


Transport of bacteria through biochar-amended soils

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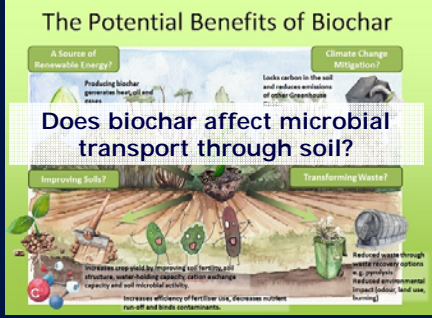
Collaborators

- Dr. Sergio Abit - Oklahoma State University
- Dr. Sharon Walker - UC Riverside
- Dr. Keri Cantrell - USDA-ARS
- Stacy Antle - USDA-ARS



The Potential Benefits of Biochar

Does biochar affect microbial transport through soil?



Source: Center for Agroecology and Food Security at Coventry University Web Site

Why do we care about microbial transport

- Animal manures are often applied to agricultural lands
- Animal manure may contain pathogenic microorganisms
- Potential for pathogens to migrate from the soil surface to the water table.

Health concerns - gastrointestinal distress ⇒ death



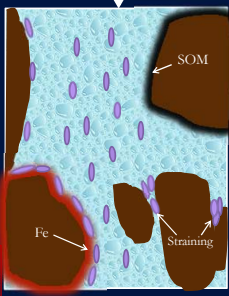
Factors affecting pathogen/indicator movement through soils and aquifers

Geochemical

- Soil solution ionic strength, composition, and pH
- Surface coatings on soil (Fe- and Al-oxides)
- Organic matter present in solution and soil

Biological

- Size
- Motility
- Survival
- Surface properties
 - Surface charge & hydrophobicity



Physical

- Pore-size distribution
- Flow rate
- Soil texture
- Surface area
- Presence of macropore flow
- Soil moisture content

Objectives:

- To determine whether biochar addition to soil affects transport of bacteria
- To determine important factors affecting transport through biochar-amended soil

Experimental Treatments

Biochar feedstock

Poultry litter and pine chips

Pyrolysis temperature

350 and 700 °C

E. coli strains

SP1HO1 (- 6.2 mV) and SP2B07 (- 45 mV)

Water Content

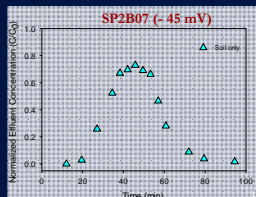
Fully saturated and ~50% saturated

Soil texture

Fine sand and sandy loam

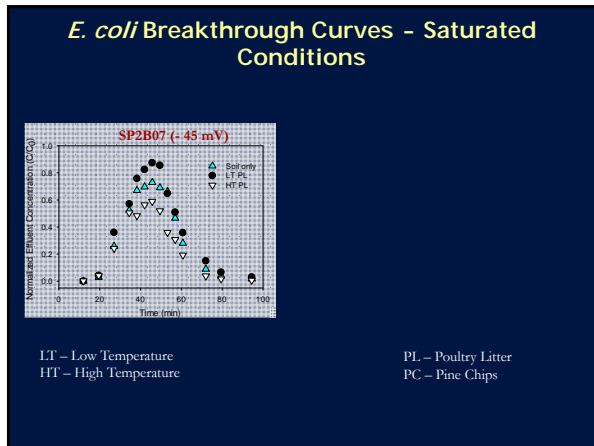
Results

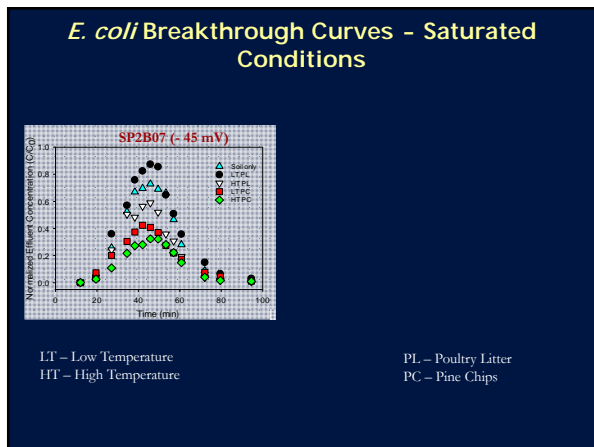
E. coli Breakthrough Curves - Saturated Conditions

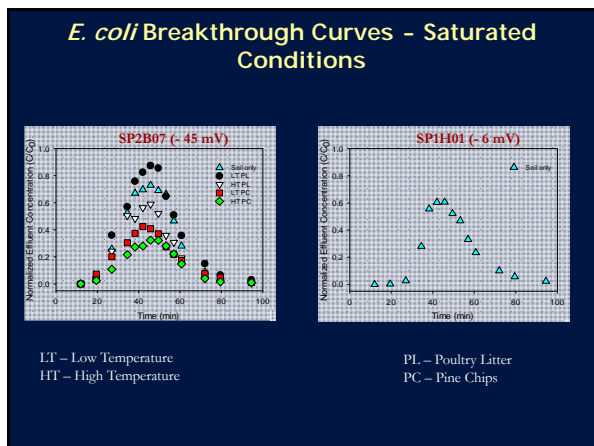


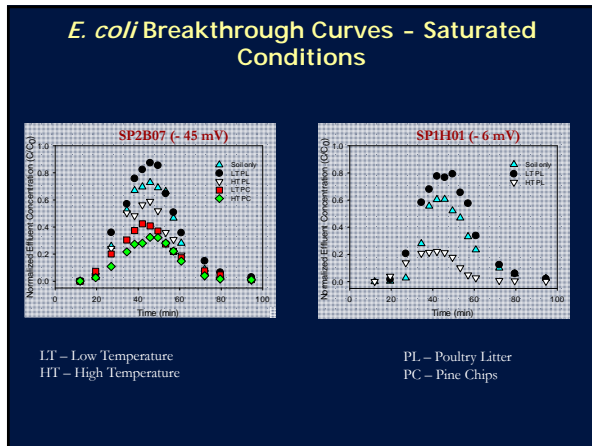
LT - Low Temperature
HT - High Temperature

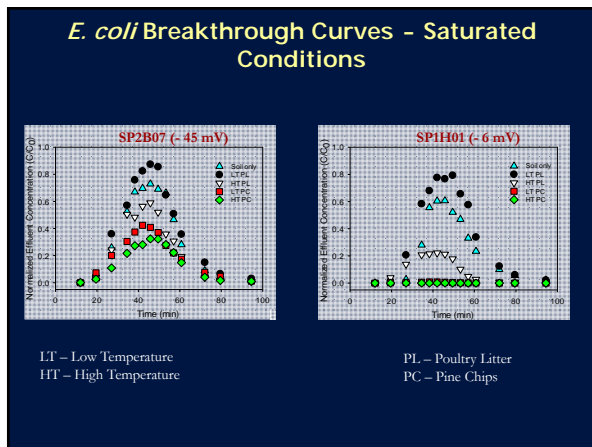
PL - Poultry Litter
PC - Pine Chips











E. Coli recovery for water saturated conditions

| | Recovery (%) | |
|------------|---------------------|--------------------|
| | SP2B07 (~ 45 mV) | SPIH01 (~ 6 mV) |
| Soil | 80 a | 58 b |
| Poultry-LT | 88 a | 90 a |
| Poultry-HT | 60 b | 23 c |
| Pine -LT | 48 c | 0.77 d |
| Pine-HT | 36 c | 0.02 d |

Effect of water content on *E. Coli* recovery

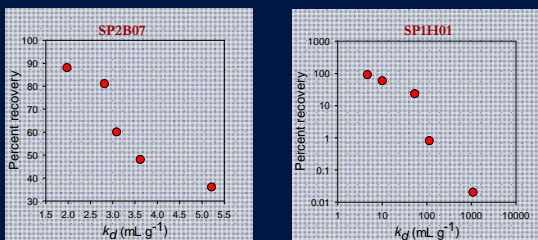
| | Fully saturated Recovery (%) | | 50% saturated Recovery (%) | |
|------------|------------------------------|--------|----------------------------|--------|
| | SP2B07 | SP1H01 | SP2B07 | SP1H01 |
| Soil | 80 a | 58 b | 56 a | 16 a |
| Poultry-LT | 88 a | 90 a | 46 a | 21 a |
| Poultry-HT | 60 b | 23 c | 11 b | 0.30 b |
| Pine -LT | 48 c | 0.77 d | 10 b | 4e-5 c |
| Pine-HT | 36 c | 0.02 d | 3.4 b | 5e-5 c |

- Trends generally same as saturated columns
- Impact of biochar addition more pronounced

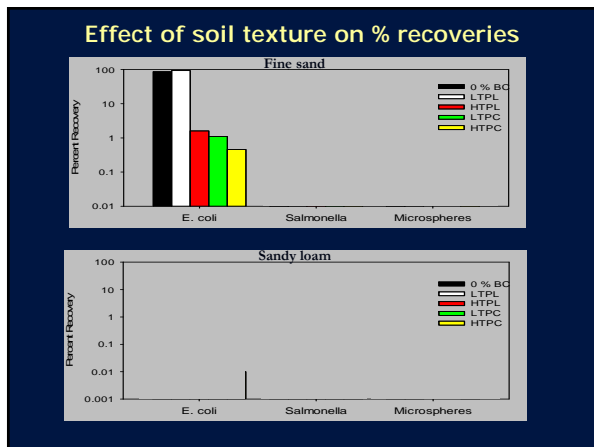
What are the mechanisms?

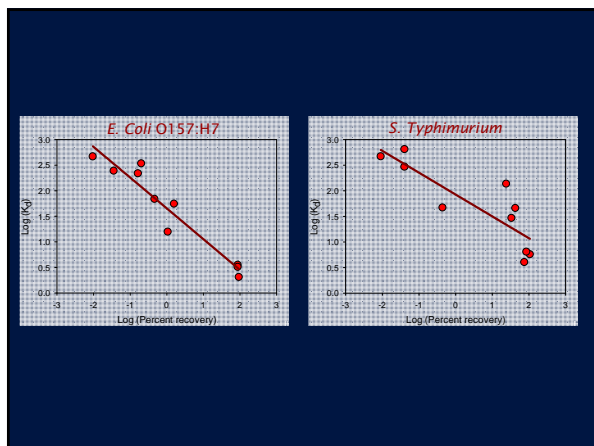
- Increased die-off of bacteria?
- Changes in chemical properties of soil, soil solution, or bacterial surface properties?
- Clogging of pores by biochar (i.e. increased straining?)
- Increased sorption?

Correlation between recovery and sorption coefficient







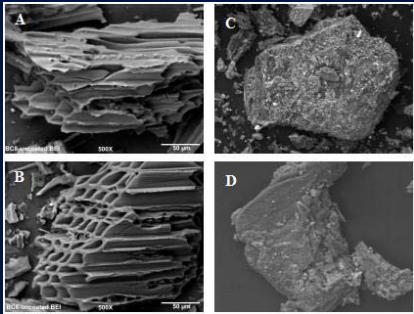


Conclusions

- Important factors controlling bacterial transport through biochar-amended soil include:
 - Biochar feedstock
 - Pyrolysis temperature

Pine Chips

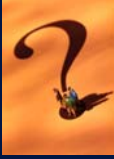
Poultry Litter



Conclusions

- Important factors controlling bacterial transport through biochar-amended soil include:
 - Biochar feedstock
 - Biochar pyrolysis temperature
 - Surface properties of bacteria
 - Water content of soil
 - Soil texture
- Mechanisms still not clear but biochar appears to affect sorption of bacteria

Questions?



Bolster, C.H. and Abit, S.M. 2011. Biochar pyrolyzed at two temperatures impacts *E. coli* transport through a sandy soil. *Journal of Environmental Quality*. 41:124-133.

Abit, S.M., Bolster, C.H., Cai, P., and Walker, S.L. 2012. Influence of feedstock and pyrolysis temperature of biochar amendments on transport of *Escherichia coli* in saturated and unsaturated soil. *Environmental Science and Technology*. 46: 8097-8105.

Abit, S.M., Bolster, C.H., Cantrell, K.B., Flores, J.Q., and S.L. Walker. 2014. Transport of *Escherichia coli*, *Salmonella typhimurium*, and microspheres in biochar-amended soils with different textures. *Journal of Environmental Quality*. 43:371-378.
