Using a Cereal Rye Cover Crop to Improve Soil Health in a Corn Silage – Soybean Cropping System in Iowa

T.C. Kaspar[1], E.B. Moore[2], M. Wiedenhoeft[2], M. Shipitalo[1], Ben Knutson[1], Keith Kohler[1], Jaxon Goedken[2], and C.A. Cambardella[1]

[1]USDA-ARS, National Laboratory for Agriculture and the Environment, Ames, IA

[2]Iowa State University

Introduction

A cereal rye cover crop is one of the few cover crop species that has been consistently successful in Iowa in corn-soybean rotations. Thus, it has the most potential to improve soil health in this cropping system. Unfortunately, there have been few studies to demonstrate improved soil health with cover crops in corn-soybean rotations in Iowa or the Upper Midwest.

Methods

- Experimental site is on the ISU Boyd Farm near Boone, IA and the predominant soils are Clarion loam and Nicollet clay loam with 2% slope over the entire site. A corn silage-soybean rotation with no till and the experimental treatments were established in 2001 with 5 replications and both phases of the rotation present in each year.
- For these measurements two treatments were evaluated:
  A rye cover crop following both corn silage and soybean and a no rye (control) treatment. The rye winter cover crop was planted after harvest with a grain drill and killed with glyphosate in the spring.
- For soil organic matter (SOM), particulate organic matter (POM), and potential N mineralization (PNM) three soil cores were taken in untracked interrows at 5 locations in each plot during June in 2010 and 2011 (600 cores). Each soil core was divided into 0-5cm and a 5-10cm depth layers and all cores from a plot were composited into one sample. Samples were mixed, sieved, air-dried, and refrigerated prior to analysis. Samples were burned at 460°C for weight loss on ignition measurement of SOM. Samples were dispersed with hexametaphosphate and POM was collected on a 53-µm sieve. Samples were re-hydrated and incubated for 28 days to determine nitrogen mineralization potential.
- For measurements of runoff, infiltration and sediment a rainfall simulator was used to apply a 65-mm simulated rainfall over 60 min on a 1.5 by 3-m area with relatively uniform slopes between 5 treatment pairs following a corn silage crop in Oct. of 2014.
- For wet aggregate stability samples were taken at 4 locations in untracked interrows of each plot to a depth of 5 cm using a 5.7-cm diameter tulip bulb planter in June 2016. Samples from the four locations were combined into two subsamples and then each subsample was split into 3 approximately 90 g sub-subsamples for analysis. Samples were pushed through an 8 mm sieve, air dried, and refrigerated until measurement. A nest of sieves with mesh sizes of 4, 2, 1, 0.5, and 0.25 were stacked in order and each soil sample was placed on the top sieve, the nest of sieves is submerged in water, and then oscillated up and down for 5 min. The aggregates remaining on each sieve are collected dried and weighed.

Results

- Rye cover crops increased soil organic matter, particulate organic matter, and potential N mineralization particularly in the top 5cm of soil (Table 1). SOM was also increased significantly in the 5- to 10-cm layer, whereas the POM and PNM increased, but was not statistically significant. It is important to consider that over 600 cores were taken in an area of approximately 0.417 ha (1 acre) after 10 years of cover crops in order to detect significant differences.
- The rye cover crop increased time to first runoff, decreased the amount of runoff after 60 min of rainfall, increased the amount of water that infiltrated, and decreased the total amount of sediment in the runoff (Table 2). Because the rye cover crop was alive, cover crop water use, root enmeshing of soil particles, and rye shoots and crowns impeding surface water flow and soil detachment were probably important. These results match earlier work on erosion and cover crops in the spring.
- Wet aggregate stability for all aggregate size classes above 0.25 mm were increased with a rye cover crop after 15 years (Table 3) and is consistent with increased infiltration.

Table 1. Soil organic matter, particulate organic matter, and potential N mineralization in the 0- to 5-cm and 5- to 10-cm soil layers in a no-till field with a corn silage-soybean rotation and treatments with and without rye cover crops since 2001 averaged over samples taken in 2010 and 2011 in both phases of the rotation.†

Measurement	Soil Organic Matter with Weight Loss on Ignition		Soil Particulate Organic Matter		Potential Nitrogen Mineralization	
Depth Layer	0- to 5-cm	5- to 10-cm	0- to 5-cm	5- to 10-cm	0- to 5-cm	5- to 10-cm
	-------- g SOM kg soil^{-1} ---		------ g POM kg soil^{-1} ------		------- mg N kg soil^{-1} -------	
Treatment						
Rye Cover Crop	56.5 a	50.2 a	8.8 a	4.0 a	49.6 a	24.6 a
No Cover Crop	49.3 b	47.6 b	6.1 b	3.2 a	35.8 b	18.5 a
% Increase	14.6	5.5	44.3	25.0	38.6	32.7

Table 2. Time to initial runoff, runoff amount, infiltration amount, and sediment in runoff as the result of a 60-min, 65-mm, simulated rainfall on a 1.5 by 3 m area in Oct. 2014 on plots with and without a rye cover crop since 2001.†

Measurement	Time to Runoff	Runoff Amount	Infiltration Amount	Sediment
	----- sec ---	---------- mm ----------		----- kg ha^{-1} ----
Treatment				
Rye Cover Crop	636 a	9.5 b	55.5 a	142 a
No Cover Crop	294 b	27.3 a	37.7 b	444 b
% Increase or Decrease	116.3	-65.2	47.2	-68.0

Table 3. Fraction of total soil weight composed of aggregates from each size class measured using wet sieving for soil taken from 0- to 5-cm layer in June 2016 in a no-till field with a corn silage-soybean rotation and treatments with and without rye cover crops since 2001 averaged over samples taken in both phases of the rotation.

Cover Crop Treatment	Aggregate Size Class (mm)						Aggregate Mean Weight Diameter
	0.25 - 0.5	0.5 - 1.0	1.0 - 2.0	2.0 - 4.0	> 4.0	Total > 0.25	
	---------- aggregate weight g/total sample weight g ----------						--- mm ---
Rye Cover Crop	0.229 a	0.127 a	0.029 a	0.021 a	0.012 a	0.418 a	0.254 a
No Cover Crop	0.210 b	0.087 b	0.017 b	0.010 b	0.006 b	0.330 b	0.111b
% Increase	9	46	71	110	100	27	129

Conclusions and Comments

- Using corn silage rather than corn harvested for grain allowed for earlier cover crop planting and more growth. Additionally, removal of most of the corn residue with silage harvest probably helped to accentuate and measure differences in soil health due to cover crops.
- Soil variability resulting from soil types, landscape position, previous main crop, machinery operations, and crop rows can make detecting differences in soil properties difficult and requires intensive sampling. Additionally, the inherent high degree of soil health of these Iowa soils for some properties may require many years for changes to be detectable.
- Rye cover crops can improve or maintain soil heath in Iowa with good growth.

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