Cover Crops 101
Midway Ext. Dist.

Peter Tomlinson
Kansas State University
ptomlin@ksu.edu (785) 477-2389

K-STATE
Research and Extension

Soil Biology and Cover Crops

K-STATE
Research and Extension

How Do We Measure Soil Health?

Soil Chemical Properties
(Carbon and Nutrients)

- Available C
- Total Organic C
- Easily extractable N and P
- Dissolved organic nutrients
- Traditional soil fertility tests – *Correlated to yield*

Photo:www.nrcs.usda.gov

K-STATE Research and Extension

How Do We Measure Soil Health?

Soil Physical Properties

- Wet aggregate stability – *Ability to withstand disturbance*
- Water infiltration – *Movement of water*
- Bulk Density – *Ease of root penetration*

https://www.nal.usda.gov/topics/soil-resource-management

K-STATE Research and Extension

Chemical

Physical

Biological

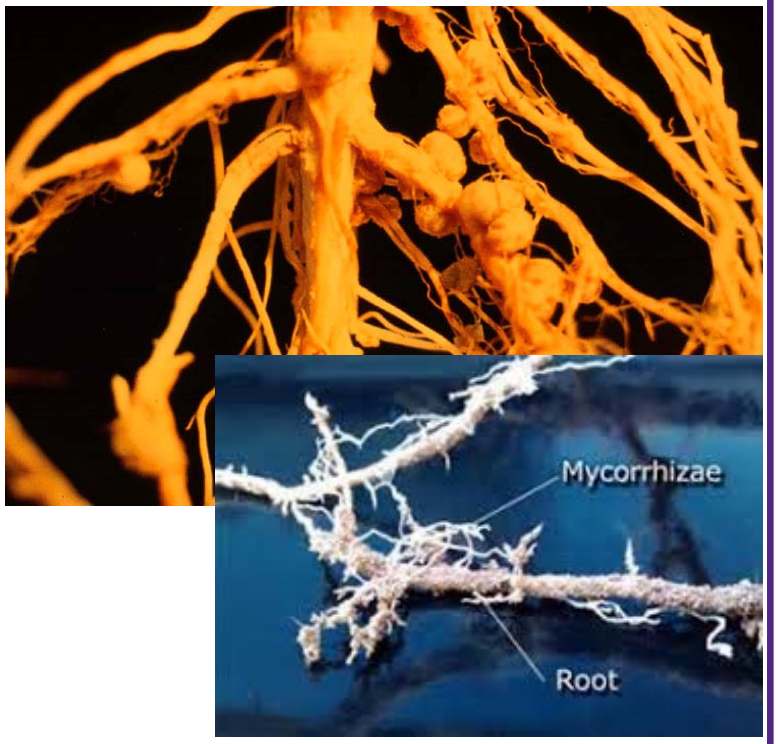
TABLE 1. Tier 1 Soil Health Indicators and Methods to be Assessed (updated 10/8/2018)		
Indicator	**Method**	**Reference**
Soil pH	1:2 soil:water, standard pH electrode system	Thomas, 1996
Soil Electrical Conductivity (EC)	1:2 soil:water, standard electrical conductivity meter system	Rhoades, 1996
Cation Exchange Capacity (CEC)	Sum of Cations: For soil pH ≥ 7.2: use ammonium acetate extractant; For soil pH < 7.2: use Mehlich 3 extractant	Knudsen, et al., 1982 Sikora and Moore, 2014
% Base Saturation (BS)	Calculation: For soil pH ≥ 7.2: use ammonium acetate extractant; For soil pH < 7.2: use Mehlich 3 extractant	Knudsen, et al., 1982 Sikora and Moore, 2014
Extractable P	For soil pH ≥7.2: use sodium bicarbonate extractant; For soil pH < 7.2: use Mehlich 3 extractant	Olsen and Sommers, 1982 Sikora and Moore, 2014
Extractable K, Ca, Mg, Na	For soil pH ≥ 7.2: use ammonium acetate extractant; For soil pH < 7.2: use Mehlich 3 extractant	Knudsen, et al., 1982 Sikora and Moore, 2014
Extractable Fe, Zn, Cu, Mn	For soil pH ≥ 7.2: use DTPA extractant derivatives; For soil pH < 7.2: use Mehlich 3 extractant	Sikora and Moore, 2014 Lindsay and Norvell, 1978
Total Nitrogen	Dry combustion	Nelson and Sommers, 1996
Soil Organic Carbon (SOC)	Dry combustion, corrected for Inorganic C, if present, using pressure-calcimeter	Nelson and Sommers, 1996 Sherrod, et al., 2002
Soil Texture	Pipette Method with a minimum of 3 size classes. Weight/volume measurements	Gee and Bauder, 1986
Aggregate Stability	Wet sieve procedure. Weight measurement	Kemper and Roseneau, 1986
Available Water Holding Capacity	Ceramic plate method measured at -33 kPa (-10 kPa for sandy soils) and -1500 kPa	Klute, 1986
Bulk Density (BD)	Core method: diameter to be determined, (most likely 2-inch or 5.08 cm)	Blake and Hartge, 1986
Erosion Rating	USDA model(s) (RUSLE2, WEPP, WEPS) appropriate for site	USDA Agricultural Research Service
Soil Penetration Resistance	Commercial soil penetrometer	Lowery and Morrison, 2002
Water Infiltration Rate	Double ring Infiltrometer	Reynolds, et al., 2012
Crop Yield	Obtained from historical and current plot yield data provided by site manager	
Short-Term Carbon Mineralization	4-day incubation followed by CO2-C evolution and capture at 50% water-filled pore space.	Zibilske, 1994
Nitrogen Mineralization Rate	Short-term anaerobic incubation with ammonium and nitrate measured colorimetrically pre- and post-incubation	Bundy and Meisinger, 1994

Source: https://soilhealthinstitute.org/north-american-project-to-evaluate-soil-health-measurements/

How Do We Measure Soil Health?

Soil Biological Properties

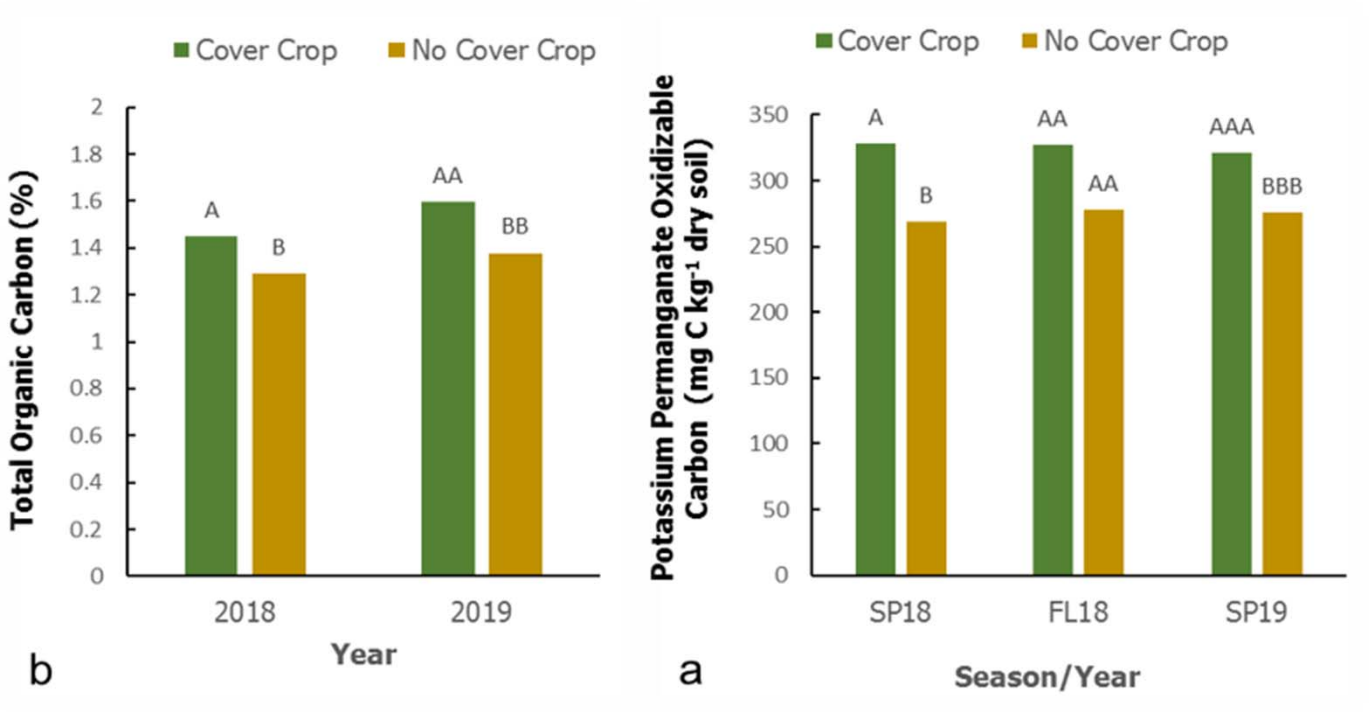
- Microbial biomass C - *Size*
- Soil respiration - *Activity*
- C, N, and P cycling enzyme activity - *Activity*
- Microbial community structure (Phospholipid Fatty Acids or PLFA) - *Diversity*



Photos: www.nrcs.usda.gov

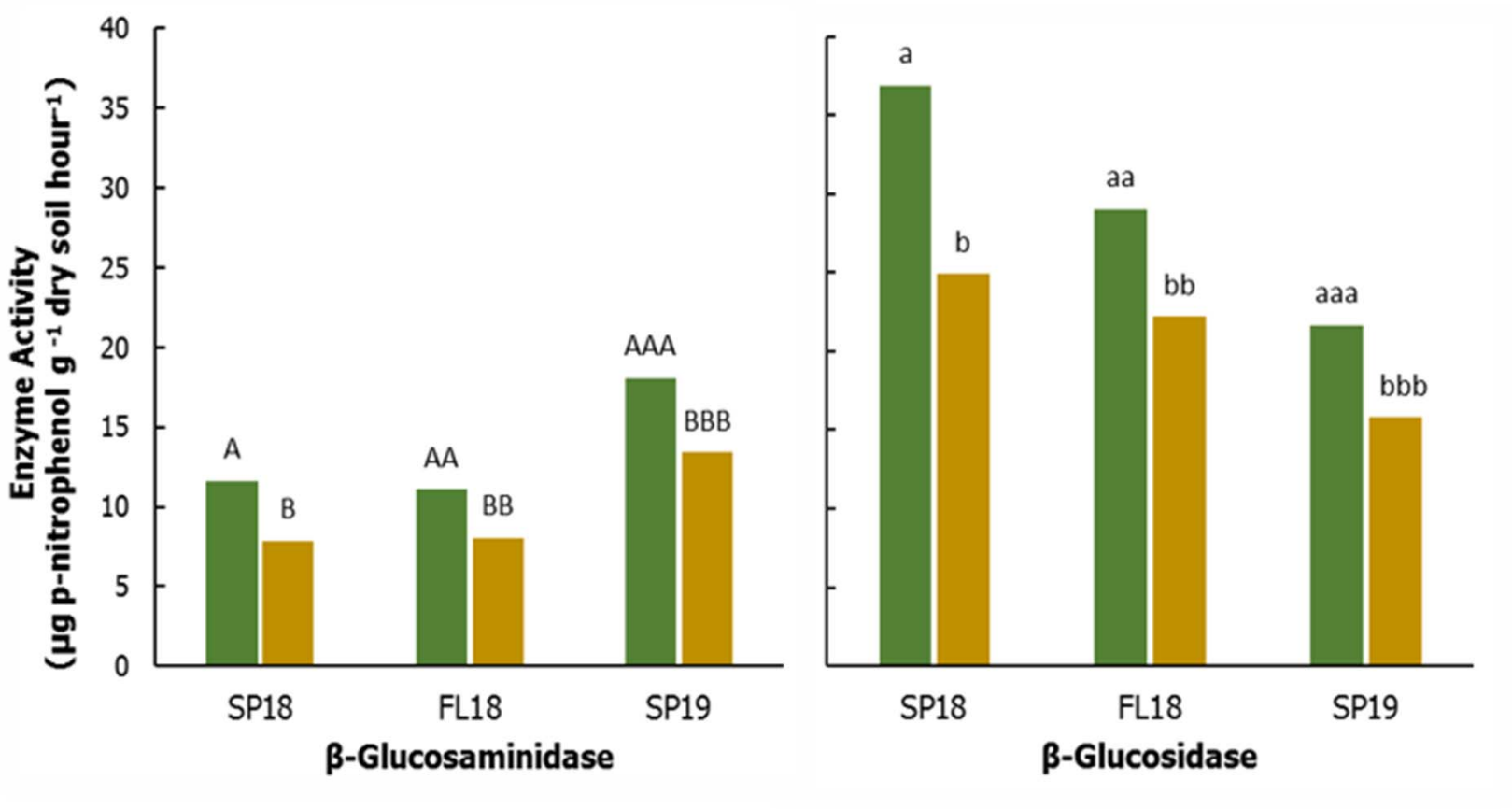
K-STATE Research and Extension

Cover crop effects on soil Carbon

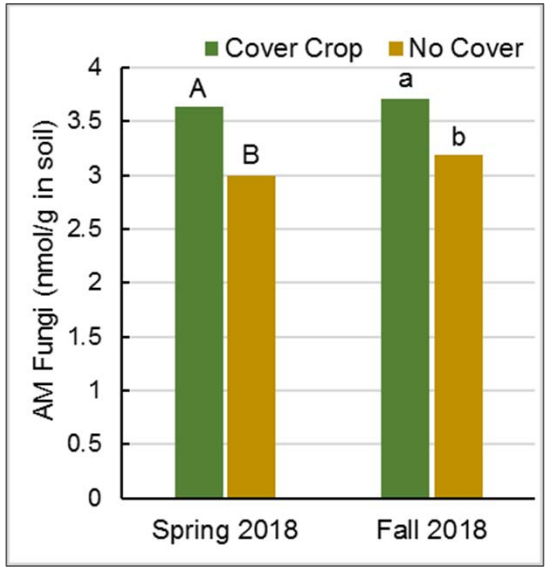


Cover crop plots had **10-15% more** total Organic C and available C

Cover crop effects on C cycling enzymes

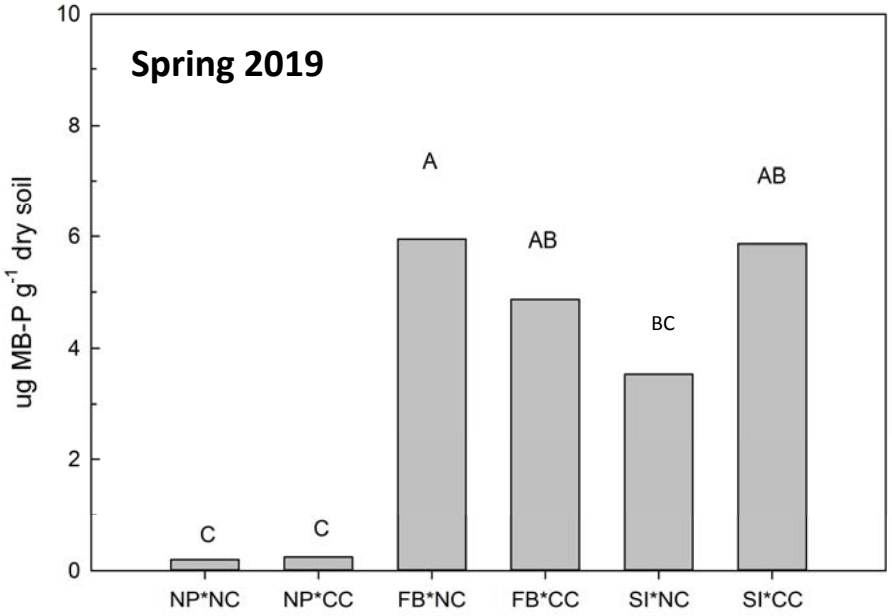


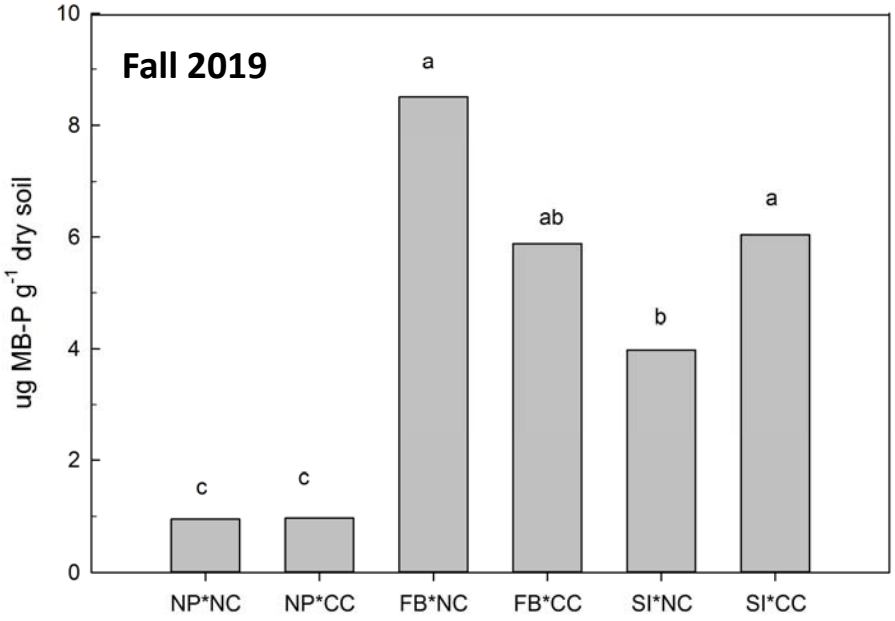
Cover crop effects on soil biological indicators



Microorganism Category	Spring 2018		Fall 2018	
	%			
	Cover Crop	No Cover Crop	Cover Crop	No Cover Crop
Fungi	3.8	3.1	3.7	3.5
AM Fungi	4.6	4.3	5.2	5.1
Actinomycetes	16.3	17.5	15.7	15.8
Anaerobic Bacteria	1.8	1.8	1.9	1.9
Eukaryotes	2.0	1.6	2.3	2.3
Gram Neg Bacteria	39.8	39.0	39.8	40.9
Gram Pos Bacteria	31.7	32.7	31.3	30.5

Microbial Biomass P

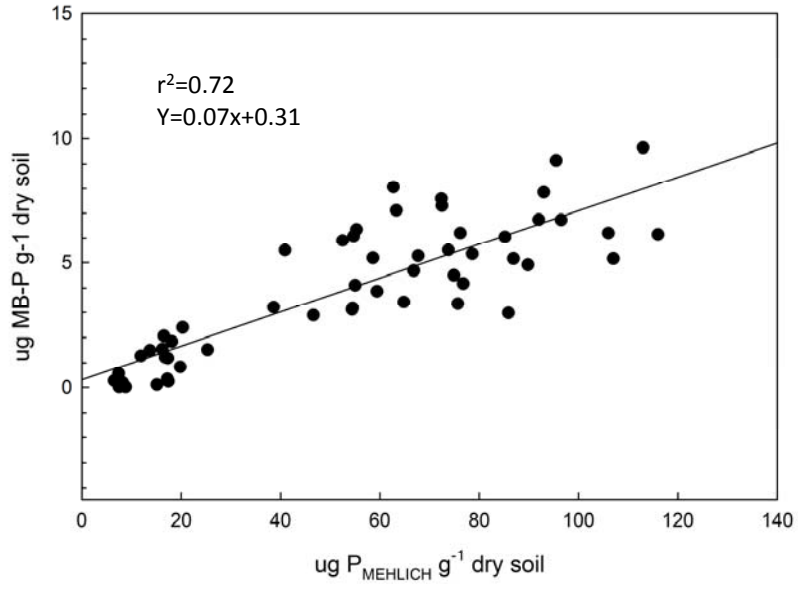




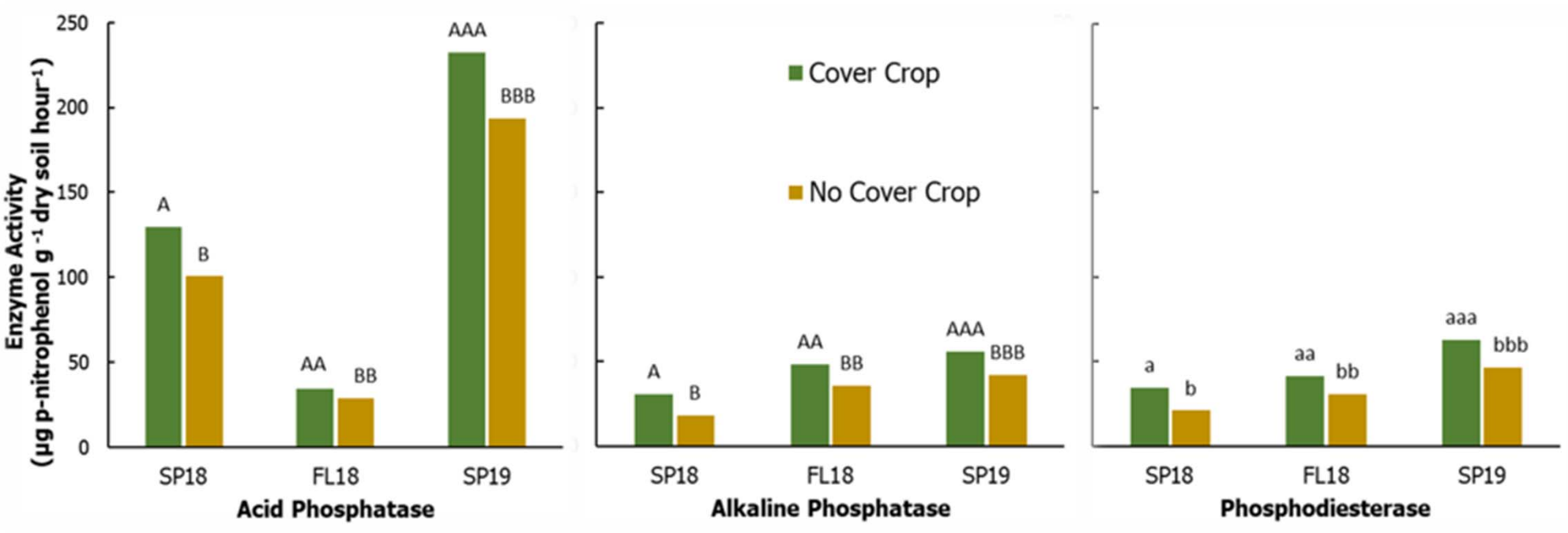
*Letters indicate significant differences $p<0.05$

Microbial Biomass P – P Pools

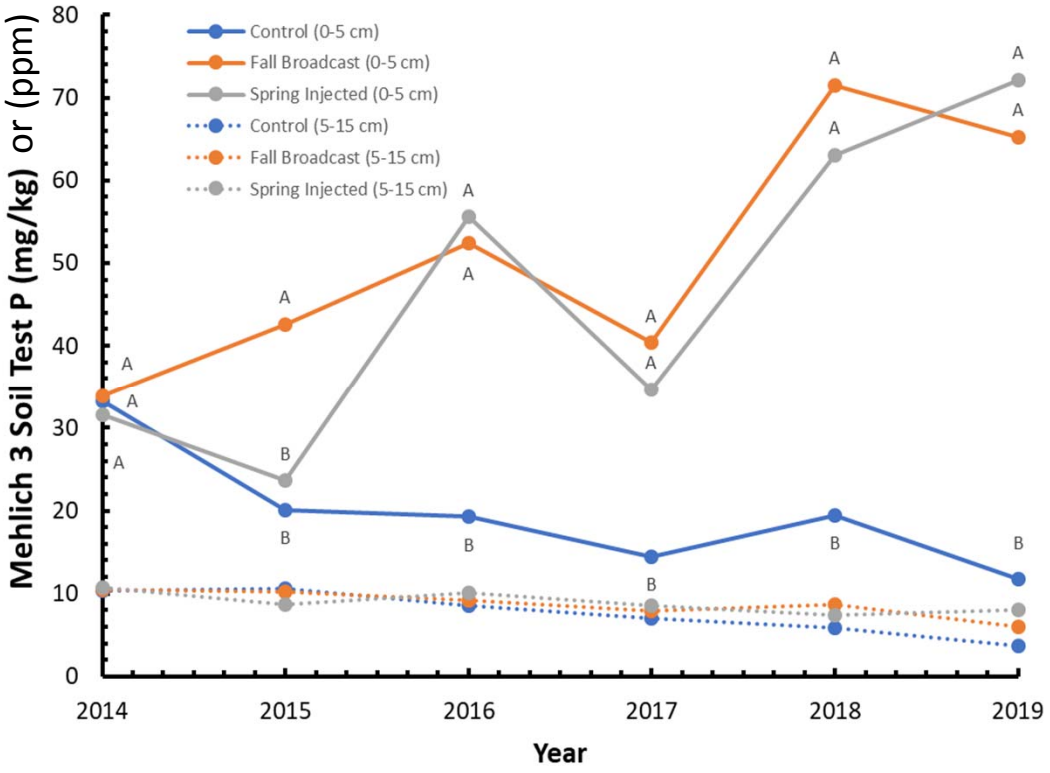
- In all seasons, MB-P was correlated to $P_{MEHLICH}$ r^2=0.72 ($p<0.001$)



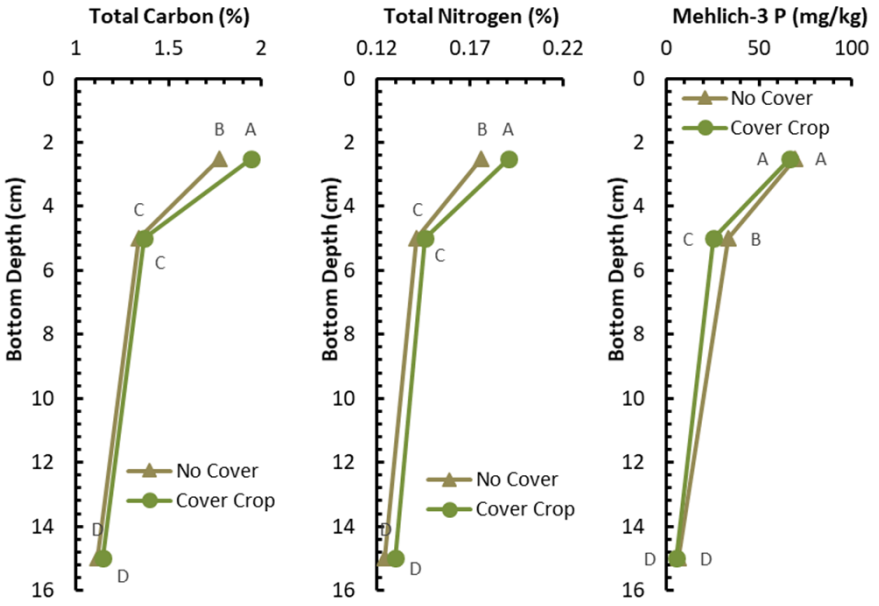
Cover crop effects on P cycling enzymes



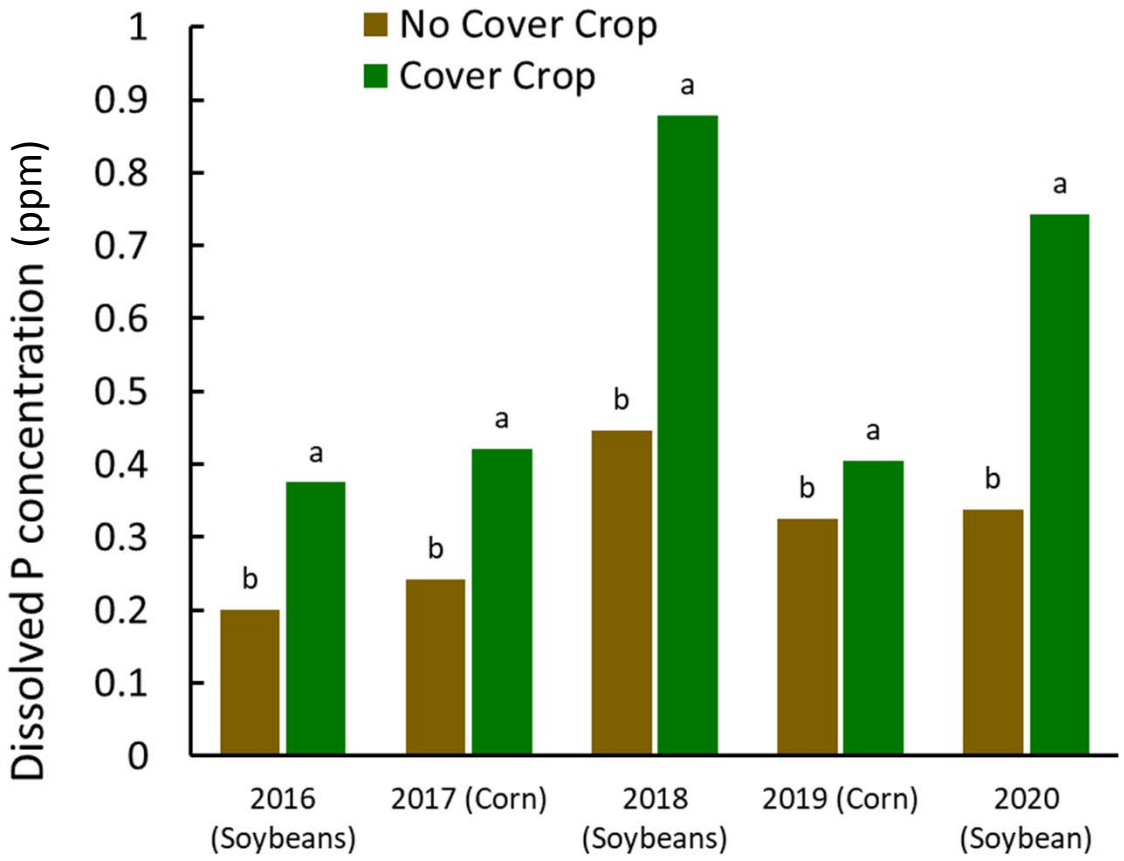
Treatment effects on soil chemical properties



Effects of cover crop in 2019 soil sampling



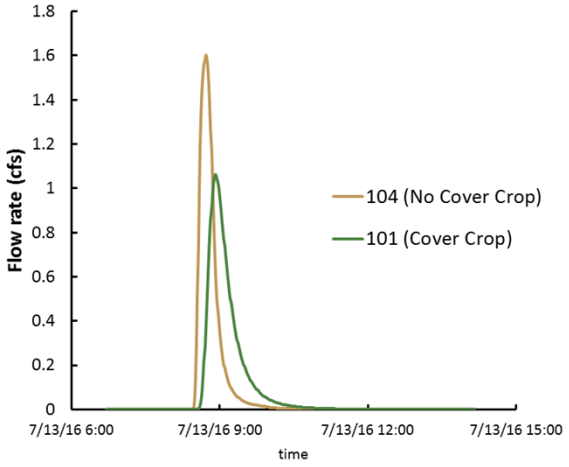
Cover crop effects on dissolved P loss

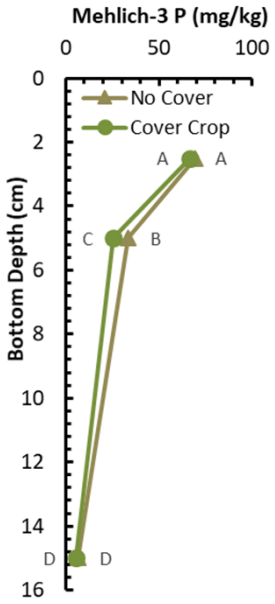


What factors are likely contributing to dissolved P runoff

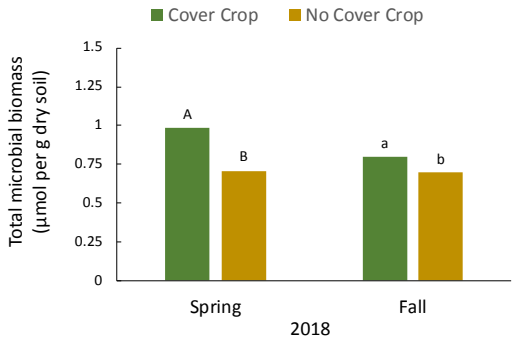
Stratification

Water - longer residence time





Higher microbial biomass & activity



Take Away

- Biological soil health improved with cover crops
- Cover crops reduced erosion
- Dissolved P runoff losses increased with cover crops, may need to rethink P fertility

K-STATE Research and Extension

Final Thoughts

Conservation management needs to be targeted to meet specific goals

More information is needed to understand how soil health will impact outcomes

Soil health measurements should be chosen and interpreted carefully

K-STATE Research and Extension

Thank you to our funding sources

United States Department of Agriculture
Natural Resources Conservation Service

United States Department of Agriculture
National Institute of Food and Agriculture

HATCH project 1004284

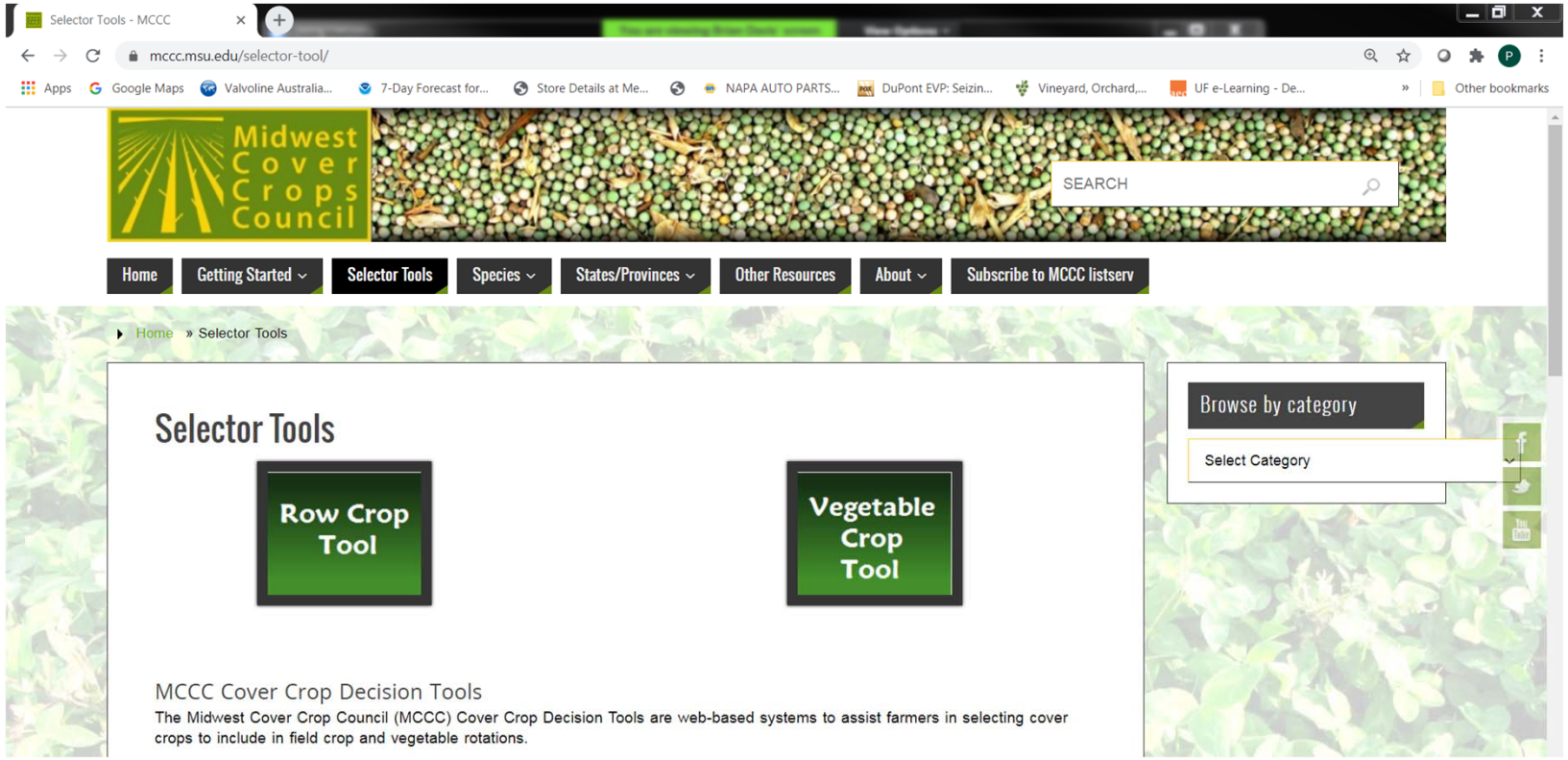
Cover Crop Selection

K-STATE
Research and Extension

What is your Objective

- Operation specific
  - Build residue
  - Reduce N leaching
  - Weed control
  - Reduce soil loss …
- What are willing to spend?
  - Seed costs
  - Fertilizer costs
  - Equipment
  - Soil moisture

Cover Crop Selection



https://mccc.msu.edu/selector-tool/

K-STATE Research and Extension

Environmental Quality Extension Program

Peter Tomlinson
Kansas State University
ptomlin@ksu.edu (785) 477-2389

K-STATE
Research and Extension