Pelleted Poultry Litter and Inorganic-N Fertilizer Increase Cotton Yield

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BACKGROUND INFORMATION AND RESEARCH PROBLEM

Nitrogen (N) is the most important plant nutrient in cotton (*Gossypium hirsutum* L.) production. Improved N-fertility practices enable cotton growers to maximize the return on their fertilizer investments and protect the environment from potential environmental consequences of excessive N loss to ground and surface waters. Innovations in crop production such as introduction of new fertilizers and new short-season cultivars necessitate continuous research for refinement of fertility recommendations and methods of predicting in-season N requirements. In recent years poultry producers have turned to pelletization to increase the economic feasibility of transporting poultry litter from nutrient-rich poultry production areas to areas of high demand for nutrients such as the Mississippi Delta Region of Arkansas (MDRA). Field studies on evaluation of cotton response to pelleted poultry litter (PPL) in the MDRA are needed to provide information for growers who might be interested in utilizing poultry manure as a source of N. The specific objectives of studies reported here were to evaluate the effect of inorganic N fertilizer and PPL application rate on a) seedcotton yield and b) petiole NO_3-N concentration on a soil commonly used for cotton production in the MDRA.

PROCEDURES

During the 2004 growing season two replicated field experiments were conducted at the University of Arkansas Cotton Branch Experiment Station (CBES) in Marianna, Ark., on a Zachary silt loam. The two studies were implemented as one study arranged in a split-plot randomized complete block structure with four replications of each treatment. Each subplot was 43-ft long and 12.6-ft wide allowing for four rows of cotton with 38-inch row spacings. Nitrogen source was the main plot factor and N rate was the subplot factor. Cotton ('PayMaster 1218') was planted on 25 May, seedlings emerged on 30 May, first bloom occurred on 22 July, and cotton was harvested with a mechanical picker on 8 November.

Treatments for the inorganic-N fertilizer experiment were 0, 40, 80, 120, 160, and 200 lb N/acre. The first 40 or 80 lb N/acre were broadcast as ammonium sulfate and incorporated with a do-all. The balance of each inorganic-N fertilizer rate was knifed in as urea ammonium nitrate solution (32% N) according to the schedule in Table 1. Pelleted litter was applied at rates of 0, 1500, 3000, 4500, 6000, and 7500 lb/acre supplying 0, 60, 120, 180, 240 and 300 lb total-N/acre. Pelleted litter was broadcast by hand and incorporated with a do-all on 24 May. On 5 May, 80 lb K_2O/acre as potassium chloride and 46 lb P_2O_5/acre as triple superphosphate were surface-applied and incorporated in all plots. Conventional tillage and pest management practices were followed and irrigation was managed according to the University of Arkansas Cooperative Extension Service Irrigation Scheduler Program. Cotton petiole samples were collected from the 5^{th} node from the top of 20 plants selected randomly in each plot from the week before first bloom until the end of the 5^{th} week of bloom. Cotton petioles were dried overnight at 70°C and ground to pass a 1-mm sieve. A 0.1 g sub-sample was mixed with 30 mL of 0.025 *M* aluminum sulfate solution, stirred, and allowed to stand for 15 minutes. Petiole NO_3-N concentration was determined using an ion-specific electrode.

The effect of N rate for each N source on seedcotton yield and petiole NO_3-N was analyzed separately using a randomized complete block design because the total-N rates between sources differed. Analysis of variance was performed using the SAS GLM procedure. Significant treatment means were separated by the Waller-Duncan test.

RESULTS AND DISCUSSION

Inorganic-N Fertilizer

Application of 120 lb N/acre produced the greatest seedcotton yield (Table 2) and was significantly greater than N rates ≤40 lb N/acre. Although not significantly lower than the maximum yield produced with 120 lb N/acre, seedcotton yields declined numerically when N rates exceeded 120 lb N/acre due in part to excessive vegetative growth. Petiole NO_3-N concentrations reflected N application rate and time (Table 2). Numerical petiole NO_3-N concentrations varied among N rates between 14 July and 28 July, but were not statistically different. Significant differences among N rates occurred only during the 4th and 5th week of bloom. Petiole NO_3-N concentrations were not statistically compared across time, but showed that petiole NO_3-N concentration in cotton fertilized with 0, 40, and 80 lb N/acre had decreased by the 2nd week of bloom (28 July, Table 2). For N rates >80 lb N/acre, petiole NO_3-N decreased between the first (20 July) and 4th (11 August) weeks of bloom. Nitrogen application on 4 August caused an increase in petiole NO_3-N between the 4th (11 August) and 5th (17 August) weeks of bloom indicating that cotton utilized late-season applied N. At the end of the 5th week of the bloom (17 Aug) the NO_3-N concentrations in cotton petioles receiving 40 and 80 lb N/acre on 4 Aug for 160 and 200 lb N/acre treatments were at least three times higher than the other treatments (Table 2).

Pelleted Poultry Litter

Application of PPL significantly increased seedcotton yield (Table 3). However, unlike the inorganic-N fertilizer, application of >120 lb N/acre (>3000 lb PPL/acre) did not numerically reduce the seedcotton yield. Presumably, slow release of N from PPL did not promote excessive vegetative growth, as was the case with inorganic N rates >120 lb N/acre. Seedcotton yield increased as PPL-N rate increased from 0 to 120 lb N/acre and reached a plateau from 120 to 300 lb N/acre. Although the numerically greatest yields were produced by application of 300 lb PPL-N/acre, the yield was not statistically different from 120 and 240 lb PPL-N/acre. Except for the 300 lb PPL-N/acre rate, yields between each increasing-rate increment of inorganic- and PPL-N were comparable numerically, suggesting that pelleted poultry litter rates of 120 lb N/acre supplied adequate plant-available N for the production of maximal cotton yields. Petiole NO_3-N concentrations i) were not different among PPL-N rates within each sample time; ii) generally decreased during the season; and iii) were numerically greater on 14 July and 11 August than values obtained for cotton receiving inorganic-N. However, no discernable trend was observed between the PPL-N rate and petiole NO_3-N (Table 3). By the 1st week of bloom (20 July) petiole NO_3-N concentrations were below the minimum sufficiency levels regardless of N rate and source (Table 2 and 3). Analysis of cotton seed, lint, whole plant, and soil samples collected at or after harvest may provide valuable insight into the causes of yield enhancement due to PPL application.

PRACTICAL APPLICATION

Yield of cotton grown on a typical MDRA agricultural soil was significantly increased by application of N fertilizer or PPL. The optimal N rate for inorganic-N fertilizer was 120 lb N/acre and for PPL was 240 lb PPL-N/acre. The seedcotton yields increased linearly with increasing PPL-N rate. This might be due to slow but continuous release of N from PPL. Research should be continued to investigate the fertilizer-N value of various poultry litter sources for use as an alternative and/or a complement to inorganic-N, as well as P and K fertilizers for cotton grown in Arkansas.

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LITERATURE CITED

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Table 1. Nitrogen source, rate, and application times for evaluating the effect of inorganic-N fertilizer and pelleted poultry litter (PPL) on seedcotton yield and petiole NO_3-N at the Cotton Branch Experiment Station in 2004.

N source	PPL rate	Total N rate	Preplant (May 24)	Sidedress N (July 21)	Sidedress N (August 4)
	(lb/acre)	(lb N/acre)			
Control	0	0	0	0	0
AS[z]	0	40	40	0	0
AS, Urea	0	80	40	0	40
AS, Urea	0	120	80	40	0
AS, Urea	0	160	80	40	40
AS, Urea	0	200	80	40	80
PPL-control	0	0	0	0	0
PPL	1,500	60	60	0	0
PPL	3,000	120	120	0	0
PPL	4,500	180	180	0	0
PPL	6,000	240	240	0	0
PPL	7,500	300	300	0	0

[z] AS, ammonium sulfate

Table 2. Effect of inorganic-N fertilizer rate on seedcotton yield and petiole NO_3-N concentration at the Cotton Branch Experiment Station in 2004.

N rate	Seedcotton yield	14 July wk before 1st bloom	20 July 1st wk of bloom	28 July 2nd wk of bloom	11 August 4th wk of bloom	17 August 5th wk of bloom
(lb N/acre)	(lb/acre)	(mg NO_3-N/kg)				
0	1723	5740	4673	2330	504	534
40	2648	6135	4942	2333	380	384
80	2937	6350	6137	1050	347	531
120	3264	4799	5827	2330	1787	461
160	2919	8576	4775	3278	499	1540
200	2953	6651	4209	2555	842	1855
Minimum sufficiency level[z]		5000	10000	9000	5000	2000
P-value	0.002	0.956	0.40	0.513	0.020	0.0002
MSD at 0.05[y]	503	NS	NS	NS	918	593

[z] Published by Snyder et al. (1995)
[y] Minimum Significant Difference as determined by Waller-Duncan Test (NS, not significant at P=0.05).

Table 3. Effect of N-rate from preplant-incorporated pelleted poultry litter (PPL) on seedcotton yield and cotton petiole NO_3-N concentration at the Cotton Branch Experiment Station in 2004.

N rate	Seedcotton yield	14 July wk before 1st bloom	20 July 1st wk of bloom	28 July 2nd wk of bloom	11 August 4th wk of bloom	17 August 5th wk of bloom
(lb N/acre)	(lb/acre)	(mg NO_3-N/kg)				
0	1743	8916	5298	2690	836	461
60	2677	11607	5537	3757	3165	390
120	3291	5880	5309	1324	1283	245
180	3090	11708	5554	3049	2028	350
240	3376	6765	5703	832	2320	386
300	4118	9993	7016	2921	933	461
Minimum sufficiency level[z]		5000	10000	9000	5000	2000
P-value	0.006	0.705	0.827	0.711	0.2152	0.7071
MSD at 0.05[y]	858	NS	NS	NS	NS	NS

[z] Published by Snyder et al. (1995).
[y] Minimum Significant Difference as determined by Waller-Duncan Test (NS, not significant at P=0.05).