Biosolids, Poultry Manure, and Urea Increase Corn Yield in Arkansas

M. Mozaffari, N.A. Slaton, J.R. Long, C.G. Herron, and C. Kennedy

BACKGROUND INFORMATION AND RESEARCH PROBLEM

Supplemental nitrogen (N) fertilization is a prerequisite for producing maximum corn (*Zea mays* L.) grain yields in Arkansas. The market for corn has been favorable in recent years, but a large fraction of the increase in the farmers' income has been diverted to cover the record high N-fertilizer prices. In response, farmers have turned to fresh (FPL) and pelleted poultry litter (PPL) as alternative fertilizers. Heat-dried and pelleted biosolid is a high-organic matter and low-grade fertilizer that is being sold under the trade name of Top Choice Organic (TCO)[1] by some fertilizer dealers in Arkansas. There is very little information on nutrient availability of and corn yield response to poultry litter or biosolid applied to soils in eastern Arkansas. Arkansas growers who might be interested in using these soil amendments will benefit from research aimed at defining the N-fertilizer value of poultry litter and biosolids. The specific research objective was to evaluate the effect of FPL, PPL, TCO, and urea N-fertilizer sources applied at equal total-N rates on corn grain yield.

PROCEDURES

A replicated field experiment was conducted at the Lon Mann Cotton Research Station in Marianna, Ark., on a Calloway silt loam during 2008. Agricultural limestone was applied to the field at 2 ton/acre on 15 March. A composite soil sample was collected from the 0- to 6-inch depth of each replication (n=5) before applying any fertilizer. Soil samples were dried, crushed, and soil NO_3-N was extracted with 0.025 *M* aluminum sulfate and measured with a specific-ion electrode (Donahue, 1992). Other soil nutrients were extracted with Mehlich-3 solution and the concentrations of elements in the extracts were measured by inductively coupled plasma atomic emission spectroscopy. Soil particle size analysis was performed by the hydrometer method (Arshad et al., 1996). Selected soil properties are listed in Table 1.

Pelleted poultry litter was purchased from a local fertilizer dealer and TCO was provided by MANCO Fertilizer Company (http://manncofertilizer.com/products.html). Fresh poultry litter was obtained from a baling facility in northwest Arkansas. Sub-samples of FPL, PPL, and TCO were analyzed by the University of Arkansas Agricultural Diagnostic Laboratory using standard methods (Table 2, Peters et al., 2003). The experimental design was a randomized complete block with a factorial arrangement of four N sources (FPL, PPL, TCO, and urea) applied at five total-N rates (60, 120, 180, 240, and 300 lb total N/acre, Table 3) and compared to a no N control (0 lb N/acre). Each treatment was replicated five times. A blanket application of KCl (0-0-60), triple superphosphate (0-46-0), and $ZnSO_4$ (18% S and 24% Zn) was made to supply 120 lb K_2O, 46 lb P_2O_5, 6.7 lb Zn, and 5 lb S/acre on 15 April. All N-fertilizer treatments were also applied and incorporated on 15 April. Corn cultivar Pioneer 32B29 was planted on 22 April and emerged on 29 April. Corn management closely followed University of Arkansas Cooperative Extension Service recommendations for irrigated-corn production. Each plot was 25-ft long and 10-ft wide allowing for four rows of corn planted in 30-inch-wide rows. Corn plants in the center 2 rows of each plot were harvested with a plot combine on 17 September and grain yields were adjusted to 15.5% moisture content.

Analysis of variance was performed using the GLM procedure of SAS to evaluate the effect of N source and rate on corn grain yield. When appropriate, significant treatment means were separated with the Waller-Duncan minimum significant difference (MSD) method at a significance level of 0.10.

RESULTS AND DISCUSSION

Poultry Litter and Biosolid Properties

The TCO biosolid contained greater total N, C, and P contents than either poultry litter source, but its K content was much lower (Table 2). The TCO also had lower moisture and pH than poultry litter. The Ca contents were numerically similar among N sources. In all three N sources, organic N was the predominant form of N and NH_4-N was the predominant inorganic N form. All three amendments are potentially high-organic matter, low-grade N-P-K (FPL or PPL) or N-P (TCO) fertilizers.

[1] Mention of a trade name is for facilitating communication only. It does not imply any endorsement of a particular product by the authors or the University of Arkansas, or exclusion of any other product that may perform similarly.

Corn Grain Yield

The N-source-by-rate interaction did not have a significant effect on corn grain yield ($P = 0.5206$). Corn grain yield was significantly affected by the main effects of N source and rate. Averaged across N sources, corn yields increased progressively and significantly as N rate increased and ranged from 89 to 217 bu/acre (Table 4). Maximum grain yield was produced by application of 300 lb N/acre and yields of corn receiving N were significantly higher than corn that received no N. Averaged across all N rates, grain yield was greatest for corn fertilized with urea and slightly lower for corn fertilized with FPL, PPL, or TCO, which all produced similar corn yields (Table 4).

PRACTICAL APPLICATIONS

Results from this one trial indicate that FPL, PPL, and TCO are high-organic matter, low-grade sources of N-P-K (PPL and FPL) or N-P (TCO) that could be used in corn fertilization programs. Corn grain yields were increased similarly by FPL, PPL, and TCO, but not to the same extent as corn fertilized with urea. The results suggest that while FPL, PPL, and TCO supply some plant-available N, they should be combined with conventional N fertilizers for producing maximum crop yields and preventing application of excessive P rates. Additional research is needed at multiple site-years for a reliable assessment of N availability from FPL, PPL, and TCO; and to develop science-based, field-tested guidelines for integrating these organic soil amendments into an economically and environmentally sustainable nutrient management strategy for Arkansas corn farmers.

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Table 1. Selected soil chemical property and soil particle size distribution means (0- to 6-inch depth) of samples taken before planting corn in a N-fertilization study conducted at the University of Arkansas Lon Mann Cotton Research Station in Marianna, Ark., on a Calloway silt loam during 2008.

		Mehlich-3-extractable nutrients							Soil particle size			
Soil pH[z]	Soil NO_3-N[y]	P	K	Ca	Mg	Cu	Zn	SOM[x]	Sand	Silt	Clay	Texture
	(ppm)							(%)	(%)			
6.9	5	45	74	1199	193	0.9	3.4	1.16	6	78	16	silt loam

[z] Soil pH was measured in a 1:2 (volume:volume) soil-water mixture.
[y] NO_3-N measured by ion-specific electrode.
[x] SOM, soil organic matter determined by weight loss on ignition.

Table 2. Selected chemical property means of fresh poultry litter (FPL), pelleted poultry litter (PPL), and Top Choice Organic pelleted biosolid (TCO) on an 'as is' basis used in a N-fertilization experiment conducted at the University of Arkansas Lon Mann Cotton Research Station in Marianna, Ark., on a Calloway silt loam during 2008.

N source	n[z]	pH	H_2O	Total C	Total N	Total P	Total K	Total Ca	NO_3-N	NH_4-N
			(%)						(ppm)	
FPL	5	8.1	34	22.3	2.95	1.85	3.09	2.55	92	5346
PPL	6	7.4	14	28.1	3.57	1.33	3.04	2.18	1530	2632
TCO	8	5.9	7	36.7	6.28	2.23	0.38	2.24	259	2075

[z] n = number of sub-samples analyzed.

Table 3. Total N and amendment rates for fresh poultry litter, pelleted poultry litter, biosolids (Top Choice Organic), and urea used in a N-fertilization experiment with corn conducted on a Calloway silt loam at the University of Arkansas Lon Mann Cotton Research Station in Marianna, Ark., during 2008.

	Amendment rate			
Total N rate	Urea	Fresh litter	Pelleted litter	Biosolid
(lb N/acre)	(lb material applied/acre)			
60	130	2,069	1,681	955
120	261	4,138	3,361	1,911
180	391	6,207	5,042	2,866
240	521	8,276	6,723	3,822
300	652	10,345	8,403	4,777

Table 4. Corn grain yield as affected by N source, averaged across N rate, and N rate, averaged across N sources, in a N-fertilization experiment conducted at the University of Arkansas Lon Mann Cotton Research Station in Marianna, Ark., on a Calloway silt loam during 2008.

Total N rate	Corn yield (N source means)	N source	Corn yield (N rate means)
(lb N/acre)	(bu/acre)		(bu/acre)
0	89	None	89
60	123	Fresh litter	162
120	148	Pelleted litter	162
180	177	Biosolid	171
240	186	Urea	182
300	217		
MSD 0.10[z]	9		9
P value	<0.0001		<0.0001

[z] Minimum Significant Difference (MSD) as determined by Waller-Duncan Test at *P*= 0.10.