in 2005 during the experiment is shown in Fig. 2. Immediately after collection, water samples were acidified with concentrated HCl and frozen until analyzed. Water samples were filtered through a 0.45 μm membrane and analyzed for PO_4-P, NH_4-N and NO_3-N by the Soil Testing Laboratory, Auburn University.

Litter quality was determined at the beginning and at the end of the storage period. Litter from selected piles were allowed to remain for 1 year and then tested again in January, 2006. Samples of the litter were analyzed for

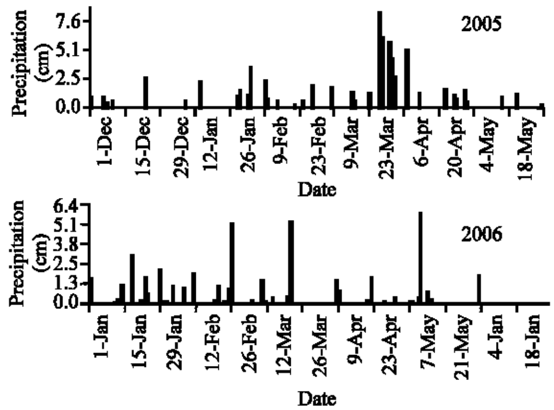

Fig. 2: Precipitation at the site during the course of the experiment in 2005 and 2006

percent moisture, percent ash and total N, P, K, Ca, Mg, B, Cu and Zn concentrations by the Soil Testing Laboratory, Auburn University, using procedures outlined by Hue and Evans (1986).

The experimental design was a completely randomized block design with four replications. Statistical analyses were performed using the Statistical Analysis System (SAS Institute, 1985) and means were separated at an *a priori* 0.05 probability level.

Large pile study methods (2006): In 2006, large piles of 5 Mg per pile were utilized during the winter and spring of 2006 to compare different techniques of temporary storage of dry poultry litter (Fig. 1b). This study used similar treatments as were used in the min-piles, but was imitated to determine if similar results would be observed under full scale litter piles (which were more representative of what producers would use) as were observed with the mini-piles. The experiment was conducted at E.V. Smith Research Center where it could be visited by local farmers. A 25-ton truck load of fresh poultry broiler litter was delivered from the Dekalb County, Alabama, area on January 7 2006. Five piles of litter were made with each pile containing 5 Mg. The treatments studied included, polyethylene plastic covered pile, Western HayGard™ covered pile, an uncovered flat pile, a uncovered cone shaped pile and a uncovered cone shaped pile with a powdered PAM coating. PAM, a high molecular weight (14 millions), having 30% anionic charge density with 100% active ingredient PAM (Floeger AN 934 SH was obtained from Chemtall Inc., Riceboro, GA). A no-litter control treatment was also included. The polyethylene treatment was similar to the USDA-NRCS recommended storage with the litter covered with 6 mil black polyethylene plastic which was weighted down with concrete blocks. The Western HayGard™ litter pile was covered with a commercially available alternative cover (manufactured by Xton, Inc., Florence, Al)).

The uncovered pile was considered the worst way to store litter and it is dumped on the ground and left. The cone shaped pile was an uncovered pile that was purposefully shaped into a pyramid or cone to shed as much water as possible. The powdered polymer coated pile used a commercially available, dry, PAM material which was spread on a cone-shaped pile. Once the PAM material became wet, it was believed that it would prevent or slow the further infiltration of moisture.

The site was on about 2-3% slope and a berm was placed up slope of the piles to prevent water from running under the piles. A 6-inch barrier of sheet metal was placed around each pile enclosing about 900 square feet for each pile (Fig. 1). Runoff was collected in a flume at the lowest point of each pile in a 5 gallon bucket place in a hole and setting in a larger, plastic basin. Rainfall was monitored at the site and at a nearby weather station about ¼ mile from the site. Precipitation in 2006 during the experiment is shown in Fig. 2. Runoff samples were collected after each rainfall event from January 7 through June 30, 2006, but there was no runoff at the site after early May. Immediately after collection, water samples were acidified with concentrated HCl and frozen until analyzed. Water samples were filtered through a 0.45 μm membrane and analyzed for total solids, electrical conductivity, NH_4-N, NO_3-N, total P, soluble P (ortho P), K, Mg, Na, Ca, B, Cu, Mn, Zn and Fe.

Litter quality was determined from each pile at the beginning of the experiment, once during the experiment and again at the termination of the experiment on June 30, 2006. The latter samples were taken near the surface of the piles and separate samples were taken about 3 feet inside the piles. Samples of the litter were analyzed for percent moisture, Percent ash and total N, P, K, Ca, Mg, B, Cu and Zn concentrations by the Soil Testing Laboratory, Auburn University, using procedures outlined by Hue and Evans (1986).

RESULTS AND DISCUSSION

Small pile study, 2005: Initially during the measuring period, light rainfall events were mostly absorbed by the litter as illustrated by the level of runoff on February 22, 2005 (Table 1). However, during the last few rainfall events most of the rainfall ran off the piles. Estimates of the total N and soluble P removed from the site can be made based on litter mass and rainfall. Clearly, all the uncovered piles resulted in high runoff losses of both ammonium-N and soluble P (Table 1 and 2, Fig. 3).

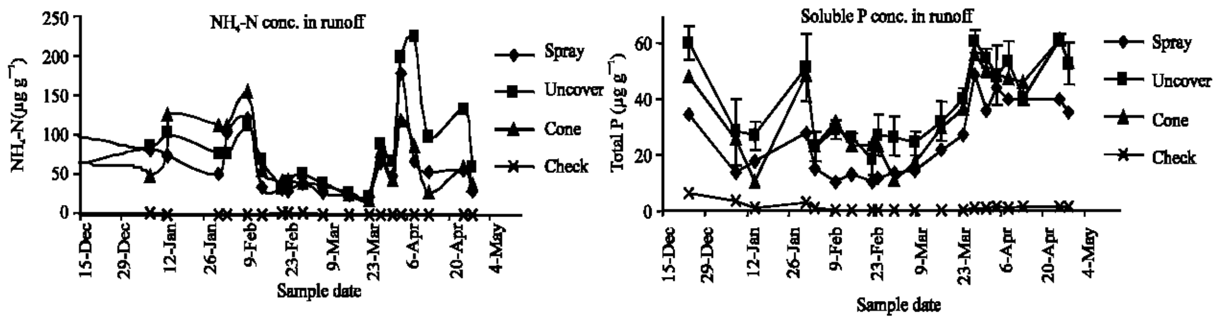

Fig. 3: Ammonium-N and soluble P in runoff during thr storage period in 2005: spray = cone-shaped pile sprayed with a polymer; uncover = uncovered pile; cone - uncovered cone shaped pile, check = no litter

Table 1: Estimate of treatment effect on runoff, total N and total P removed, 2005

	Mean runoff measured 22 February after 0.12-inch rainfall event (L/m^2)	Estimate of total N removed from site during last few rainfall events	Estimate of total P removed from site during last few rainfall events
		Litter cm rainfall ($g\ Mg^{-1}$)	
Uncovered	0.12	14.5	6.2
Cone-shaped	0.26	10.2	5.5
Latex polymer	0.23	9.8	4.0
Control - no litter	2.86	<0.2	<0.1

Table 2: Mean concentrations of nitrate, ammonium and total P in runoff, 2005

Pile treatment	Nitrate-N	Ammonium-N	Total P
		($mg\ L^{-1}$)	
Uncovered	1.6	82a	40a
Cone-shaped	1.2	65b	36a
Latex polymer	4.4	60b	26b
Control - no litter	0.3	<1c	<1c
	NS	p<0.001	p<0.001

Table 3: Litter analysis on a dry matter basis as affected by treatment

Dry matter analysis	Original litter	Final litter analysis after 180 days storage: Covered pile	Uncovered pile	Cone-shaped	Polymer sprayed	p>F
Moisture[1] (%)	20.80	15.00	24.00	33.00	24.00	**
Ash(%)	35.30	31.80	22.40	31.30	23.60	***
N (%)	04.06	2.41	1.25	1.50	01.29	***
P_2O_5 (%)	04.86	5.01	3.02	3.66	3.21	***
K_2O (%)	03.28	2.83	1.78	2.32	1.80	***
Ca (%)	03.28	3.40	2.07	2.49	2.21	***
Mg (%)	00.63	0.61	0.41	0.48	0.42	***
B ($mg\ kg^{-1}$)	56.00	47.00	30.00	40.00	31.00	***
Cu ($mg\ kg^{-1}$)	290.00	457.00	352.00	414.00	348.00	**

Results for the analysis of the litter are shown in Table 3. The litter storage treatments had significant effects on all measured parameters. Exposed piles absorbed so much water that they were saturated near the base and some were saturated throughout the pile. Although the piles absorbed water, they also dried out rapidly during the warm, spring weather. Therefore, all the analyses except moisture are reported on a dry matter basis. Mass was not measured, but observation indicated that the exposed piles lost considerable mass through decomposition. This resulted in higher P and metal concentrations (Table 3). At the same time, K concentrations were lower in the exposed piles as a result of K leaching through the exposed piles. Losses of nutrients through leaching would not be a problem in a properly covered litter pile.

One of the uncovered piles and the two covered piles were tested exactly 1 year after the test started (Table 4). The effects of moisture, leaching and decomposition were evident in the exposed piles. While the covered piles lost some N during the year's storage, the moisture did not change dramatically from what we found after 180 days (Table 3). Other measures of the litter quality indicated that the litter had been dramatically degraded after a year of exposure.

The results of the 2005 experiment demonstrate that poultry litter should not be left exposed to rainfall. Rainfall on an exposed pile would result in moisture being rapidly

Table 4: Litter analysis on a dry matter basis after 1 year of storage

Dry matter analysis	Original litter	Litter analysis after 12 months storage: Polyethylene covered	HayGard® covered	Uncovered
Moisture[1] (%)	20.8	21.3	14.0	53.4
Ash (%)	35.3	31.2	28.7	50.2
N (%)	4.06	2.99	2.77	2.21
P_2O_5 (%)	4.86	3.62	3.37	6.16
K_2O (%)	3.28	3.67	3.50	1.03
Ca (%)	3.28	5.12	4.58	9.14
Mg (%)	0.63	0.72	0.67	1.37
B (mg kg^{-1})	56	53	50	45
Cu (mg kg^{-1})	290	609	567	858
Zn (mg kg^{-1})	375	729	672	1427

[1]Moisture reported on fresh weight basis

Zn (mg kg^{-1}) 375 442 278 335 300 ***

**: $p<0.05$, ***: $p<0.01$ [1]Moisture reported on fresh weight basis

Table 5: Approximate runoff volumes collected during the period of the experiment, 2006

Treatments	18-Jan	23-Jan	1-Feb	13-Feb	27-Feb	22-Mar	10-Apr	11-May
	Liters							
No litter	0	0.1	2.5	0	60	57	0	50
Poly covered	19+	19	63	6	63+	61	1	50+
HayGard	19+	15	51	0	63+	54	0	50+
Uncovered	2.5	19	19	0	60	57	0	50+
Cone-shaped	19+	19	38	5	60	56	0	17
PAM-coated	19+	19	24	3	60	65	0	6.5

Table 6: Mean analysis of water quality parameters in runoff samples during the season, 2006

Treatment	Total solids (%)	Electrical conductivity (mmhos/cm)	NH_4-N	NO_3-N	Total P	Ortho-P	K
			(mg L^{-1})				
No litter	0.15	0.13	5.4	1.6	0.56	0.48	18
Polyethylene	0.03	0.24	9.1	2.0	5.12	4.94	38
Hay Gard®	0.10	0.73	38.7	8.1	9.87	8.50	103
Uncovered	0.14	0.94	27.6	2.7	12.85	8.36	165
Cone-shaped	0.25	1.43	54.3	8.1	19.75	13.56	228
PAM-coated	0.25	1.64	52.6	9.5	13.73	7.67	291
$LSD_{P<0.05}$	0.16	0.63	25.9	ns	08.50	6.30	118

Treatment	Ca	Mg	B	Cu	Fe	Zn	Na
	(mg L^{-1})						
No litter	3.4	2.5	0.04	0.14	0.44	0.16	12
Polyethylene	4.7	4.0	0.04	0.25	0.89	0.38	19
Hay gard®	10.2	6.6	0.15	0.58	2.08	0.71	41
Uncovered	13.0	9.3	0.23	1.11	2.25	1.31	62
Cone-shaped	19.4	15.7	0.34	1.52	4.83	2.01	77
PAM-coated	23.5	18.4	0.34	1.54	4.46	4.91	106
$LSD_{p<0.05}$	8.3	6.5	0.15	0.62	1.65	2.12	39

absorbed into the exposed litter resulting in degradation of the fertilizer value of the litter and potential nutrient runoff. Although current USDA-NRCS guidelines for temporary litter storage may not be appreciated by some producers, these guidelines seem adequate to protect both litter and surface water quality. On the other hand, in a properly covered pile, there was no opportunity for leaching losses. However, since the piles were so small in comparison to what a producer would normally use (300 pounds versus several tons), it was not clear if the results of this study would be applicable to a commercial pile of stored litter. Therefore, the test was repeated utilizing larger piles in 2006.

Large pile study, 2006: In 2006, the large pile study was initiated (Fig. 1b). During the winter of 2006 rainfall resulted in slightly drier than average conditions and during the spring of 2006 a much drier than average condition occurred (Fig. 2). Runoff from the large piles at the site occurred only when rainfall exceeded about 0.75 inch and runoff did not necessarily occur on all treatments after every rainfall event. Runoff samples were collected eight times during the experiment and the approximate volumes are shown in Table 5.

Results of mean nutrient concentration in runoff during the sampling period of 2006 are shown in Table 6. The results of NH_4-N and soluble P concentration as well as electrical conductivity in runoff samples over time are shown in Fig. 4. In this year, runoff losses from the covered treatments were also included. Large differences in runoff quality were observed due to treatments (Table 6, Fig. 4). Every parameter measured in runoff indicated a highly significant ($p<0.001$) increase in nutrient concentration compared to the no litter control

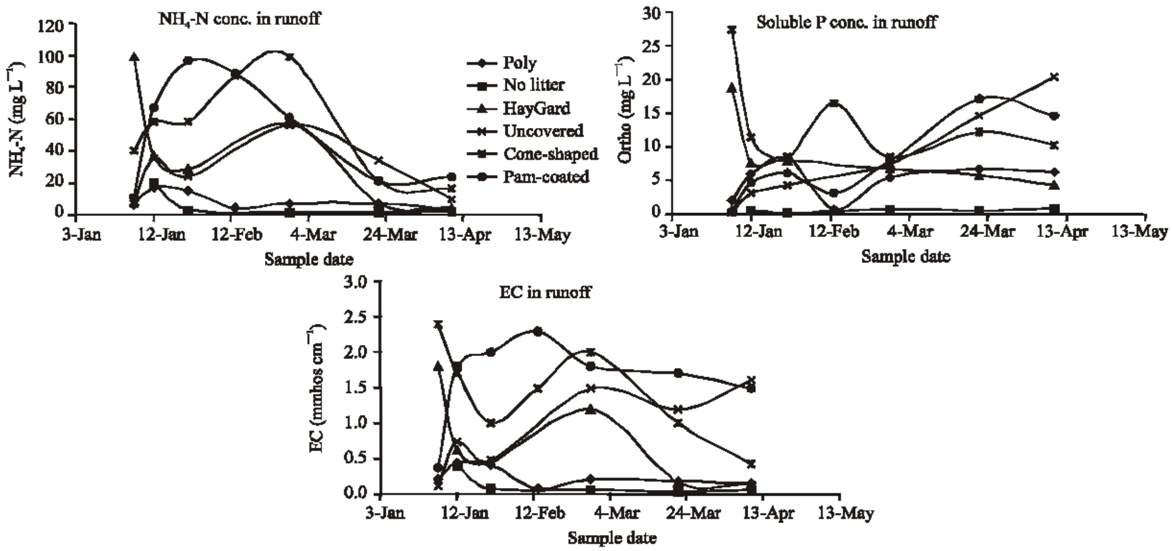

Fig. 4: Concentration of ammonium-N, soluble P and Electrical Conductivity (EC) in runoff over time as affected by cover treatments in 2006

Table 7: Mean values and variability in initial litter analysis (5) on an as-sampled basis 2006

Analysis (units)	Mean value	Std. Deviation	Minimum value	Maximum value
Moisture (%)	30.10	1.40	28.20	32.20
Ash (%)	15.50	0.90	14.40	16.70
N (%)	03.43	0.15	03.28	03.65
P_2O_5 (%)	02.03	0.07	01.97	02.16
K_2O (%)	02.33	0.08	02.26	02.44
Ca (%)	03.02	0.11	02.86	03.15
Mg (%)	00.42	0.01	00.40	00.44
B (mg L^{-1})	32.00	1.50	31.00	35.00
Cu (mg L^{-1})	286.00	16.00	272.00	314.00
Fe (mg L^{-1})	810.00	203.00	664.00	1137.00
Mn (mg L^{-1})	554.00	23.00	534.00	593.00
Zn (mg L^{-1})	299.00	12.00	291.00	321.00

treatment except nitrate-N (Table 6). Significant differences in nutrient concentration were also observed with the covered treatments compared to the uncovered piles (Table 6). The slight increase in nutrients in the covered piles versus the no litter treatment were probably due to small clumps of litter that may have been spilled outside of the covered area and/or water movement along the edges of piles. The two covered treatments were equally effective at reducing nutrient concentration in runoff compared to the uncovered piles. All uncovered piles appeared to result in substantial nutrient runoff during the season.

The results of NH_4-N and soluble P concentration as well as electrical conductivity in runoff samples over time are shown in Fig. 4. Some of the high values found in the first runoff event, especially the high values for the HayGard® treatment were probably as a result of contamination from litter spilled in and around the site. Almost all the nutrients and elements analyzed showed similar trends in that the covered piles had the lowest concentrations throughout the sampling period and the uncovered piles had the highest concentrations.

Samples were taken from each of the 5 litter piles at the initiation of the experiment and analyzed to determine the variability of the litter quality (Table 7). In fact, the litter was very consistent from one pile to the next. On an as-sampled basis, the litter was a 3.4-2.0-2.3 grade fertilizer (69-41-47 pounds N-P_2O_5-K_2O per ton). The litter was a little wetter (30.1% moisture) than typical broiler litter which should be around 20% moisture or less.

Litter quality samples were taken in late March and at the conclusion of the experiment in early June 2006 from both the surface 6 inches and from around 3 feet deep within the center of each pile. Complete analyses on a dry matter basis are presented in Table 8. Changes in gravimetric moisture content, ash, N, P and K with time and treatment are presented in Fig. 5 and 6.

The most important analysis to note is the change in moisture from inside the piles to the surface of the piles (Table 8 and Fig. 5). While one would reason that exposed

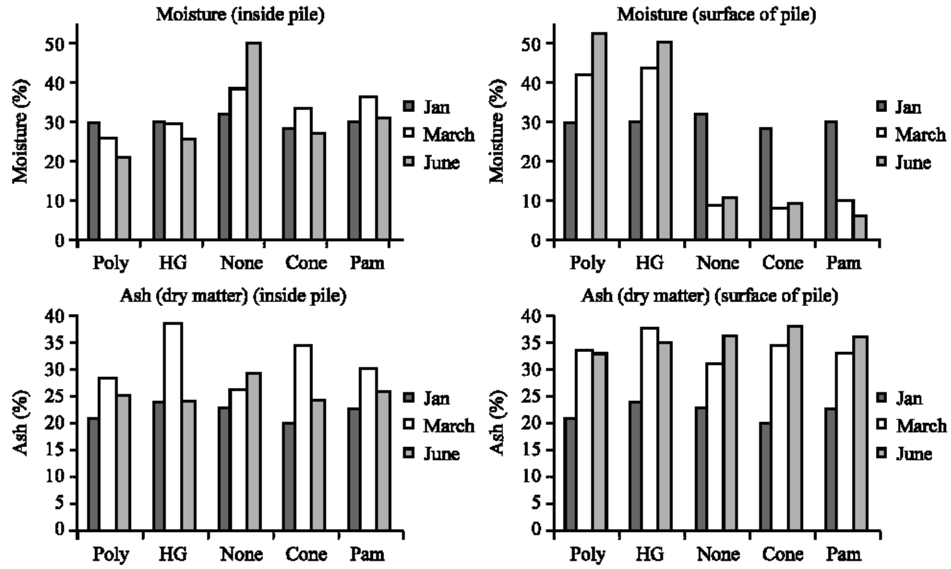

Fig. 5: Moisture (as sampled) and ash (dry matter basis) in litter from samples collected on the surface (6 in.) of the piles and from inside the piles (3 ft.) as affected by storage treatment

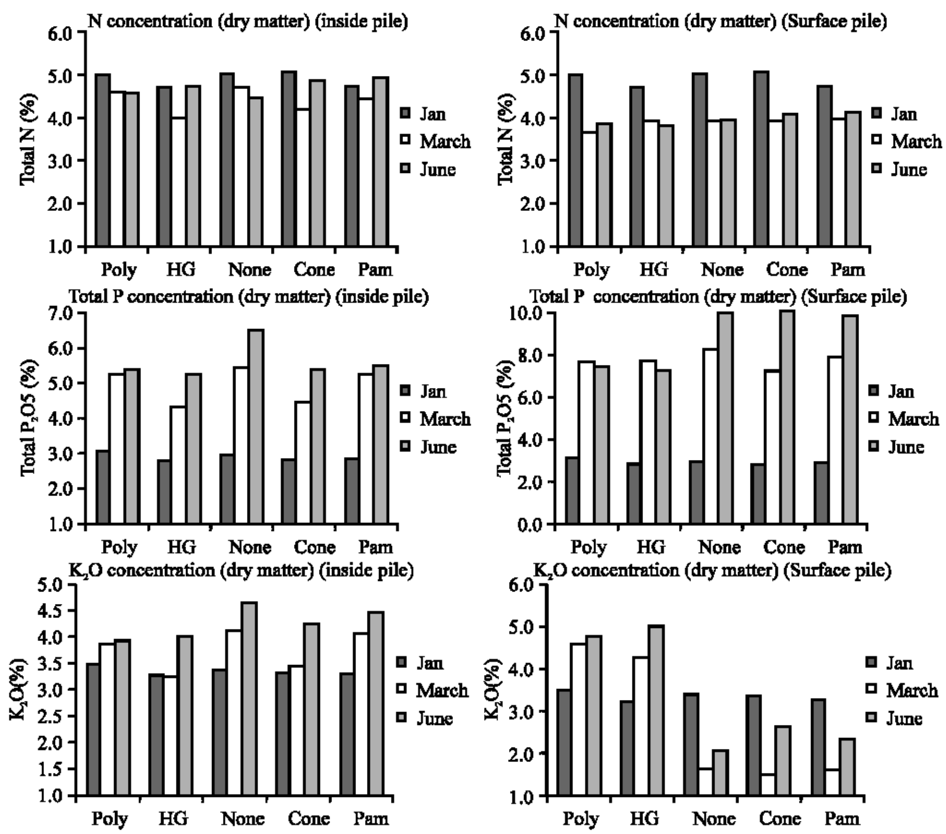

Fig 6: Nitrogen, P and K in dried litter from samples collected on the surface (6 in.) of the piles and from inside the piles (3 f) as affected by storage treatment

Table 8: Litter analysis on a dry-matter basis as affected by treatment, time of sampling and position in pile, 2006

		Pile treatment and time of sampling									
		Poly covered		HayGard® covered		Un-covered		Cone-shaped		PAM-coated	
Analysis	Initial mean	Mar	June	Mar	June	Mar	June	Mar	June	Mar	June
Samples taken on surface 6-inches											
Moisture (%)	30.10	42.30	52.60	49.50	50.50	8.40	10.70	8.0	9.30	9.90	5.90
Ash (%)	22.10	33.20	32.70	37.40	34.90	30.70	35.90	30.3	38.40	32.60	36.00
N (%)	4.90	3.64	3.84	3.92	3.81	3.94	3.91	3.92	4.09	3.97	4.10
P_2O_5 (%)	2.90	7.38	7.24	7.48	7.07	7.95	9.83	7.09	9.98	7.64	9.64
K_2O (%)	3.33	4.59	4.72	4.20	4.96	1.59	2.07	1.51	2.62	1.59	2.35
Ca (%)	4.32	5.30	6.54	5.66	6.26	6.29	8.96	5.99	9.85	6.37	8.69
Mg (%)	0.60	1.14	1.01	1.18	0.97	1.28	0.77	1.08	0.82	1.25	0.80
Na (mg)	--	6180.00	6670.00	5642.00	7111.00	4345.00	5876.00	3718.00	6950.00	4395.00	6988.00
B (mg L^{-1})	46.00	64.00	65.00	65.00	70.00	34.00	49.00	31.00	56.00	36.00	54.00
Cu (mg L^{-1})	409.00	639.00	601.00	607.00	612.00	485.00	666.00	439.00	633.00	531.00	655.00
Fe (mg L^{-1})	1158.00	1422.00	1400.00	1869.00	1668.00	1541.00	1712.00	1196.00	1588.00	1530.00	1873.00
Mn (mg L^{-1})	792.00	759.00	738.00	778.00	741.00	889.00	986.00	779.00	1009.00	875.00	1015.00
Zn (mg L^{-1})	427.00	646.00	609.00	661.00	650.00	671.00	769.00	598.00	794.00	683.00	800.00
Samples taken near center of pile											
Moisture (%)	30.10	25.80	21.10	26.40	32.20	38.40	50.60	33.30	27.60	36.70	31.30
Ash (%)	22.10	28.00	25.00	38.30	24.30	26.30	28.90	34.30	24.30	30.30	26.30
N (%)	4.90	4.40	4.58	3.93	4.74	4.72	4.45	4.17	4.86	4.44	4.95
P_2O_5 (%)	2.90	5.27	5.40	4.31	5.27	5.42	6.54	4.42	5.40	5.24	5.52
K_2O (%)	3.33	3.87	3.92	3.23	3.98	4.11	4.61	3.44	4.21	4..06	4.44
Ca (%)	4.32	3.64	4.42	3.18	4.55	4.27	5.77	3.55	4.84	4.09	4.73
Mg (%)	0.60	0.75	0.72	0.64	0.73	0.83	0.93	0.69	0.72	0.80	0.76
Na (mg L^{-1})	--	5438.00	5524.00	4604.00	5434.00	5714.00	6423.00	4588.00	5884.00	5781.00	6377.00
B (mg L^{-1})	46.00	54.00	56.00	46.00	54.00	57.00	65.00	48.00	59.00	55.00	60.00
Cu (mg L^{-1})	409.00	477.00	479.00	374.00	472.00	504.00	576.00	424.00	505.00	508.00	505.00
Fe (mg L^{-1})	1158.00	1470.00	1096.00	2323.00	1051.00	1077.00	1257.00	1794.00	972.00	1600.00	1132.00
Mn (mg L^{-1})	792.00	589.00	545.00	581.00	534.00	573.00	680.00	584.00	534.00	597.00	558.00
Zn (mg L^{-1})	427.00	482.00	495.00	410.00	465.00	498.00	597.00	430.00	507.00	513.00	521.00

piles would have a higher moisture concentration within the pile, higher moisture was actually observed only in one of the uncovered treatments (none in Fig. 5) where moisture increased to 70% by the end of the experiment. On the other hand, the uncovered piles (none, cone and polymer in Fig. 5) were actually much drier (<10% moisture) on the surface than the initial pile moisture condition. This was undoubtedly due to the dry weather with little rainfall prior to sampling in March and June. The covered piles (Poly and HG) were actually dramatically higher in moisture on the surface by the end of the experiment. This was due to moisture condensation inside the polyethylene or the HayGard® fabric. At the deep sampling depth within the covered piles, moisture did not change or actually decreased slightly.

On a dry matter basis within the piles, the ash concentration did not change dramatically over time although a slight increase in ash in all treatments may be observed Table 8). However, on the surface, ash concentration increased under all treatments indicating that significant decomposition was probably occurring on the surface of all piles, especially the uncovered piles. This increase in ash content on the surface of the uncovered piles would have been even more dramatic if the data had been calculated on an as-sampled basis, because moisture was higher in the covered piles and much lower in the uncovered piles. Changes in nutrient concentrations of N, P and K in litter are used as examples in Fig. 6 and reported only on a dry matter basis. There was a trend toward lower N concentrations within the piles regardless of method of storage. This trend was very obvious on the surface of all the piles where decomposition would have been most dramatic because of moisture and oxygen availability. When litter is reported on a dry matter basis, there was no apparent difference in the methods of storage. However, when the same data is reported on an as-sampled basis as a producer would be spreading the litter, the surface of the uncovered piles indicate about the same N concentration at the end of the experiment as when we began because of the drier condition of the surface of the uncovered piles. The covered piles, on the other hand, had dramatically lower N concentrations in the surface because of the higher moisture.

Phosphorus concentrations on a dry matter basis increased dramatically both inside and on the surface of all piles, especially the uncovered piles. This, again, was due to simple decomposition and shrinkage of the litter pile. Unfortunately, the loss of mass could not be accurately measured with the large piles. There was only a slight increase in K concentration within the piles over time. On the surface, this increase was also evident in the covered piles. However, the litter on the surface of the uncovered piles showed a definite decrease in K concentration, which was likely caused by a decomposition of the litter and leaching of K out of the surface. Changes in the nutrient content of the piles from the surface to within the piles clearly indicated that care is needed in sampling techniques so as to accurately determine the nutrient concentrations for application purposes.

CONCLUSION

In both years, the uncovered piles absorbed rainfall but also dried out on the surface rather rapidly in the spring. They also resulted in much higher runoff of ammonium-N, soluble P and all other measured runoff parameters. Covered litter was wet on the surface from condensation under the cover, but generally resulted in less runoff of nutrients and maintained its fertilizer nutrient concentration. Exposed litter rapidly decomposed due to the wetting and drying effect. All litter apparently lost some mass, although this was observed and not measured.

The data from 2006 verified on a large scale what we observed in smaller, replicated piles in 2005. Dry broiler litter must be covered in order to protect litter quality and to prevent extensive nutrient runoff. We had hoped that piling litter in a cone or coating it with a dry, moisture absorbing PAM would allow storage of the litter without covering but this did not seem to work any better than normal piling. Litter was very moisture absorbent (even without the polymer). But it also dried out rapidly on the surface. This absorbency and drying effect seems to promote rapid decomposition of the litter near the surface and loss of mass. There were much higher runoff losses for all measured parameters from uncovered piles than from covered piles. Even covered piles resulted in higher concentration of nutrients in runoff than a check plot with no litter. This was probably due to spilled litter around the piles and some seepage around the edges. There could be an argument made that litter piles could be left uncovered for up to two to four weeks if rainfall is less than 1 inch or so but this would be difficult to monitor. The reasoning would be that the litter itself would absorb most of the rainfall and the risk of runoff is not much greater than what we observed from a covered pile. However, once runoff occurred from the uncovered piles, nutrient concentrations were much higher from the uncovered piles.

Dry broiler litter should be covered in order to protect litter quality and to prevent extensive nutrient runoff. The type of cover did not seem to matter. We found that the commercially available HayGard® fabric was easier to handle, would last for several years and did not rip and tear. The less expensive, polyethylene did a good job of protecting the litter but could tear and would be much more likely to blow off in a storm. Condensation under the polyethylene does create a wet surface on the litter pile, but this had minimal effect on the overall litter quality. However, the difference in the surface and the interior of the pile should be considered when sampling the pile for analysis.

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