Solvita as a Test of N Mineralization and an Indicator of N Response in Minnesota Soils

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Background

Extractable and mineralizable nitrogen (N) both contribute to the N pool that can be accessed for plant uptake. Thus, accurate estimation of soil potentially mineralizable N (PMN) is desired to help predict optimum N fertilizer rate recommendations for farmers. Traditional laboratory incubations are recognized as the standard for predicting PMN, but they are labor intensive, expensive, and cannot supply in-season recommendations due to long incubation times. A new test from Solvita that determines the burst of soil respiration after rewetting dry soil is a relatively simple and low cost tool being marketed as an easy way to estimate soil N response (Haney et al, 2008; Haney and Haney, 2010). 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.

Project Objectives:
1) Compare the Solvita test with standard laboratory aerobic incubation techniques
2) Determine whether the Solvita test is a better measure of soil N supply than soil OM level
3) Use existing corn N response studies in Minnesota to determine whether fertilizer N recommendations can be improved based on the Solvita test.

Methods

First year study (2013-14)
- Samples were collected from control plots for 7 corn N response trials in central and southern Minnesota.
- Determined Solvita CO_2-burst concentration, soil organic matter content (LOI) and KCl extractable NH_4^+ and NO_3^- for 80 samples at 2 depths (0-15 and 15-30 cm, n=160).
- Stanford and Smith (1972) aerobic incubation test of Potentially Mineralizable N (PMN) for 20 samples at 2 depths.
- Economically optimum N rate (EONR) values were calculated for 60 samples.

Second year study (2014-15)
- In May 2014, a total of 144 samples were collected from 36 sites with corn N response trials in Minnesota at 2 depths (0-15 cm, 15-30 cm, n=288).
- To test repeatability, duplicate tests of the Solvita CO_2- Burst kit for 70 samples have been completed so far (n=140).
- Additional tests to be run include aerobic incubations to determine PMN and potentially mineralizable C, and water extractable C and N.

Illustration of Solvita test

Fig. 1. General procedure of Solvita CO2-Burst test. http://solvita.com/soil

Acknowledgments and References

References Cited: Haney et al., 2008. Comm Soil Sci & Plant Anal 39:2706; Haney and Haney, 2010. Comm Soil Sci & Plant Anal 41:1493; Stanford and Smith, 1972. SSSAJ 36:465.
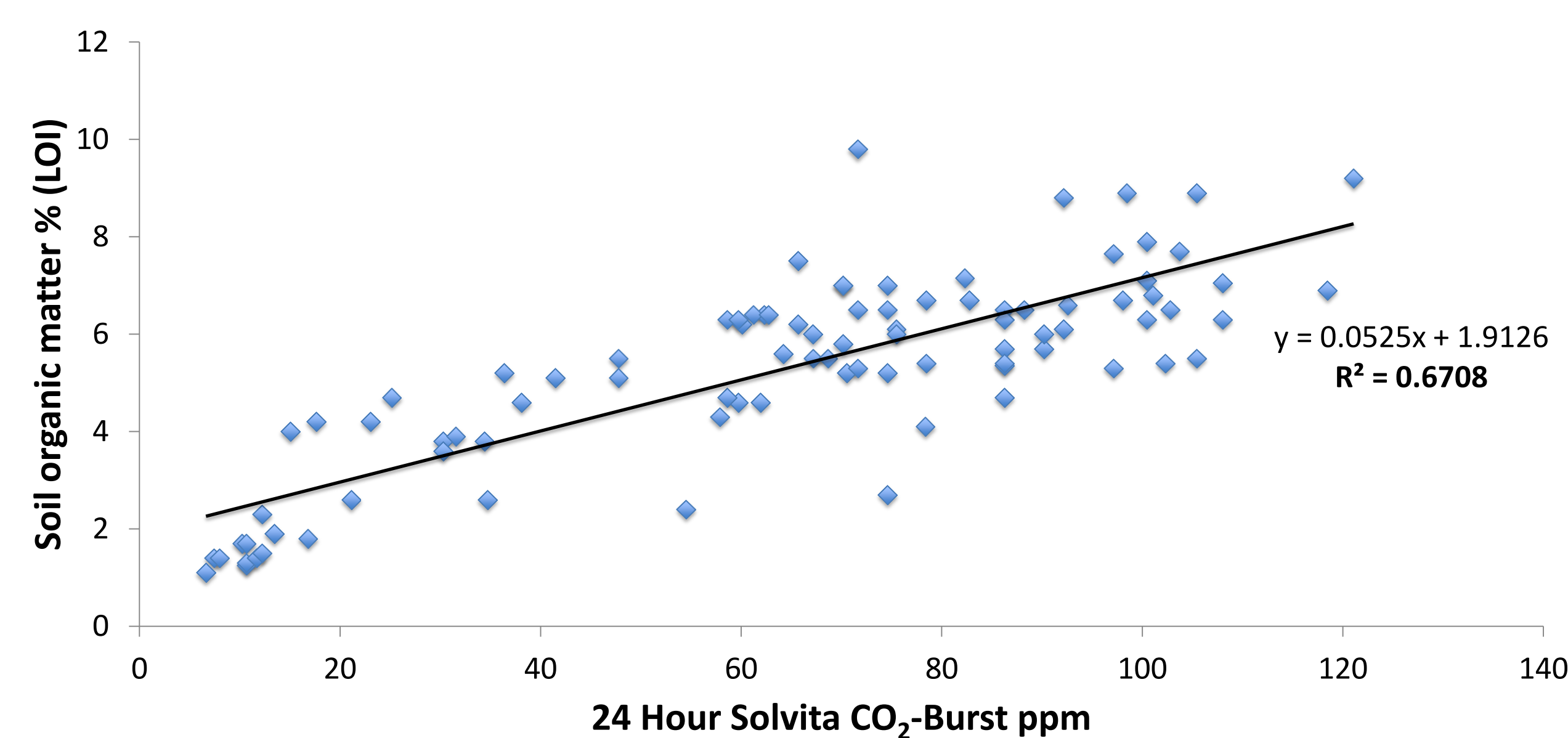
Results

$y = 0.0525x + 1.9126$
$R^2 = 0.6708$

Fig. 2. 24 Hour Solvita CO_2-Burst (ppm) vs Soil Organic Matter (LOI) for the 0-15 cm depth, n=90

- Solvita and SOM results are highly correlated (p < 0.001)
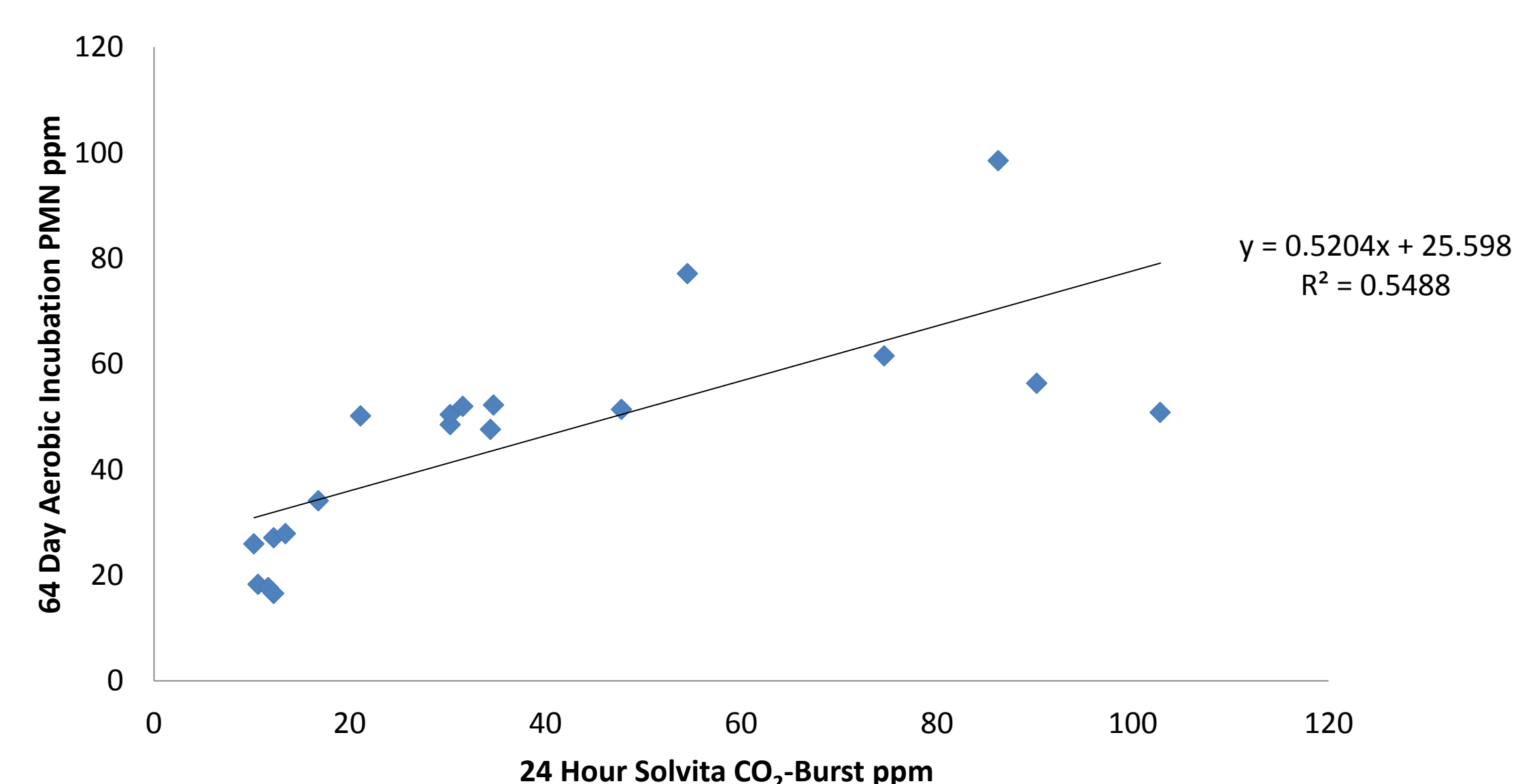

$y = 0.5204x + 25.598$
$R^2 = 0.5488$

Fig. 3. PMN results from 64-Day Aerobic Incubation (ppm) vs Solvita CO_2-Burst (ppm) for the 0- 15 cm soil samples

- Solvita and PMN results are significantly correlated (p < 0.01) but more data are needed since sample number is small (n=20).
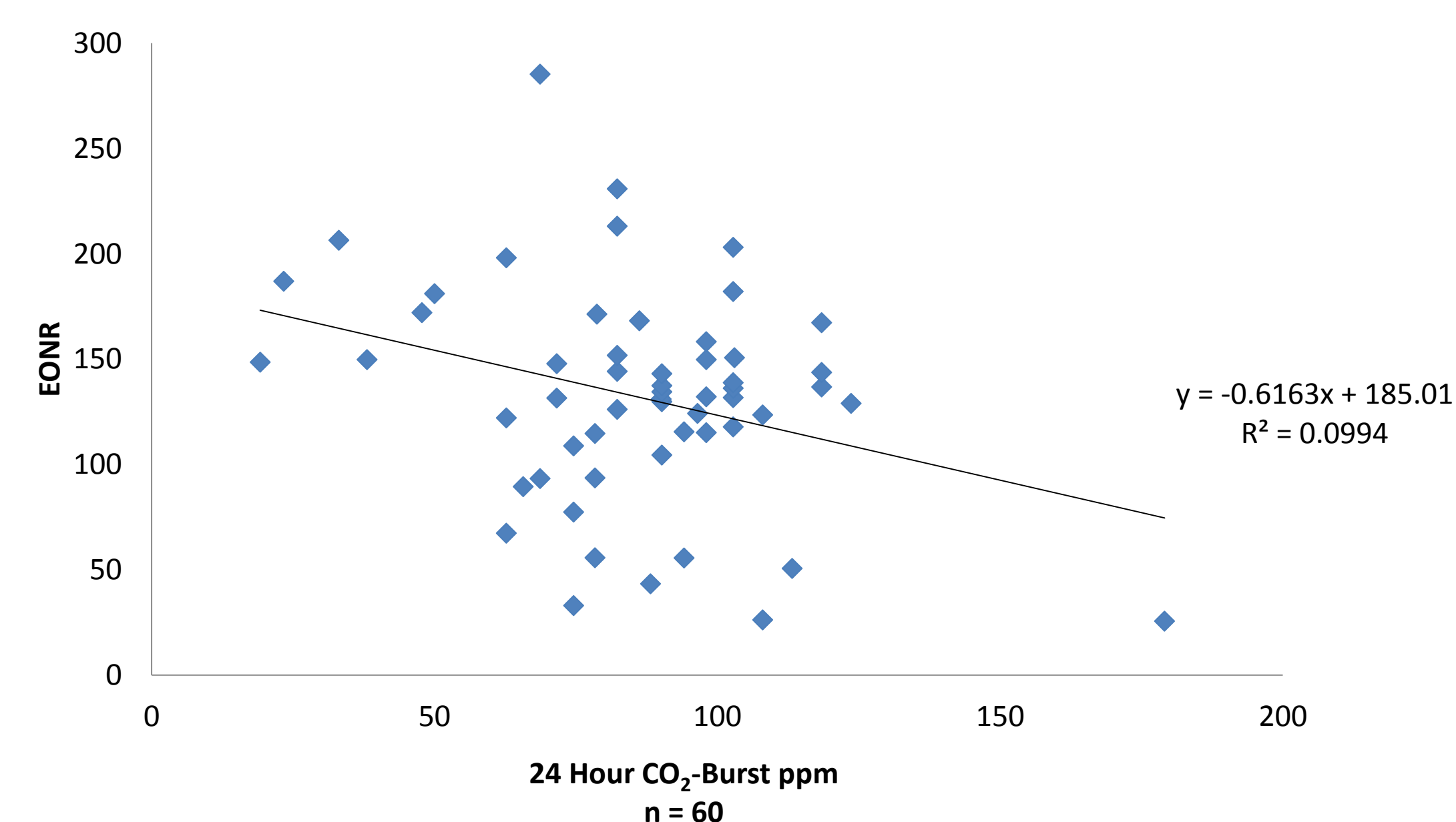

$y = -0.6163x + 185.01$
$R^2 = 0.0994$

Fig. 4. Correlation between 24 hour Solvita CO_2-Burst (ppm) and economically optimum N rate (EONR).

- If Solvita is a good indicator of mineralizable N, it should be related to optimum N rate. For 60 sample points where EONR was calculated, we found a poor relationship between the two.
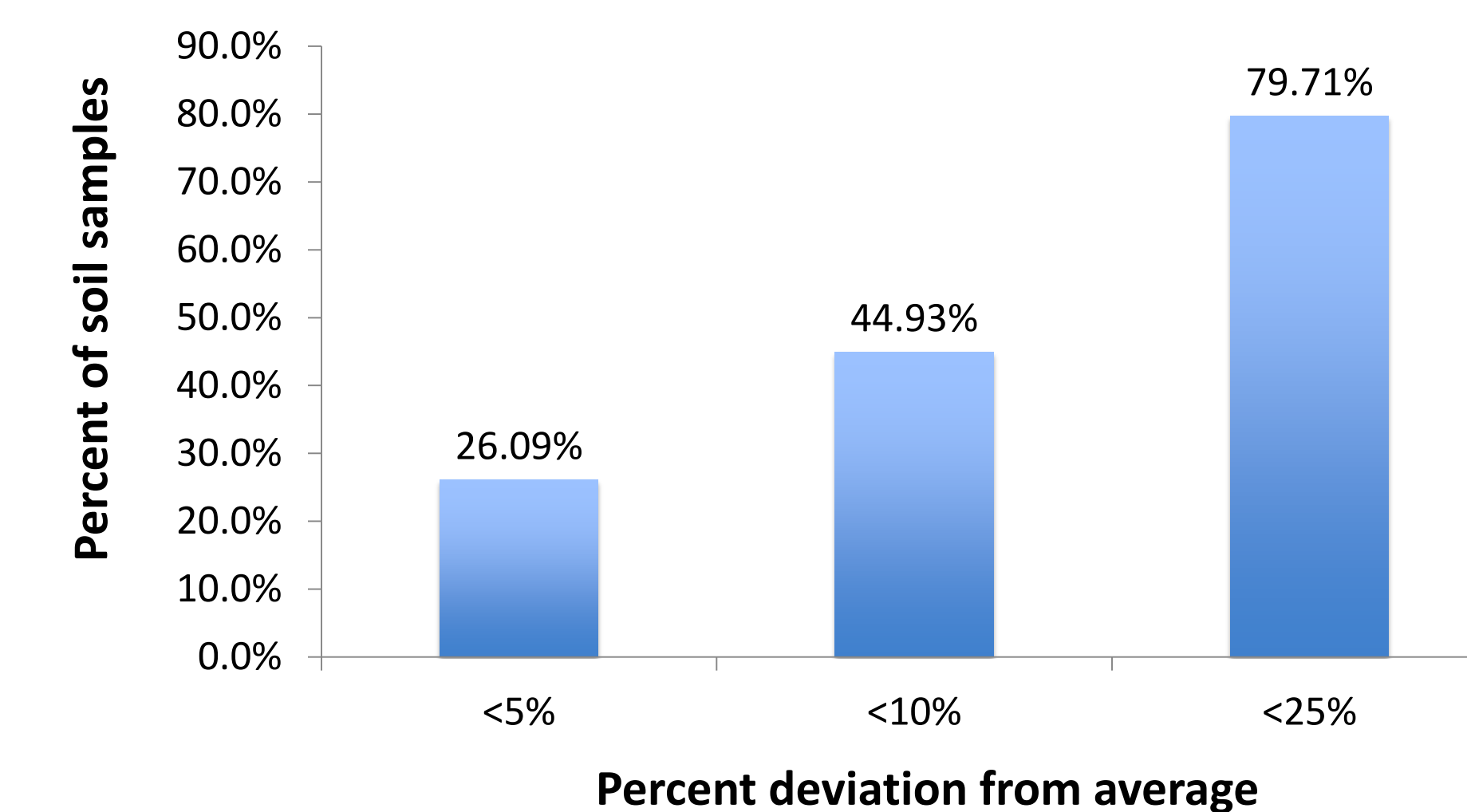
Results (continued)

Fig. 5. Repeatability Test. The percentage deviation from average of two samples is calculated by using the equation $\frac{|X_1 - \bar{X}| + |X_2 - \bar{X}|}{2} \div \bar{X}$.

Only 26 % of the duplicate samples are within 5% deviation from the mean even when tested by the same operator in exactly the same manner and under constant temperature and moisture conditions, and only 45% of the samples are within 10% deviation.

Correlation (r values) among soil measurements for 2013 and 2014 soil samples at 0-15, 15-30 and 0-30 cm soil depths. Levels of statistical significance are indicated as p < 0.05 (*), p < 0.01 (**) and p < 0.001 (***)

Soil sample depth	CO_2 vs SOM	CO_2 vs Extr N	CO_2 vs PMN	CO_2 vs EONR
0 - 15 cm	0.820 *** (n=20) 2013 (n=70) 2014	0.505 * (n=20) 2013	0.737 ** (n=20) 2013	-0.211 (n=60) 2013
15 – 30 cm	0.692 *** (n=20) 2013 (n=70) 2014	0.128 (n=20) 2013		-0.112 (n=60) 2013
0 – 30 cm	0.809 *** (n=20) 2013 (n=70) 2014	0.381 (n=20) 2013		

The Solvita CO_2-burst results were well correlated to organic matter content at both depths (p < 0.001). There was also a significant relationship between CO_2 and KCl-extractable N for the 0-6 inch depth (p < 0.04).

Conclusions

- The 24 Hour Solvita CO_2-burst test correlates well with organic matter content especially in the surface (0-15 cm) layer.
- The correlation was less strong, though significant, between the Solvita test and PMN determined by a 64 day aerobic incubation. Additional samples are being tested for PMN.
- The relationship between the Solvita test values and EONR was not significant.
- Repeatability and precision of the Solvita test is a concern because 20% of the duplicate samples deviated more than 25%.

Overall, the Solvita CO_2 burst test is correlated with SOM and PMN, but it is not clear whether Solvita results are any better than SOM as a predictor of mineralizable N. Further testing of more samples and methods will provide additional information.