Methods to Track Changes in Soil Biological Properties under Different Management Practices

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Introduction

Soil health testing is aimed at achieving multiple goals including: understanding soil constraints beyond nutrient limitations and excesses, targeting management practices to alleviate those constraints, measuring soil improvement or degradation from management, improve awareness of soil health, enable valuation of farmland, and enable assessment of farming system risk. Soil microbes play a direct role in driving multiple soil chemical and physical processes important for overall ecosystem function, but also have direct and indirect effects on plant productivity and quality. As a result, we suggest that soil conservation and regeneration should focus not only plant nutrient status and erosion control but also on the status of the soil biological community, its function, and overall soil health. The overall goal of this project was to identify the linkages between soil health management practices (individually and collectively) and soil health indicators on an array of soil samples collected from across the USA under different management practices.

Approach

619 samples soil samples (0-15 cm) were collected from across the USA from a variety of soil types, climate zones, and agronomic or rangeland practices (Figure 1). These include long-term, replicated agricultural research sites from OR, MN, IN, IL, and CA; and five USDA Plant Materials Center Cover Cropping Trials from MO, FL, MD, ND, and AK; and producer-owned/operated fields and long-term ranching operations. Samples were submitted for the following suite of soil health measurements: Cornell's Comprehensive Assessment of Soil Health (CASH), beta-glucosidase activity (BG), and phospholipid fatty acid (PLFA) profiling of the microbial community (Buyer and Sasser, 2012; Moebius-Clune et al., 2016; USDA-NRCS, 2014). Molecular analysis (16S) also was conducted on a subset of samples.

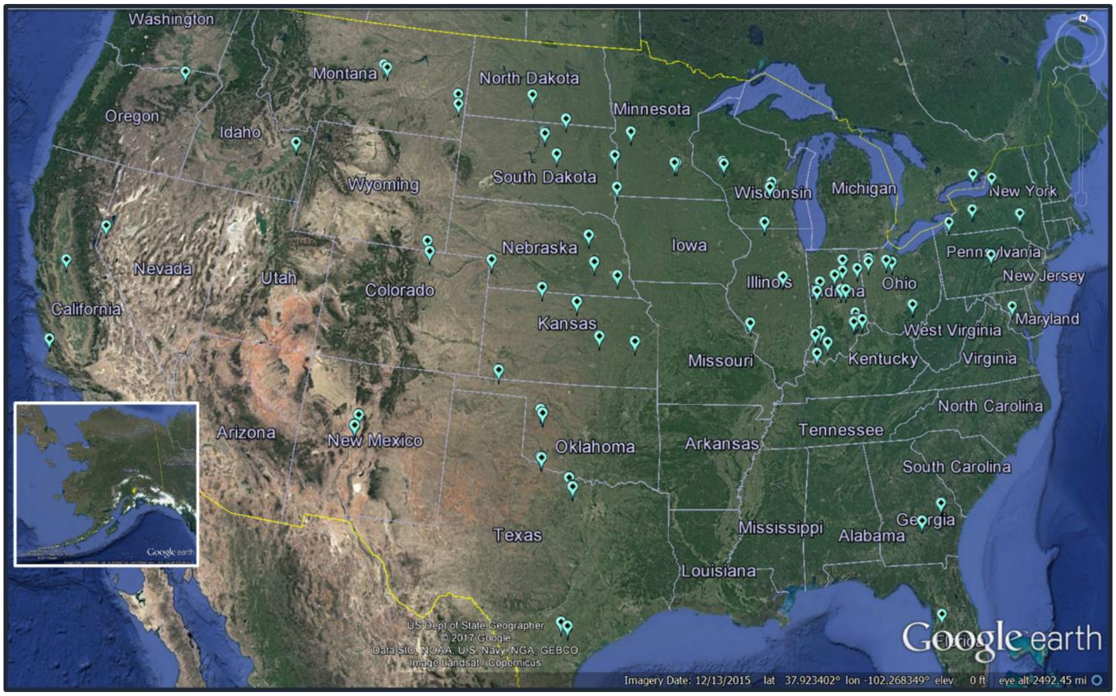

Figure 1. Map indicating location of soil sampling effort in agricultural and rangeland fields across the USA.

Results

Of the soil samples analyzed with PLFA and CASH (N=233), overall CASH score and total PLFA concentration were positively correlated ($p<0.0001$) supporting the concept that microbial abundance plays a pivotal role in soil health processes (Figure 2). Management practices are also related to various soil health indicators; for example, based on 146 samples, as cover crop richness increased, active carbon increased (Figure 3). Using examples from the Century Experiment at the Russell Ranch at University of California at Davis (http://asi.ucdavis.edu/programs/rr/about/century-experiment), cover cropping in a corn-tomato rotation had a positive impact on soil health indicators including active carbon (Figure 4), soil respiration (Figure 5), and abundance of arbuscular mycorrhizal fungi (Figure 6) based on PLFA analysis.

Additional samples and analyses are on-going. Ultimately, the indicators responsive to management and those that best predict ecosystem function and productivity will be identified. An overarching goal is to better quantify how management practices influence soil health.

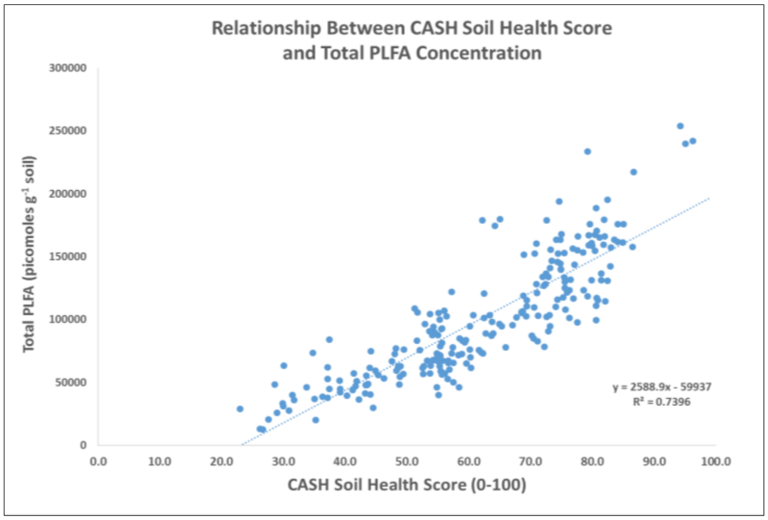

Figure 2. Relationship between CASH soil health score and total PLFA concentration

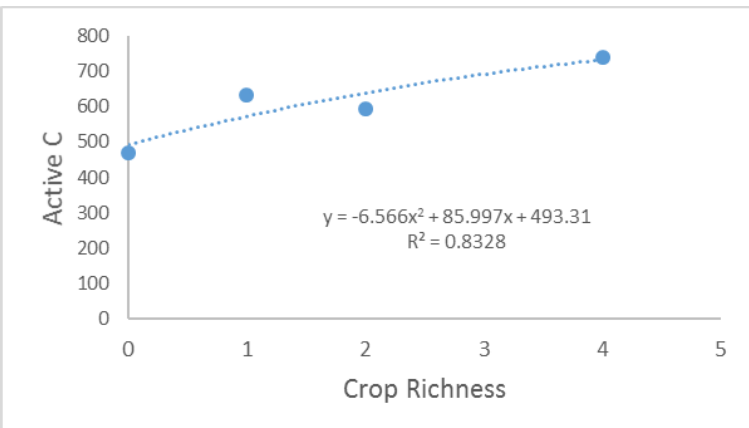

Figure 3. Relationship between cover crop richness and active carbon

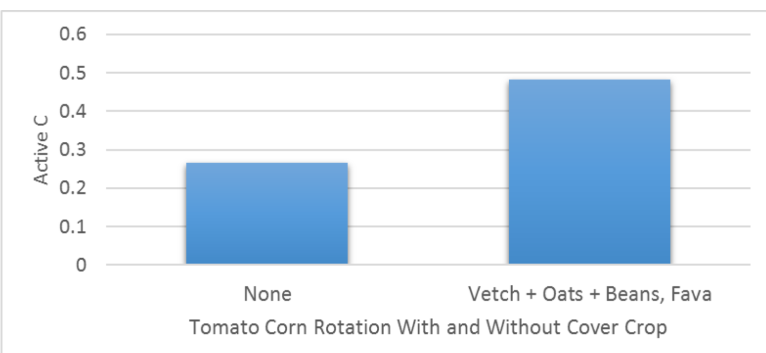

Figure 4. Effect of cover crop (vetch, oats, and fava beans) in a tomato-corn rotation on active carbon at the Century Experiment, Russell Ranch.

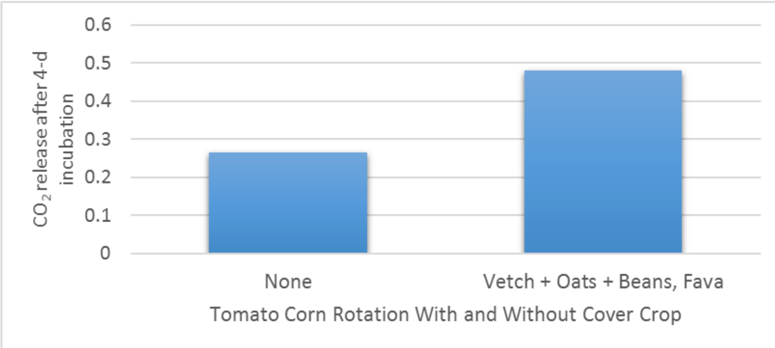

Figure 5. Effect of cover crop (vetch, oats, and fava beans) in a tomato-corn rotation on soil respiration (CO_2 release after 4-d incubation) at the Century Experiment, Russell Ranch.

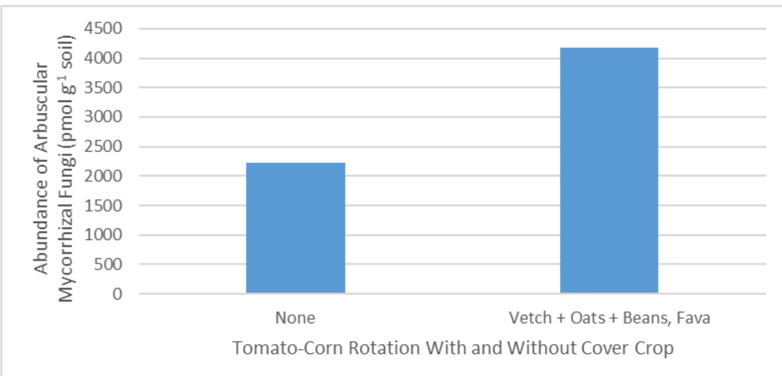

Figure 6. Effect of cover crop (vetch, oats, and fava beans) in a tomato-corn rotation on abundance of AMF at the Century Experiment, Russell Ranch.

References

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