Enhanced Management

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How does managing phosphorus with reduced manure rates affect soil nitrate and organic matter?

Reducing manure application rate to prevent build-up of soil phosphorus (P) is a common nutrient management practice where P levels are very high. This overall reduction in nutrient application presents a challenge to meet most or all of corn crop nitrogen (N) needs with manure. Immediate incorporation of spring applied manure to conserve the ammonia-N that's lost with surface applications can help. Over time, how do reduced rates of manure, with or without tillage incorporation, affect soil fertility and health, especially soil nitrogen and organic matter?

Soil Organic Matter only increased in the trial plots with high rates of composted manure.

To address this, a five year study set up in 2001 in Aurora, NY used high and low rates of spring applied liquid dairy manure and composted dairy manure solids on a Lima silt loam field with 3.5% organic matter. The crop history was long-term corn harvested for grain with no manure. During the five years of the study, corn silage was the sole crop. Changes in soil nitrate and organic matter were evaluated for each manure source and application rate, in control plots with no inputs, and in plots with no manure where inorganic fertilizer was applied to meet crop needs.

Field study treatments: The study had six treatments and five replications: (1) low rate of composted dairy solids (P-based; 20 tons/acre), (2) high rate of composted dairy solids (N-based; 32 tons/acre), (3) low rate of liquid dairy manure with immediate (within one hour) tillage incorporation (P-based; 7,000 gals/acre), (4) high rate of liquid dairy manure application (N-based; about 20,000 gals/acre), (5) zero N as a control (0 lbs N/acre) and (6) side-dress inorganic N (urea ammonium nitrate) at the recommended rate of 100 lbs N/acre. For field preparation, each plot was chisel-plowed, disked, and rolled with a cultimulcher. The low rate manure plots were chisel-plowed twice. The first pass was to incorporate manure directly after application. Corn for silage was planted and harvested in the crop years 2001 through 2005.

What did we find? Soil Organic Matter **(SOM, Figure1)**: After five years, only one treatment yielded an increase from the original 3.5% SOM. In the plots with high rates of composted manure SOM increased to 3.9%. The low rate of composted manure did not impact SOM, nor did the high rate of liquid dairy manure. However, the low rate of liquid manure with tillage-incorporation resulted in an 11% decrease in SOM to 3.1%. The inorganic N plots (no manure or compost applied) showed an 18% decrease in SOM, dropping from 3.5 to 2.87%.

Soil Nitrate **(Figure 2)**: Soil cores from 0 - 8 inch depth were collected at three different time periods to evaluate end-of-season

Fig. 1: Soil organic matter. Treatments were HC: high rate of compost; LC: low rate of compost; HM: high rate of manure; LM: low rate of manure; N0: zero N control; and N100: 100 lbs sidedressed N/acre. This figure compares SOM in April 2006 with SOM in April 2001 for each fertility treatment.

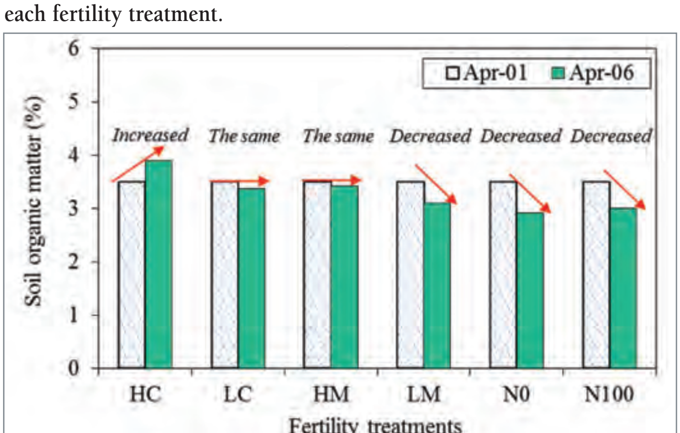
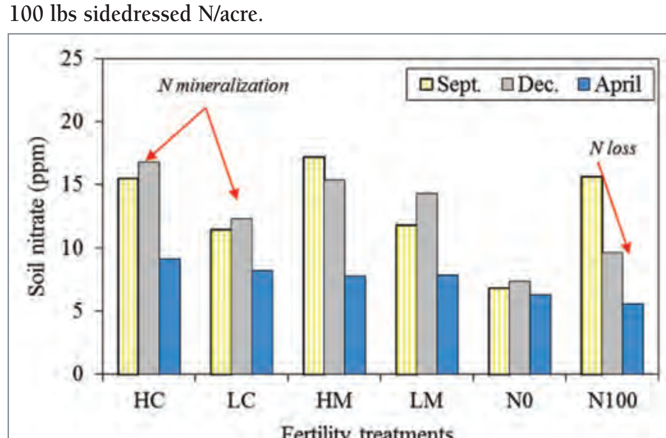


Fig. 2. Soil nitrate (0 - 8 inches) levels as influenced by fertility treatments from September to April (averaged over 2003 - 2005). Treatments were HC: high rate of compost; LC: low rate of compost; HM: high rate of manure; LM: low rate of manure; N0: a zero N control; and N100: 100 lbs sidedressed N/acre.



soil nitrate levels in each of the treatments. This was done immediately after harvest during September, in December before snowfall, and in the following April. Sampling was done in study years four, five and six (2003 - 2005) to exclude the first two years of transition from no prior manure to the inputs used in the study. Averaged over years four, five and six of the study, soil nitrate loss in the fall (from September to December) was the highest, at 38% loss in the inorganic N plots. This large decrease was attributed to N loss through leaching and/or de-nitrification. Nitrate loss of about 10% also occurred in plots that received a high rate of liquid manure. In plots that had either high or low applications of composted manure, as well as the plots that had the lower rate of liquid manure, soil nitrate increased 8% from September to December. This suggests that in these treatments, nitrate mineralization in that time period exceeded nitrate-loss.

These results show mineralization of organic N into nitrate from spring applied manure continuing from post corn harvest (September in this study) into December. The following April, soil nitrate levels were significantly lower and similar among all treatments each year, showing a "reset" of nitrate levels that reflects weather impacts on bare soil.

What Does This Mean for Managing N? When following P based manure application guidelines, capturing the N is an important management strategy to meet crop needs. Earlier work showed that P based manure management of fields with no recent manure history can limit N and contribute to reduced crop yields. Mineralized N available in the fall can be effectively captured by planting winter-hardy cover crops with rapid fall growth. This will help with the N supply for the next season's crop as well as offer the soil protective qualities of cover crops.

Organic Matter: Soil organic matter plays a vital role in nutrient cycling and in "weather proofing" soils and crops from extreme conditions, helping to reduce yield losses when weather stress occurs.

In this study levels of SOM only increased in plots with high levels of composted manure and decreased where manure was tillage incorporated or no manure was applied. These results suggest that where tillage is used, in this case, chisel and disk, applying manure during corn years without using cover crops will not improve or in some cases maintain SOM. Practices such as no till or strip till, use of winter hardy cover crops, and injection rather than tillage incorporation of manure, can help counteract organic matter losses in addition to conserving nitrogen.

Acknowledgments: Research this material is based on is supported, in part, by the National Institute of Food and Agriculture, USDA (Award 2013-68002-20525) and by Federal Formula Funds. ❐

*For questions about these results contact **Quirine Ketterings**, Professor, Cornell University Department of Animal Science, at 607-255-3061 or qmk2@cornell.edu, and/or visit the Cornell Nutrient Management Spear Program website at: nmsp.cals.cornell.edu.*

Corn Silage Hybrid Trial

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Testing Program. Results are online at scs.cals.cornell.edu/extension-outreach/field-crop-production/variety-trials#corn-silage.

Starting in 2016, the NY trials used new methods to evaluate the milk producing potential of corn silage. The Cornell Net Carbohydrate & Protein System (CNCPS) model was used to predict the expected milk yield (in pounds per day) of a typical, Northeastern high lactating ration with each of the participating corn hybrids entered into the same total ration. Again, the relative ranking of the hybrids is more useful than the absolute values, but this approach uses a much more in depth analysis to assess how each hybrid may perform in an actual ration compared to previous approaches. It is evident in the report how the uNDF content of each hybrid may affect the potential dry matter intake of the ration and the subsequent effect on projected milk yield.

Starch Content & Digestibility: Starch content is a popular number to look at and justifiably so. At the risk of excessive repetition, this is another case where it is critical to look at these values in the context of the location mean, rather than absolute values as growing conditions and stage of harvest (whole plant dry matter) can affect this value.

Starch digestibility is more challenging. We know this value changes as the silage ferments, and laboratories continue to refine their ability to accurately predict starch digestibility using NIR methods, compared to the more intensive wet chemistry laboratory testing methods. It is also recognized that results from green (unfermented) samples, as are often used in Hybrid Testing Programs, are less consistent. It is generally accepted that a hybrid with good starch digestibility before fermentation will remain incrementally better after fermentation when compared to a hybrid that starts with lower digestibility before fermentation. Inquiring with a company about their data is quite beneficial, especially if they have wet chemistry data on fermented samples. It is always best to compare results from the same laboratory. However, if the results available are from different labs, ask for data from multiple hybrids to establish the relative differences in like datasets.

Yield and Agronomic Characteristics: While yield often receives too much attention in silage hybrid selection, you do want strong hybrids that have a competitive yield and are able to handle potential stressors. Some of these stressors may be more broadly driven by weather, while others may be typical of the micro-climate you farm, such as soil drainage, air drainage (disease prevalence) or elevation-driven temperature trends.

This is another instance where rather than focusing on actual yield numbers, pooling data from multiple locations and sources and matching this with weather data from those locations will help you understand if a hybrid's performance is consistent across conditions or if it excels and falters in certain situations that may be applicable to your area. ❐

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