NC STATE UNIVERSITY

# Crop Rotation and Seasonal Effects on Amino Sugar-Nitrogen Test Values in the Humid Southeast

CROP SCIENCE

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## INTRODUCTION

➢Warm temperatures and high rainfall in the southeastern USA reduce the reliability of stand-alone residual $NO_3^-$-N tests as $NO_3^-$-N is commonly lost through leaching and denitrification. Additionally, residual $NO_3^-$-N tests do not measure N that may be mineralized after sampling, resulting in under estimation of the soil N supply.

➢Accurate assessment of plant available soil N from mineralization of soil organic matter could be important for improving in-season N recommendations for soft red winter wheat in the humid Southeastern USA.

➢The amino sugar-N test (ASNT) is intended to measure a potentially mineralizable fraction of soil organic N, amino sugar N. If the ASNT can accurately predict mineralizable N that will become available to the crop it could have important economic implications for in season N recommendations.

## OBJECTIVES

➢To evaluate the effects of soil profile depth on the ASNT in the Southeastern USA.

➢To evaluate the effect of crop rotation, seasonality and fertilizer application on the ASNT.

➢To evaluate the effect of soil type and geographic location on the ASNT.

## MATERIALS & METHODS

➢Experiments were conducted from Fall 2005-present at ten 0.2 ha sites across North Carolina.

➢Of these ten sites five were in long-term no-till Piedmont fields and five conventionally tilled Coastal Plain fields selected based on soil series and mapping unit.

➢At each location an RCBD with five replications and seven N-rate treatments was initiated in Fall 2005. For the experiment reported here a location was randomly picked within each block for soil sampling. At each location 6-8 soil cores were taken to a depth of 30 cm. Each core was divided in 0-10, 10-20, and 20-30 cm depth increments which were bulked into a single sample for each depth-by-block. These sampling locations were then GPS referenced in order to return to these locations three times each year coinciding with planting, mid season and harvest through May 2007.

➢Soil samples were analyzed for amino sugar-N (ASN) using the procedure described by Khan et al. (2001) and modified by Williams et al. (2007).

➢Soil samples were also analyzed for residual $NO_3^-$-N and $NH_4^+$-N.

➢Repeated measures analysis was conducted in PROC MIXED SAS Version 9. Six error covariate structures were modeled: a nontemporal covariance structure that assumed independent and identically distributed errors and five temporal covariance structures. The best fit covariance model for ASN, residual soil $NO_3^-$-and $NH_4^+$-N at each site and sampling depth was selected using Akaike Information Criterion (Akaike, 1974). A least squared means procedure was used for means separation of ASN, residual $NO_3^-$-N and $NH_4^+$-N over time and across depths.

**Table 1. ANOVA results for ASNT at each of ten locations. The best fit model and significance for the main effects of soil sampling depth and sampling time and their interaction are shown.**

| Soil Series | Best Fit Model | Depth | Time | Depth*Time |
|---|---|---|---|---|
| **Coastal Plains Locations** | | | | |
| Pantego | Spatial Spherical | *** | *** | *** |
| Bayboro | Spatial Spherical | *** | *** | ** |
| Lynchburg | Compound Symmetry | *** | *** | ns |
| Norfolk | Compound Symmetry | *** | *** | *** |
| Goldsboro | Spatial Spherical | *** | *** | * |
| **Piedmont Locations** | | | | |
| Hiwassee† | Spatial Exponential | *** | *** | ns |
| Davidson | Compound Symmetry | *** | *** | * |
| Pacolet | Spatial Exponential | *** | *** | * |
| Hiwassee‡ | Spatial Gaussian | *** | *** | * |
| Cecil | Compound Symmetry | *** | *** | ns |

**Table 2. ANOVA results for $NO_3^-$-N at each of ten locations. The best fit model and significance for the main effects of soil sampling depth and sampling time and their interaction are shown.**

| Soil Series | Best Fit Model | Depth | Time | Depth*Time |
|---|---|---|---|---|
| **Coastal Plains Locations** | | | | |
| Pantego | IID§ | * | *** | ns |
| Bayboro | IID§ | *** | *** | *** |
| Lynchburg | Spatial Spherical | * | *** | *** |
| Norfolk | IID§ | ** | *** | *** |
| Goldsboro | IID§ | *** | *** | *** |
| **Piedmont Locations** | | | | |
| Hiwassee† | Spatial Exponential | ** | *** | *** |
| Davidson | IID§ | ns | *** | ns |
| Pacolet | Compound Symmetry | ** | *** | ns |
| Hiwassee‡ | Spatial Spherical | ** | *** | * |
| Cecil | Spatial Spherical | ** | *** | *** |

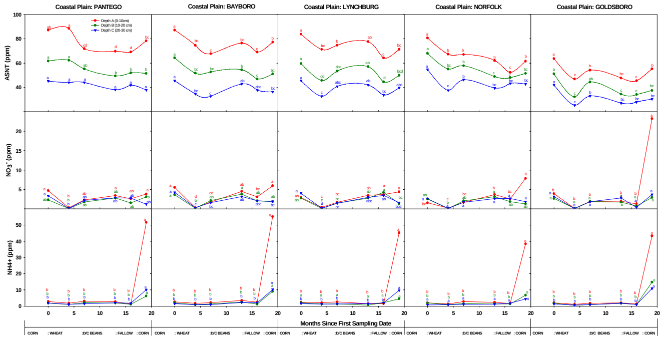
**Table 3. ANOVA results for $NH_4^+$-N at each of ten locations. The best fit model and significance for the main effects of soil sampling depth and sampling time and their interaction are shown.**

| Soil Series | Best Fit Model | Depth | Time | Depth*Time |
|---|---|---|---|---|
| **Coastal Plains Locations** | | | | |
| Pantego | IID§ | *** | *** | *** |
| Bayboro | IID§ | *** | *** | *** |
| Lynchburg | Spatial Spherical | *** | *** | *** |
| Norfolk | Spatial Spherical | *** | *** | *** |
| Goldsboro | Spatial Spherical | *** | *** | *** |
| **Piedmont Locations** | | | | |
| Hiwassee† | Spatial Spherical | *** | *** | * |
| Davidson | Spatial Spherical | ** | *** | ns |
| Pacolet | Spatial Spherical | * | *** | ns |
| Hiwassee‡ | Spatial Spherical | ns | ** | ns |
| Cecil | Spatial Spherical | ns | ** | ns |

†Hiwassee clay loam 2-6% slopes.
‡Hiwassee clay 2-6% slopes.
§ Independent and identically distributed errors

* Significant at the 0.05 probability level.
** Significant at the 0.01 probability level.
*** Significant at the 0.001 probability level.

Fig.1: ASNT (ppm), $NO_3^-$-N (ppm), and $NH_4^+$-N (ppm), vs Months Since First Sampling for Conventionally Tilled Coastal Plain Sites. The colored letters correspond to the separation of means over time within each soil sampling depth.




## RESULTS: COASTAL PLAIN SITES

➢The five Coastal Plain sites consisted of a Pantego Fine Sandy Loam, Bayboro Loam, Lynchburg Sandy Loam, Norfolk Loamy Sand, and a Goldsboro Loamy Sand. Sampling began at all these sites following a grain corn crop and continued through a winter wheat, double-cropped soybeans, fallow, and corn rotation. All crops were conventionally tilled except for the no-till double-cropped soybeans.

➢In the sandy loam and loam soils sites ASNT decreased to varying degrees with increasing depth on all dates (Fig.1), resulting in the main effect of depth and the interaction of depth*time being significant (Table 1). In the sandier Norfolk and Goldsboro soil sites the main effect of depth and the interaction of depth*time were also significant but ASNT at some depths on some sampling dates was not significantly different (see for example Fig. 1 Norfolk month 16).

➢There is a general trend for ASNT to decrease over the winter months (sample months 4, and 16). This may be due to lower microbial activity over these cooler wetter months and lower breakdown of stover and movement of organic substrate into the amino sugar-N pool. There is also a trend for the highest ASNT values to be associated with the corn crop (sample months 0, and 19), possibly due to breakdown of the wheat and soybean residues associated with tillage prior to corn planting.

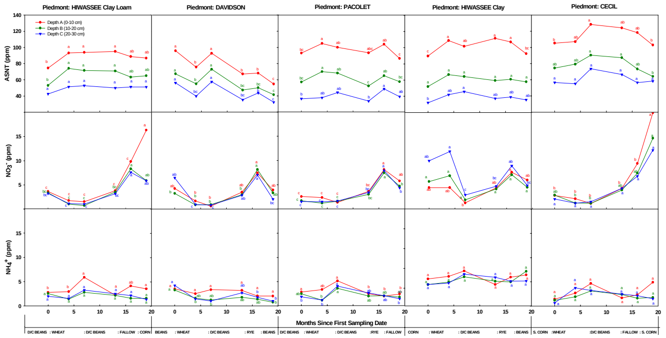
➢Pre-plant fertilizer N was applied prior to sampling date 0 and after sampling date 16 for the winter wheat and corn crops respectively. Wheat top-dress fertilizer N was applied just after sampling date 4. Corn side-dress fertilizer N was applied just prior to sampling date 19 and this explains the spike in $NH_4^+$-N at all sites and the increase in $NO_3^-$-N at three of the five sites. The ASNT values for these sites do not reflect the large increase in soil $NH_4^+$-N following this corn side-dress application.

➢Soil $NO_3^-$-N decreased over the winter months following pre-wheat tillage but remained stable the following winter through the no-till rotation.

REFERENCES

Khan, Mulvaney, & Hoeft. 2001. A simple soil test for the detecting sites that are non-responsive to nitrogen fertilization. Soil Sci. Soc. Am. J. 65:1751-1760.
Williams, Crozier, White, & Crouse. 2007. Comparison of soil nitrogen tests for corn fertilizer recommendations in the humid southeastern USA. Soil Sci, Soc. Am. J. 71:171-180.

Fig. 2: ASNT (ppm), $NO_3^-$-N (ppm), and $NH_4^+$-N (ppm), vs Months Since First Sampling for the No-Till Piedmont Sites. The colored letters correspond to the separation of means over time within each soil sampling depth.




## RESULTS: PIEDMONT SITES

➢The five Piedmont sites consisted of a Hiwassee Clay Loam, Davidson Clay Loam, Pacolet Clay, Hiwassee Clay, and a Cecil loam. Sampling began at all these sites just prior to winter wheat planting following different crop rotations. All crops were no-till.

➢In the Pacolet and Hiwassee Clay soils ASNT decreased to varying degrees with increasing depth on all dates (Fig.2), resulting in the main effect of depth and the interaction of depth*time being significant (Table 1). In the coarser textured clay loam Hiwassee and Davidson soils the main effect of depth was significant but on many sampling dates the B and C depths did not differ significantly. In the coarsest textured Cecil loam there was large spatial variability across the site resulting in a non significant separation of means across depths.

➢There was a general trend for ASNT values to be higher following full season soybeans compared to double-crop soybeans (see Hiwassee Clay Loam, Davidson and Pacolet sampling date 0). There was also a trend for ASNT to decrease following a rye cover-crop in contrast to over-winter fallow. ASNT increased where corn stover was left in the field compared to where corn was harvested for silage (see Hiwassee Clay and Cecil sampling dates 0 and 4).

➢At all these no-till Piedmont sites pre-plant fertilizer N was applied just after soil sampling date 0 and top-dress N was applied just after soil sampling date 4 for the winter wheat crop. At the Hiwassee Clay Loam and Cecil sites N was also applied after soil sampling date 16 for corn crops. This corn N application explained the spike in $NO_3^-$-N at these two sites. At the Hiwassee Clay site a failed corn crop lead to high levels of residual $NO_3^-$-N being present at soil sampling date 0. While some effects for $NH_4^+$-N were statistically significant, differences between depths and across time were probably agronomically negligible.

## CONCLUSIONS

**➢This data shows that time of year, soil sampling depth and rotation/tillage have a significant impact on ASNT.**

**➢It also shows that the ASNT is not highly sensitive to either soil $NO_3^-$-N or $NH_4^+$-N.**