THE OHIO STATE UNIVERSITY / SCHOOL OF ENVIRONMENT AND NATURAL RESOURCES / SOIL MICROBIAL ECOLOGY LABORATORY

BIOCHEMICAL ASSAYS TO DETECT MANAGEMENT IMPACTS ON SOIL QUALITY

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INTRODUCTION

Soil quality is often related to crop yield assuming that higher quality soils deliver higher yields. Thus, soil quality (SQ) indicators are needed that can quantify the ability of soils to deliver ecosystem services, but also guide land managers in implementing and monitoring sustainable soil management practices.

From our previous research we have found several enzyme activity assays meet requirements for serving as SQ indicators. However, enzyme activities, like many soil properties, vary with soil organic matter (C_{org}) and other soil properties.

This is why it might be necessary to collect soil samples from different functional soil classes on the field. In addition, normalization of activity to C_{org} may provide an index to separate soil management effects more clearly than enzyme activities alone.

OBJECTIVES

- Evaluate the association of selected enzyme activities with yield and C_{org} using soil samples from farmers' fields in Ohio (OH), Illinois (IL), and Iowa (IA) under Full tillage and No Tillage (Maximum Farming®, Ag Spectrum) management practices.
- Determine the potential for a calibration index that is sensitive to soil management and independent of soil C_{org} by using enzyme activity alone or in a ratio with C_{org}.

Table 1: Sites

State	Location
Ohio	Circleville
Illinois	Prairie City
Iowa	DeWitt

Table 2: Management differences

Full Tillage

> Moldboard plow
- Broadcast and band fertilization

No Tillage

> Maximum Farming®
- Balanced fertilization based on management Zones (precision farming)

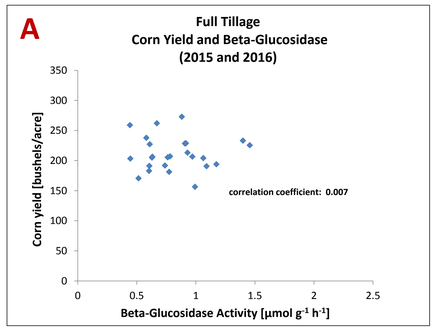
METHODS

A total of 198 soil and crop yield samples were collected in 2015 and 2016 at farmer's fields in OH, IL, and IA at four different functional soil classes using the Agsoil Analytics functional map technology (Owens, 2016). Where 1 equals good quality and 4 poor quality (low drainage, more clay).

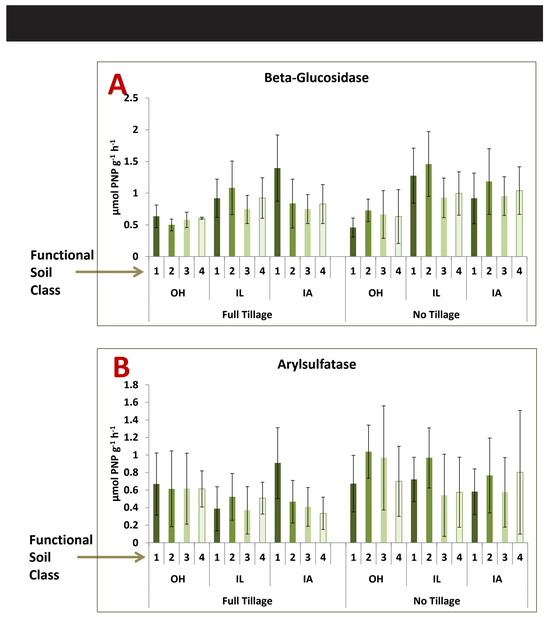
The following analytical methods were used:

1) Beta-glucosidase and Arylsulfatase assays were performed on field fresh and sieved (2mm) soils sampled at 0-15cm depth in May 2015 and 2016, and stored at 4˚C. Enzyme activities were measured after 1 hr incubations at 37 °C with p-nitrophenyl substrates and buffered pH.
2) Total C_{org} (L.O.I.) was measured on air-died and sieved (2mm) soils.
3) Enzyme activity ratios were calculated as: Enzyme : C_{org} = µmol PNP g-1 h^{-1} / C_{org} * 100
4) Corn and soybean yield (Bu/ac) was estimated in September 2015 and 2016 using a field method by collecting yield samples in 1000th of an acre.

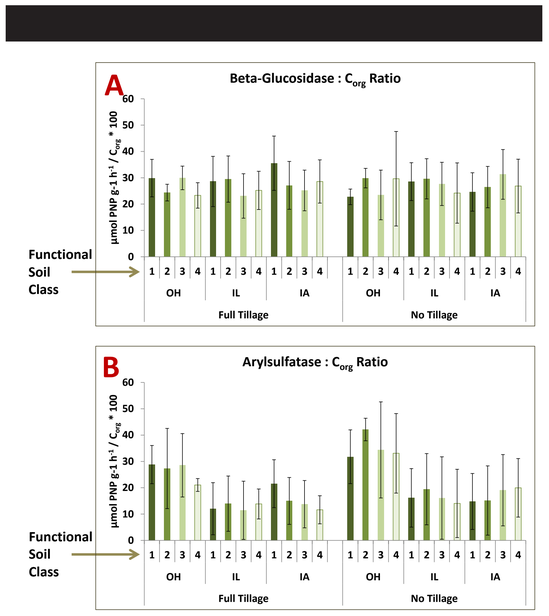
Figures 1A and 1B: Enzyme activities and Yield



Figures 2A and 2B: Enzyme activities



Figures 3A and 3B: Enzyme activity ratio with C_{org}



RESULTS and DISCUSSION

- There is no correlation of yield and enzyme activities at Full Tillage sites (Figure 1A). Enzyme activities and yield correlate at No Tillage sites (Figure 1B). This suggests that properties of No Tillage soils influence enzyme activities and yields concomitantly.
- Enzyme activities vary with geographic region (Figures 2A and 2B). No Tillage sites tend to show higher soil enzyme activities when compared to their Full Tillage counterpart. Functional soil class 1 which is considered as good quality soil tends not to show the highest enzyme activities when compared to gradually lower quality soil classes 2, 3, and 4 (poor quality soil). This might be due to underlying factors such as fertilization or small scale differences in soil properties which is not captured by the Agsoil Analytics functional map technology.
- Beta-Glucosidase ratios with C_{org} vary around 30 (Figure 3A) while Arylsulfatase : C_{org} ratios are more variable and tend to be highest in Ohio under No Tillage management.

CONCLUSIONS

We have seen correlations between yields and soil enzyme activities in No-Tillage soils and enzyme activities tend to be higher in 0-15 com soil depth under No Tillage compared to Full Tillage sites.

If functional soil classes are affecting soil enzyme activities is still unclear, results so far have shown that small scale differences might not be captured by the Agsoil Analytics functional map technology and thus enzyme activities measured to date are mostly not declining with decreasing soil function.

BIBLIOGRAPH

Owens, 2016: Functional Soil Class Mapping. Online Article: Purdue startup commercializes soil-mapping technology to improve crops, increase yields (http://www.purdue.edu/newsroom/releases/2015/Q4/purdue-startup-commercializes-soil-mapping-technology-to-improve-crops,-increase-yields.html)

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