Cotton Response to Poultry Manure and Biosolids in Leveled Soils

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RESEARCH PROBLEM

Row-crop farmers in eastern Arkansas and other regions level land to create a gentle and uniform slope across a field to increase irrigation water-use efficiency. After land leveling, soil productivity may be reduced by the extensive soil manipulation, which often requires that organic amendments be applied to aid in restoring soil productivity (Brye et al., 2004).

BACKGROUND INFORMATION

Growers in eastern Arkansas have traditionally used fresh poultry litter (FPL) to restore soil productivity after land leveling, but FPL is not always readily available or the existing equipment may not be suitable for its application. Municipal biosolids have high organic matter content, contain N and other plant nutrients, and have been successfully used for mine land reclamation (Sopper, 1992). A type of pelleted biosolids has recently become available in eastern Arkansas and is being marketed under the trade name of Top Choice Organic® (TCO)[2]. Information on the potential effectiveness of TCO for restoring the productivity of precision leveled fields will be beneficial for Arkansas growers who may be interested in alternatives to FPL. Therefore, the objective of this research was to evaluate cotton (*Gossypium hirsutum* L.) response to FPL, pelleted poultry litter (PPL), and TCO in combination with synthetic fertilizers on a leveled soils in eastern Arkansas.

RESEARCH DESCRIPTION

A field experiment was conducted on a Loring silt loam at the Lon Mann Cotton Research Station in Marianna, Arkansas during 2008. This field had been precision leveled by removing the top 3 to 8 inches of soil from areas of

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[2] We do not endorse or recommend any commercial products.

higher elevation and depositing it in areas of lower elevation. A composite soil sample was collected from the 0-to 6-inch depth of each replication (n = 4) before applying any soil amendments. 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 measured by extraction with Mehlich-3 solution. Soil particle size analysis was performed by the hydrometer method (Arshad et al., 1996). Sub-samples of FPL, PPL, and TCO were analyzed as prescribed by Peters et al. (2003). The experimental design was a factorial arrangement of FPL, PPL, and TCO each applied at two rates (1,000 and 2,000 lb/acre) plus 50 lb N/acre as urea (urea-N); a treatment consisting of 50 lb N/acre as urea; and a control that received no fertilizer or organic amendment. All cotton plots except the control were fertilized with muriate of potash and triple superphosphate to supply 90 lb K_2O and 90 lb P_2O_5/acre, respectively. All soil amendments were hand-applied and incorporated on 23 May. Each plot was 40-ft long and 12.6-ft wide allowing for four rows of cotton with 38-inch wide row spacings. Stoneville 4554B2RF cotton was planted on 27 May. The two center rows of cotton were harvested with a spindle-type picker on 6 October. Analysis of variance was performed using the GLM procedure of SAS to evaluate the effect of FPL, PPL, TCO and urea-N on seedcotton yield. When appropriate ($P \leq 0.1$), means were separated by the minimum significant difference (MSD) method.

RESULTS

Properties of Soils and Organic Amendments

In the 0- to 6-inch depth, soil texture was silt loam, organic matter was relatively low, soil P availability was medium and soil K availability was low (Table 1). The chemical properties differed among the three organic amendments and may have influenced the outcome of the research since the amendments were applied at uniform rates of material resulting in different nutrient addition rates. The FPL and PPL contained similar amounts of K, but the PPL had a lower moisture content and a higher N content than FPL resulting in slightly more N being applied in each rate increment. Likewise, the TCO had a lower moisture and higher N content than PPL and had the greatest N addition in each application rate increment. The amounts of N added in each rate are listed in Table 3.

Seedcotton Yield

Organic amendment and urea application significantly ($P < 0.0001$) increased seedcotton yield as compared to cotton receiving no N or soil amendment (Table 3). The average seedcotton yield in the control was 829 lb/acre compared to 2668 to 3829 lb/acre for cotton receiving urea-N only or urea-N plus an organic amendment. Among the amended treatments, urea plus 2000 lb TCO/acre produced the highest yield. Seedcotton yield of cotton fertilized with 2000 lb TCO/acre plus urea-N was significantly higher than cotton fertilized with the same rates of FPL or PPL plus urea-N. This is a reflection of higher total N content of TCO biosolids

(Table 3). Application of 2000 lb/acre of FPL plus 50 lb of urea-N/acre supplied 110 lb of total N/acre, and application of 1000 lb/acre of TCO plus 50 lb urea-N/acre supplied 112 lb of total N/acre. Seedcotton yield of cotton fertilized with a total of 110 lb of total N/acre from FPL and urea was not significantly different from the yield of plants fertilized with 112 lb of total N/acre from TCO and urea. The yield difference among treatments amended with 2000 lb FPL, PPL, TCO can be attributed to the higher N content of the TCO. Application of 2000 lb TCO/acre plus urea supplied 174 lb total N/acre, whereas 2000 lb FPL or PPL/acre plus urea supplied 110 and 122 lb total N/acre, respectively.

PRACTICAL APPLICATION

Fresh or pelleted poultry litter and TCO in combination with urea increased seedcotton yields in a precision-leveled soil. Cotton response to application of 2000 lb/acre of TCO plus 50 lb urea-N/acre was more pronounced than the same amount of either FPL or PPL plus urea. Seed cotton yield of plants fertilized with a comparable amount of total N from FPL plus urea or TCO plus urea was not significantly different. Nitrogen contribution and maybe some other constituents of these organic amendments improved cotton yields. Additional work is needed to ascertain the consistency of these results across a diverse group of soils and cropping systems.

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Table 1. Selected soil chemical property means (0-to 6-inch depth) of samples taken before applying soil amendments on two recently leveled soils at University of Arkansas Lon Mann Cotton Research Station in Marianna in 2008.

Soil	Soil	Mehlich-3-extractable nutrients							Soil physical properties			
pH[1]a	NO_3- N [2]	P	K	Ca	Mg	Cu	Zn	SOM [3]	Sand	Silt	Clay	Texture
	---------------- (ppm)							---------------- (%)				
5.9	10	54	79	1493	315	1.3	1.9	1.10	5	71	24	silt loam

[1] Soil pH was measured in a 1:2 (weight:volume) soil-water mixture.
[2] NO_3-N measured by ion-specific electrode.
[3] SOM, soil organic matter determined by Weight Loss on Ignition.

Table 2. Selected chemical properties of fresh poultry litter (FPL), pelleted poultry litter (PPL), and Top Choice Organic (TCO) pelleted biosolids on 'as is' basis.

N source	n[1]	pH	H_2O	Total C	Total N	Total P[2]	Total K[3]	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

[1] number of samples analyzed.
[2] lbs/ton P_2O_5 = %Total P on "as is" basis multiplied by 20 x 2.29.
[3] lbs/ton K_2O = %Total K on "as-is" basis multiplied by 20 x 1.2.

Table 3. Effect of fresh poultry litter (FPL), pelleted poultry litter (PPL), and Top Choice Organic pelleted biosolids (TCO) on seedcotton yield in a recently leveled Loring silt loam at University of Arkansas Lon Mann Cotton Research Station in Marianna in 2008.

Organic amendment		Nitrogen applied			Seedcotton yield
Type	Rate	Organic N[1]	Urea-N	Total N[2]	
		-------------------------- N lb/acre ------------------------			--- lb/acre ---
None (control)	0	0	0	0	829
None	0	0	50	50	2668
PPL	1000	36	50	86	2782
PPL	2000	72	50	122	3205
FPL	1000	30	50	80	2532
FPL	2000	60	50	110	2895
TCO	1000	62	50	112	2992
TCO	2000	124	50	174	3829
P value					<0.0001
MSD at 0.10[3]					377

[1] calculated from total N content of the organic amendment on ‘as is’ basis in Table 2.
[2] calculated as the sum of organic N and urea-N.
[3] Minimum Significant Difference (MSD) as determined by Waller-Duncan Test at P = 0.10.