# Supplemental Nitrogen Fertilizer for No-Till Tobacco Following Simulated Excessive Rainfall

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## Abstract

Soil erosion and nitrates can both result in environmental pollution without good crop production management. The objective of this research was to determine the feasibility of no-tillage transplanting flue-cured tobacco *(Nicotiana tabacum)* into a winter cover crop of rye *(Secale cereale)*, and to determine the supplemental N required by growing tobacco following a large simulated rainfall event under two weed control treatments. Tobacco was no-tillage transplanted into killed rye cover crop using an in-row subsoil no-tillage planter followed by a conventional one-row Mechanical Brand Transplanter in a second operation. The no-tillage transplanting procedure worked well. Diagnostic leaf N concentration, leaf yield, and leaf N content were increased by as much as 15%, 27%, and 38%, respectively, by the use of a chemical herbicide compared to the control. High rainfall/irrigation of 4 total inches in a 2-day period just prior to flowering resulted in supplemental N requirement of about 50 lb/acre. This high response to supplemental N indicated that previous fertilizer N had been lost from the root zone.

## Introduction

Soil erosion can be excessive from conventional tillage flue-cured tobacco *(Nicotiana tabacum* L.) (Doyle and Worsham, 1986). No-tillage transplanting of tobacco into winter cover crops has been successful in North Carolina (Doyle and Worsham, 1986; Wiepke, et al., 1988) and is presently receiving new emphasis in North Carolina (Worsham, 1995), Tennessee (Fowlkes, 1995; Drueger, et al., 1995) and Kentucky (Pearce, 1995; Pearce, et al., 1995) as well as this work in Florida.

This continued and renewed emphasis on conservation tillage for tobacco as well as other crops is in part due to actions of the U.S. Congress in the passage of the Food Security Act (1985) and the Food, Agriculture, and Conservation Trade Act (1990). The Food Security Act (1985) required farmers who want to remain eligible for USDA program benefits and are farming highly erodible land to develop, actively apply and fully implement a conservation plan according to schedule by the end of 1994. The Food, Agriculture, and Conservation Trade Act (1990) reinforced these farm management requirements first required by the Food Security Act (1985).

Precise and timely application of N fertilizer to crops grown on sandy soil is important in order to reduce leaching and economic losses by farmers as well as possible ground water pollution from nitrates. Excessive rainfall or irrigation can leach applied N from root zones of soils used for tobacco in Florida and can be avoided to some extent by using multiple sidedress applications of N (Smith, 1980) or corrected by replacement of the leached N (Persow and Whitty, 1982). Leaching losses can be excessive from heavy rainfall events in Florida and corn *(Zea mays* L.) and grain or forage sorghum *(Sorghum bicolor* L. Moench) responded best to N being applied in three or four split applications from planting to layby (Gallaher, et al., 1992; Lang, 1994). Winter cover crops in succession multiple cropping systems have been found to be effective in reducing nitrate leaching (Hargrove, et al., 1992) and many cover crops can provide substantial supplemental N (Gallaher, 1993). The objectives of this research were to determine the feasibility of no-tillage transplanting flue-cured tobacco into a winter cover crop of rye and determine the supplemental N required by growing tobacco following a large simulated rainfall event under two weed control treatments.

## Materials and Methods

The field experiment was conducted in 1994 at the University of Florida's Green Acres Agronomy Farm near Gainesville, Florida. 'Wrens Abruzzi' rye was drilled into a harrowed seedbed at 90 lb/acre in November 1993 on an Arredondo fine sand (fine-sandy siliceous, Hyperthermic Grossarenic Paleudult). Rye received 500 pounds per acre of

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$12(N)-4(P_2O_5)-8(K_2O)$ Jan. 10, 1994 and 2 pints 2-4-D/acre to control winter broadleaf weeds Jan. 24 1994.

Two pints Gramoxone@(F'araquat)/acre plus labeled rate of nonionic surfactant were broadcast over the rye at early anthesis on April 7, 1994. Rows 48 inches wide were laid off on April 11 using an in-row subsoil no-tillage planter (Brown-Harden). This unit did a strip tillage 12 inches deep under the row and prepared a clean seedbed in the standing rye about 4 to 6 inches wide over the row. Rye was partially pressed down in the middles, especially near the strip-tilled areas. Flue-cured tobacco, cultivar 'K326,' was transplanted at a spacing of 16 inches into the subsoil strips with a one-row Mechanical Brand Transplanter on April 12. The transplanter had to be operated in the same direction as the no-tillage subsoil unit in order to eliminate dragging and disruption due to the compressed rye. Fertilization consisted of 650 lb/A 6(N)-6(Pz05)-18($K_2O$) on April 28, 650 lb/A 6(N)-6(P,0,)-18($K_2O$) on May 9, and 300 Ib/A 6(N)-6($P_2O_5$)-19(K,0) on May 16. This represented a total of 96 lb N/acre and, under normal circumstances, should have been adequate for maximum flue-cured tobacco production under Florida conditions (Stocks and Whitty, 1992).

Whole-plot treatments consisted of application of the herbicide Poast@ (sethoxydin) broadcast on April 18 at 1 pint formulated product/acre with a nonphytotoxic oil versus a control that received no weed control. Subplot treatments consisted of a supplemental sidedress application of N as ammonium nitrate at rates of *0*, 25, 50, and 75 lb N/acre. The sidedress N was applied June 19 followed by 0.2 acre-inch of irrigation to immediately move the N into the root zone. Rainfall was supplemented by overhead sprinkler irrigation as needed once or twice per week. The supplemental N was applied following a few days of heavy rainfall (1 acre-inch on June 18) and irrigation, which simulated 2 acre-inches of rainfall on June 18 and an additional 1 acre-inch on June 19.

The final subplot area was 22 feet long and 48 inches wide. Tobacco was topped at early flowering. Suckers were chemically controlled by a broadcast spray of 3 lb ai/A Maleic hydrazide [MH(WSSA)] immediately after topping. One week following topping, the topmost leaf was collected at random from six plants in each subplot for N analysis. The end plants were removed between plots prior to harvest, leaving **15** plants per 20 feet long subplots. Bottom leaf harvest was on July 13 and top leaf harvest was on July 27. Leaves were cured in a commercial tobacco barn. Stalks were harvested on July 27. All leaves and stalks were dried at 70 "C in a forced-air oven until dry, weighed, chopped as necessary, and ground to pass a 2-mm stainless steel screen using a Wiley mill. Samples were stored in sterile airtight plastic bags.

Nitrogen analysis consisted of weighing 100 mg of dry ground tobacco into 1-inch diameter 100-ml Pyrex test tubes. A salt catalyst mixture (2.3 g $K_2SO_4$:$CuSO_4$ in an 8:1 ratio), 2 glass boiling beads, and 10 ml of concentrated $H_2SO_4$ was added to each tube and mixed on a vortex mixer. The tubes were placed in an aluminum digestion block (Gallaher, et al., 1975), predigested by the careful addition of 2 mL of concentrated $H_2O_2$, and tubes covered with small glass funnels. Samples were digested for 3.5 hours, cooled, diluted with distilled water, cooled and brought to 75 mL of volume, and stored in Nalgene storage bottles. Nitrogen was determined colorimetrically using an autoanalyzer.

Data were tabulated, transformed as necessary, and ASCII files prepared using Quattro Pro@ (1987). Analysis of Variance was conducted using Mstat? (1985). The tables and manuscript were finalized using Wordperfect@ (1990).

## Results and Discussion

The no-tillage subsoil strip-tillage transplanting of tobacco was successful with 100% survival of the seedlings. Tobacco plants appeared to have good root systems and experienced no lodging from the subsoil management. Farmers who are interested in this management should be able to utilize an in-row subsoil no-tillage planter with the transplanter units attached to the subsoiler frame. Because of the long distance from the rear of the tractor to the seats on the transplanter, one or two hydraulic helper wheels on the transplanter would likely be necessary to achieve successful planting in one operation.

The total N applied in the complete fertilizer was 96 lb/Acre and should have been adequate for high yield tobacco under Florida conditions. Leaf analysis showed that average N concentration increased by 76% from the 0 lb N/A treatment to the 75 lb N/A treatment (Table **1).** This indicated that either not enough N was applied or that the excess rainfall/irrigation did, in fact, leach N below the tobacco roots. Leaf N was in greater concentration for the herbicide-treated plots compared to the check at all levels of N fertilizer applied. This indicated that the greater numbers of weeds in the check plots were competing with tobacco for N. Leaf N appeared to approach sufficient levels (Jones et al., 1991) at the 50 lb N/A rate in the herbicide treated plots but would require 75 lb N/A or greater fertilizer N in the check plots.

Nitrogen concentration in the diagnostic leaf was positively related to dry matter yield (Tables **1** & 2). Leaf yield responded to 50 lb supplemental N/A, stalk yield to between 25

**Table 1. No-tillage tobacco leaf N concentration from weed control and supplemental N treatments. Florida 1994.**

| Herbicide Applied | Plant Part | Nitrogen Rate, lb/acre 0 | 25 | 50 | 75 | Average |
|---|---|---|---|---|---|---|
| | | | % | | | |
| Yes | Leaves | 2.04 | 2.38 | 3.25 | 3.14 | 2.85* |
| No | Leaves | 1.79 | 2.23 | 2.84 | 3.00 | 2.47 |
| Average | Leaves | 1.91 d | 2.30 c | 3.05 b | 3.37 a | |

LSD Q 0.05 p among N means = 0.29
CV subplot N means = 10.54%
* = significant difference between herbicide means Q 0.05 1,

Values among average N means not followed by the same letter are significantly different according to LSD test at the 5% level. No significant interactions occurred between weed control treatments and N treatments.

and 50 lb N/A and whole plant yield to 25 lb N/A (Table 2). Herbicide treatment resulted in greater leaf and total plant yield compared to the check. The leaf to stem dry matter ratio indicated that the supplemental N was required in greater quantities for leaf dry matter production compared to the stem (Table 2). This would be expected since the stem would develop first during plant growth and development and would have had access to an assumed sufficient level of fertilizer N prior to the excess rainfall/irrigation time.

Twice as much N was recovered in the leaf dry matter at the 50 lb supplemental N/A rate compared to the control (Table 3). This relationship held true for the total plant as well. Consistently greater amounts of N was removed by tobacco parts and total plant from the herbicide-treated plots compared to the control (Table 3).

**Table 2. No-tillage tobacco plant dry matter yield from weed control and supplemental N treatments, Florida 1994.**

| Herbicide Applied | Plant Part | Nitrogen Rate, lb/acre 0 | 25 | 50 | 75 | Average |
|---|---|---|---|---|---|---|
| | | ---- lb dry matter/acre ---- | | | | |
| Yes | Leaves | 1,182 | 1,764 | 1,896 | 1,736 | 1,645* |
| No | Leaves | 931 | 1,107 | 1,631 | 1,482 | 1,288 |
| Average | Leaves | 1,056 c | 1,436 b | 1,764 a | 1,609 ab | |

LSD @ 5% level among N means = 317
CV subplot N means = 20.64%
* = significant difference between herbicide means @ 5% level

| Herbicide Applied | Plant Part | 0 | 25 | 50 | 75 | Average |
|---|---|---|---|---|---|---|
| | | ---- lb dry matter/acre ---- | | | | |
| Yes | Stalks | 1,057 | 1,484 | 1,402 | 1,471 | 1,354 NS |
| No | Stalks | 1,048 | 1,013 | 1,448 | 1,260 | 1,192 |
| Average | Stalks | 1,052 b | 1,249 ab | 1,424 a | 1,366 a | |

LSD @ 5% level among N means = 275
CV subplot N means = 20.60%
NS = No significant difference between herbicide means @ 5% level

| Herbicide Applied | Plant Part | 0 | 25 | 50 | 75 | Average |
|---|---|---|---|---|---|---|
| | | ---- lb dry matter/acre ---- | | | | |
| Yes | Plant | 2,239 | 3,249 | 3,298 | 3,207 | 2,998* |
| No | Plant | 1,979 | 2,120 | 3,079 | 2,743 | 2,480 |
| Average | Plant | 2,109 b | 2,685 a | 3,189 a | 2,975 a | |

LSD @ 5% level among N means = 561
CV subplot N means = 19.51%
* = significant difference between herbicide means @ 5% level

| Herbicide Applied | Plant Part | 0 | 25 | 50 | 75 | Average |
|---|---|---|---|---|---|---|
| | | ---- dry matter, leaf/stem ratio ---- | | | | |
| Yes | Plant | 1.14 | 1.19 | 1.36 | 1.19 | 1.22* |
| No | Plant | 0.88 | 1.11 | 1.14 | 1.19 | 1.08 |
| Average | Plant | 1.01 b | 1.15 ab | 1.25 a | 1.19 a | |

LSD @ 5% level among N means = 0.15
CV subplot N means = 12.53%
* = significant difference between herbicide means @ 5% level

Values among average N means not followed by the same letter are significantly different according to LSD test at the 5% level. No significant interactions occurred between weed control treatments and N treatments.

## Summary and Conclusions

Erosive soils and national U.S. policy may necessitate that some farmers adapt conservation tillage management for tobacco as has been done for other crops. This study demonstrated that no-tillage subsoil transplanted tobacco into rye cover crop could be successful in Florida. Modification of existing equipment should make this management practical for erosion-prone soils. Weed control is essential to reduce competition with tobacco under these conditions. The herbicide treatment consistently gave larger leaf N concentrations, dry matter yield and N removal by the crop. More experimentation with herbicide treatments is needed. Even the herbicide treatment had some weeds that may have been controlled with a second application of the same herbicide.

**Table 3. No-tillage tobacco plant N content from weed control and sumlemental N treatments, Florida 1994.**

| Herbicide Applied | Plant Part | Nitrogen Rate, lb/acre 0 | 25 | 50 | 75 | Average |
|---|---|---|---|---|---|---|
| | | ---- lb N/acre ---- | | | | |
| Yes | Leaves | 19.9 | 31.1 | 40.3 | 42.8 | 33.5* |
| No | Leaves | 15.1 | 18.7 | 31.7 | 31.7 | 24.3 |
| Average | Leaves | 17.5 b | 24.9 b | 36.0 a | 37.3 a | |

LSD @ 5% level among N means = 8.1
CV subplot N means = 26.79%
* = significant difference between herbicide means @ 5% level

| Herbicide Applied | Plant Part | 0 | 25 | 50 | 75 | Average |
|---|---|---|---|---|---|---|
| | | ---- lb N/acre ---- | | | | |
| Yes | Stalks | 8.7 | 13.9 | 17.0 | 20.2 | 17.0+ |
| No | Stalks | 8.6 | 8.6 | 14.1 | 12.6 | 11.0 |
| Average | Stalks | 8.6 c | 11.3 bc | 15.5 ab | 16.4 a | |

LSD @ 5% level among N means = 4.4
CV subplot N means = 32.20%
* = significant difference between herbicide means @ 10% level

| Herbicide Applied | Plant Part | 0 | 25 | 50 | 75 | Average |
|---|---|---|---|---|---|---|
| | | ---- lb N/acre ---- | | | | |
| Yes | Plant | 28.6 | 45.0 | 57.3 | 63.1 | 48.5* |
| No | Plant | 23.7 | 27.3 | 45.9 | 44.4 | 35.3 |
| Average | Plant | 26.1 b | 36.2 b | 51.6 a | 53.7 a | |

LSD @ 5% level among N means = 12
CV subplot N means = 27.20%
* = significant difference between herbicide means @ 5% level

| Herbicide Applied | Plant Part | 0 | 25 | 50 | 75 | Average |
|---|---|---|---|---|---|---|
| | | ---- N content, leaf/stem ratio ---- | | | | |
| Yes | Plant | 2.31 a* | 2.36 aNS | 2.45 aNS | 2.14 aNS | 2.32 |
| No | Plant | 1.73 b | 2.18 ab | 2.25 a | 2.54 a | 2.18 |
| Average | Plant | 2.02 | 2.27 | 2.35 | 2.34 | |

LSD @ 5% level among N means = 12
CV subplot N means = 27.20%
* = significant difference between herbicide means @ 5% level

Values among average N means within a weed treatment not followed by the same letter are significantly different according to LSD test at the 5% level.
* and NS = Significant and nonsignificant difference, respectively between weed treatments within a N treatment at the 5% level.

Excess application of water from either rainfall, irrigation, or both can result in losses of fertilizer N either due to leaching or erosion. Tobacco leaf and whole plant yield was improved by as much as 75% from application of supplemental N in this study. This indicated that either not enough N was applied in the complete fertilize; management or, what was more likely, that the excess water received by the crop resulted in leaching of the N out of the tobacco root zone. Based on the results of this study it is recommended that 50 Ib supplemental N/A be sidedressed immediately on tobacco, if rainfall/irrigation amounts of 3 acre-inches or more are received in a 3-day period within a 2- to 3-week period prior to flowering.

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