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LACK OF INCORPORATION REDUCES BENEFITS OF POULTRY LITTER APPLIED TO NO-TILL COTTON

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Abstract

Poultry litter is a multi-nutrient fertilizer that can only be applied to no-till cotton by broadcasting on the soil surface without incorporation. This practice leaves some fraction of litter-derived N vulnerable to volatilization loss. Research was conducted in north MS in 2003 to estimate the magnitude of litter benefit loss due to lack of incorporation of surface-applied broiler litter. The results showed that applying litter on the soil surface without incorporation is an effective method of fertilizing no-till cotton. However, nearly 10% of the litter benefit is lost due to lack of incorporation, which implies an upward adjustment by ≈10% of the litter rate is necessary when litter is used as the primary fertilizer of no-till cotton.

Introduction

Poultry litter is a rich source of nearly all mineral nutrients needed for plant growth (Tewolde et al., 2004). Use of poultry litter as a fertilizer under no-till cotton production practice implies that litter is applied on the surface by means of broadcasting and not incorporated. This practice exposes the litter and its nutrients to risks of loss through volatilization and runoff. The magnitude of litter-derived nutrient loss due to runoff or volatilization and whether surface-applied unincorporated litter is an effective application method under no-till or reduced-till cotton production systems is not well understood. Therefore, the objective of this research was to estimate the magnitude of litter benefit reduction when broadcast-applied and not incorporated in no-till cotton.

Materials and Methods

The research was conducted at Pontotoc Ridge-Flatwoods Experiment Station of the Mississippi State University in 2003. Broiler chicken litter with or without 34 kg ha^{-1} supplemental UAN-N was applied immediately before planting to supply a total of 101 kg ha^{-1} plant-available N. The litter was collected from a local broiler chicken production house and was relatively dry with only 20% moisture. The treatments are listed in Table 1.

The litter was surface-applied with a spreader designed and built in-house by USDA-ARS. It is equipped with a system that controlled application rate and dispensed the litter evenly across a 180-cm swath. Once applied the litter for the incorporated treatment was lightly incorporated with the top ≈5 cm using a tractor-powered rototiller several hours after application. This method of incorporation allowed the mixing of the litter with the soil to reduce loss of litter-derived nutrients to volatilization and possibly to runoff with minimal alteration of the tillage. Supplemental N as urea-ammonium nitrate solution (UAN) was band-applied at the 1st square stage.

Table 1. Treatments of incorporated and non-incorporated broiler litter and inorganic N as urea-ammonium nitrate solution (UAN) tested at the Pontotoc Ridge-Flatwoods Experiment Station in North Mississippi in 2003.

Treatment	UAN-N	Broiler Litter, Mg ha^{-1}	
	kg ha^{-1}	*Incorporated*	*Nonincorporated*
Untreated	0	0	0
Standard	101	0	0
Litter+UAN	34	5.5	0

Litter+UAN	34	0	5.5
Litter alone	0	8.2	0
Litter alone	0	0	8.2

Results and Discussion

Research conducted in 2003 at Coffeeville, MS demonstrated that applying litter on the soil surface without incorporation is an effective method of fertilizing no-till cotton with poultry litter. Lint yield in this research increased by 100 kg ha^{-1} for every 1 Mg ha^{-1} of applied litter (Fig. 1). However, this research did not compare incorporated against unincorporated litter and, therefore, does not show whether the lint yield response could have been greater than 100 kg lint for every 1 Mg litter ha^{-1} had the litter been soil-incorporated.

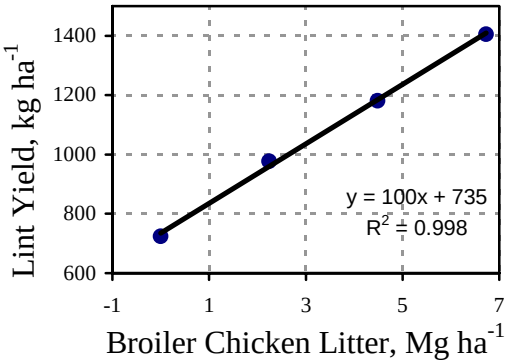

Fig. 1. Response of no-till cotton to surface-applied and non-incorporated broiler litter at Coffeeville, MS in 2003.

The research at Pontotoc, which compared incorporated to unincorporated litter, demonstrated that lack of incorporation in fact significantly ($P<0.05$) reduces benefits of litter under no-till production systems (Table 2). Lint yield was reduced by up to 131 kg ha^{-1} when the litter was broadcast-applied and not incorporated relative to the incorporated treatment. Leaf area index (LAI) was also reduced by up to 13% when litter was not incorporated (Table 2).

Table 2. Lint yield of cotton fertilized with broiler litter with or without additional N fertilizer as urea-ammonium nitrate solution UAN 32% N) comparing incorporated vs. non-incorporated litter, Pontotoc MS, 2003.

Treatment	UAN-N	Litter Rate	Incorporated	Non-incorporated	Increase
	kg ha^{-1}	*Mg ha^{-1}*	*Lint Yield, kg ha^{-1}*		%
Untreated	0	0	1143	----	----
Standard	101	0	1306	----	----
Litter+UAN	34	5.5	1370	1267	-7.5
Litter alone	0	8.2	1444	1313	-9.0
				Leaf Area Index	
Untreated	0	0	1.8	----	----
Standard	101	0	3.0	----	----
Litter+UAN	34	5.5	3.0	2.8	-5.9
Litter alone	0	8.2	2.8	2.4	-13.5
				Chlorophyll Index	
Untreated	0	0	36.1	----	----
Standard	101	0	43.6	----	----
Litter+UAN	34	5.5	39.0	38.7	-0.8

Litter alone	0	8.2	35.9	36.3	1.1

Fiber length or other fiber quality measurements were not affected by litter incorporation but fertilization with litter produced significantly ($P<0.1$) longer fibers (data not shown).

Measurement of chlorophyll index with Minolta's SPAD meter did not detect any differences between incorporated and non-incorporated litter treatments (Table 2). The meter measurements also showed that the chlorophyll index of cotton fertilized with litter alone was identical to that of the untreated cotton. Only cotton fertilized with the conventional UAN fertilizer had distinctly greater chlorophyll index. This suggests the usefulness of the widely used meter to detect yield-affecting treatments is questionable.

References

Tewolde, H., K. R. Sistani, and D. E. Rowe. 2004. Broiler litter as a complete nutrient source for cotton. pp. 2551-2556. *In* D. A. Richter (Ed.), Proceedings of the 2004 Beltwide Cotton Conferences**,** January 5-9, 2004, San Antonio, TX. National Cotton Council, Memphis, TN.