

Evaluation of the Solvita Test As an Indicator of Mineralizable Nitrogen in Minnesota Soils.

Xinyi Tu^{1*}, Deborah Allan¹, Carl Rosen¹, Jeffrey Coulter², Daniel Kaiser¹

¹ Department of Soil, Water and Climate, University of Minnesota, Saint Paul, MN

² Department of Agronomy and Plant Genetics, University of Minnesota, Saint Paul, MN

Introduction

- Accurate, low-cost soil test estimation of potentially mineralizable N (PMN) could improve fertilizer recommendations and increase N fertilizer use efficiency.
- Traditional laboratory incubation is recognized as the standard method for predicting PMN, but this procedure is expensive and cannot supply in-season recommendations due to the long incubation time required.
- The Solvita quick test for CO₂ flush after soil wetting has been proposed as an indicator of microbial activity and PMN.
- Previous studies have shown high correlations between soil respiration rate from this 24-hour test and the estimated mineralizable N pool from incubation experiments, but this method has not been tested for Minnesota soils and conditions.
- In our previous work, we found significant variability due to sample preparation, so we decided to test soil wetting methods in more detail.

Objectives

- Evaluate three different wetting methods to determine the one with the least variability.
- Compare the Solvita CO₂-Burst test with standard laboratory aerobic incubation techniques for PMN determination.
- Determine whether the Solvita test is a better measure of soil N supply than soil organic matter (SOM) level or extractable nitrogen.
- Relate these results to previous crop history and soil texture.

Methods

- In May 2014, a total of 148 samples were collected from control plots at 26 sites with corn N response trials in Minnesota at 2 depths (0-15 cm, 15-30 cm, n=296). Samples were dried at 40 °C and ground to pass through a 2 mm sieve.
- The samples were collected in northern, central, and southern Minnesota with three types of previous crops (alfalfa, corn, and soybean) and 6 different soil textures (clay, silt clay, silt clay loam, clay loam, silt loam, and loamy sand).
- KCl-extractable nitrogen, SOM (LOI), and Solvita CO₂-Burst tests were conducted for all 148 samples.
- For two soil textures (5 reps), 3 wetting methods were tested for repeatability:
 - fixed volume procedure (Solvita official manual, 2013). 20 ml DI water was added to each sample.
 - 50% water-filled pore space (WFPS) method (Franzlubbers, 1999). DI water was added to the samples based on determination of soil volume and calculated pore space.
 - quantitative soil saturation (Parnes and Brinton, 1986). Soil moisture content was brought to 70% saturation.
- We compared the fixed volume (n = 160) to the 50% WFPS (n = 296) method. The average of duplicates was used to determine variability.
- PMN values for 45 samples were determined by the 64-day aerobic incubation method (Stanford and Smith, 1972).
- Corn yield data was collected at the end of the season.

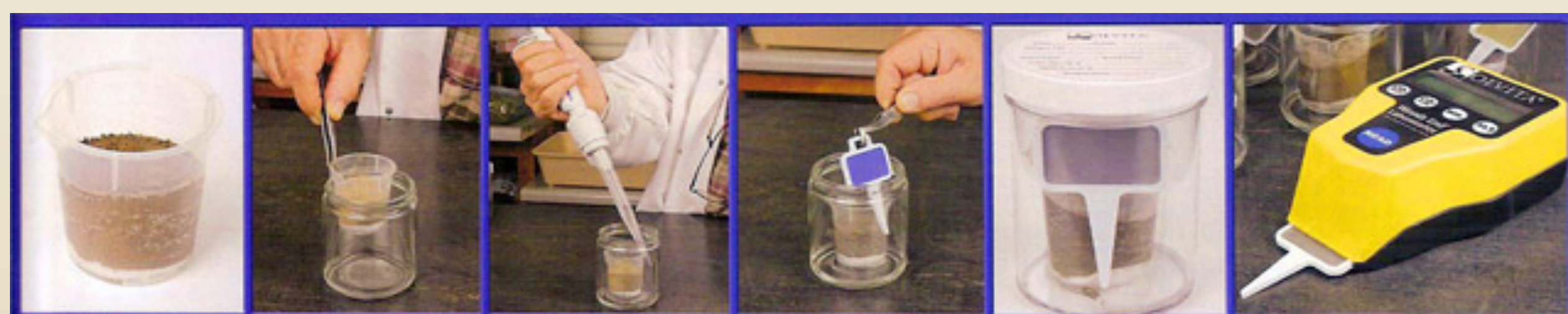


Figure 1. General procedure of Solvita CO₂-Burst test. <http://solvita.com/sol>

References Cited

- Franzlubbers, A.J., R.L. Haney, F.M. Hons (1999) Relationships of chloroform fumigation-incubation to soil organic matter pools. *Soil Biology and Biochemistry* 31 (1999) 395-405
- Parnes R., W. Brinton. (1986) *Soil Testing Methods Manual*. Woods End Laboratory. Unpublished document.
- Solvita official manual, 2013
- Stanford, G. and S.J. Smith, 1972. Nitrogen mineralization potentials of soils. *Soil Sci. Soc. Am. Proc.* 36:465-472.

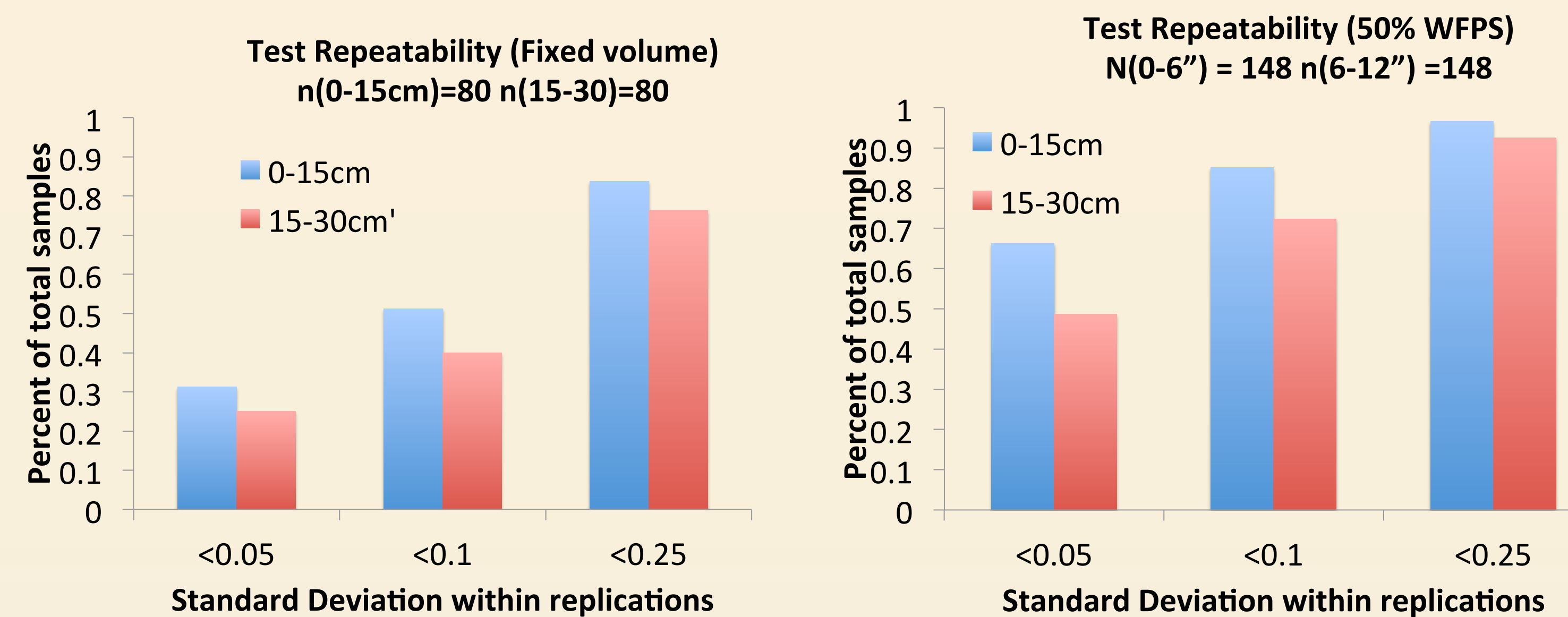
Results

1. Wetting Method Summary

a. Three Wetting Methods (tested on 5 samples of each of 2 soils).

	Hubbard Loamy Sand			Webster Clay loam		
	Quantitative Soil Saturation	50% WFPS	Fixed Volume	Quantitative Soil Saturation	50% WFPS	Fixed Volume
Mean of Solvita Results ppm	41.54	31.67	9.44	87.86	97.28	75.71
Standard Deviation	19.76	17.82	3.50	8.43	1.58	9.73
Coefficient Of Variation	0.48	0.56	0.37	0.10	0.02	0.13

b. Test Repeatability Comparison (Fixed volume vs 50% WFPS)



2. Solvita CO₂-Burst Test vs SOM (LOI), Extractable N and PMN (n=148)

2.1 Solvita CO₂-Burst vs OM

Previous Crop	n	Correlation coefficient	P value
Alfafa	56	0.28	0.036*
Corn	44	0.11	0.49
Soybean	48	0.12	0.41
All samples	148	0.22	0.007**

*, ** = Significant at 5%, 1% level

Texture	n	Correlation Coefficient	P value
Silty Clay and Clay	16	0.16	0.55
Silty Clay Loam and Clay Loam	104	0.23	0.017*
Silt Loam and Loamy Sand	28	0.85	<0.0001**
All samples	148	0.22	0.007**

2.2 Solvita CO₂-Burst vs Extractable N

Previous Crop	n	Correlation coefficient	P value
Alfafa	56	-0.10	0.49
Corn	44	0.60	<0.0001**
Soybean	48	0.47	0.0008**
All samples	148	0.43	<0.0001**

*, ** = Significant at 5%, 1% level

Texture	n	Correlation Coefficient	P value
Silty Clay and Clay	16	0.68	0.0041**
Silty Clay Loam and Clay Loam	104	0.33	0.0005**
Silt Loam and Loamy Sand	28	0.73	<0.0001**
All samples	148	0.43	<0.0001**

2.3 PMN v.s. Solvita CO₂-Burst, OM, Extractable N, and Yield (n = 45)

	Solvita	SOM	Extractable N	PMN
Solvita	--			
SOM	0.55**	--		
Extractable N	0.58**	0.58**	--	
PMN	0.36*	0.46**	0.27++	--
Yield (n = 40)	0.32*	0.38*	0.44**	0.36*

Correlation coefficient and significance. ++, *, ** = Significant at 10%, 5%, 1% level.

- The fixed volume procedure gives significantly lower results for the Solvita CO₂-Burst test, especially in the sandy soil.
- CVs for all 3 wetting methods were quite high for the sandy soil.
- 50% WFPS had a significantly lower CV than the other wetting methods for the clay loam.
- Since most of the samples collected were from clay loam soils, the 50% WFPS method was chosen for conducting the Solvita test.

- Repeatability of the Solvita test was greatly improved with the 50% WFPS wetting method. 85% of the duplicate samples had variability under 10% (0-6") compared to 51% with the fixed volume procedure.

- The Solvita CO₂-Burst test correlations with SOM were better for loams and sands than for clay soils, probably because clays have more recalcitrant organic matter that would not be accessed by the Solvita test.

- Solvita correlated well with SOM only for soils with alfalfa as the previous crop.

- The Solvita test correlated well with extractable N for all soil textures and for previous crops of corn and soybean. Where alfalfa was the previous crop, the extractable N did not correlate with the active pool of organic matter measured by the Solvita kit.

- Both Solvita and SOM correlated well with PMN and with each other, although Solvita was not a better predictor of PMN than SOM was.
- For this subset of 45 samples, extractable N had the best correlation with Solvita, SOM, and yield of any of the tests.

Conclusions

- It appears the fixed volume wetting method yields quite variable results and artificially low values for coarse textured soils
- The Solvita CO₂-Burst test correlated well with SOM for soils with previous crops of alfalfa and for sand, loam or clay loam textures. Correlation with SOM was poor for clay soils (although number of samples was low) and for previous history of corn and soybean.
- In our previous study, the SOM and Solvita results were equally well correlated to PMN (r=0.48 vs 0.47, n=19), but for the current work SOM had a higher r value than Solvita (r=0.46 vs 0.36, n=45). Thus, our results so far do not suggest that the Solvita test is a better indicator of PMN than SOM.
- Based on our findings for the clay soils and those with a previous crop of alfalfa, we conclude that the Solvita CO₂-Burst test is measuring a pool of active, labile C. Our final test, currently underway, will compare Solvita results with the permanganate-oxidizable C (POxC or Cornell) test.

Acknowledgments

The authors would like to acknowledge: (1) funding from the Minnesota Agricultural Fertilizer Research and Education Council, (2) Fabian Fernandez, Paulo Pagliari, and Jeff Vetsch for access to field trials, (3) sample collection assistance from the Soil, Water, and Climate (SWC) field crew, (4) help with statistical analysis from Karina Fabrizio, and (5) sample access from and helpful discussions with members of the SWC Nutrient Management Team.