# Effect of Fall Nitrogen On Corn Residue Breakdown in Illinois

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## Introduction

- No-till has become more prevalent over time in the Midwest due to lower machinery requirements, reduced soil erosion and runoff, and improved soil water infiltration and cover.
- However, no-till systems present challenges for growers, such as residue management, reduced yields, cooler and wetter soil conditions, and poor plant emergence, distribution and uniformity in comparison to conventional tillage. Moreover, no-till continuous corn (*Zea Mays*) systems usually present a thick residue cover, increasing the risk of poor plant stand and reduced yields.
- Several factors and their interactions influence residue decomposition, including temperature, soil moisture, nutrient availability, as well as the material's C:N ratio, lignin, and carbohydrate contents. Management influences the amount of residue left on the field after harvest, the position of the residue (buried or on the surface) and the particle size of the residue.
- An increasingly common agronomic practice is the application of small amounts of post-harvest nitrogen (N) fertilizer to speed the rate of residue decomposition. However, the merit of such a practice has not been properly evaluated through research.

## Research Objectives

- To investigate the potential of post-harvest N fertilizer to increase the decomposition rate of corn residue, especially stalks.
- To determine if a particular source of N provides an advantage to residue decomposition and lower C:N ratios.
- To quantify the amount of remaining soil inorganic N in the soil by planting time for the fall treatments.

## Materials and Methods

- Field experiments were conducted during the 2012-2013 growing seasons in Urbana, IL, in Drummer silty clay loam and Flanagan silt loam soils with 0-2% slopes.
- Corn was planted after corn. The experiment was a split plot arrangement with four replications in an RCBD, with N application timing (Sept., Oct., Nov., pre-plant) as the main plots and N rate (0, 34, 67, 134, 202 kg ha$^{-1}$) and N source as subplots. All N applications were broadcast on 6x15 m plots. Sources of N were liquid AMS and UAN. Fall treatments (Sept., Oct., Nov.) were tested only at the highest rate (202 kg ha$^{-1}$), receiving a split N application of 34 kg ha$^{-1}$ in the fall and the remainder of 168 kg ha$^{-1}$ before planting.
- Corn residue bags were filled with 0.5 kg of field moist residue left from the preceding season within 24 hrs. of the N applications in Sept., Oct., and Nov. The bags were collected for analysis in Sept., Oct., Nov., Dec., and April. Stalk strength was measured after drying the bags to constant weight. The diameter and internode distance of stalks were recorded using a digital caliper and ruler, and mechanical strength of stalks was measured with a penetrometer (Dillon GL Digital Force Gauge) equipped with a cone tip to punch a hole in the middle of the internode distance of the stalk. All residue material was ground and analyzed for C:N ratios.
- Soil inorganic N ($NH_4^+$ and $NO_3^-$) was measured for the control and fall treatments at a depth of 0-36 inches. Samples were taken in the fall, after planting (soil fertilization had already been applied), and after harvest.

## Weather Data

Air temperature and precipitation including departures (in parenthesis) from the 20-year average (1989-2008)

| Year | Month | Temperature | Precipitation |
|---|---|---|---|
| | | °C | mm |
| 2011 | April | 11.9(0.6) | 214.4(131.2) |
| 2011 | May | 16.9(-0.1) | 122.4(2.6) |
| 2011 | June | 22.8(0.5) | 106.6(10.9) |
| 2011 | July | 26.8(3.1) | 39.6(-73.4) |
| 2011 | August | 24.1(1.2) | 44.9(-48.6) |
| 2011 | September | 17.5(-1.6) | 70.8(-0.7) |
| 2011 | October | 12.6(0.1) | 66.8(-15.8) |
| 2011 | November | 7.6(1.7) | 128.2(46.3) |
| 2011 | December | 1.6(2.3) | 81.2(20.4) |

| Year | Month | Temperature | Precipitation |
|---|---|---|---|
| | | °C | mm |
| 2012 | January | -0.3(2.3) | 88.3(28.4) |
| 2012 | February | 1.7(1.9) | 36.3(-16.2) |
| 2012 | March | 12.5(7.4) | 48.5(-20.4) |
| 2012 | April | 12.5(1.2) | 36.1(-47.1) |
| 2012 | May | 20.5(3.5) | 90.1(-29.5) |
| 2012 | June | 22.7(0.4) | 46.2(-49.5) |
| 2012 | July | 27.6(3.8) | 14.4(-98.5) |
| 2012 | August | 23.1(0.1) | 142.2(48.6) |
| 2012 | September | 17.8(-1.3) | 142.4(70.8) |
| 2012 | October | 10.7(-1.9) | 137.6(55.1) |
| 2012 | November | 4.7(-1.2) | 30.9(-50.9) |
| 2012 | December | 2.5(3.2) | 65.2(4.1) |

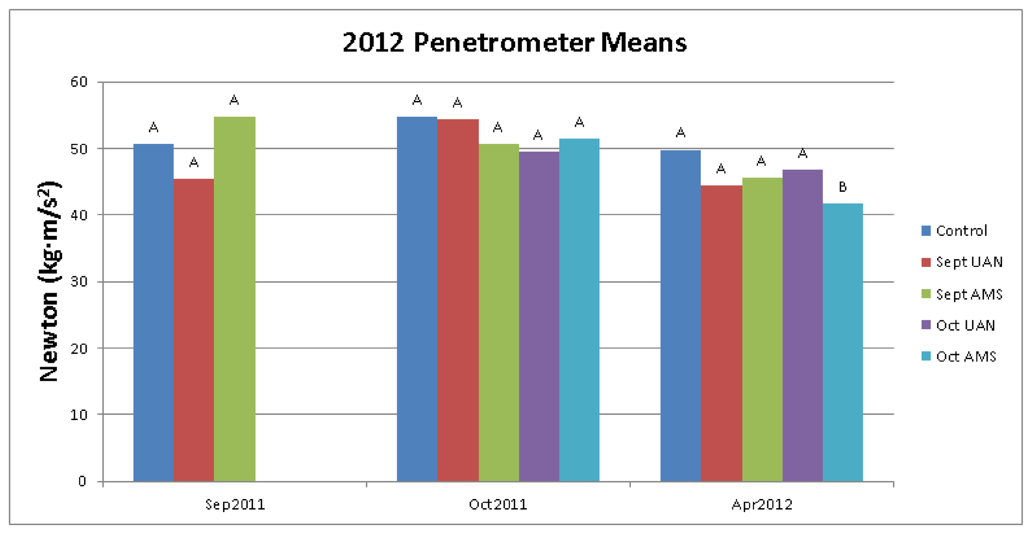
| Year | Month | Temperature | Precipitation |
|---|---|---|---|
| | | °C | mm |
| 2013 | January | -1.7(0.8) | 70.6(10.6) |
| 2013 | February | -1.3(-1.1) | 91.1(38.6) |
| 2013 | March | 1.3(-3.8) | 37.3(-31.6) |
| 2013 | April | 10.3(-1.1) | 181.1(97.9) |
| 2013 | May | 18.1(1.1) | 118.8(-0.8) |
| 2013 | June | 21.8(-0.5) | 135.6(39.8) |
| 2013 | July | 22.8(-0.9) | 88.3(-24.6) |
| 2013 | August | 22.9(-0.1) | 12.1(-81.3) |
| 2013 | September | 20.6(1.5) | 12.4(-59.1) |

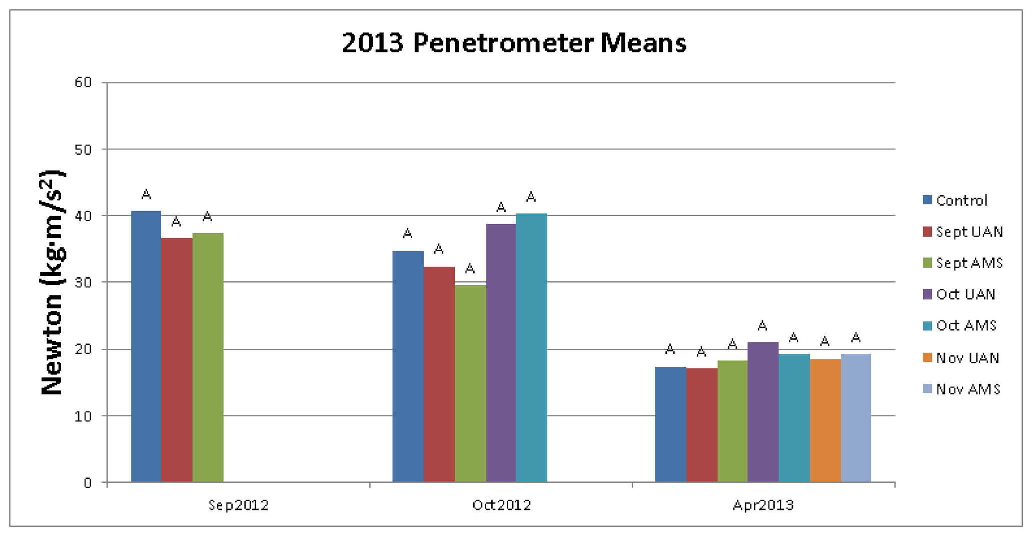
- The 2011 season was close to the 20-yr. normal ranges, except for a water deficit in July-August. The amount and quality of crop residue produced from the 2011 season was typical. The 2012 season presented a lack of precipitation between February and July. The amount and quality of crop residue produced from the 2012 season was very low relative to normal years.
- The 2013 season had excessive precipitation which delayed planting until June 7$^{th}$. A period with almost no precipitation occurred during the last part of July and August.
- The fall-winter periods between 2011-2012 and 2012-2013 were slightly different, with the 2011-2012 period receiving about 200 mm less precipitation. In 2012, the topsoil was very dry starting in March, while in 2013 there was excessive precipitation in early spring.

## RESULTS

### Penetrometer Values

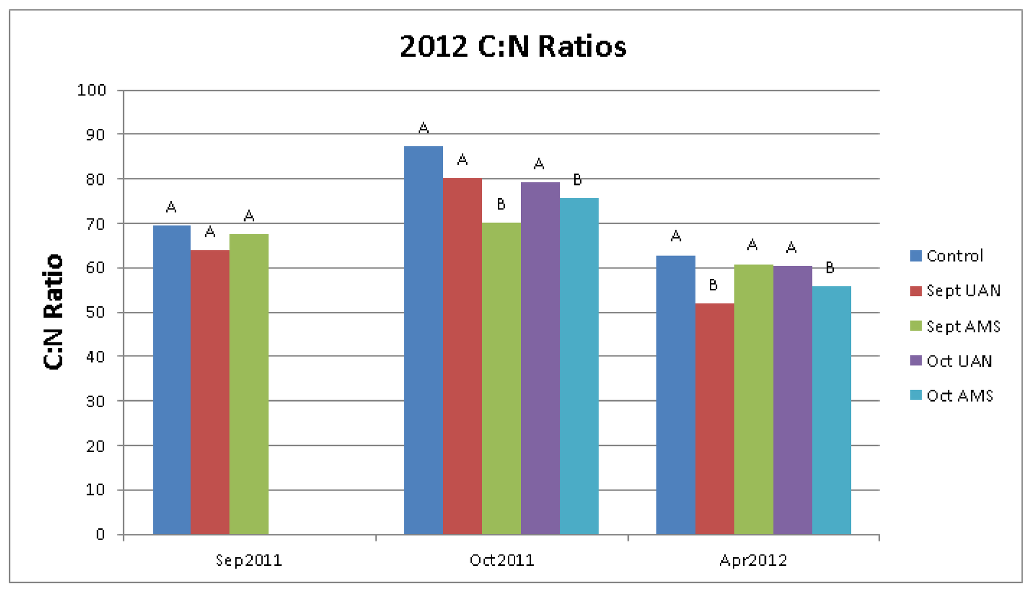
- In 2012 the control displayed some of the highest numerical (although not statistically significant) penetrometer values, especially at the last sampling. The treatment with the lowest value received N in October and not in September as we expected.
- In 2013 the penetrometer values started lower than the first season, illustrating the fact that residue produced in the 2012 season was of poorer quality. There were no statistical differences in penetration resistance between treatments at any of the sampling times.

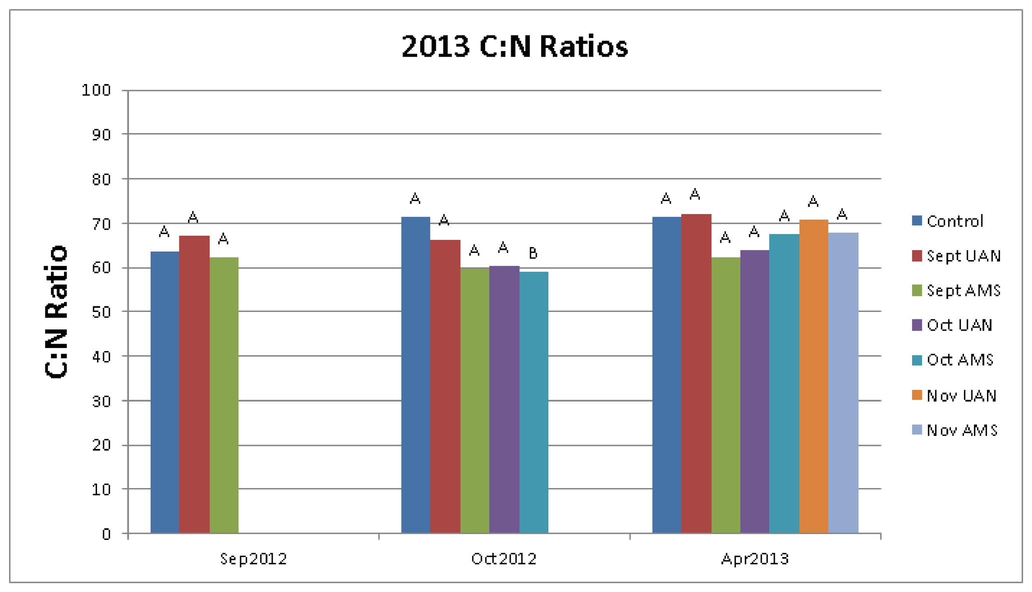



### C:N Ratios

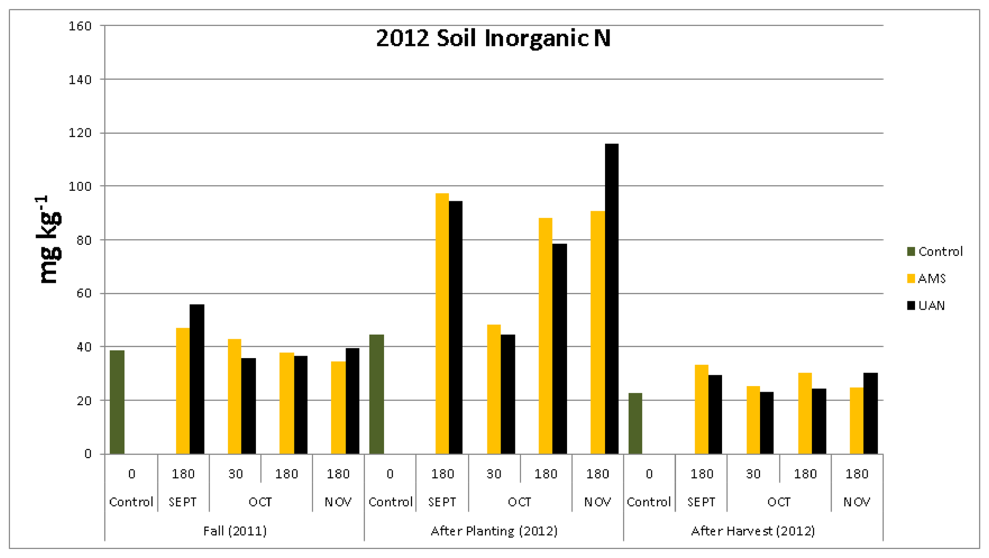
- During both seasons, the control showed one of the highest C:N ratios, which was expected, though the differences were not always statistically significant.
- The 2012 season presented a reduction in the C:N ratios, with very similar values between treatments at the April sampling. While there were a few significant differences between treatments, the differences were small and inconsistent.
- The 2013 season showed no change in C:N ratios over time, likely a reflection of the poor quality of the starting material. The ratios from both seasons suggest that applying N in the fall had little or no impact in reducing C:N ratios.

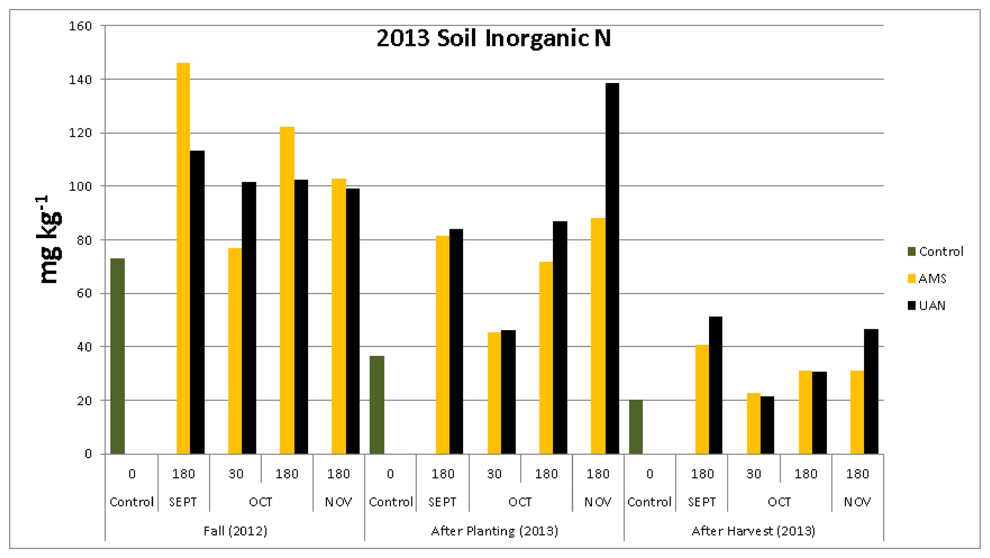



### Soil Inorganic N

- During 2012 there was sufficient N in the root zone but weather conditions likely reduced plant N uptake.
- Although 2013 started with very high N levels, by the second sampling the soil tests were similar to the previous season at the same period, indicating that substantial N loss likely occurred between the fall and the sampling after planting.




## Discussion

Some treatments showed evidence that the C:N ratio can be reduced to favor higher decomposition rates; however, the ratios are still well above 25, which by convention is the point where microbial decomposition can proceed without additional N.

Although the weather and quality of the residues were very dissimilar for both seasons, the application of post-harvest N fertilizer had minimal to no effect in increasing residue decomposition. Our results provide evidence that fall N application to aid residue decomposition is not warranted even when applications are done as early as September, when air and soil temperatures are adequate to sustain the microbial activity needed for residue decomposition.