

Residual Effect of Pelleted Poultry Litter and Freshly Applied Inorganic Nitrogen Fertilizer on Corn in Arkansas

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BACKGROUND INFORMATION AND RESEARCH PROBLEM

Nitrogen (N) is the essential plant nutrient that is usually most limiting to corn (*Zea mays* L.) yield. Pelleted poultry litter (PPL) is currently being marketed in Arkansas as an N source. Rising cost of synthetic fertilizers and the increasing number of acres under corn production have renewed Arkansas corn producers' interest in PPL. The PPL that is currently marketed in Arkansas is produced in Delaware and very little information is available about N availability of PPL in soil and cropping conditions of Arkansas. In response to the need for such information for Arkansas growers, we started a long-term experiment to evaluate immediate and residual availability of N from PPL in Arkansas in 2005 (Mozaffari et al., 2005; 2006). This report describes the third year of results. The research objective was to evaluate the residual N-fertilizer value of PPL applied two years ago on corn growth and yield.

PROCEDURES

In 2007 a replicated field experiment was continued at the Lon Mann Cotton Research Station (LMCRS) in Marianna, Ark., on a Loring silt loam. The experimental treatments included annual (2005-2007) applications of total-N rates of 50, 100, 150, 200, 250, and 300 lb N/acre as inorganic N fertilizer (INF) to the same plots every year and a one-time PPL application at rates of 2660, 5320, 7980, 10,640, and 13,300 lb/acre in 2005 only, with approximate total-N rates of 80, 160, 240, 320, and 400 lb total-N/acre. The PPL N rates were based on the minimum guaranteed analysis of PPL (3.0% total-N) provided by the manufacturer. A no N (0 lb N/acre) control was also included in the study. In early April of 2007, before planting, composite soil samples were collected from the 0- to 6-inch depth of each plot. Soil samples were dried, crushed, extracted with Mehlich-3 solution, and the concentrations of elements in the extracts were measured by inductively coupled plasma atomic emission spectroscopy. Soil nitrate was extracted with 0.025 M aluminum sulfate and measured with an ion-specific electrode. Soil pH was measured in a 1:2 (weight:volume) soil-water mixture.

Corn cultivar Pioneer 33B54 was planted on 9 April 2007 and seedlings emerged on 16 April. Corn management

closely followed University of Arkansas Cooperative Extension Service recommendations for irrigated-corn production. Each plot was 40-ft long and 12.6-ft wide allowing for four rows of corn planted in 38-inch wide rows. No additional PPL or inorganic N fertilizer was applied to plots that received PPL in 2005. However, plots designated for INF received the same rates of INF each year including 50, 100, 150, 200, 250, and 300 lb N/acre. In 2007, INF N was applied in two split applications. A preplant application of 20 lb N/acre was made on 9 April as ammonium sulfate and the balance of INF was applied 38 days after emergence (24 May) by broadcasting urea to the soil surface. About the same time, 100 lb Sol-Po-Mag™/acre (potassium-magnesium sulfate, 0-0-22-22) was surface applied to supply 22 lb/acre of K₂O and S to all plots. No P fertilizer was applied, since Mehlich-3-extractable soil test-P was 'Above Optimum'. When corn plants were at the 5 to 6 leaf stage (18 May), the aboveground portion of five plants was collected from the no N control and residual PPL plots by cutting plants 2 inches above the soil. Plant samples were dried overnight at 70°C, ground to pass a 1-mm sieve, and analyzed for N by the Kjeldahl procedure. Plant dry weights were recorded and used to calculate and compare total-N uptake. Ear-leaf samples were collected at early-silk stage (22 June) from 10 plants/plot and analyzed as described previously. The middle two rows of each plot were harvested with a plot combine on 28 August 2007. Grain yields were adjusted to 15.5% moisture content for statistical comparison of yield data.

The experiment was a randomized complete block with four replications of each treatment. Analysis of variance was performed using the GLM procedure of SAS to evaluate the effect of inorganic-N fertilizer and residual PPL on corn growth responses. Significant treatment means were separated by the Waller-Duncan Minimum Significant Difference (MSD) test ($P=0.05$ and 0.10) when appropriate.

RESULTS AND DISCUSSION

The preplant soil pH and nitrate ranged from 6.2 to 6.6 and 18 to 28 ppm, respectively, and were not affected by N source or rate applied in 2005 and 2006 (Table 1). Mehlich-3-extractable Ca, Mg, and Mn soil concentrations were not affected by the treatments (data not shown). Soil-test concentrations of P, K, Zn, and Cu were significantly different among treatments

(Table 1). As expected, Mehlich-3-extractable P, K, Cu, and Zn were usually similar among INF treatments (Table 1). However, application of ≥ 240 lb N/acre as PPL significantly increased soil concentrations of Mehlich-3-extractable P, K, and Cu.

Nitrogen uptake by corn seedlings in residual PPL plots was not significantly ($P=0.2447$) different than the no N control (Table 2). Nitrogen concentration in corn ear-leaves differed significantly among treatments, but was similar among all PPL rates and the unfertilized control. Ear-leaf N concentrations in treatments that received ≥ 50 lb N/acre as INF were significantly greater than the unfertilized control and tended to increase numerically as N rate increased (Table 2).

Experimental treatments significantly ($P < 0.0001$) affected corn grain yields (Table 2). Corn yields increased numerically and significantly as INF-N rate increased until maximum yields were produced with 250 to 300 lb N/acre (Table 2). The maximum yields for INF-treated and residual-PPL plots were 203 and 94 bu/acre, respectively. In 2007, corn yields receiving all rates of PPL in 2005 were significantly ($P=0.10$) higher by 10 to 23 bu/acre than the no N control, but were significantly lower than plots treated with ≥ 50 lb N/acre as INF. This suggests that the residual benefit of a single PPL application lasts for at least two growing seasons beyond the year of application and the magnitude of residual benefit increases as PPL rate increases. In 2006, corn yields receiving PPL in 2005 were 7 to 25 bu/acre greater than the no N control with a trend for yield differences to increase as PPL rate increased (Mozaffari et al., 2007).

PRACTICAL APPLICATIONS

Application of INF in 2007 and residual N from PPL (applied in 2005) significantly increased corn yields. Maximum grain yields were produced with application of 250 lb N/acre of INF. Application of ≥ 80 lb N/acre from PPL produced corn yields that were significantly higher than when no N was applied. However, the yields from residual PPL-N applied in 2005 were less than 50 lb N/acre of INF applied annually. The study shows that in a typical eastern Arkansas silt loam the residual

benefit of PPL-N in the third year after application is significant but very small and cannot sustain maximum corn yield without inorganic-N fertilizer. Although the residual benefit of INF was not studied, one-time applications of INF may also show similar residual benefits as PPL. Data from this 3-year study indicate that PPL cannot be used as a sole source of N for crop production, but can be used with INF to supply a portion of the N as well as other essential nutrients such as P, K, and Zn that are routinely recommended for corn production. Additional research on other soils (i.e., multiple sites) is needed to provide a comprehensive assessment of the immediate (year 1) and residual availability of N and other nutrients from PPL.

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Table 1. Selected chemical properties of the soil samples collected in spring 2007 before planting from plots (0- to 6-inch depth) that received inorganic N fertilizer (INF) in 2005 and 2006 and pelleted poultry litter (PPL) in 2005.

N source	N rate		Soil pH ^z	NO ₃ -N ^y	P	K	Cu	Zn
	2005	2006						
	----- (lb N/acre) -----					----- (ppm) -----		
None	0	0	6.5	23	65	181	2.0	4.6
INF	50	50	6.2	24	63	175	1.8	3.4
INF	100	100	6.3	20	63	177	2.0	4.0
INF	150	150	6.3	23	56	167	1.9	3.6
INF	200	200	6.4	28	63	193	2.2	3.9
INF	250	250	6.2	26	53	165	1.7	3.3
INF	300	300	6.5	21	65	180	2.0	5.3
PPL	80	0	6.4	20	79	218	2.3	4.3
PPL	160	0	6.3	20	77	216	2.3	4.6
PPL	240	0	6.6	24	79	210	2.4	4.7
PPL	320	0	6.6	27	111	256	3.1	5.9
PPL	400	0	6.5	18	96	231	2.9	5.7
MSD at $P = 0.05^x$			0.5	30	18	40	0.4	1.9
MSD at $P = 0.1^w$			0.4	24	15	24	0.3	1.6
P value			0.186	0.9566	<0.0001	0	<0.0001	0.026

^z Soil pH was measured in a 1:2 (weight:volume) soil-water mixture.

^y NO₃-N measured by ion-specific electrode.

^{x,w} Minimum Significant Difference as determined by Waller-Duncan Test at $P=0.05$ and $P=0.1$, respectively.

Table 2. Effect of inorganic-N fertilizer (INF) rate applied in 2007 and residual effect of pelleted poultry litter (PPL) rate (applied in 2005) on corn grain yields at the Lonon Man Cotton Research Station (LMCRS) in 2007.

N source	Application rate			N uptake by		Corn yield (bu/acre)
	2005	2006	2007	seedlings (g/5 seedlings)	Leaf N (%)	
	----- (lb N/acre) -----					
Control	0	0	0	1.24	2.15	71
INF	50	50	50	--	2.82	115
INF	100	100	100	--	3.37	163
INF	150	150	150	--	3.44	185
INF	200	200	200	--	3.88	186
INF	250	250	250	--	3.71	203
INF	300	300	300	--	3.84	203
PPL	80	0	0	1.51	1.99	81
PPL	160	0	0	1.29	2.02	82
PPL	240	0	0	1.11	2.10	90
PPL	320	0	0	1.75	2.10	94
PPL	400	0	0	1.40	2.11	84
P value				0.2447	<0.0001	<0.0001
MSD at 0.05 ^z				--	0.36	10
MSD at 0.10 ^y				--	0.3	9

^{z,y} Minimum Significant Difference as determined by Waller-Duncan Test at $P=0.05$ and $P=0.1$, respectively.