Applying Poultry Litter in the Fall Diminishes its Fertilizer Value

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ABSTRACT

Applying poultry litter in the fall to cotton and other row crops may be a practical option for farmers that have no time to manage litter application in the spring. However, whether fall-applied litter is as effective as spring-applied litter is not well investigated. On-farm research conducted at three locations in Mississippi indicated that applying litter in the fall may not be as effective as applying litter in the spring. Cotton responded very poorly to broiler litter in two of three years at Macon, MS where the litter was applied in the fall. Broiler litter applied in the fall at this location increased lint yield by only 62 lbs lint $acre^{-1}$ ton^{-1} litter in 2003 and by 40 lint $acre^{-1}$ ton^{-1} litter in 2004 compared with 230 lbs $acre^{-1}$ ton^{-1} litter in 2002. The yield response to litter at two other locations in 2003 and 2004 where the litter was applied shortly before or after planting in the spring ranged between 121 and 161 lbs $acre^{-1}$ ton^{-1} litter. These results suggest that there is substantial risk of mineralization and loss of mineralized litter-N before planting when litter is applied in the fall. We suspect leaching and denitrification as the primary causes of N loss when soil moisture and temperature conditions in the fall and winter after applying litter are ideal for the mineralization of litter-N.

INTRODUCTION

The vast majority of the estimated one million tons of litter generated by Mississippi's poultry industry is land-applied usually within short distances of confined poultry production areas on pastures as a fertilizer. This practice is likely to be gradually reduced and eventually eliminated because continued litter application to the same land for an extended period usually leads to environmentally unsustainable overload of nutrients particularly that of phosphorus. Land planted to cotton can ease the enormous burden placed on pastures nearby chicken houses because cotton is a million-acre crop in the state and consumes up to 120 million lbs of nitrogen, 23 million lbs of phosphate, and 82 million lbs of potash annually (USDA, 2004). Poultry litter can supply all of these nutrients implying that land under cotton has the capacity to assimilate a large fraction of the litter produced in the state with relatively minimum concerns of nutrient buildup and environmental risks in the immediate future.

Typically, spring is the ideal time to apply litter to cotton and other row crops (Mitchell, 2003). However, many growers of cotton and other row crops choose to not use litter as a fertilizer partly because applying litter in the spring competes with other farm activities. Applying litter in the fall or winter may be an alternative practice to applying litter in the spring for farmers that have little or no time to manage litter application in the spring. However, according to Mitchell (2003) applying litter more than one month prior to planting in Alabama is risky because spring rains could cause leaching or denitrification loss of readily available litter-N. Mitchell's (2003) advice is not supported with research results and whether fall-applied litter is as effective as spring-applied litter is not well investigated. On-farm research conducted at

three locations in Mississippi between 2002 and 2004 assessed the effectiveness of fall-applied broiler litter as the primary fertilizer for cotton grown conventionally, under no-till, or reduced tillage.

MATERIALS AND METHODS

On-farm research was conducted at three locations (Macon, Cruger, and Coffeeville) in Mississippi in 2002, 2003, and 2004. At each location, fresh broiler litter was applied at 0, 1, 2, or 3 tons/acre and compared against a standard farm fertilization program. The standard farm fertilization included N rates of 105 to 120 lbs/acre; P and K fertilizers were applied as needed based on pre-plant soil analysis. The treatments were compared in a randomized complete block design with three or four replications. The plots at each location were as large as 4933 ft^2 at Cruger, 6000 ft^2 at Macon, and 6080 ft^2 at Cofeeville.

Litter at Macon was applied in the fall on 8 November 2001, 3 December 2002, and 14 November 2003 and plots were planted with cotton the following spring on 25 April 2002, 8 May 2003, and 7 May 2004. Litter at Cruger was applied in the spring on 16 April 2002, 15 April 2003, 9 April 2004 and planted on 19 April 2002, 16 April 2003, and 19 April 2004. Litter at coffeeville was also applied in the spring on 29 April 2002, 27 May 2003, 7 May 2004 and planted on 21 May 2002, 2 May 2003, and 28 April 2004. Litter at all locations was applied using a commercial spreader equipped with speed-sensing ground radar, electronic scale, and rate-control computer system. At Macon and Cruger, the litter was soil-incorporated within one day of application while the litter at Coffeeville was not incorporated as this location grows cotton with no-till. Differences in management of the farms and background soil properties are shown in Table 1.

Table 1. Management variations and background soil properties before initiating the research at each of the three farms where broiler litter was tested as a fertilizer for cotton.

Location	Tillage	Row spacing	Season litter applied	Initial pH	Initial Organic matter
		inch			%
Cruger	Conventional	40	Spring	5.8	1.3
Macon	Reduced	30	Fall	6.5	2.0
Coffeeville	No-till	38	Spring	5.9	1.5

RESULTS AND DISCUSSION

Broiler litter applied in the spring within few days of planting cotton in responsive soil resulted in good lint yield response. The yield response to litter at Coffeeville and Cruger in 2003 and 2004 where the litter was applied just before planting in the spring ranged between 121 and 161 lbs lint per acre for every ton of applied litter (Table 3, Fig. 1). The response to litter in 2002 at both locations was smaller most likely because the soil was less responsive as this was the first season of the test. The amount of total litter needed to bring the yield comparable to that

of the conventional fertilization was determined to be 3.5 ton/acre (average across the three years) at Coffeeville and 4.3 ton/acre at Cruger. These litter rates are not unreasonable considering the conventional N fertilization rates at each of these locations was ≈120 lbs/acre at Cruger and ≈105 lbs/acre at Coffeeville and the N content of the litter used was ≈2.5 to 3.0% on a fresh weight basis.

Similar to that of Cruger and Coffeeville, the yield response of cotton to litter at Macon where the litter was applied in the fall several months before planting in 2002 was also large, 230 lbs lint per acre for every ton of applied litter (Table 3, Fig. 1). At this rate in 2002, only 2.4 ton/acre of litter would have been sufficient to increase yield to be comparable to that of the conventional N fertilization. In sharp contrast to 2002, cotton responded very poorly to litter in 2003 and 2004 at Macon where the litter was applied in the fall. Fall-applied litter at this location increased lint yield by only 62 lbs/acre/ton in 2003 and by 40 lbs/acre/ton in 2004 compared with 230 lbs/acre/ton in 2002 (Table 3). It would have been necessary to apply 7.6 ton/acre in 2003 and 15.6 ton/acre in 2004 to obtain lint yield comparable to the yield of the conventional fertilization.

These results suggest that the fall-applied litter in 2003 and 2004 lost its fertilizer potency most likely because of leaching and denitrification of mineralized N. We suspect soil temperature and moisture conditions in 2003 and 2004 were more ideal for the mineralization of litter N and for the loss of mineralized N by leaching, denitrification, or by both means. Daily soil temperature measured and recorded at a weather station adjacent to the study site indicates soil temperature was more ideal to N mineralization in the few months before planting in 2003 and 2004 than in 2002. There were much fewer days with ≤40°F minimum soil temperature at the 2-inch depth in February and March in 2003 and 2004 than in 2002 (Table 2). Rain records further showed that the 2003 and 2004 seasons were more ideal for loss of mineralized N by leaching and denitrification than the 2002 season. In addition to receiving more rain (20.5 inches in 2003 and 19.3 inches in 2004 compared with 15.6 inches in 2002), there were more days with rain ≥2.0 inches between January 1 and April 30 in 2003 and 2004 than in 2002. Records show 3.4, 3.1, and 3.5 inches of rain was received on February 21, April 6, and April 24, 2003, respectively. There was one day with 4.86 inches of rain on February 5 in 2004 while none of the rain measured between January 1 and April 30, 2002 was ≥2.0 inches. Both the rain pattern and the soil temperature records suggest that conditions were more ideal in 2003 and 2004 than in 2002 for mineralization and loss of litter N by leaching and denitrification. The results of this research indicate that the effectiveness of fall-applied litter in increasing cotton yield depends on soil temperature and moisture conditions between application and planting.

Table 2. Number of days with ≤40□F minimum soil temperature at 2-inch depth.

Year	December	January	February	March	April
	---------- *Days with ≤40□F soil temperature* ----------				
2002	12	23	24	13	3
2003	6	22	6	0	0
2004	24	19	9	2	0

Findings of this research seem to support the advice of Mitchell (2003) that litter should not be applied earlier than one month before planting. Our results demonstrate that applying litter in the fall during certain years may not be as effective as applying litter in the spring. Therefore, we discourage applying litter in the fall or winter to cotton in Mississippi and similar other southeastern cotton-producing states as it is difficult, if not impossible, to predict weather conditions during the four to five months preceding cotton planting.

none to up to 3 ton/acre. The projected or estimated lint yields were derived from regression equations of actual lint yield and applied poultry litter.

Location	Season	Actual yield of standard	Projected yield of control	Actual yield of control	Estimated yield increase	Projected optimum litter rate
		----------*lbs/acre*----------			*lbs/acre/ton litter*	*ton/acre*
Coffeeville	2002	1142	780	786	114	3.2
	2003	1111	669	645	160	2.8
	2004	1155	607	667	121	4.5
Cruger	2002	1489	1335	1312	44	3.5
	2003	1594	840	827	160	4.7
	2004	1427	692	649	161	4.6
Macon	2002	1408	846	915	230	2.4
	2003	930	460	460	62	7.6
	2004	950	326	284	40	15.6

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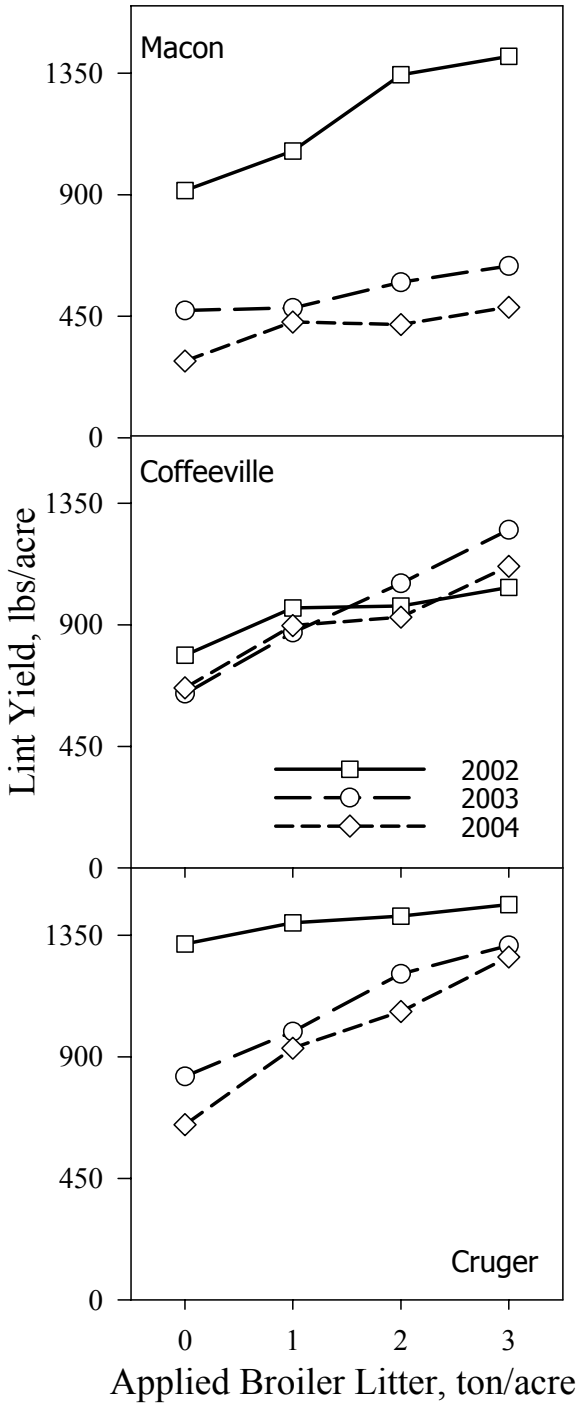

Fig. 1. Cotton lint yield response to broiler litter applied in the fall (Macon, MS) or spring (Cruger and Coffeeville, MS) in 2002-2004.