

Biochar Research at SUNY Plattsburgh: Tailoring biochar applications for North Country Soils



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Biochar is a rapidly growing area of research!

Major Themes in Recent Biochar Research



Biochar research has shifted from “does it work” to **precision application** “under what conditions, for how long, and at what cost” does it work?

Major Research Gaps

1) Context Dependency & Predictability

- Studies have shown *high variability* in biochar impacts on microbial communities, carbon flux, nutrient cycling, and crop yield across soil types, climates, pyrolysis temperatures, and application practices.

2) Long-Term Field Studies

- Many studies are short-term; **long-term persistence of effects** — especially carbon sequestration stability, microbial shifts, and crop productivity — is insufficiently studied.

3) Interaction With Other Practices

- Co-application with fertilizers, organic amendments, composts, or cover crops are promising, but interaction effects are not well understood.

4) Economic feasibility for growers



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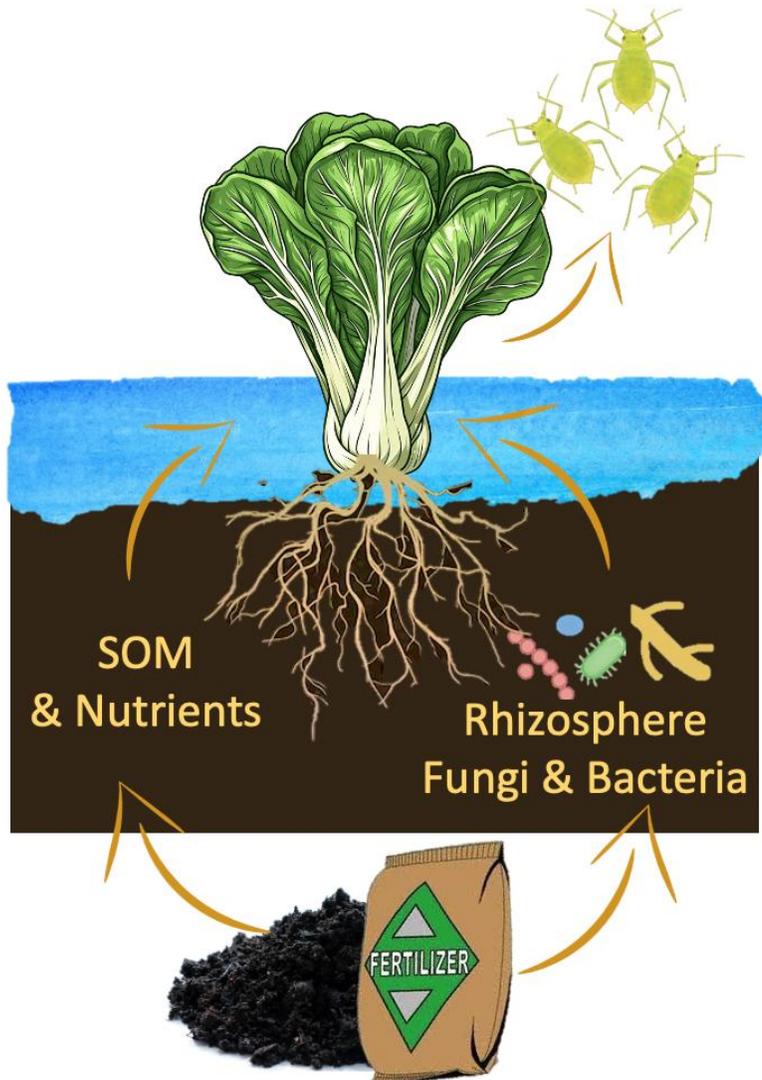
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Research Question:

- Can combinations of biochar & organic fertilizers enhance yields, resilience to flooding & resistance to insect pests?

Hypotheses:

- Biochar, by adsorbing toxins produced during flooding, promoting plant-growth promoting microbes, & reducing nutrient leaching, may improve plant resilience to flooding.
**However, as biochar increases the water holding capacity of soil, it could slow recovery post-flooding by maintaining high water content.*
- Yields will be highest under both normal and flooding conditions in plants amended with both biochar and organic fertilizers.

Experimental Design



Bok Choy *var. Black Summer*



Standardized by total nitrogen



After 2 weeks, flooded half the plants
& watered rest to field capacity for 6 days

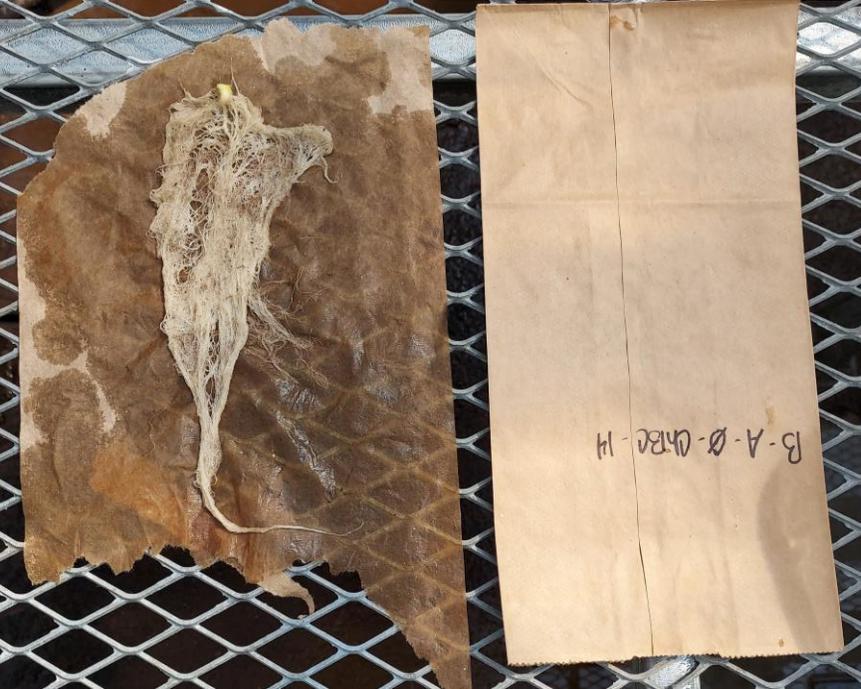


Allowed plants to drain for 24 hours



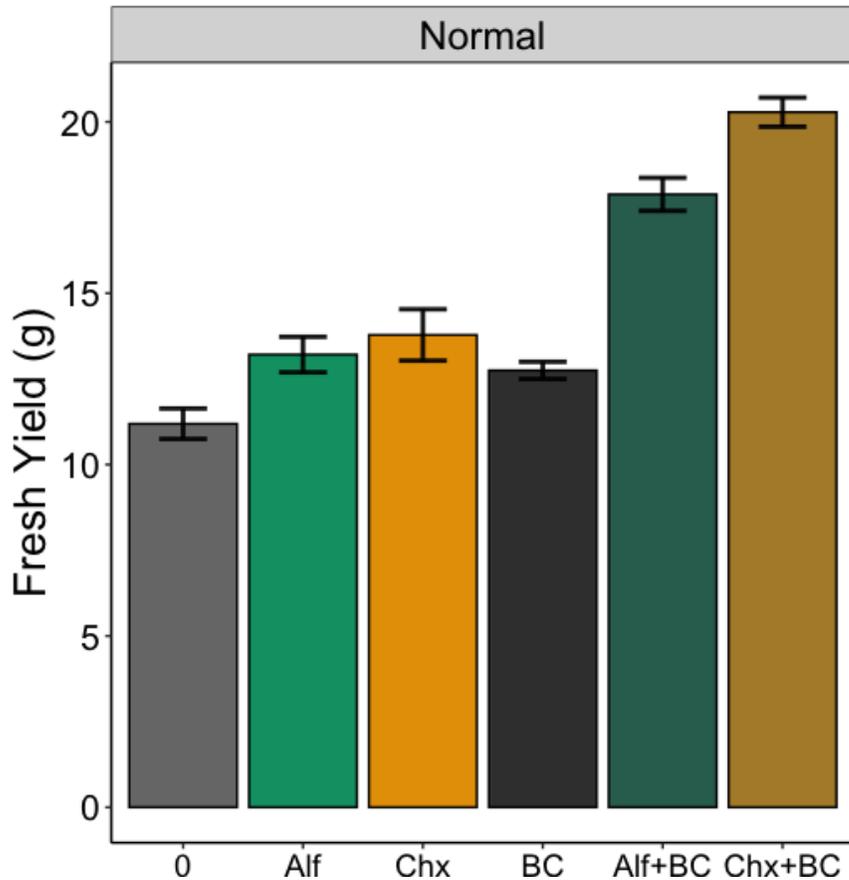
Add 3 green peach aphids
(*Myzus persicae*) to half the plants





- After 2 weeks of recovery, counted the aphids & harvested.
- Measured fresh yield, leaf surface area, above & belowground biomass
- Collected leaves for nutrient analyses, toughness, and proportion water content.
- Collected rhizosphere soil from a subset of plants to extract DNA for microbial analyses & bulk soil for nutrient analyses

Combinations of biochar & fertilizers substantially increased yield

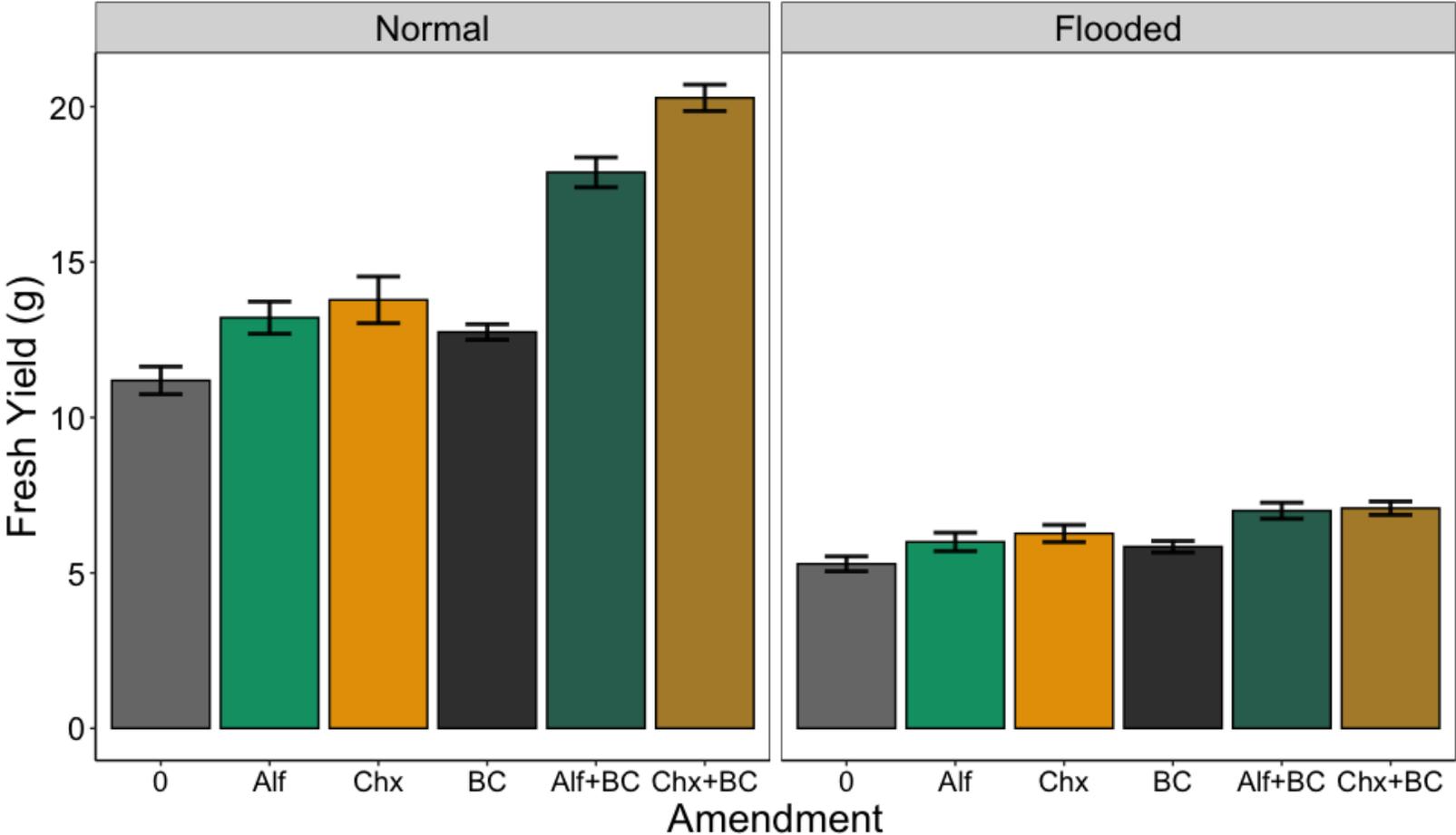


- Addition of any amendment on its own increased yields compared to the control by ~18%.
- Addition of alfalfa meal and poultry litter with biochar increased by 60 and 81%, respectively.



(Amendment: $F_{5,292} = 65.5$, $P < 0.001$ | Flooding: $F_{1,292} = 2401.7$, $P < 0.001$ | Amendment * Flooding: $F_{5,292} = 8.1$, $P < 0.001$)

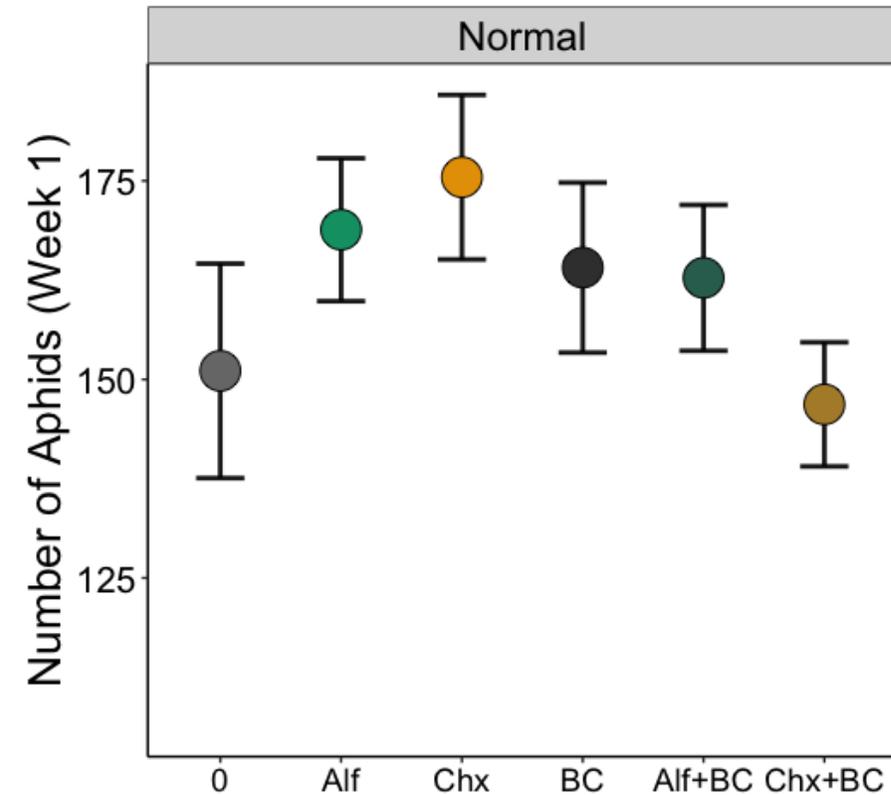
Even under flooding, biochar & fertilizer combinations increase yields



- Flooding reduced yields by over half.
- Amendments alone still increased yield by ~15%, but biochar/fertilizer combinations only increased yields by ~30%.

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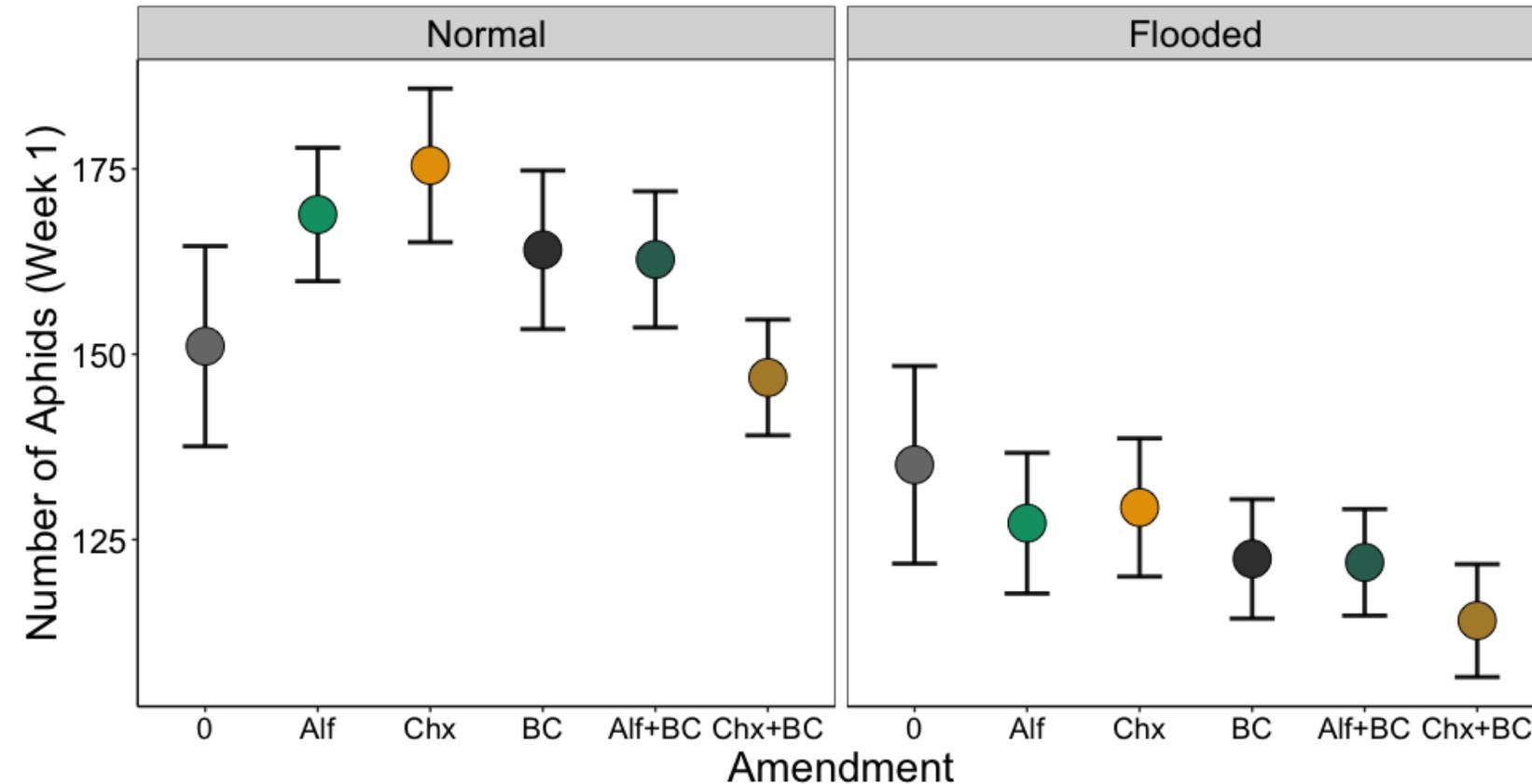
Adding biochar to poultry litter reduces aphid abundances



- Fertilization, especially with poultry litter, increases aphid abundances.
- However, adding biochar to the poultry litter reduces aphid abundances substantially.

(Amendment: $X^2=51.6$, $df=5$, $P<0.001$ | Flooding: $X^2 = 11.4$ $df = 1$, $P<0.001$ | Amendment * Flooding: $X^2 = 24.2$, $df = 5$, $P<0.001$)

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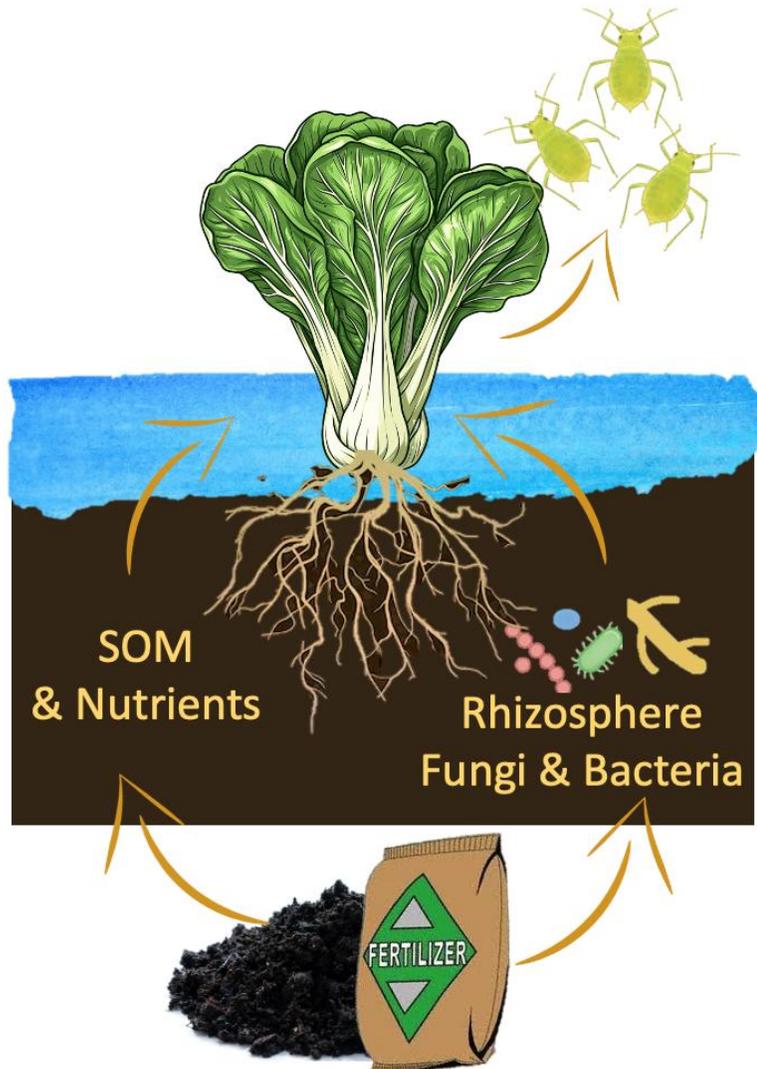


- Fertilization, especially with poultry litter, increases aphid abundances.
- However, adding biochar to the poultry litter reduces aphid abundances substantially.
- Under flooding, biochar + poultry litter still led to the lowest aphid population sizes.

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Summary

- Application of biochar + organic amendments (esp. poultry litter) increases yields, even under flooding, and reduces aphid densities.

Next Steps!

- Measuring soil nutrients & microbial communities to determine the mechanisms by which biochar + fertilizers increased yields & resistance to aphids.
- Optimizing biochar concentrations in distinct North Country soil types

Optimizing biochar application for North Country soils

One of two soil types:

One of five biochar concentrations (tons/ha):



 0 (Control)

 1

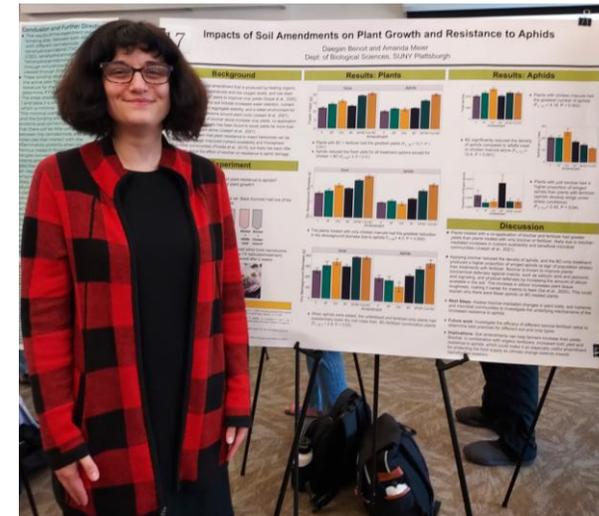
 5

 10

 20

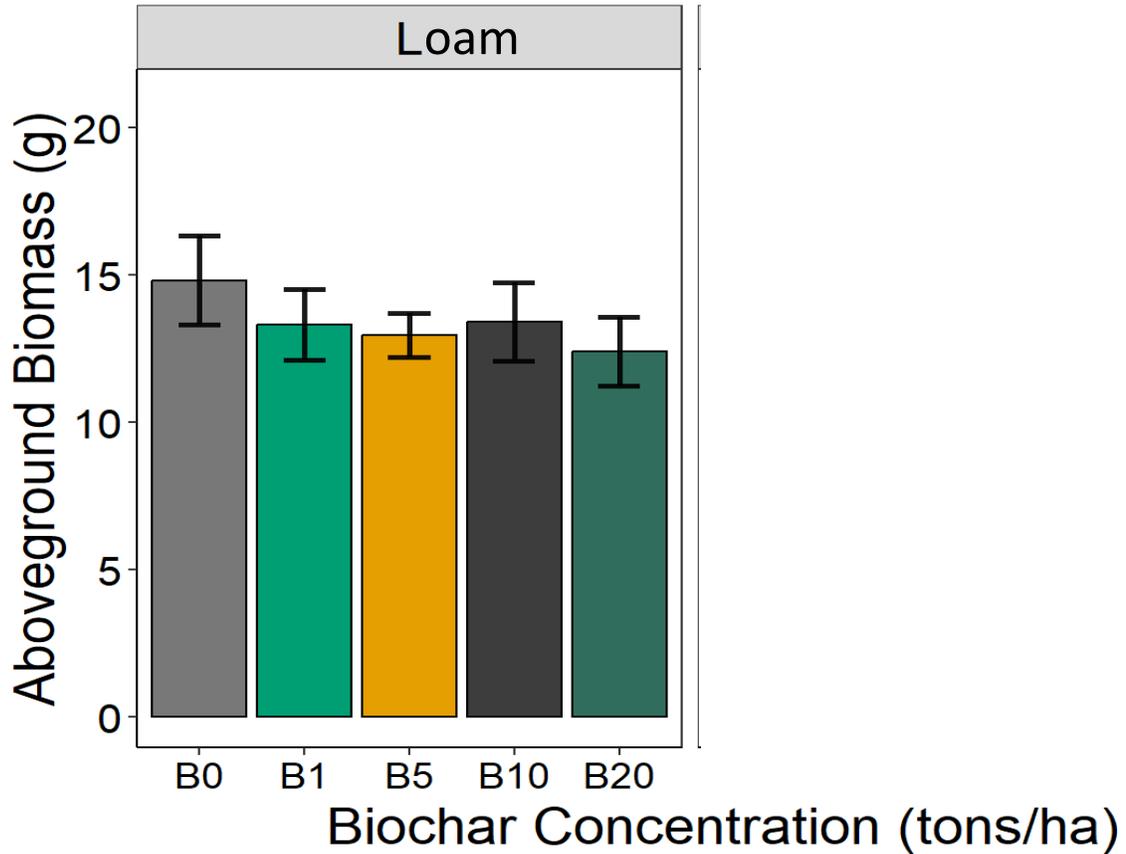


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Biochar reduced yields, especially in sandy soils

- No significant effect of biochar on fresh yield in loam soil.



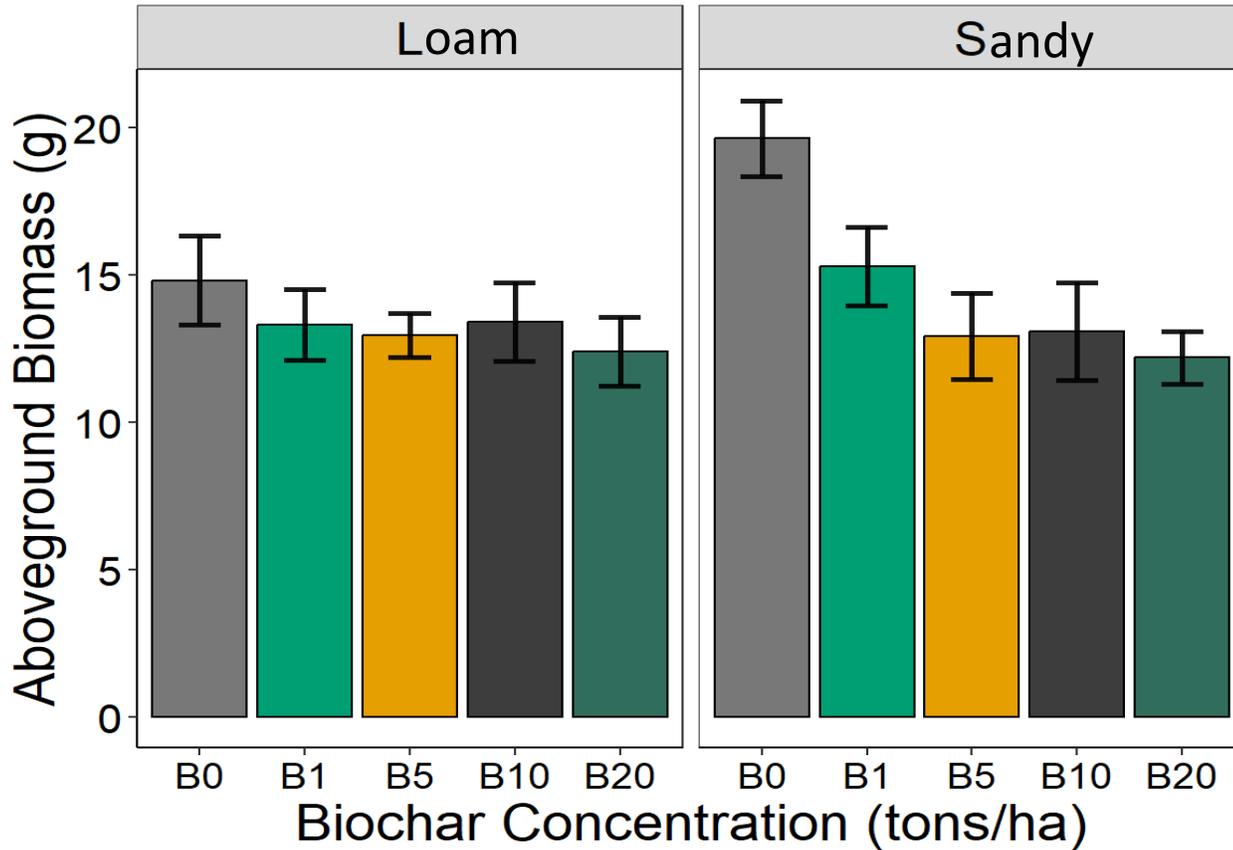
Loam soil



Biochar concentration: $F_{4,102}=3.32, p=0.0134$ | Biochar x Soil Type: $F_{4,102}=2.50, p=0.0471$

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- Adding biochar reduced yields, especially at high concentrations in the sandy soil.
- Likely due to insufficient fertilizer added with the biochar.

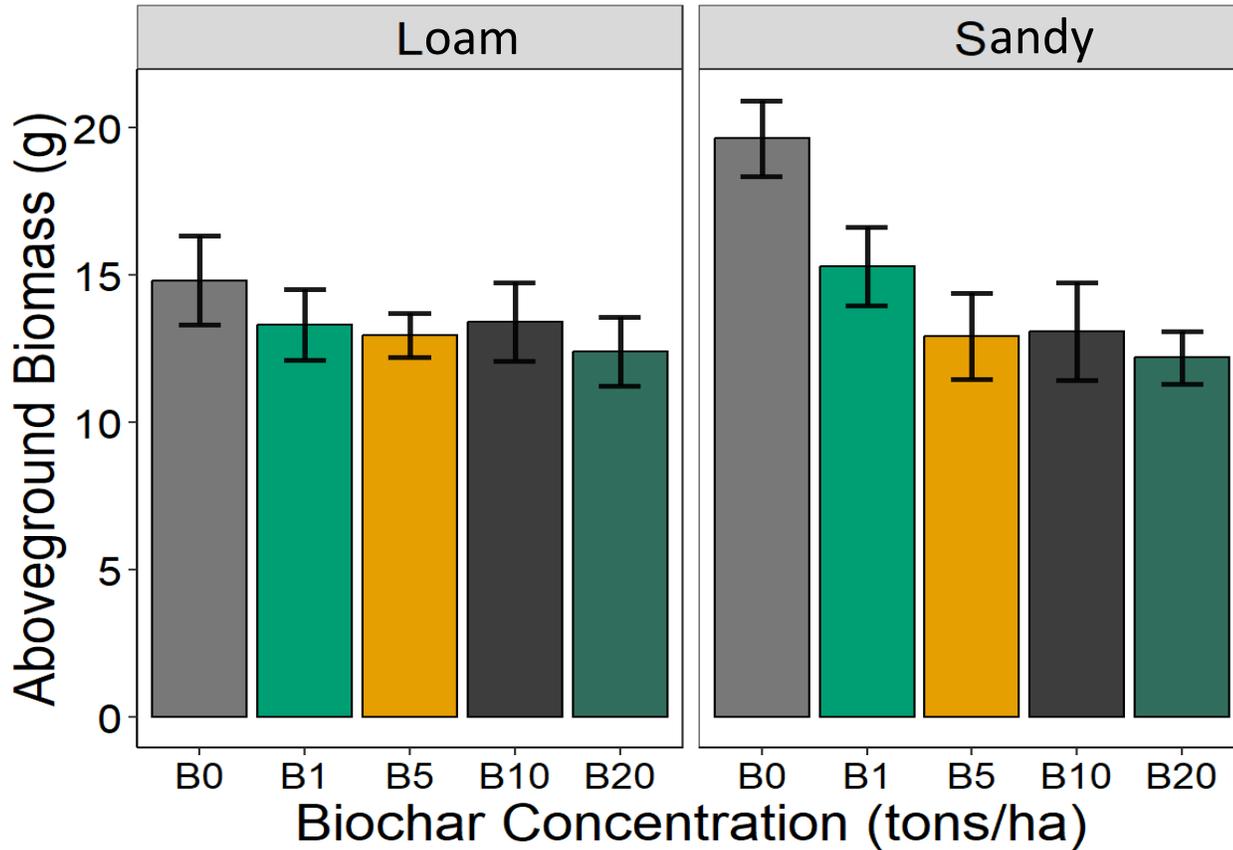
Loam soil

Sandy soil



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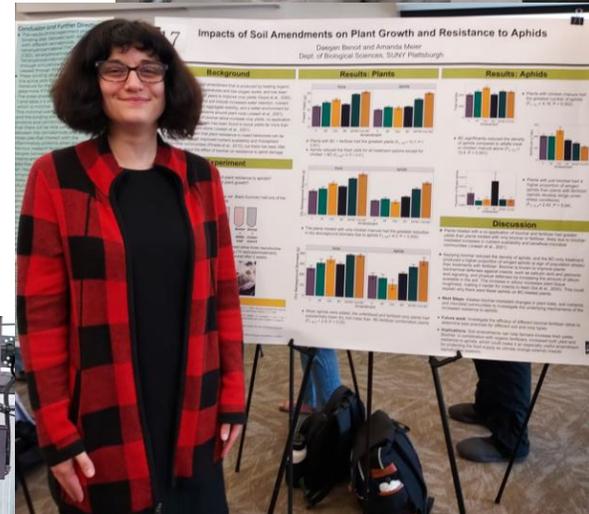
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Future Research: Assessing more North Country soil types, optimizing application of biochar with fertilizers and compost, and hopefully field trials!

Thank you!

Questions?



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