Effect of Organic Nitrogen Source and Application Rate on the Yield and Quality of Flue-cured Tobacco

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Presentation Outline

- Introduction
- Methods & Materials
- Results
- Conclusions
- Questions

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Introduction

- Organic tobacco market is rapidly expanding in North Carolina
  - Estimated 1,200 to 1,600 hectares
- Multiple manufacturers presently purchasing leaf in North Carolina
  - Very strong demand that continues to increase
- Organic production has proven to be a profitable market for a variety of FCV producers

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Introduction

- Despite market and grower base expansion, many production questions exist:
  - seedling production
    - floatbed fertility
  - insect and disease control (greenhouse and field)
  - weed control
  - nitrogen management
- At present it is not recommended that organic N sources be used in conventional production
  - Great variability exists in terms of N content and rate of N mineralization
  - Late season N uptake can result in significant greening, leaf drop, and increased insect/sucker pressure

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Introduction

Nitrogen Source Overview-Restrictions

- USDA-National Organic Program (NOP) certification dictates that certified organic nutrient sources must be used
  - If a grower is found to be non-compliant, then NOP certification is lost
  - Three year process to regain NOP certification
- NOP also limits the use of Sodium Nitrate ($NaNO_3$)
  - <20% of the total N applied can be sourced from Sodium Nitrate
- Livestock waste (manure/litter) is currently prohibited from tobacco production
- Certified organic N sources derived from livestock by-products are readily available to producers
  - Typically comprised of hydrolyzed feather, meat, and blood meal

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Introduction

Organic Nitrogen Fertilizer-Feather Meal Complex

Advantages

- Relatively high total N content
  - 8 to 13% total N
- Low P content
  - Sources available with P, if needed
- Easy to apply when pelletized
- Ample supply of material
- Safe to use

Disadvantages

- Largely comprised of N_{org}
  - <0.1% N_{min}[3]
  - 0.19% N_{min} guaranteed
- Variable rate of mineralization
- Potential for late season uptake
- Difficult to apply when material is not pelletized
- $US 600 to 750/ha

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Introduction
Organic Nitrogen Research Efforts

- Field corn fertilized with feather meal has yielded as well as, sometimes better than, poultry litter applications[1]
- 60-65% N recovery eight weeks after incubation[2,3]
  - 45 and 55% N recovery one and two weeks after application, respectively[2]
    - Hydrolyzed feather meal only
  - 47 to 50% N recovery two weeks after application[3]
    - Comparison of fish powder, blood meal, feather meal, and seabird guano
- 52% N recovery 11 weeks after incubation when hydrolyzed for 90 minutes[4]
  - Most recovery occurred between week three and week five
  - N recovery <30% when hydrolyzed <90 minutes
- Significant quantity of mineralization following application, reduced mineralization rate mid to late season.

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Research Purpose

- Evaluate organic N sources for:
  - Impact to Tobacco Yield
    - Should application rate increase?
  - Impact to Tobacco Quality
    - Late-season greening?
  - Impact to Nitrogen Uptake
    - How variable are mineralization rates?
  - Impact to Leaf Chemistry

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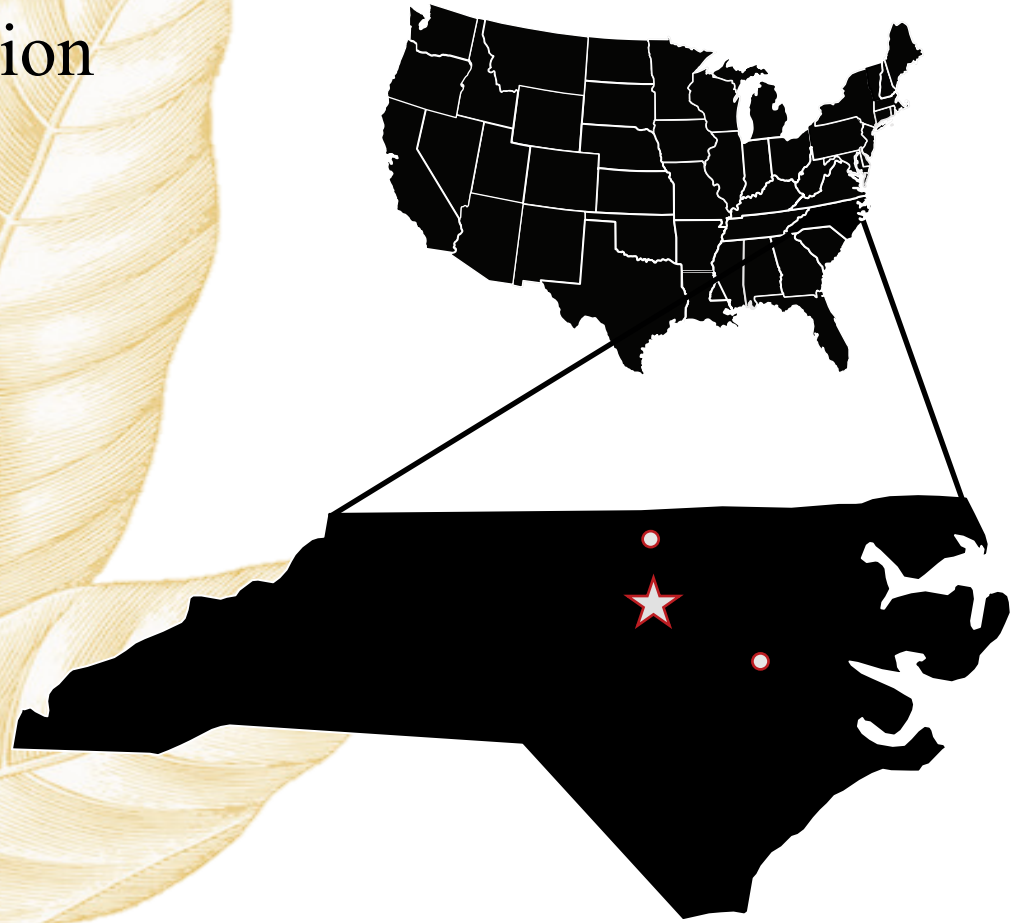
Research Locations

- Lower Coastal Plain Research Station
  - LCPRS
  - Kinston, North Carolina
  - Coastal Plain Growing Region

- Oxford Tobacco Research Station
  - OTRS
  - Oxford, North Carolina
  - Piedmont Growing Region



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Methods and Materials
Nitrogen Source Overview

Nature Safe 13-0-0

Nutrimax 12-1-0

Materials applied below, at, and above recommended rates

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Methods and Materials
Experimental Design and Data Collection

Experimental Design

- RCBD w/factorial treatment arrangement
  - Conventional N check included
- Four row plots, 13.7 m in length
  - LCPRS row width = 1.12 m
  - OTRS row width = 1.22 m
- Data collection from center two rows of each plot

Data Collection

- <u>N content of Tissue Samples:</u>
  - Layby and topping
    - 5 whole leaves from each plot
    - 4th leaf below apical meristem
  - Cured leaf
    - Composite sample of all stalk positions
- <u>SPAD:</u>
  - Topping only
  - Average of 10 plants per plot
  - 4th leaf below apical meristem
- Leaf yield, quality, and chemistry

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Treatment List

Nitrogen Source	Application Rate	LCPRS[a]	OTRS[b]
		kg/ha	
Nature Safe (13-0-0)	Base -17 kg/ha	56	62
Nature Safe (13-0-0)	Base	73	79
Nature Safe (13-0-0)	Base +17 kg/ha	90	95
Nature Safe (13-0-0)	Base +34 kg/ha[c]	107	112
Nutrimax (12-1-0)	Base -17 kg/ha	56	62
Nutrimax (12-1-0)	Base	73	79
Nutrimax (12-1-0)	Base +17 kg/ha	90	95
Nutrimax (12-1-0)	Base +34 kg/ha[c]	107	112
28% UAN	Base	73	79

[a] LCPRS; Lower Coastal Plain Research Station
[b] OTRS; Oxford Tobacco Research Station
[c] +34 kg/ha treatments added in year two of study

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Additional Notes

Treatment Application

- Plots managed with conventional practices
  - N was the only certified organic input
- Organic N applied pre-transplanting
- 28% UAN applied with CO_2 pressurized backpack
  - Split-application
- K and S applied via sulfate of potash magnesia (K-Mag)

Data Analysis

- Results analyzed using SAS ver. 9.4
  - ANOVA
  - PROC GLM
- Control trt vs. each organic trt
  - Dunnett's t-test
- Organic N treatments only
  - Control treatment removed
    - Interactions of source x rate
    - Main effects of source or rate
  - Fisher's Protected $LSD_{.05}$

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Additional Notes

Location	Soil Series	Taxonomic Classification	Variety	Transplanting Date
LCPRS-12	Norfolk loamy sand	Fine-loamy, kaolinitic,thermic Typic Kandiudults	NC 71	Apr. 19
OTRS-12	Helena sandy loam	Fine, mixed, semiactive, thermic Aquic Hapludults	CC 27	May 08
LCPRS-13	Norfolk loamy sand	Fine-loamy, kaolinitic,thermic Typic Kandiudults	NC 196	Apr. 15
OTRS-13	Appling sandy loam	Fine, kaolinitic, thermic Typic Kanhapludults	CC 27	May 16

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Additional Notes

Monthly and Seasonal Precipitation

Month	2012-LCPRS	2012-OTRS	2013-LCPRS	2013-OTRS	LCPRS Avg	OTRS Avg
	cm					
April	3.7	9.9	7.8	11.6	8.1	7.8
May	18.6	15.6	9.5	11.6	9.8	10.6
June	1.8	5.7	25.3	26.3	11.4	8.5
July	15.6	28.1	14.0	24.1	13.4	11.4
August	23.9	16.5	13.7	10.7	13.6	11.5
September	4.5	13.8	5.3	4.9	14.3	10.7
October	11.1	6.3	0.1	5.9	8.4	9.4
Total	**80.5**	**95.9**	**75.7**	**95.1**	**79.0**	**69.9**

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Results

Conventional Treatment vs. Organic Treatments

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Table 1. The effect of a conventional nitrogen source compared to various application rates of two organic nitrogen sources to tobacco yield, quality, SPAD, nitrogen content, and leaf chemistry. Data are pooled across all growing environments[a,b].

Treatment[c]	Yield	QI[d]	SPAD	Layby	Topping	Cured Leaf	Tot. Alk.	Red. Sug.
	kg/ha			% N			%	
NS -17 kg/ha	2,726	84*	42.3	4.12*	2.68 *	1.59*	2.36*	17.9*
NS base	2,772	85	41.5*	4.16*	2.77	1.64*	2.48	18.3*
NS +17 kg/ha	2,770	83*	43.8	4.46	2.74*	1.73*	2.63	16.7*
NM -17 kg/ha	2,622	82*	41.7*	4.16*	2.58*	1.65*	2.41*	17.8*
NM base	2,637	81*	42.0*	4.24*	2.60*	1.67*	2.49	17.6*
NM +17 kg/ha	2,672	83*	42.8	4.30*	2.74*	1.64*	2.56	17.7*
28% UAN base	2,819	89	44.8	4.71	3.00	1.91	2.78	15.2

[a] Treatment means followed by an asterisk are significantly different from the control treatment at the α=0.05 level.
[b] +34 kg/ha application rate removed from analysis
[c] NS; Nature Safe, NM; Nutrimax
[d] Tobacco quality assessed on a scale of 1-100, with 100 being of the highest quality

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Table 2. The effect of a conventional nitrogen source compared to various application rates of two organic nitrogen sources to tobacco yield, quality, SPAD, nitrogen content, and leaf chemistry in 2013[a]. Data are pooled across two environments.

Treatment[b]	Yield	QI[c]	SPAD	Layby	Topping	Cured Leaf	Tot. Alk.	Red. Sug.
	kg/ha			% N			%	
NS -17 kg/ha	2,575	90	38.8	4.35	2.09	1.57	2.12	17.2
NS base	2,673	90	37.1	4.47	2.18	1.59	2.26	17.7
NS +17 kg/ha	2,638	90	39.3	4.58	2.15	1.66	2.38	16.0
NS +34 kg/ha	2,857	89	40.8	4.95	2.59	1.67	2.29	16.4
NM -17 kg/ha	2,607	89	38.4	4.42	2.06	1.67	2.28	16.6
NM base	2,549	90	38.7	4.39	2.02*	1.60	2.25	17.7
NM +17 kg/ha	2,669	90	39.0	4.68	2.22	1.60	2.44	17.7
NM +34 kg/ha	2,885	91	40.1	4.76	2.34	1.70	2.40	16.1
28% UAN base	2,643	91	41.3	4.63	2.35	1.69	2.49	16.4

[a] Treatment means followed by an asterisk are significantly different from the control treatment at the α=0.05 level
[b] NS; Nature Safe, NM; Nutrimax
[c] Tobacco quality assessed on a scale of 1-100, with 100 being of the highest quality

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Results

Organic Treatments Only

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Table 3. Main effects of organic nitrogen source and application rate[a,b]. Data are pooled across all growing environments.

Factor	Yield	Quality[c]	SPAD	N-Layby	N-Topping	N-Cured	TA	RS
Source	kg/ha				%			
NS[d]	2,756 a	84 a	42.5 a	4.25 a	2.73 a	1.65 a	2.49 a	17.6 a
NM[e]	2,644 a	82 b	42.1 a	4.23 a	2.64 a	1.65 a	2.49 a	17.7 a
Rate								
-17 kg/ha	2,674 a	83 a	42.0 a	4.14 b	2.63 a	1.62 a	2.38 b	17.8 ab
Base	2,705 a	83 a	41.7 a	4.20 ab	2.68 a	1.65 a	2.49 ab	17.9 a
+17 kg/ha	2,722 a	83 a	43.3 a	4.38 a	2.74 a	1.68 a	2.59 a	17.2 b

[a] Base +34 kg N/ha and conventional treatments removed from analysis
[b] Treatment means followed by the same letter within the same column and main effect are not significantly different
[c] Tobacco quality assessed on a scale of 1-100, with 100 being of the highest quality
[d] NS; Nature Safe (13-0-0)
[e] NM; Nutrimax (12-1-0)

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Table 4. Main effects of organic nitrogen source and application rate in 2013[a]. Data are pooled across two growing environments.

Factor	Yield	Quality[b]	SPAD	N-Layby	N-Topping	N-Cured	TA	RS
Source	kg/ha				%			
NS[c]	2,686 a	90 a	39.1 a	4.59 a	2.25 a	1.64 a	2.26 a	16.8 a
NM[d]	2,678 a	90 a	39.1 a	4.56 a	2.16 a	1.62 a	2.34 a	17.0 a
Rate								
-17 kg/ha	2,592 a	90 a	38.6 b	4.39 c	2.08 b	1.62 a	2.20 a	16.9 ab
Base	2,610 a	90 a	37.9 b	4.43 bc	2.11 b	1.60 a	2.26 a	17.7 a
+17 kg/ha	2,654 a	90 a	39.2 ab	4.63 b	2.18 b	1.63 a	2.35 a	16.8 ab
+34 kg/ha	2,871 a	90 a	40.5 a	4.85 a	2.46 a	1.68 a	2.41 a	16.3 b

[a] Treatment means followed by the same letter within the same column and main effect are not significantly different
[b] Tobacco quality assessed on a scale of 1-100, with 100 being of the highest quality
[c] NS; Nature Safe (13-0-0)
[d] NM; Nutrimax (12-1-0)

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Conclusions

Conventional vs. Organic

- Similar yield
- N_{org} reduced quality
  - Variegated green due to dry June in 2012
- Lower N content with N_{org}
  - More common with Nutrimax
  - More common with below base application rate of Nature Safe
- Higher RS content with N_{org}
- Lower TA content with below base N rate

Organic Only

- Application rate had a greater effect than N_{org} source
  - Early season N uptake was greater in above base application rates
- Base application rates appear to be preferable
  - Concern with late mineralization
- Producers should consider applying all N_{org} prior to transplanting

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Future Research Efforts

- Evaluate these treatments in additional environments
- Evaluate blends of N_{org} and $NaNO_3$
- Evaluate pelletized chicken litter
  - Guaranteed analysis/certified organic
  - Pelletized
  - Low cost
  - Inclusion of P
- Evaluate cover crop and cropping system contribution to soil N

Organic Nitrogen at Recommended Application Rate (78 kg/ha)

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Questions??

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