SUBSURFACE BANDED BROILER LITTER IMPROVES COTTON YIELD AND QUALITY

D. E. Rowe
Mississippi State Univ
Mississippi State, MS
S. Armstrong
Purdue Univ.
Lafayette, IN
H. Tewolde
USDA-ARS
Mississippi State, MS
T. Way
USDA-ARS
Auburn, AL
K. R. Sistani
USDA-ARS
Bowling Green, KY

Abstract

Broiler litter is typically land-applied as a fertilizer by surface broadcasting, a practice that results in volatilization loss of N as NH_3. This loss may be drastically reduced or eliminated by the use of a newly developed precision litter implement designed to apply the litter in bands just below the soil surface with little or no exposure to the air. Whether litter applied in bands to the side of the row improves yield and by how much has not been tested. The objective of this research was to determine cotton lint yield and fiber quality improvement by broiler litter applied in narrow subsurface bands compared with the traditional surface broadcast application. The results showed litter applied in subsurface bands increases cotton lint yield over litter applied as surface broadcast, which suggests subsurface band application may conserve nutrients that typically are lost during broadcast application. Lint yield of 6.7 Mg/ha banded litter treatment was equivalent to a calculated yield of 8.8 Mg/ha broadcast litter based on fitting a curve. Measurement of chlorophyll index further confirmed that litter application in subsurface band conserves litter-derived N in the soil. Fiber quality and leaf area index were not affected by subsurface band litter application compared with broadcast application. However, subsurface banding about a month after planting improved fiber quality and chlorophyll index over banding 0 to 5 d before planting.

Introduction

Broiler litter, which is viewed and handled as a waste, is a bulky mix of mainly chicken manure and bedding materials. Typically, it is land-applied as a fertilizer by surface broadcasting, a practice that results in volatilization loss of N as NH_3. Volatilization loss of NH_3-N from litter applied in the summer has been reported to exceed 24% (Sharpe et al., 2004). As much as 50-100% of NH_3-N in dairy slurry and other liquid manures may be lost to volatilization if applied by surface broadcast methods, but this loss can greatly be curtailed or nearly totally prevented if the slurry is injected into the soil (Huijsmans et al., 2003; Mattila and Joki-Tokola, 2003; Meisinger and Jokela, 2000). Volatilization loss of NH_3 in litter may also be drastically reduced or eliminated by the use of a newly developed precision litter implement designed to apply the litter in bands just below the soil surface with little or no exposure to the air. Whether litter applied in bands to the side of the row improves yield and by how much has not been tested. The objective of this research was to determine cotton lint yield and fiber quality improvement by broiler litter applied in narrow subsurface bands compared with the traditional surface broadcast application.

Materials and Methods

The research was conducted at the Mississippi Agricultural and Forest Experiment Station (MAFES), Mississippi State, MS in 2003, 2004, and 2005 in a fine sandy loam soil. Seven treatments that consisted of an unfertilized control, a standard fertilization with inorganic fertilizers based on local practices, and five broiler litter fertilizations (Table 1) were compared in a randomized complete block design with four replications. Plots consisted of four 24.4-m rows spaced 0.97-m apart. A plot received the same treatment each of the three years.

Litter for the broadcast treatments in 2003 and 2004 was surface-applied using a small-plot spreader which was equipped with a system that controlled application rate and dispensed the litter evenly across a 1.8-m swath (Fig. 1). Litter in 2005 was spread by hand to mimic the small-plot spreader. The litter applied by hand or the spreader was incorporated into the top soil layer using a rotary tiller within the same day.

Table 1. List of treatments and their description in research that compared two methods of broiler litter application and timing at Mississippi State, MS in 2003, 2004, and 2005.

Treatment	Broiler Litter	UAN-N	Date applied		
			2003	2004	2005
	Mg/ha	kg/ha			
Untreated	0.0	0	-------	-------	-------
Standard	0.0	118	8-Jul	21-June	17-June
Broadcast-2.2	2.2	0	30-May	29- April	10-May
Broadcast-6.7	6.7	0	30-May	29- April	10-May
Broadcast-11.2	11.2	0	30-May	29- April	10-May
Banded-BP-6.7†	6.7	0	30-May	29-April	10-May
Banded-AP-6.7	6.7	0	25-June	11-June	17-June

†BP=applied 0 to 5 d before planting; AP=applied at ≈5-leaf stage; UAN=urea-ammonium nitrate solution.

Litter for the two subsurface banded treatments was applied using a prototype implement that placed the litter in a precise band along one side of the row of plants by opening a small trench, dropping calibrated amount of litter into the trench, and covering it with a thin layer of soil (Fig. 1). This method of application, unlike the broadcast method, ensured little or no exposure of the litter for an extended period. The litter band in both the pre-plant and post-plant banded treatments was placed about 0.18 m away from the center of the bed where the seed was sown.

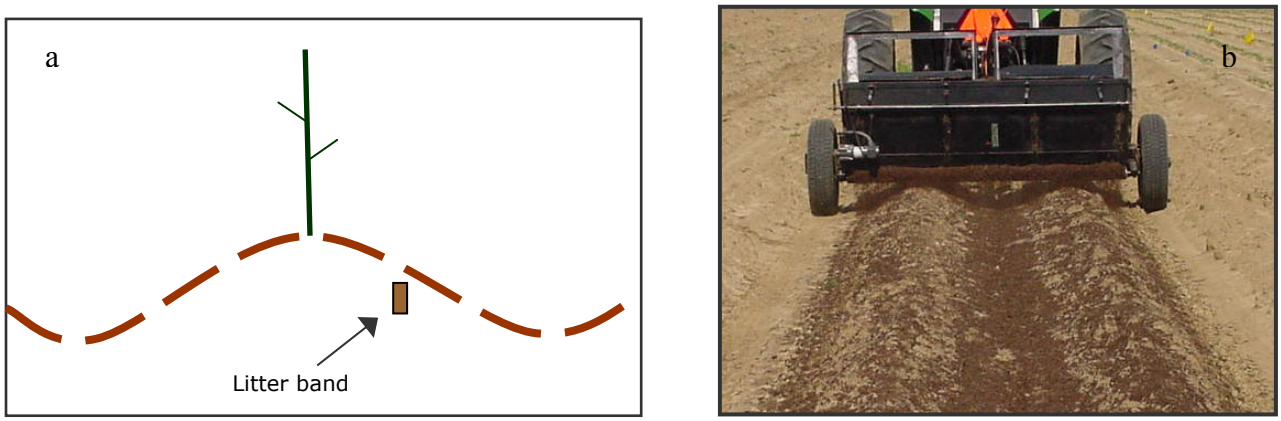

Fig. 1. A sketch showing row cross-section with subsurface band litter placement (a) and litter broadcast across two rows using a small-plot spreader (b).

Results and Discussion

Application method

Lint yield pooled across years was affected by the method of litter application. Cotton that received 6.7 Mg/ha broadcast litter yielded 982 kg/ha lint which was the same as that of the standard treatment. Applying the same amount of litter by subsurface banding at planting increased lint yield by 60 kg/ha to 1042 kg/ha., suggesting subsurface band application conserves nutrients that typically are lost during broadcast application. Lint yield of the 6.7 Mg/ha banded litter treatment was equivalent to a calculated yield of 8.8 Mg/ha broadcast litter based on fitting a

curve (Fig. 2). The subsurface banded treatment increased chlorophyll index over the surface broadcast treatment (Fig. 3), which further confirms that band litter application conserves litter-derived N in the soil. Fiber quality and leaf area index were not affected by subsurface band litter application compared with broadcast application.

Application timing

Unlike the conventional broadcast, applying litter in subsurface bands with this new implement is possible after crop establishment up until the first square stage or even later. Other than the flexibility of application timing, the benefit of applying litter after crop establishment is not known. In this research, lint yield was not affected by timing of litter application in subsurface bands. The treatment which received banded litter about a month after crop establishment yielded 1029 kg/ha compared with 1042 kg/ha for the treatment that received the banding 0 to 5 days before planting. But, applying litter about a month after planting seemed to improve fiber length and mid-season chlorophyll index. Fiber length of the banded-after-planting treatment was 28.2 mm compared with 27.8 mm for the banded-before-planting treatment. Fiber strength was also increased from 24.7 g/tex for the banded-before-planting treatment to 25.6 g/tex for the banded-after-planting treatment, but this increase was not significant at $P<0.10$. Banding the litter after planting also drastically increased chlorophyll index relative to banding before planting (Fig. 3). This response suggests "ample" N supply around the early square stage may be important for fiber growth as UAN-N applied around the same stage also had similar effect on chlorophyll index and fiber length.

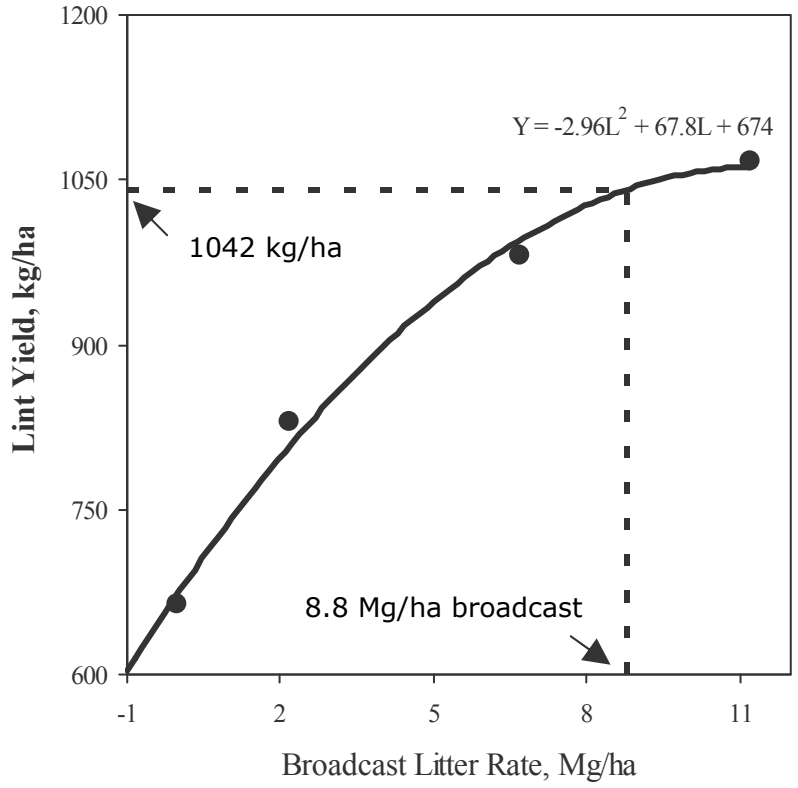

Fig. 2. Lint yield (Y) response to broiler litter rate (L) applied by surface broadcasting. Yield of 6.7 Mg/ha banded equaled yield of 8.8 Mg/ha broadcast.

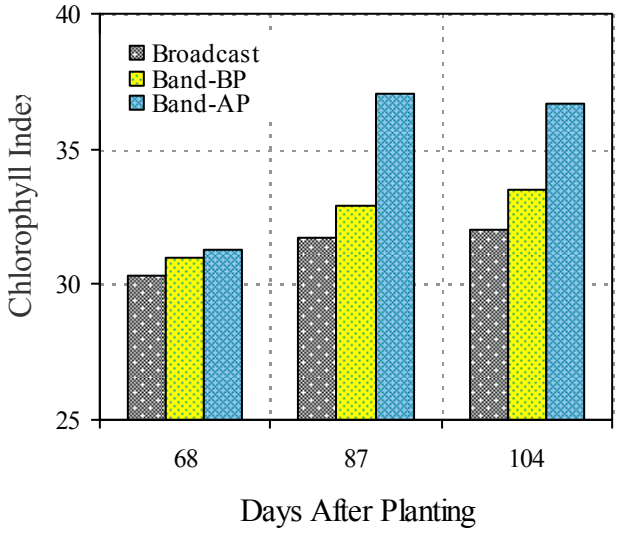

Fig. 3. Chlorophyll index of cotton fertilized with broiler litter surface broadcast before planting or subsurface banded before (BP) or after (AP) planting measured at three selected growth stages.

References

Huijsmans, J.F.M., J.M.G. Hol, and G.D. Vermeulen. 2003. Effect of Application Method, Manure Characteristics, Weather and Field Conditions on Ammonia Volatilization from Manure Applied to Arable Land. *Atmospheric Environment* 37:3669-3680.

Mattila, P.K., and E. Joki-Tokola. 2003. Effect of Treatment and Application Technique of Cattle Slurry on Its Utilization by Ley: I. Slurry Properties and Ammonia Volatilization. *Nutrient Cycling in Agroecosystems* 65:221-230.

Meisinger, J.J. and W.E. Jokela. 2000. Managing Nutrients and Pathogens from Animal Agriculture, Camp Hill, Pennsylvania. Natural Resource, Agriculture, and Engineering Service, Ithaca, NY.

Sharpe, R. R., H. H. Schomberg, L. A. Harper, D. M. Endale, M. B. Jenkins, and A. J. Franzluebbers. 2004. Ammonia Volatilization from Surface-Applied Poultry Litter Under Conservation Tillage Management Practices. *J.Environ. Qual.* 33:1183-1188.