NC STATE UNIVERSITY

Poultry Manure N Availability to Corn & Cotton Under Conventional and Conservation Tillage

DEPARTMENT of SOIL SCIENCE

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Introduction

Limited data are available to validate standard nutrient management assumptions for first and subsequent year nitrogen availability following application of poultry manures to corn (*Zea mays* L.) or cotton (*Gossypium hirsutum* L.) in North Carolina. Soils in this region vary substantially in texture and drainage class, and multiple cropping and tillage systems are involved; so additional data are needed to improve management recommendations.

Objective

- Evaluate poultry manure N source, application rate, and residual N effects on yield and plant N uptake in a cotton-corn rotation under conservation and conventional tillage

Methods & Materials

- Four locations, cotton-corn rotation 2008-2011
- Sites –
  - Tidewater Research Station– TRS, Portsmouth fine sandy loam (Typic Umbraquults), conventional tillage & no-till fields
  - Upper Coastal Plain Research Station-UCPRS, Norfolk loamy sand (Typic Kandiudults) , conventional tillage & strip-till fields
- Experimental design – RCBD, 4 reps
  - N Rate & source variables:
    - Inorganic N rates
      - Cotton 0, 45, 90, 134 kg N ha^{-1}
      - Corn 0, 67, 134, 202 kg N ha^{-1}
    - Manure sources
      - Layer manure (LM), Composted layer manure (CLM), Broiler litter (BL)
    - Manure application timing
      - Set A plots 1st & 3rd year, Set B plots 2nd year
    - Manure rates (1/2X, 1X)
      - Cotton 45, 90 kg N ha^{-1}
      - Corn 67, 134 kg N ha^{-1}
  - 6 rows by 9 m, same plots each year
  - Yield: 2-row mechanized or 6.1 m row segment manual harvest
  - Biomass: 5 plant aboveground harvest (not all years)
- Data analysis
  - Factorial analysis of manure source & rate treatments
    - SAS Proc MIXED, location & rep random
    - Least square means, t test p<0.05 or 0.1, pooled means where appropriate for coefficient calculations
  - N response regressions
    - At each location, SAS Proc GLM linear-plateau regressions

Table 1. Poultry manure application timing & residual crop effects considerations.

Year	Crop	Set A		Set B	
2008	Cotton	Manure	1st crop	No manure	
2009	Corn	No manure	2nd crop	Manure	1st crop
2010	Cotton	Manure	1st crop	No manure	2nd crop
2011	Corn	No manure	2nd crop	No manure	3rd crop

Figure 1. Manually applied manure on surface of Upper Coastal Plain site. Corn N response. Cotton N response.

Table 2. Composition of poultry manures applied in 2008.

Source	C:N ratio	Dry matter	CCE	N	P	K	Ca	Zn	Cu
		- % -							
LM	9	87	11	3.5	1.2	2.6	9.0	0.07	0.01
CLM	5	72	10	7.1	1.2	2.9	6.8	0.05	0.01
BL	14	77	0.3	2.5	0.7	1.9	2.0	0.04	0.03

Table 3. Poultry manure treatment crop yield ANOVA results. Symbols indicate significant differences at p levels of *0.05, ** 0.01, *** 0.001.

Effect	df	2008	2009		2010		2011	
		Cotton Yr 1	Corn Yr 1	Corn Yr 2	Cotton Yr 1	Cotton Yr 2	Corn Yr 1	Corn Yr 2
Source	2	ns	*	*	ns	*	ns	ns
Rate	1	*	*	ns	*	ns	ns	ns
S x R	2	ns	ns	ns	ns	ns	ns	ns
Location	3	ns	***	***	ns	ns	**	**

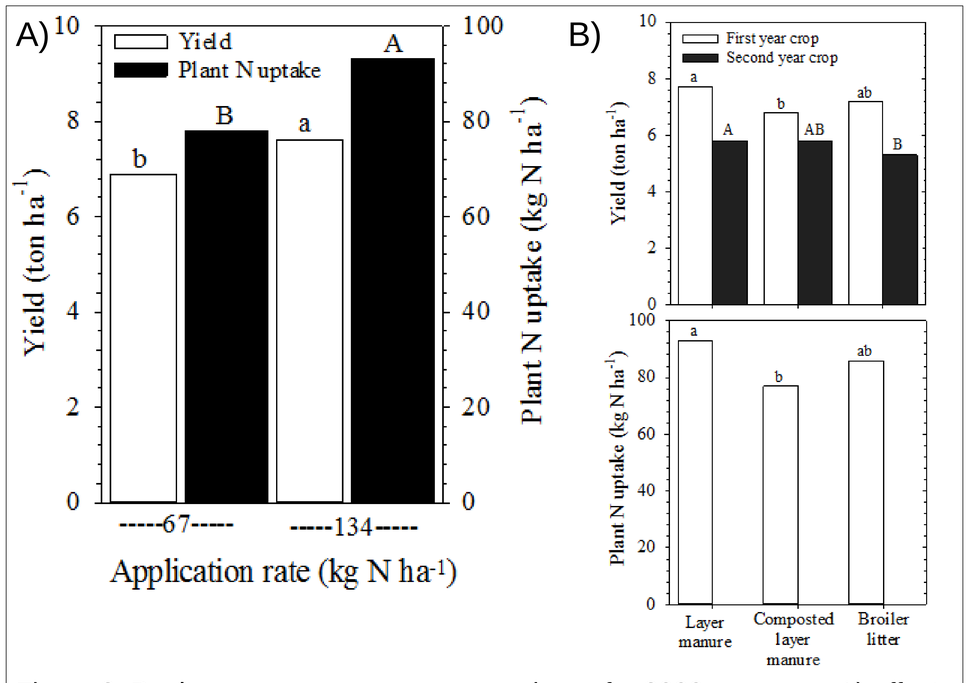

Figure 3. Poultry manure response comparisons for 2009 corn crop. A) effect of manure N rate on yield and plant N uptake, and B) effect of source on yield with manure applied either 2009 (first year crop) or in 2008 to the prior cotton crop (second year crop).

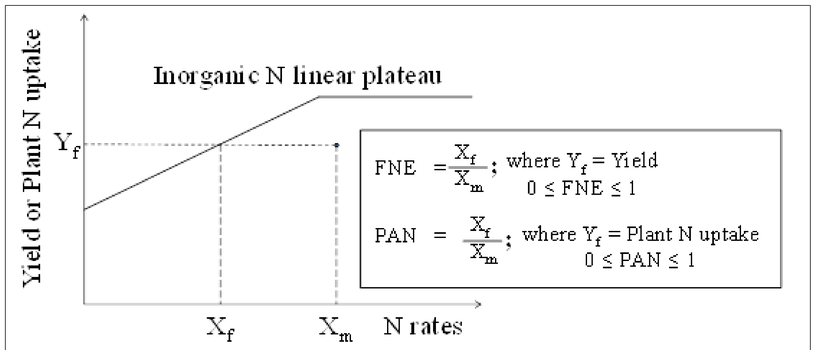

Figure 2. Fertilizer N Equivalence (FNE) or Plant Available N (PAN) coefficients were determined by comparing yield or plant N uptake of manure treatment to the inorganic N response relationship. Significant responses to inorganic N fertilizer were observed for only 9 of 16 cases for crop yield, and 7 of 8 cases for plant N uptake.

Table 4. FNE coefficients calculated for first, second, and third year of manure applications. Coefficients were based on means pooled across sources if the ANOVA found no significant source effect. The number of experimental locations contributing to each coefficient calculation is indicated in parentheses.

Year	Crop	Source	½ X rate	1 X rate
1	2009 Corn	LM	0.92 (1)	0.64 (4)
1	"	CLM	0.73 (4)	0.37 (4)
1	"	BL	0.80 (2)	0.45 (3)
1	2010 Cotton	Pooled	0.25 (1)	0.12 (1)
2	"	LM	0.32 (1)	0.16 (1)
2	"	CLM	0.10 (1)	0.05 (1)
2	"	BL	0.17 (1)	0.08 (1)
2	2009 Corn	LM	0.26 (2)	0.13 (2)
2	"	CLM	0.18 (2)	0.09 (2)
2	"	BL	0.10 (2)	0.05 (2)
2	2011 Corn	Pooled	0.50 (2)	0.25 (2)
3	"	Pooled	0.38 (2)	0.19 (2)

Summary

-Not all experiments permit coefficient estimation (especially cotton).
-Coefficient values at 1X rate were less than ½ X rate, 1X rate is more typical of routine agronomic applications.
-50-60% reasonable 1st year availability estimate, with still measurable availability during 2nd & 3rd year after application.
-For 2009 corn, yield and plant N uptake were greater with LM than with CLM source.

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