Effect of Fall Nitrogen On Corn Residue Break Down in Illinois

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Introduction

- No-till has become more prevalent over time in the Midwest, due to lower machinery requirements, costs, and labor, reduced soil erosion and runoff, improved soil health, water infiltration, soil cover, and organic matter.
- However, no-till systems present challenges for growers, such as residue management, reduced yields, colder, 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/or their interactions affect residue decomposition, such as 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. In regions like Illinois, such practices need to be thoroughly researched in order to supply producers with sound and responsible advice.

Research Objective

- 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 lower C:N ratios and penetrometer values.

Materials and Methods

- Field experiments were conducted during the 2012-2013 growing seasons in Urbana, Illinois, 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 a RCBD, with N application timing (Sept., Oct., Nov., pre-plant) as the main plots and N rate (0, 34, 67, 134, 202 kg/ha) 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), receiving a split N application of 34 kg/ha in the fall and the remainder of 168 kg/ha 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 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.
- Statistics were produced with SAS 9.3.

Weather Data

Table 1. Air temperature and precipitation including departures (in parenthesis) from the 20-year average (1989-2008)

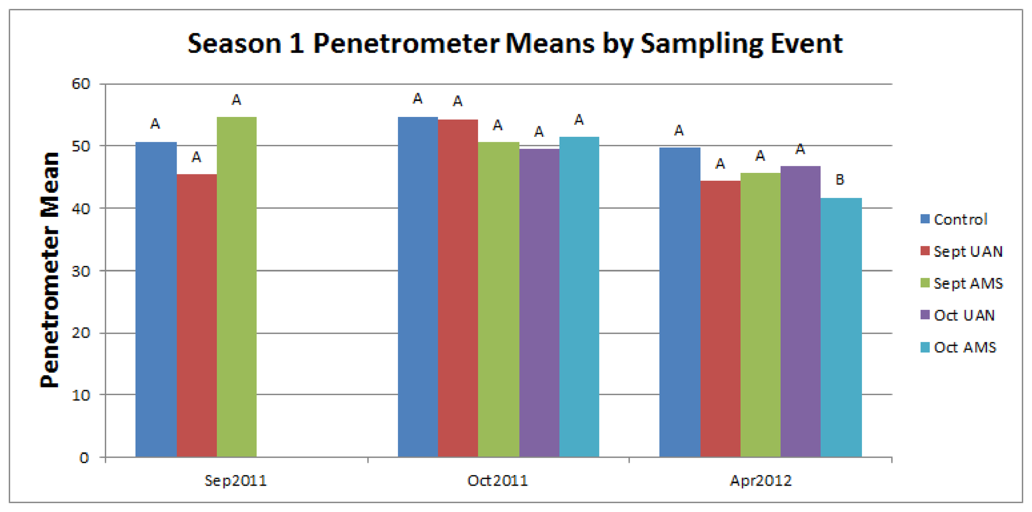
Year	Month	Temperature	Precipitation
		°C	mm
2011	April	11.9(0.6)	214.4(131.2)
2011	May	16.9(-0.1)	122.4(2.6)
2011	June	22.8(0.5)	106.6(10.9)
2011	July	26.8(3.1)	39.6(-73.4)
2011	August	24.1(1.2)	44.9(-48.6)
2011	September	17.5(-1.6)	70.8(-0.7)
2011	October	12.6(0.1)	66.8(-15.8)
2011	November	7.6(1.7)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

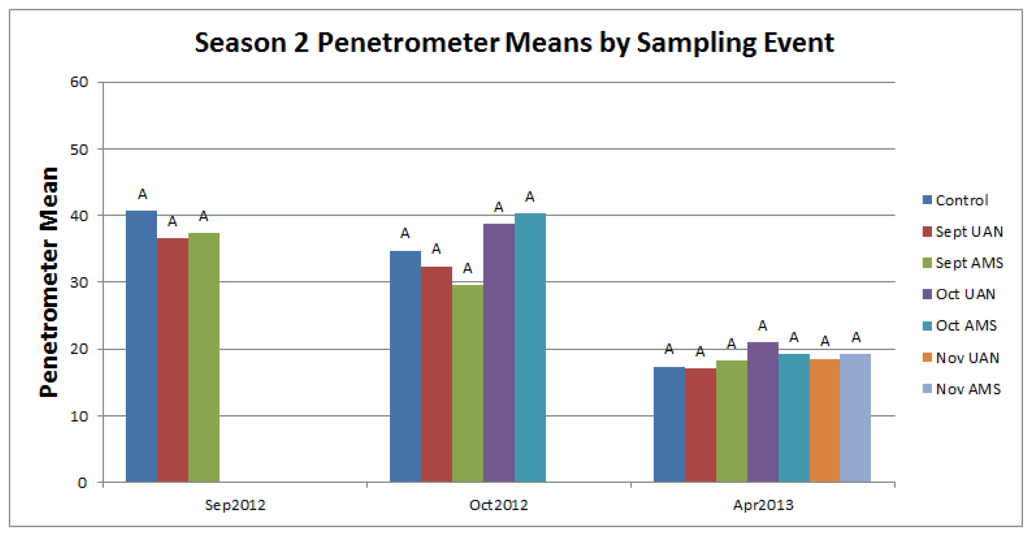
Year	Month	Temperature	Precipitation
		°C	mm
2012	January	-0.3(2.3)	88.3(28.4)
2012	February	1.7(1.9)	36.3(-16.2)
2012	March	12.5(7.4)	48.5(-20.4)
2012	April	12.5(1.2)	36.1(-47.1)
2012	May	20.5(3.5)	90.1(-29.5)
2012	June	22.7(0.4)	46.2(-49.5)
2012	July	27.6(3.8)	14.4(-98.5)
2012	August	23.1(0.1)	142.2(48.6)
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.

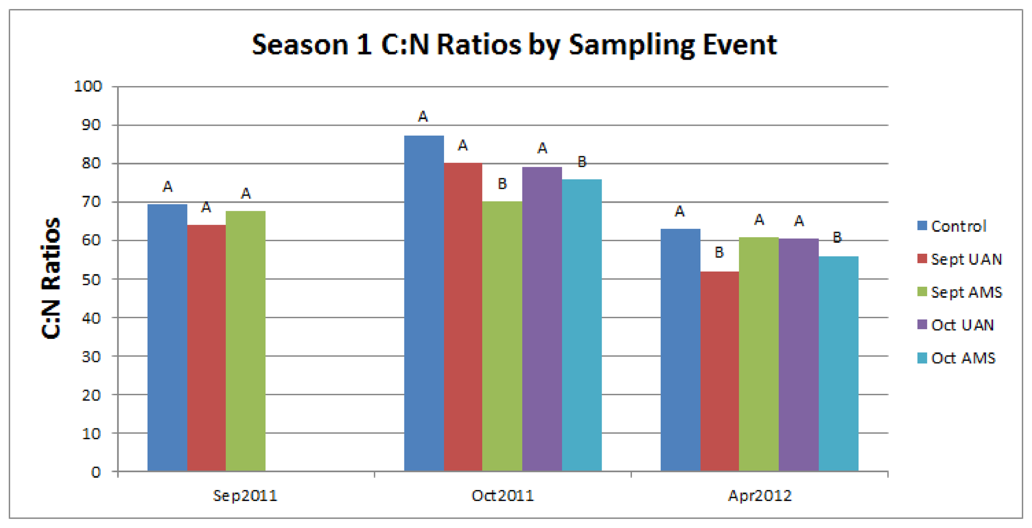
Results

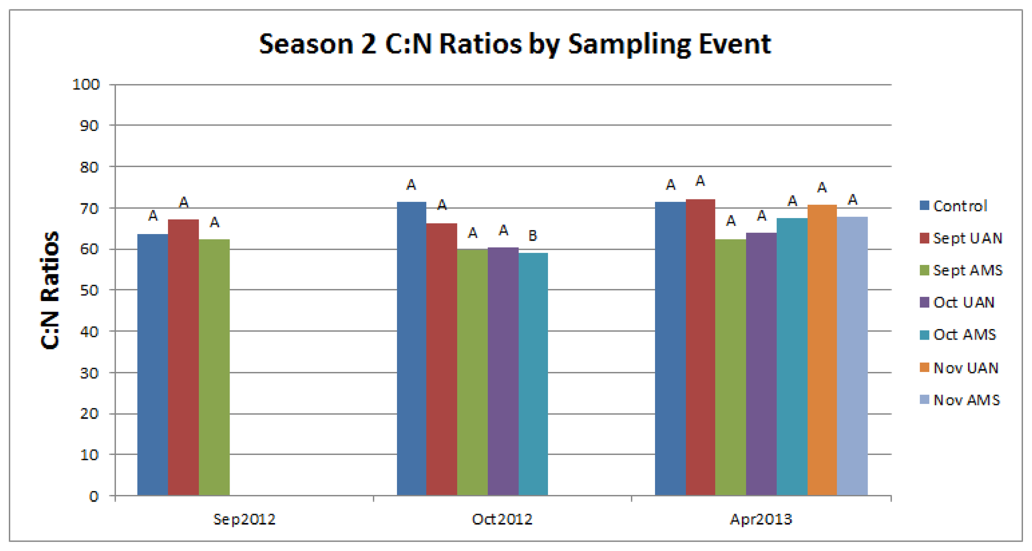




Penetrometer Results

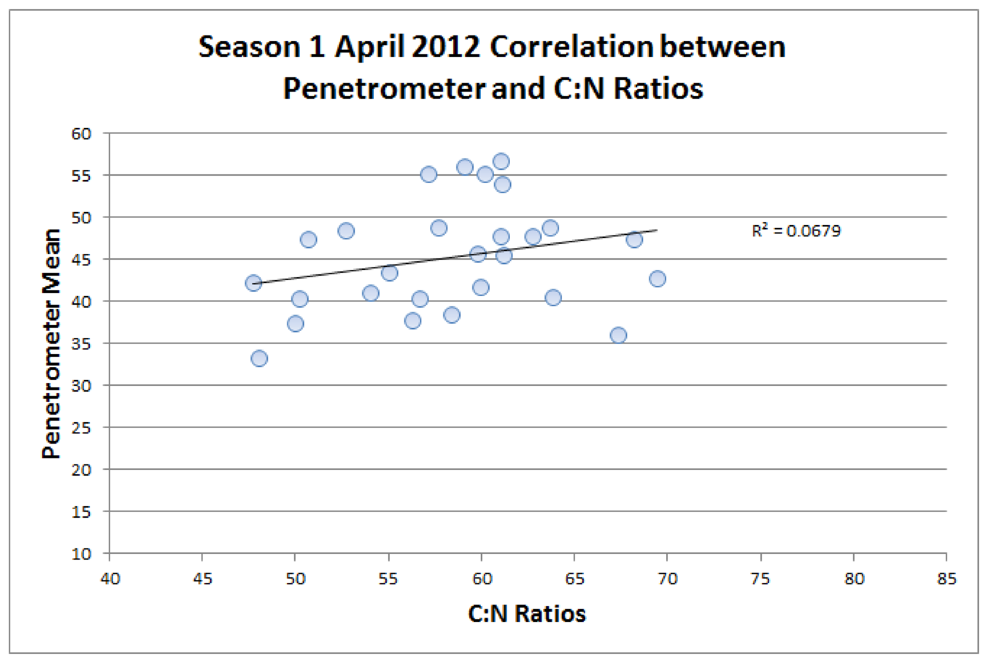
- In season 1, the control displayed some of the highest numerical (though not statistically significant) penetrometer values, especially at the last sampling. The treatment with the lowest value received N in October, and not in September as we expected.
- In season 2, the penetrometer values started lower than the first season, illustrating the fact that residue produced in the 2012 season was of small diameter and poor quality. There were no statistical differences in penetration resistance between treatments at any of the sampling times.

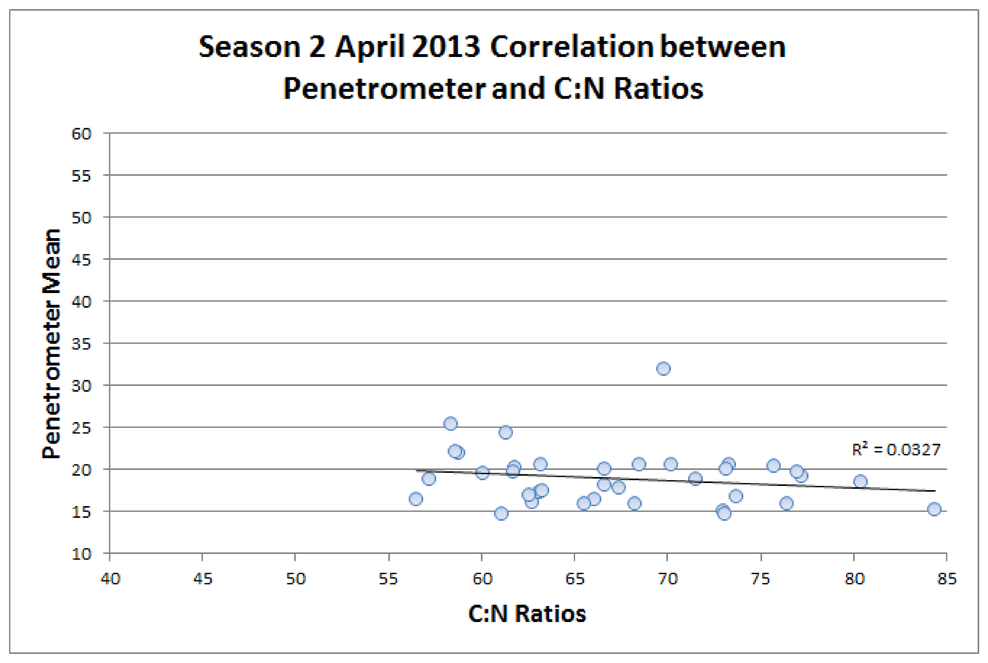




C:N Ratios Results

- During both seasons, the control showed one of the highest C:N ratios, which was expected, though the differences were not always statistically significant.
- Season 1 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. This suggest that fall N application had little or no impact in reducing C:N ratios.
- Season 2 showed no change in C:N ratios over time, likely a reflection of poor quality starting material. This result also highlights that applying N in the fall may not help reduce C:N ratios.





Correlation between Penetrometer and C:N ratios at the April Sampling

- There were no correlations for season 1 (R^2 0.07) or season 2 (R^2 0.03).

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 is by convention the value at which microbial decomposition can proceed without additional nitrogen.

Although the weather and quality of the residues were very contrasting for both seasons, the application of post-harvest N fertilizer appears to have 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 microbial activity. Further analysis is being conducted to evaluate the effect of treatments on N use efficiency by the crop.