EFFECT OF TILLAGE, ROTATION (MAIZE AND SOYBEAN), AND NITROGEN RATE IN A LONG TERM STUDY ON SOLVITA®, WATER EXTRACT, H3A EXTRACT VALUES

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OBJECTIVE

To compare the results of conventional chemical soil tests with the Solvita® and Haney/Soil Health Test to determine what additional understanding about the effect of our long-term field experimental treatments of tillage, crop rotation, and nitrogen rates can be gained.

INTRODUCTION

The Solvita® and Haney/Soil Health Tests are emerging methods of soil testing which integrates chemical and biological soil test data to assess the health of the soil. These tests may complement or supplement traditional soil testing procedures. The Solvita® test quantifies the amount of respired CO_2 after rewetting a dried soil sample over a 24hr period and has been proposed to be used to quantify microbial activity and mineralizable N and P. The Haney or Soil Health Test uses water and the extractant, H3A (which was designed to mimic plant root exudates) to assess plant available nutrients and soil health.

METHODS

- **29-yr rain-fed field experiment**
- **Experimental Design: Split-Split Plot with 4 reps**
  - **Whole-Plot treatments: Tillage- (moldboard plow (followed by a disk), disk tillage, and no-till)**
  - **Sub-Plots: Crop Rotation- continuous corn [*Zea mays L.*](CC) and corn-soybean [*Glycine max (L)* Merr.] rotation (CS)**
  - **Sub-Sub-Plots: N fertilizer rates as; 0 kg N ha^{-1}, 80 kg N ha^{-1}, and 160 kg N ha^{-1}**
- **Samples were collected in the fall of 2013 after harvest.**
  - **Sample depth: 0.20 m with a hand probe (5 cores/sample)**
  - **Analysis at Ward Laboratories (Kearney, NE).**
- **Statistics: PROC GLM module in SAS with a split-split-plot experimental design.**

Image 1. Treatment arrangement examples along with an example of the Solvita® Soil Test

RESULTS

Analysis of variance for long term yields & 2013 yields (light blue), conventional parameter (blue), and corresponding Haney biological parameters. The yellow highlights show the main effects and interactions that are distinguished using these biological tests compared to a conventional test. Further analysis of the means is needed to understand the relationship between treatments.

Table 1. Analysis of variance for long term yields, 2013 yields, and fall soil nitrates compared to Haney Biological Nitrogen Parameters.

ANOVA			Nitrogen Parameters									
Main Effect and Interactions	Ave. corn grain yield 2004-2013[1]	2013 Grain Yield[2]	Fall Conventional NO_3-N[3]	Haney N in lbs N/acre available[4]	H_20 Total N[5]	H_20 Organic N[6]	N Mineralization[7]	H3A Nitrate[8]	H3A Inorganic N[9]	H3A Ammonium[10]	Organic N Release[11]	Organic N Reserve[12]
	Significant F tests, NS > 0.20; + >0.10; * 0.05; ** > 0.01; ***> 0.001; ****<0.001											
Tillage	NS	**	*	*	**	NS	+	+	***	***	NS	****
Rotation	****	****	+	*	**	NS	**	*	**	***	NS	****
Rotation x Tillage	NS	+	*	NS	NS	NS	NS	+	+	NS	NS	**
Nitrogen Rate (N Rate)	****	****	****	****	****	****	****	****	****	****	****	****
Tillage x N Rate	+	*	NS	NS	NS	*	****	NS	*	****	****	****
Rotation x N Rate	NS	NS	**	*	**	NS	+	NS	+	****	***	****
Rotation x Tillage x N Rate	NS	*	+	NS	*	NS	***	NS	+	*	**	****
CV (%)	9.7	7.1	25	15	14.6	10.8	15.7	32.4	28.7	34.8	13.1	93.2

[1]F values average of annual ANOVA.

[2]2013 was an odd year after a severe drought in 2012.

[3]Analysis using traditional KCL extractant, reported in ppm.

[4]Calculated from nitrates, ammonium, and nitrogen release.

[5]Total water extracted N including both organic and inorganic sources.

[6]Total water extracted N minus inorganic N (NO_3 and NH_4).

[7]A Haney estimate of the amount of N immediately availible to the crop based on microbial activity and organic C:organic N value.

[8]Amount of NO_3-N extracted using H3A.

[9]Sum of H3A extracted NO_3 and NH_4.

[10]Amount of NH_4-N extracted using H3A.

[11]Total N released through microbial activity from the organic N pool (Haney Calculation).

[12]Total N left in the organic N pool following microbial release.

Table 2. Analysis of variance for long term yields, 2013 yields, and conventional Mehlich P-III compared to Haney Biological Phosphorous Parameters.

ANOVA			Phosphorous Parameters					
Main Effect and Interactions	Ave. corn grain yield 2004-2013[1]	2013 Grain Yield[2]	Conventional Mehlich P-III P (ppm)[3]	P Mineralization[4]	H3A Inorganic P[5]	H3A Total P[6]	H3A Organic P[7]	Organic P Reserve[8]
	Significant F tests, NS > 0.20; + >0.10; * 0.05; ** > 0.01; ***> 0.001; ****<0.001							
Tillage	NS	**	+	*	*	NS	NS	***
Rotation	****	****	NS	*	*	*	+	**
Rotation x Tillage	NS	+	**	+	NS	NS	NS	**
Nitrogen Rate (N Rate)	****	****	*	****	****	****	****	****
Tillage x N Rate	+	*	+	NS	NS	****	****	***
Rotation x N Rate	NS	NS	NS	NS	*	***	**	*
Rotation x Tillage x N Rate	NS	*	NS	NS	NS	***	***	**
CV (%)	9.7	7.1	19.5	31	15	12	8.3	59.6

[1]F values average of annual ANOVA.

[2]2013 was an odd year after a severe drought in 2012.

[3]Analysis using traditional Mehlich P-III methodology, reported in ppm.

[4]Amount of P released through mineralization of organic P depending on microbial activity and orgnic C:organic N ratio.

[5]Total PO_4 extracted using H3A.

[6]Total elemental P extracted using H3A and analyzed on ICAP.

[7]Total P minus inorganic P extracted using H3A (represents P not plant availible but may become availible through microbial activity.

[8]P remaining in the organic P pool following release by microbes.

Table 3. Analysis of variance for long term yields, 2013 yields, and conventional extracted K compared to Haney Biological Potassium Parameters.

ANOVA			Potassium Parameters	
Main Effect and Interactions	Ave. corn grain yield 2004-2013[1]	2013 Grain Yield[2]	Conventional K $(ppm)_3$	H3A ICAP K[4]
	Significant F tests, NS > 0.20; + >0.10; * 0.05; ** > 0.01; ***> 0.001; ****<0.001			
Tillage	NS	**	NS	NS
Rotation	****	****	NS	NS
Rotation x Tillage	NS	+	+	*
Nitrogen Rate (N Rate)	****	****	+	+
Tillage x N Rate	+	*	NS	NS
Rotation x N Rate	NS	NS	NS	*
Rotation x Tillage x N Rate	NS	*	NS	NS
CV (%)	9.7	7.1	17.2	16.4

[1]F values average of annual ANOVA.

[2]2013 was an odd year after a severe drought in 2012.

[3]Analysis using traditional K extraction methodology.

[4]Total elemental K extracted using H3A and analyzed on ICAP.

Table 4. Analysis of variance for long term and 2013 yields compared to Haney Biological Carbon Parameters.

ANOVA			Carbon Parameters		
Main Effect and Interactions	Ave. corn grain yield 2004-2013[1]	2013 Grain Yield[2]	Conventional Organic Material LOI%[3]	H2O Total Organic C[4]	Organic C:N[5]
	Significant F tests, NS > 0.20; + >0.10; * 0.05; ** > 0.01; ***> 0.001; ****<0.001				
Tillage	NS	**	**	****	***
Rotation	****	****	NS	****	+
Rotation x Tillage	NS	+	NS	**	NS
Nitrogen Rate (N Rate)	****	****	NS	**	****
Tillage x N Rate	+	*	NS	NS	**
Rotation x N Rate	NS	NS	NS	+	NS
Rotation x Tillage x N Rate	NS	*	NS	NS	NS
CV (%)	9.7	7.1	9.4	6.6	13.6

[1]F values average of annual ANOVA.

[2]2013 was an odd year after a severe drought in 2012.

[3]Analysis using traditional loss-on-ignition (LOI) methodology to measure OM.

[4]Total water extracted organic C (represents the energy source for soil microbes.

[5]Ratio of water extracted organic C to organic N (used with Solvita CO_2-C to estimate N and P mineralization); (a "good" level is below 20).

Table 5. Analysis of variance for long term and 2013 yields compared to Solvita/ Haney Soil Health Parameters.

ANOVA			Soil Health Parameters		
Main Effect and Interactions	Ave. corn grain yield 2004-2013[1]	2013 Grain Yield[2]	Solvita CO_2[3]	Soil Health Calc.[4]	Haney N in lbs N/acre available[5]
	Significant F tests, NS > 0.20; + >0.10; * 0.05; ** > 0.01; ***> 0.001; ****<0.001				
Tillage	NS	**	*	NS	NS
Rotation	****	****	+	*	+
Rotation x Tillage	NS	+	*	NS	NS
Nitrogen Rate (N Rate)	****	****	****	****	****
Tillage x N Rate	+	*	NS	****	****
Rotation x N Rate	NS	NS	**	***	**
Rotation x Tillage x N Rate	NS	*	+	***	***
CV (%)	9.7	7.1	25	12	8.3

[1]F values average of annual ANOVA.

[2]2013 was an odd year after a severe drought in 2012.

[3]Amount of CO_2-C released in 24hrs from soil microbes after soil is dried and rewetted.

[4]Represents the overall health of the soil equated by: SHC= (Solvita CO_2 / Organic C:N) + (Water Extracted Organic C / 100) + (Water Extracted Organic N /10); (a "good" score is above 7).

[5]Calculated from nitrates, ammonium, and nitrogen release using Haney Test methods.

CONCLUSIONS

- **Comparison of the traditional soil tests and the Solvita® and Haney tests indicated areas where there was similar sensitivity and areas where the Solvita® CO_2 and the Soil Health Calculation might be more sensitive to soil processes.**
- **Of most interest was the interactions between nitrogen, tillage, and rotation. The effect of higher nitrogen rates decreased CO_2 evolution, especially for no-till.**
- **The Soil Health Calculation indicated that all tillage and nitrogen rates were generally high, the high N rate decreased the Soil Health Calculation for the disk and no-till treatments.**

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