

Increasing Labile Carbon and Nitrogen Pools in Agricultural Soils Requires a Change in System, Rather than Practice.

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Introduction

Labile soil carbon (C) and nitrogen (N) dynamics are key variables in soil health assessments. Understanding these dynamics will provide a better understanding of how seasonality and various cropping systems influence soil C and N. The Wisconsin Integrated Cropping System Trial (WICST) affords us the unique opportunity to analyze how long term pasture, forage and cash-grain cropping systems affect soil health after 28 years.



Short Term Objectives

- To determine how long-term organic cash grain and forage cropping systems affect labile soil C and N.
- To determine how these labile C and N pools change with depth and over time.

Long-Term Goals

We aspire to use these indicators to further assist growers in making holistic farm management decisions that are economically viable, optimize plant nutrient availability, and promote soil organic matter accumulation.

What is PMN? What is POxC? What is PMC?

The fraction of organic N converted to plant available (or mineral) forms under specific conditions of temperature, moisture, aeration, and time.

Measure of C present in active organic matter; may provide early indication of soil C stabilization. Crop residues & organic amendments contribute to this active C pool.

Measure of C mineralized in 10 grams of soil after 1 day aerobic incubation. It has been shown to be a sensitive indicator of management-induced changes in total C.

Materials & Methods

Location:

- Wisconsin Integrated Cropping Systems Trial (25 ha) at the South-Central Wisconsin Arlington Research Station in Arlington, WI (43° 18'N; 89° 21'W).

Soil Type:

- Deep, well-drained Typic argiudall (Mollisol). *Silt loam, loess over glacial till.*

Cropping Systems Analyzed:

- Continuous corn (CC), strip till corn/soybean rotation (CS-ST), organic corn/soybean/winter wheat/berseem clover and oats (CSWB), corn/alfalfa/alfalfa/alfalfa (CAAA), organic corn/oats-alfalfa/alfalfa (COA), and pasture (PAS).
- Cash grain cropping systems: CC, CS-ST, CSWB.
- Forage cropping systems: CAAA, COA, PAS.

Planting and Harvest Dates:

- Planting: 5/3/2016 (non-organic CS), 5/20/2016 (organic CS). Harvest date: 10/20/2016.

Management:

- Manure applied to CSWB (4/20/2016 at 1.8 ton/ac), CAAA (11/20/2015 at 14,000 gal/a), and COA (11/20/2015 at 14,000 gal/a).
- Pasture rotationally grazed by dairy heifers.

Randomized complete block design

Sampling Depths:

- 0-15 cm, 15-30 cm

Sampling Dates

- Mid-month in May, June, July, August, September

PMN Methodology

- Samples were incubated at 40°C under anaerobic conditions and extracted using 2M KCl (Drinkwater, 1996).

POxC Methodology

- Carbon was oxidized with permanganate solution in 18 mL H₂O (Culman et al., 2013).

PMC Methodology

- Flush of CO₂ was measured from rewetted (50% WFPS) soils after a 24 hour aerobic incubation in 1 L canning jar at 25 degree Celsius.

Statistical Analysis

- Analyzed using Proc Mixed in SAS. Fishers LSD with significance at (P<.05).

Discussion

- The perennial pasture system and the forage-based cropping systems had greater POxC, PMC and PMN. The pasture had the highest PMC, POxC and PMN throughout the growing season.
- Certain treatment's mineralizable N pools are being replenished mid-season, while others are continuously replenished throughout the growing season until September.
- General in-season trends for PMN, PMC and POxC are different among treatments.
- Alfalfa may provide yield benefits to the subsequent corn crop by providing plant available N at key points in plant growth (i.e. V9-V10).
- Greater proportions of labile C and N reside in the top 0-15 cm than the lower 15-30 cm.

Conclusions

- To increase labile C and N pools within the cash grain system, system changes such as complete tillage reduction combined with intensive cover cropping are required.
- Forage-based cropping systems may offer soil health benefits with respect to both short-term crop productivity via nutrient mineralization and carbon stabilization.
- Although there are significant differences in PMN, PMC and POxC between forage and grain systems, shifts within a cropping system (grain or forage) in the context of this study were not enough to affect labile C and N pools.

