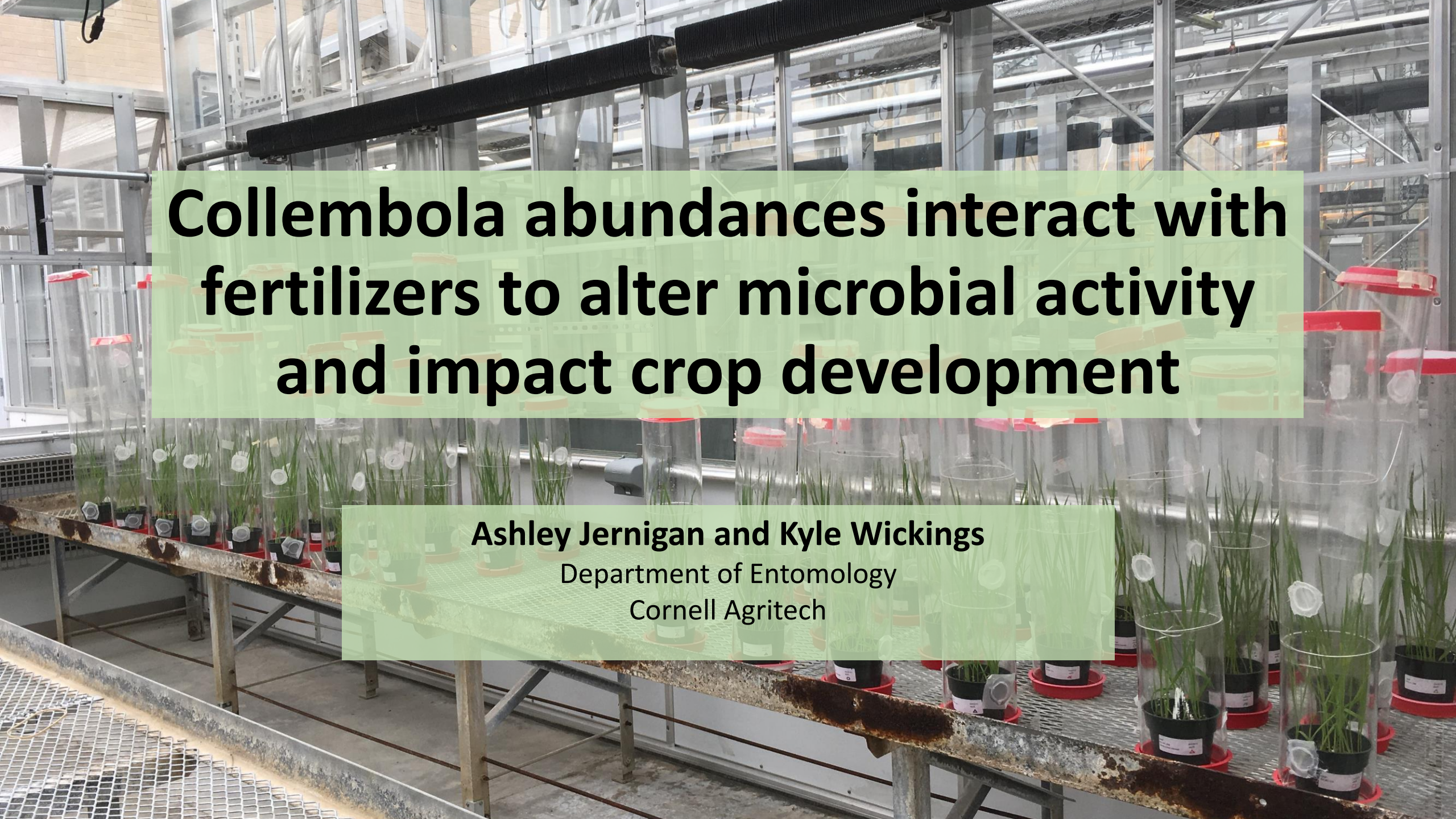


Collembola abundances interact with fertilizers to alter microbial activity and impact crop development

Ashley Jernigan and Kyle Wickings
Department of Entomology
Cornell Agritech

Key Findings

- Soil animals (Collembola) in soil may provide flexibility with fertilizer choice
- The “plant availability” of fertilizers decrease the size of microbial communities, because of plant-microbe competition for resources
- Higher densities of collembola grazing on microbes decreases size of microbial communities
- The effects of collembola on microbial activity are not persistent over time

Collembola impact soil functioning and plant growth

Collembola

- Collembola are microarthropods (tiny animals in the soil)
- Impacts important soil processes: decomposition of organic matter & nutrient mineralization
- Effect these processes through interactions with microbes, especially grazing

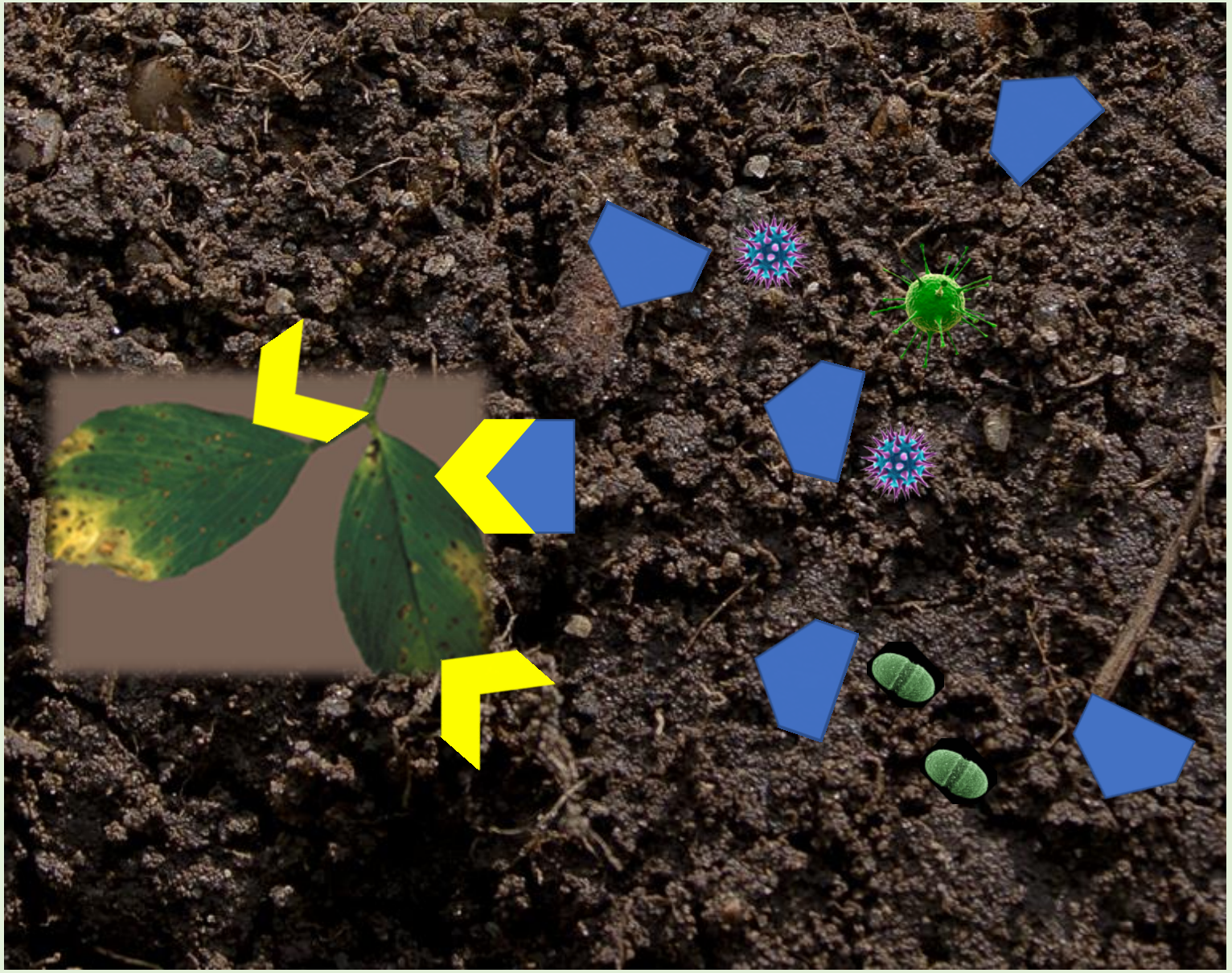
Microbes

CREDIT NATURAL RESOURCES CONSERVATION / FLICKR VIA CREATIVE COMMONS

Microbes

CREDIT NATURAL RESOURCES CONSERVATION / FLICKR VIA CREATIVE COMMONS

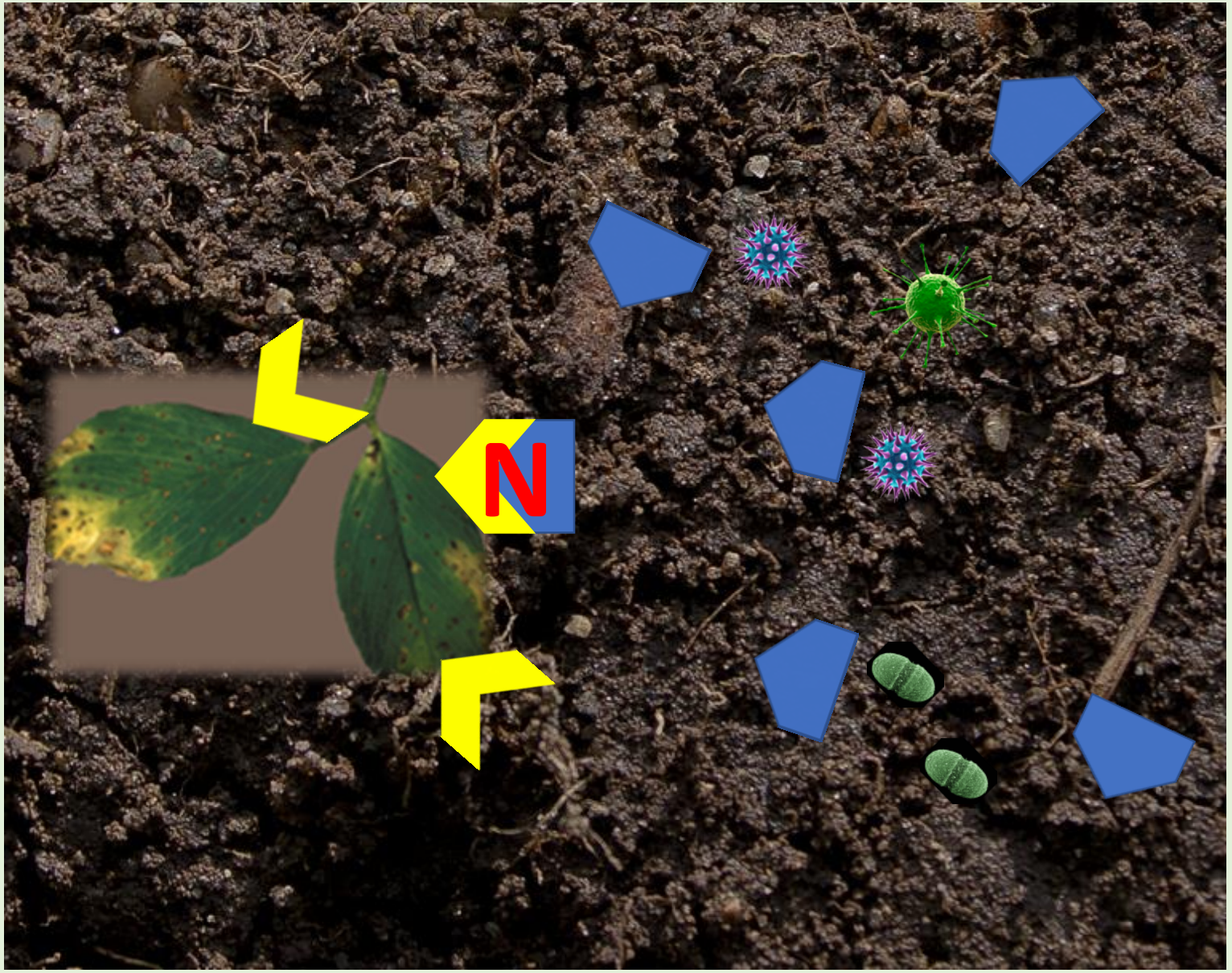
Microbial Enzymes



Food Source (substrate)

Enzyme

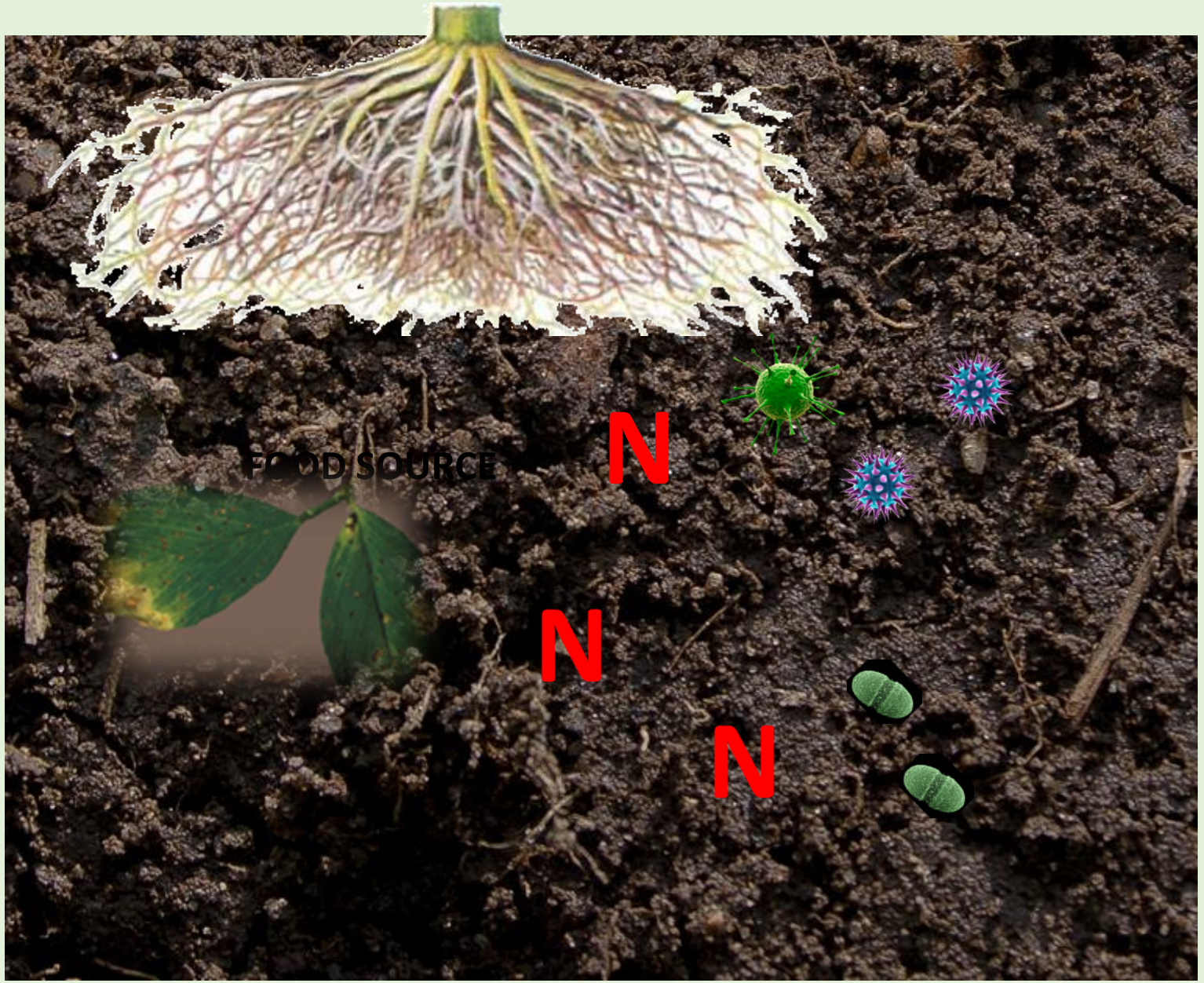
Microbial Enzymes



Food Source (substrate)

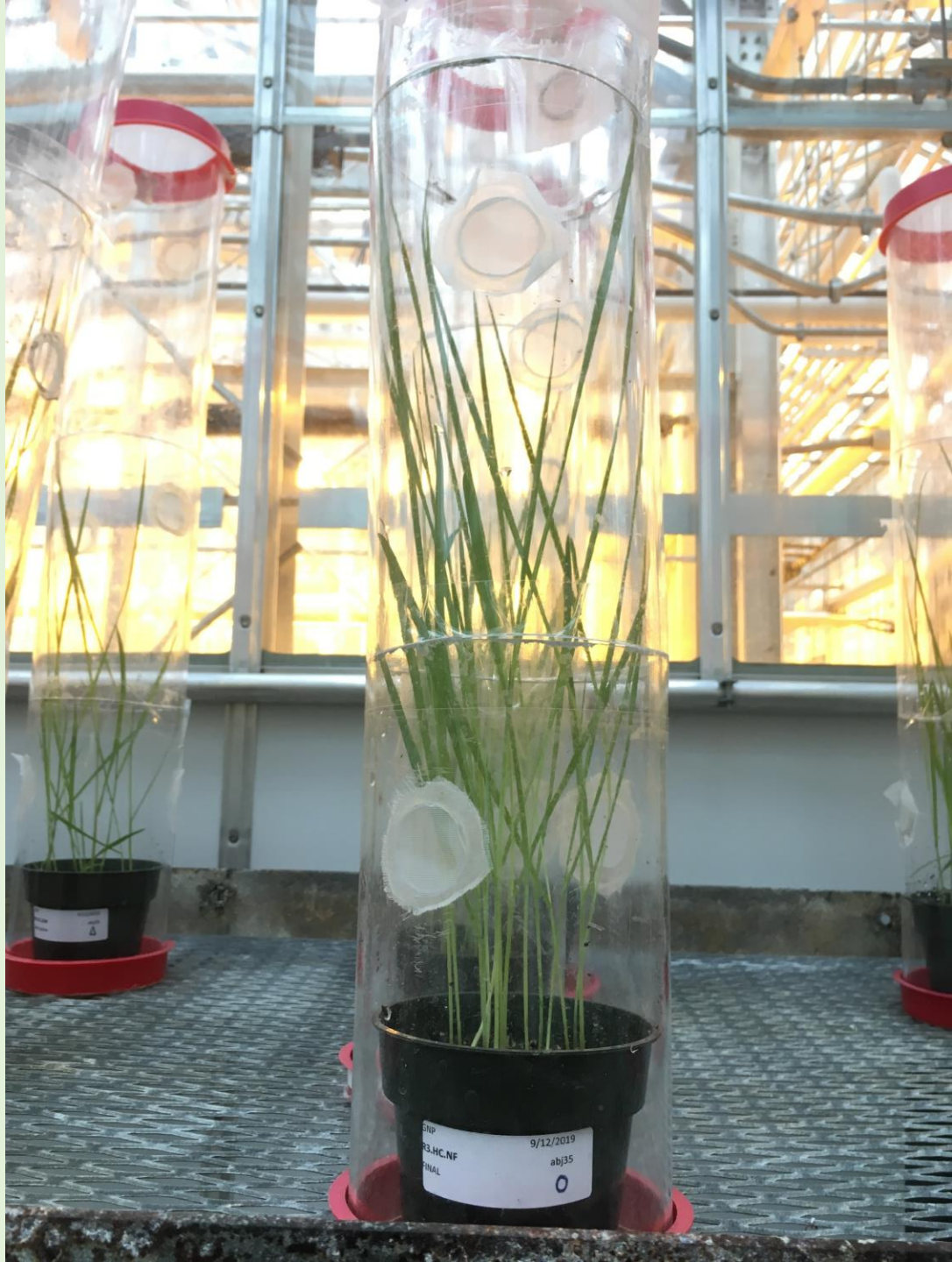
Enzyme

Plant-Microbe Competition



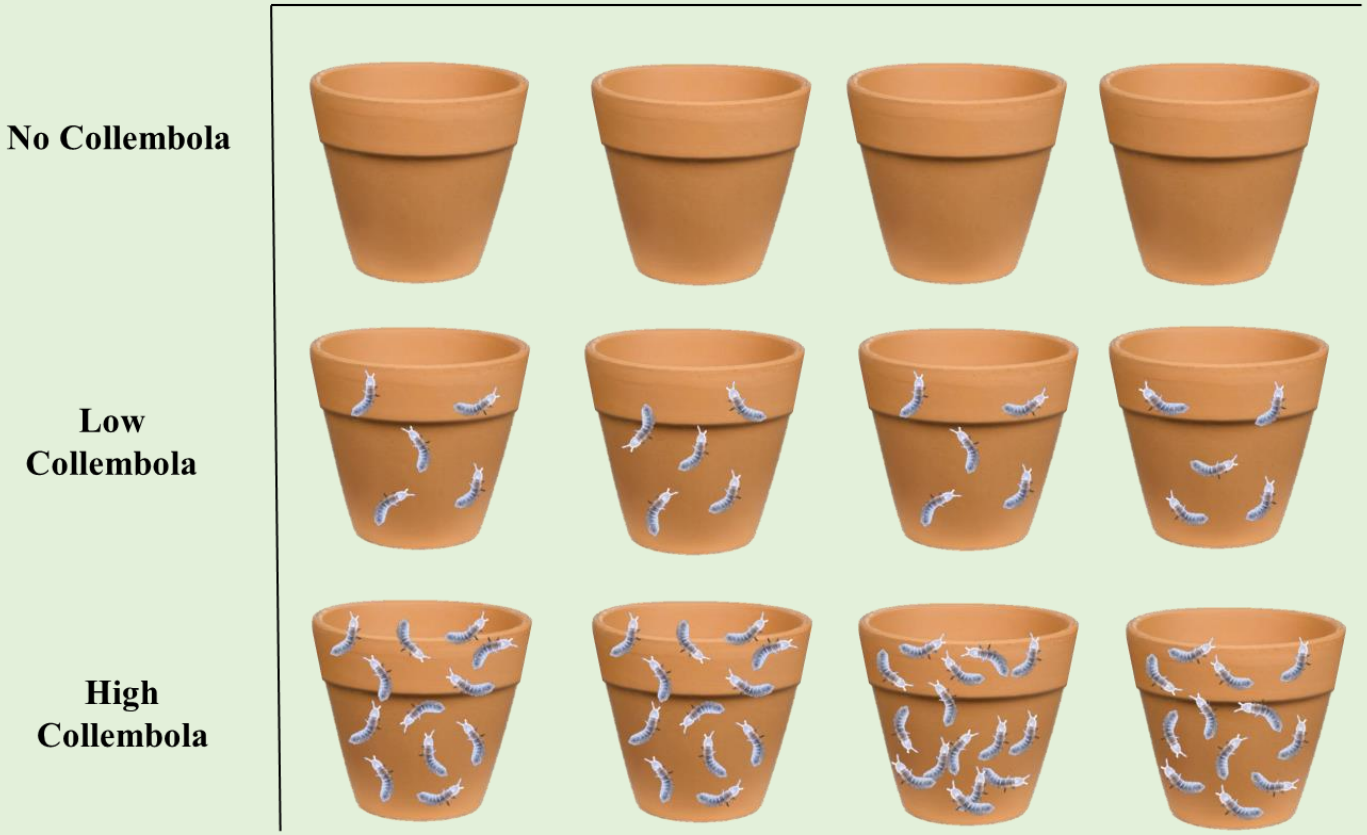
Objectives

- Determine how changes in collembola abundances influence soil microbial abundance and activity
- Determine how changes in soil biological communities impact crop growth



Experimental Design

Folsomia candida



Experimental Design

Folsomia candida

No Fertilizer

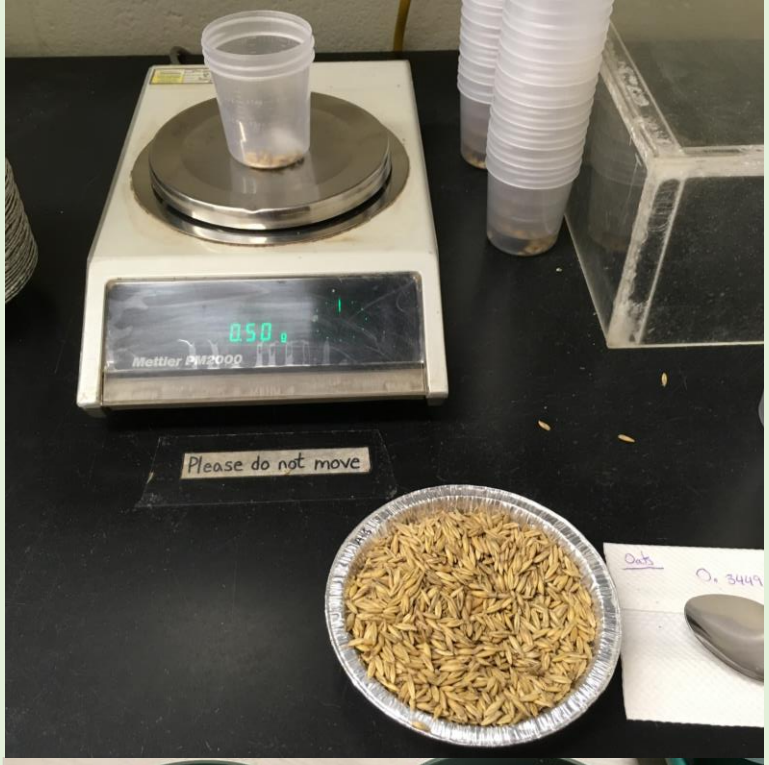
Kreher's Poultry Litter Compost

Alfalfa Green Manure

Chilean Nitrate

Experiment Set Up

- A native Arkport Loam soil was defaunated
- Defaunated soil and potting mix (1:1) was added to greenhouse pots
- Fertilizer were applied at rate of 50 lb/acre of N (0.057 grams of N/pot)
- Oat seeds were sown in pots (0.5 grams- about 20 seeds)
- Collembola (*Folsomia candida*) treatments were applied to pots



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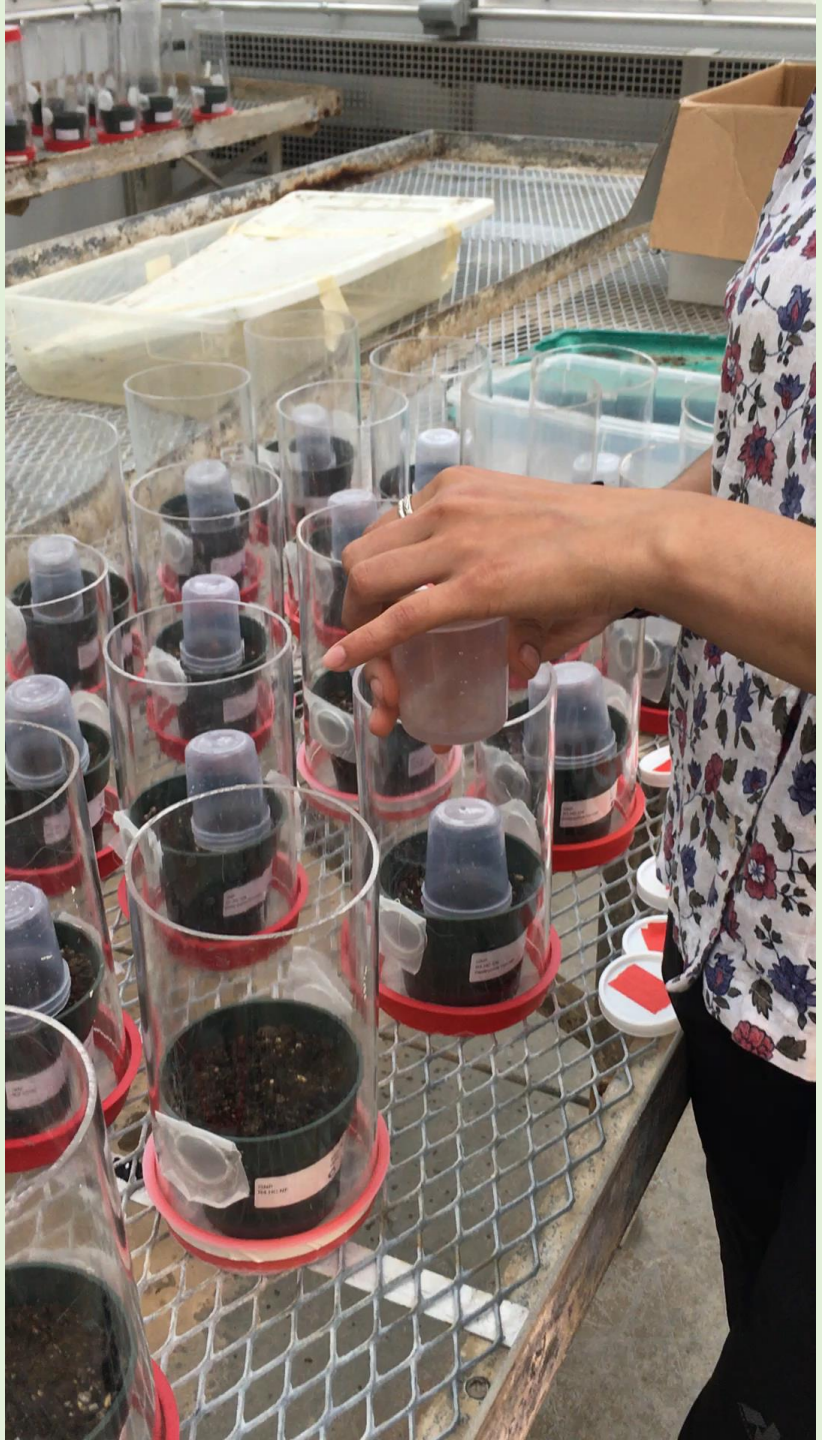
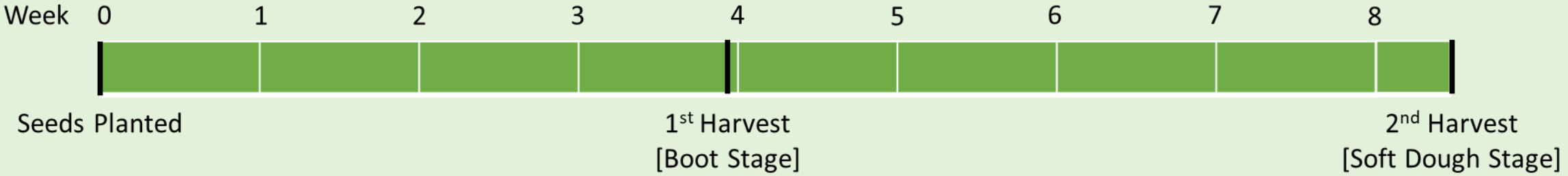
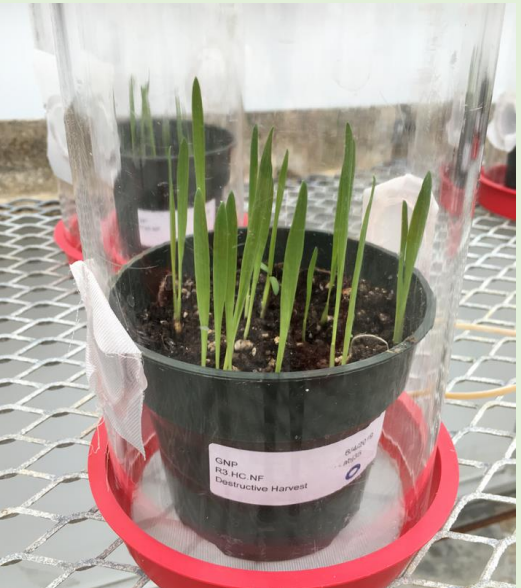
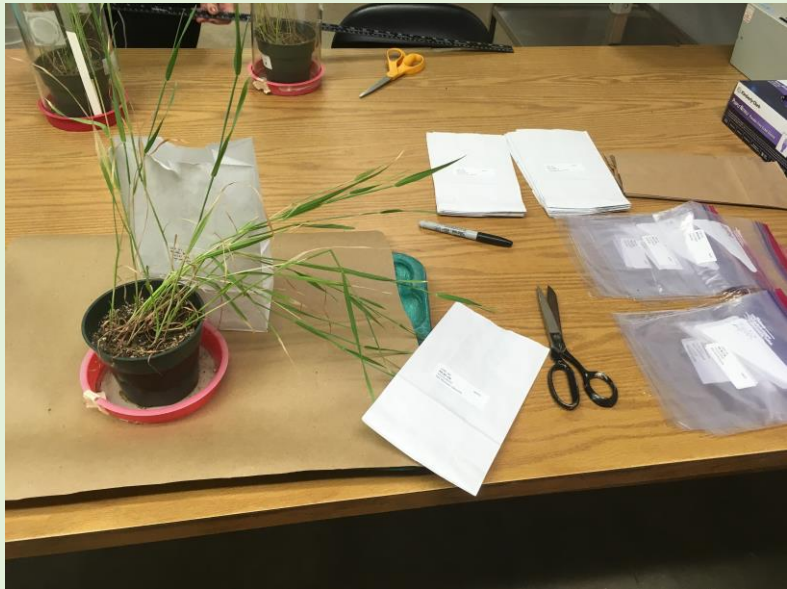


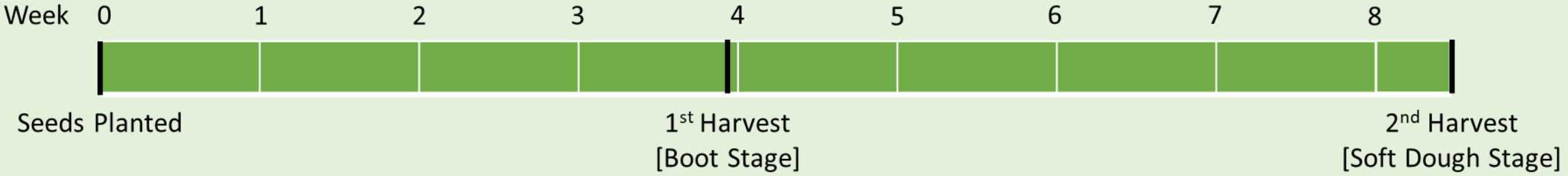


Metrics

Weekly Check Metrics	Destructive Harvest Metrics
▪ Oat growth stages ▪ Number of seeds germinated ▪ Height of plants ▪ Overall plant health observations	▪ Oat root, shoot, and seed weight ▪ Weed weight ▪ Microbial biomass ▪ Microbial enzymes ▪ Collembola abundance







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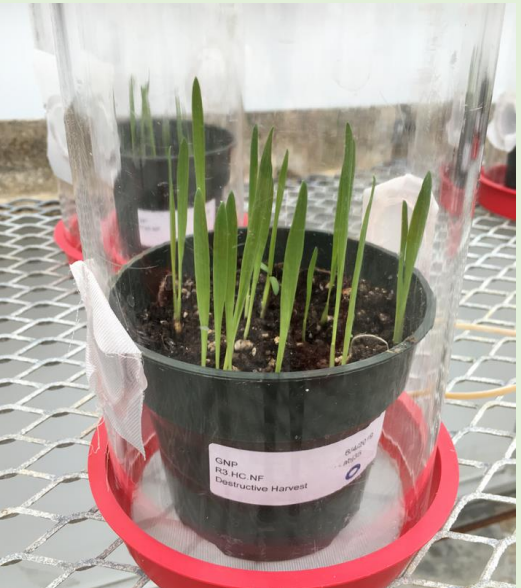

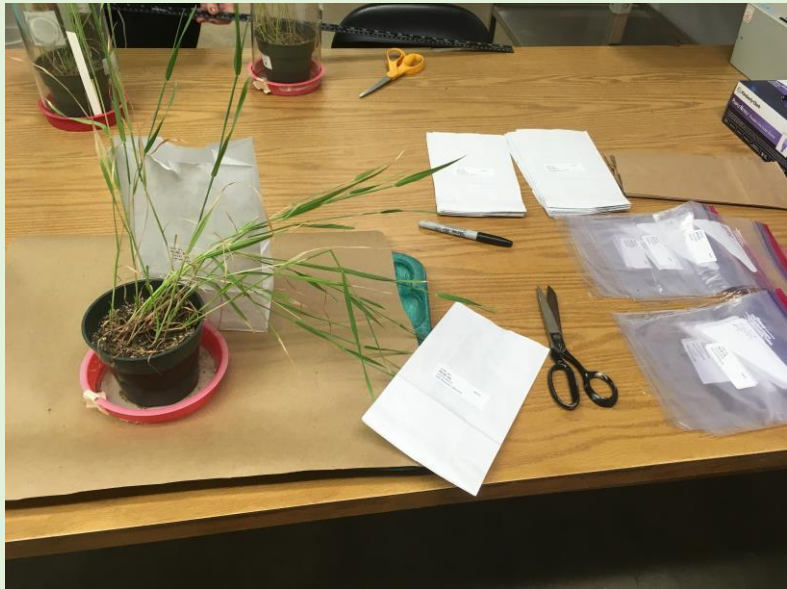

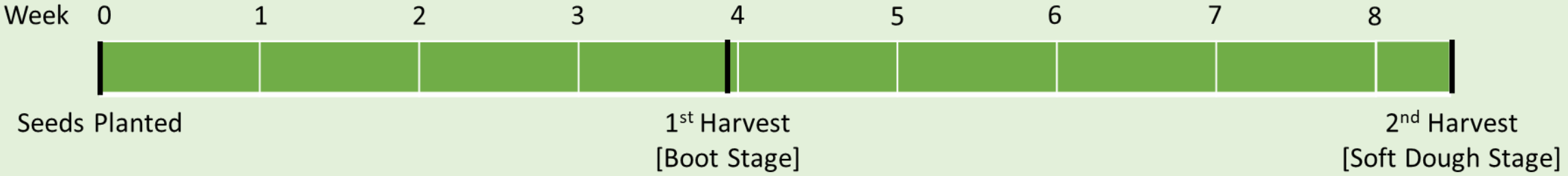

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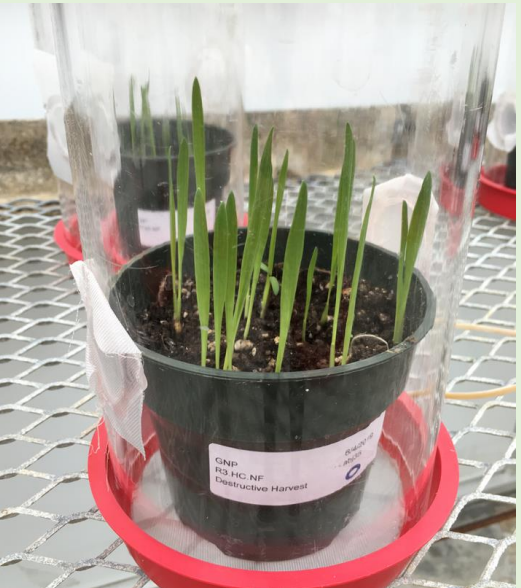
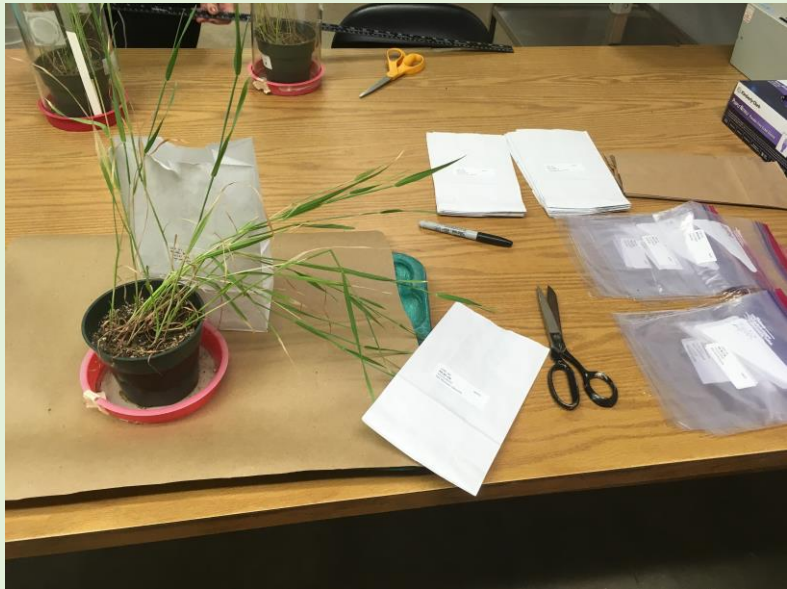


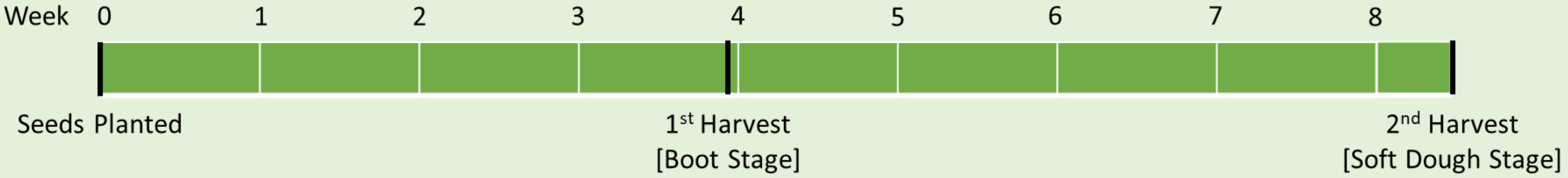


Collembola Treatment Check Results

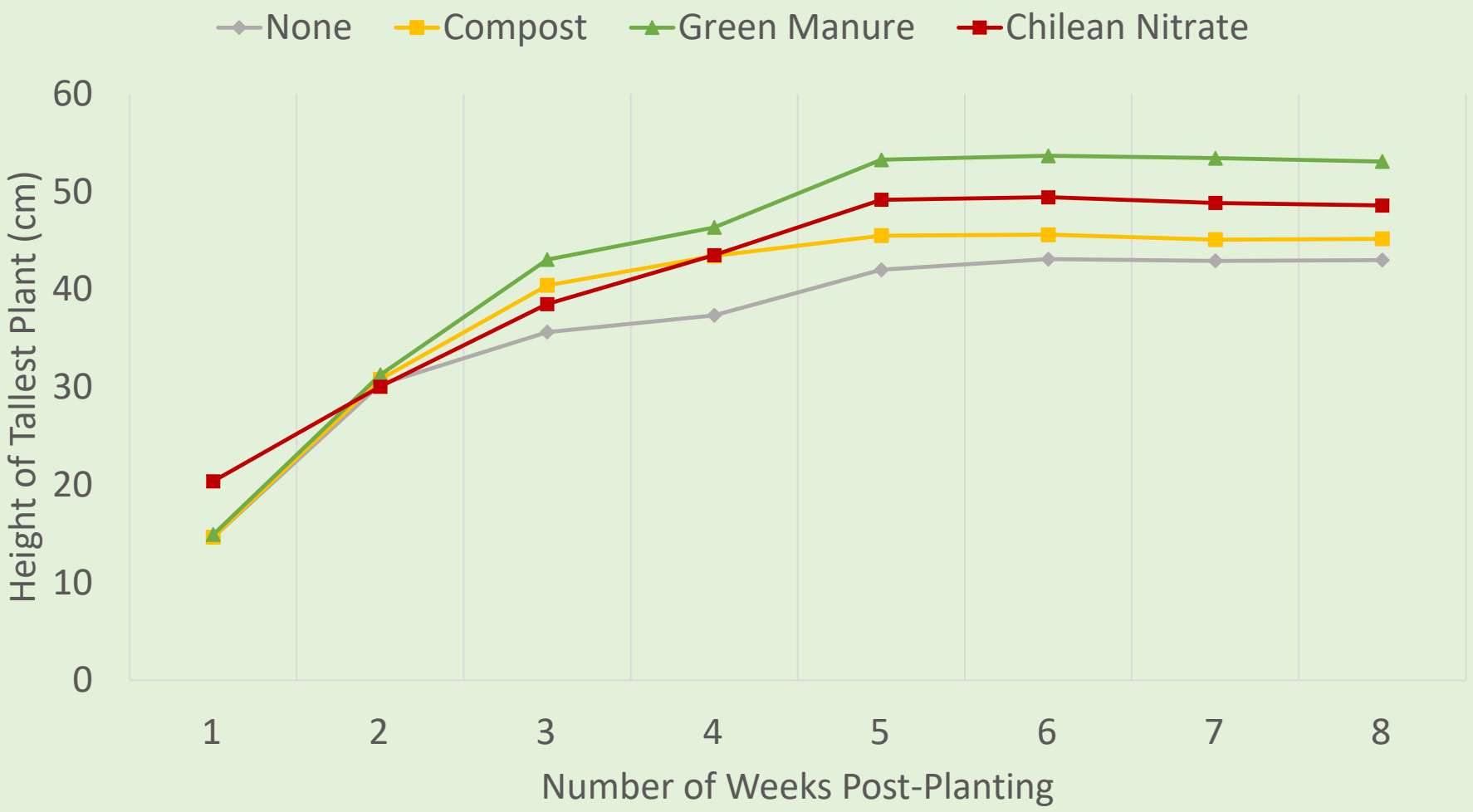
Collembola Treatment	Initial	1st Harvest	2nd Harvest
None	0	0	0
Low	100	318	3.2
High	200	820	1.8

Indicates that conditions in pots were favorable for collembola reproduction

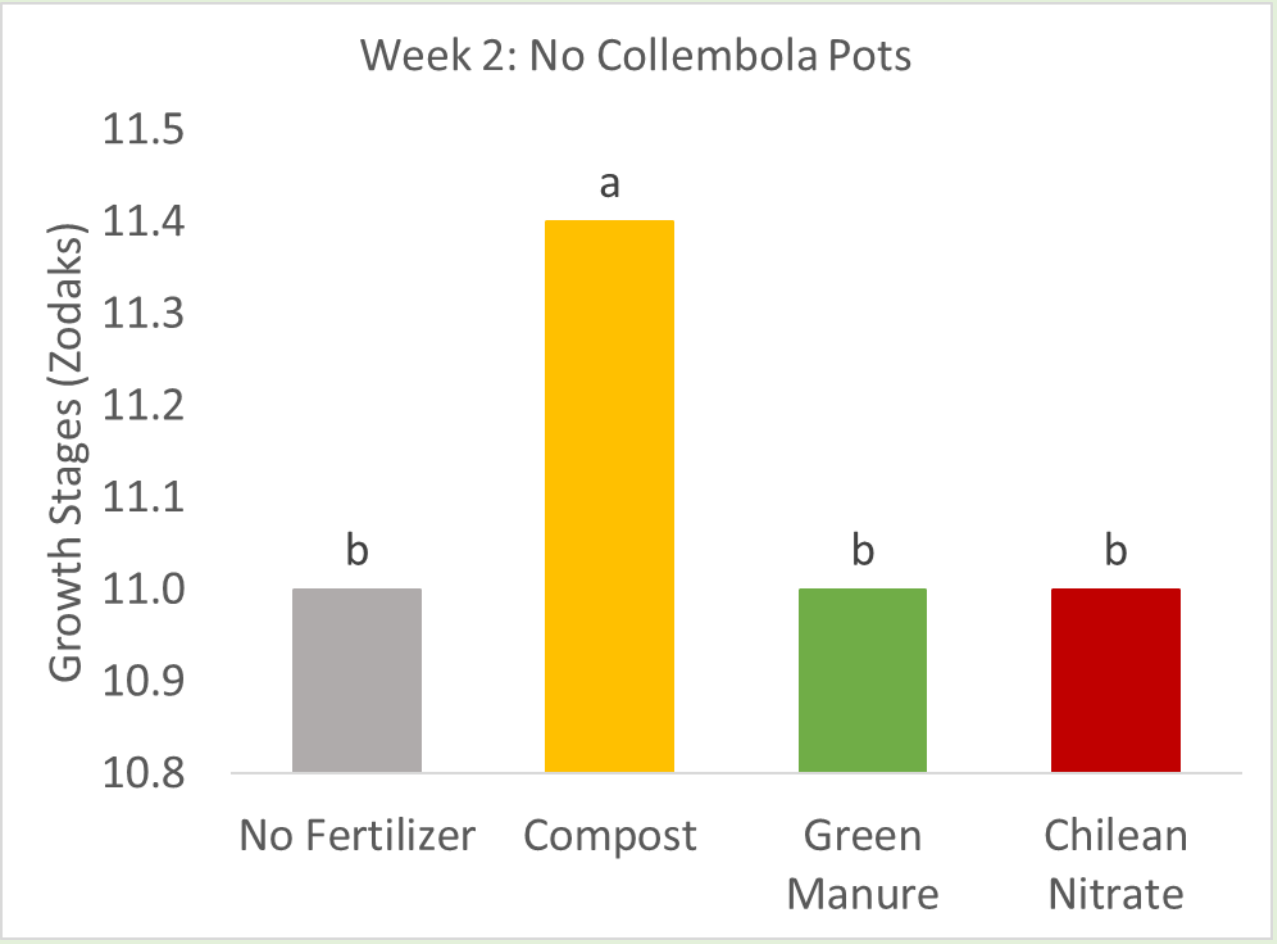
Indicates that conditions became unfavorable for collembola

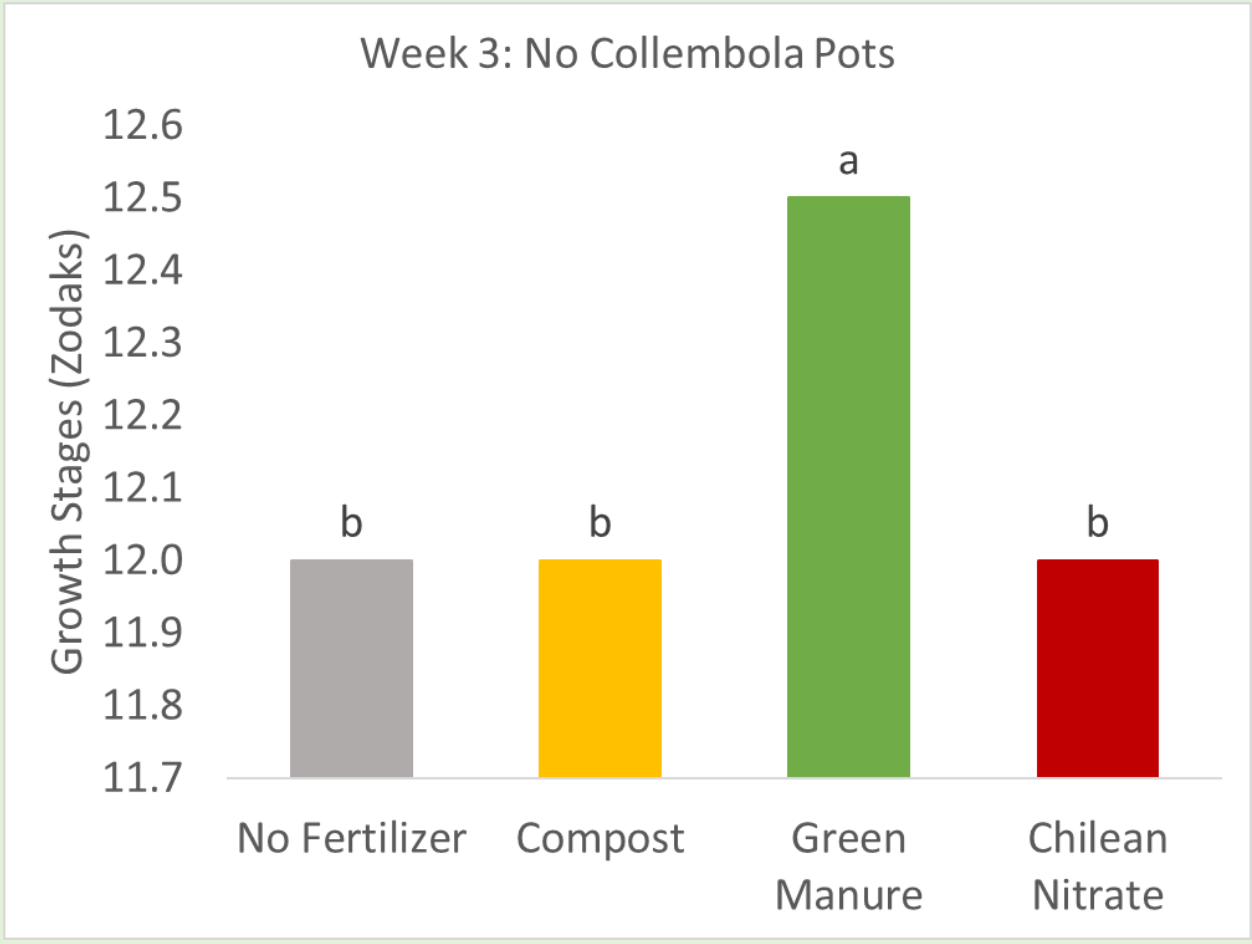


Oat Growth and Development: Plant Height



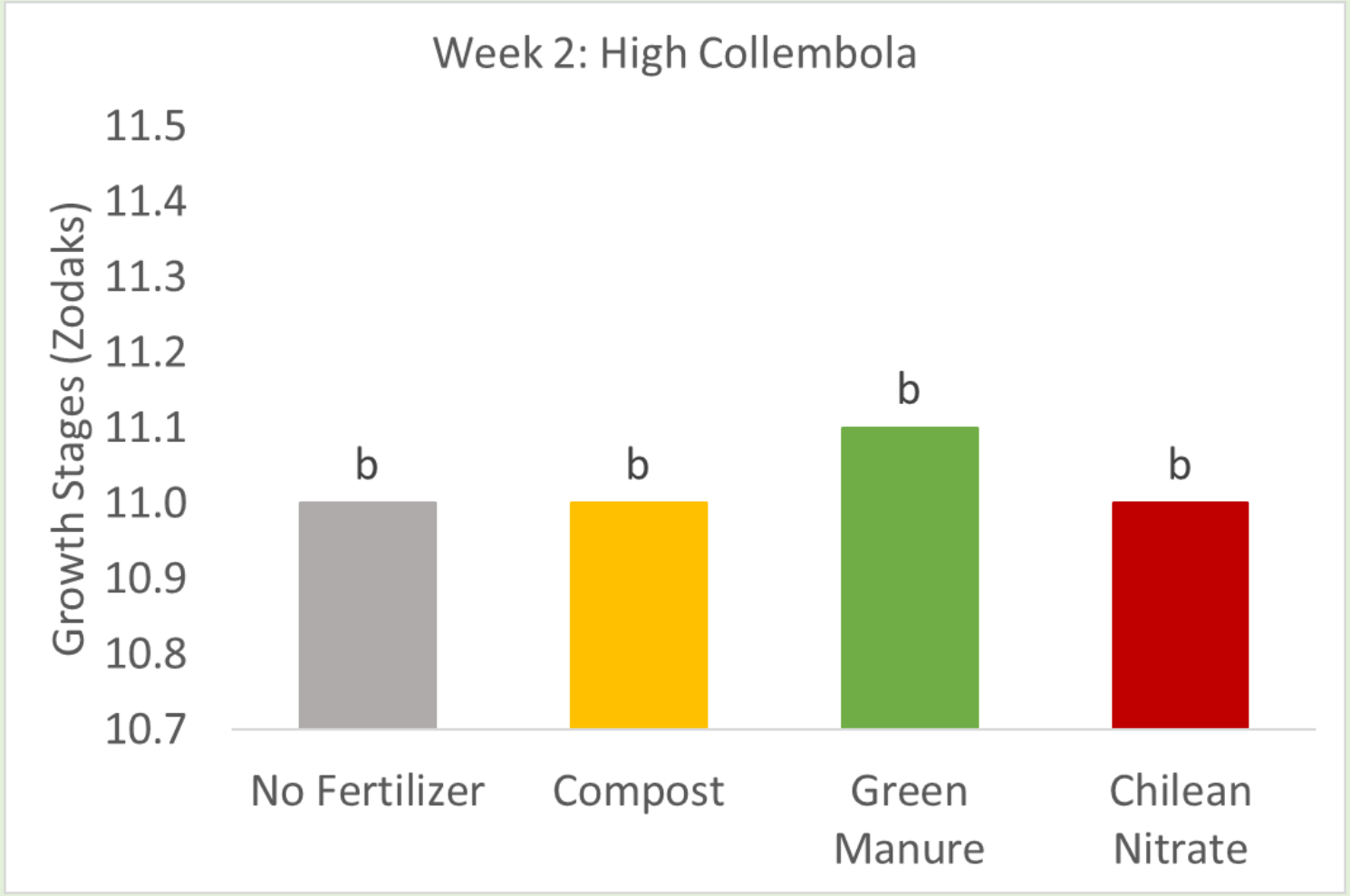
Oat Growth and Development: Growth Stages





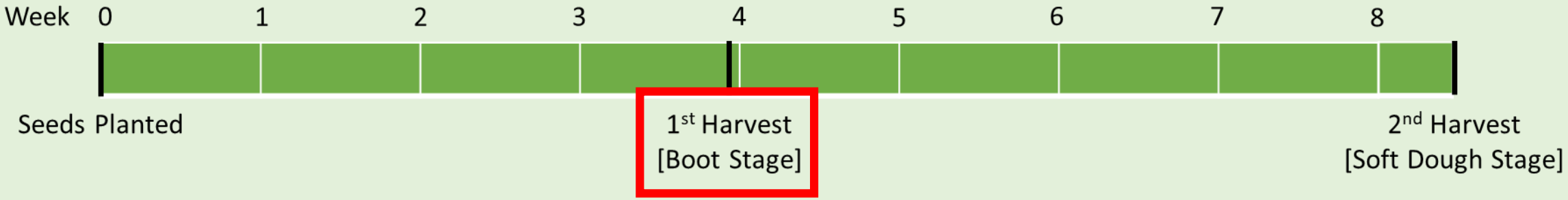
Only in no collembola pots did fertilizer have an effect

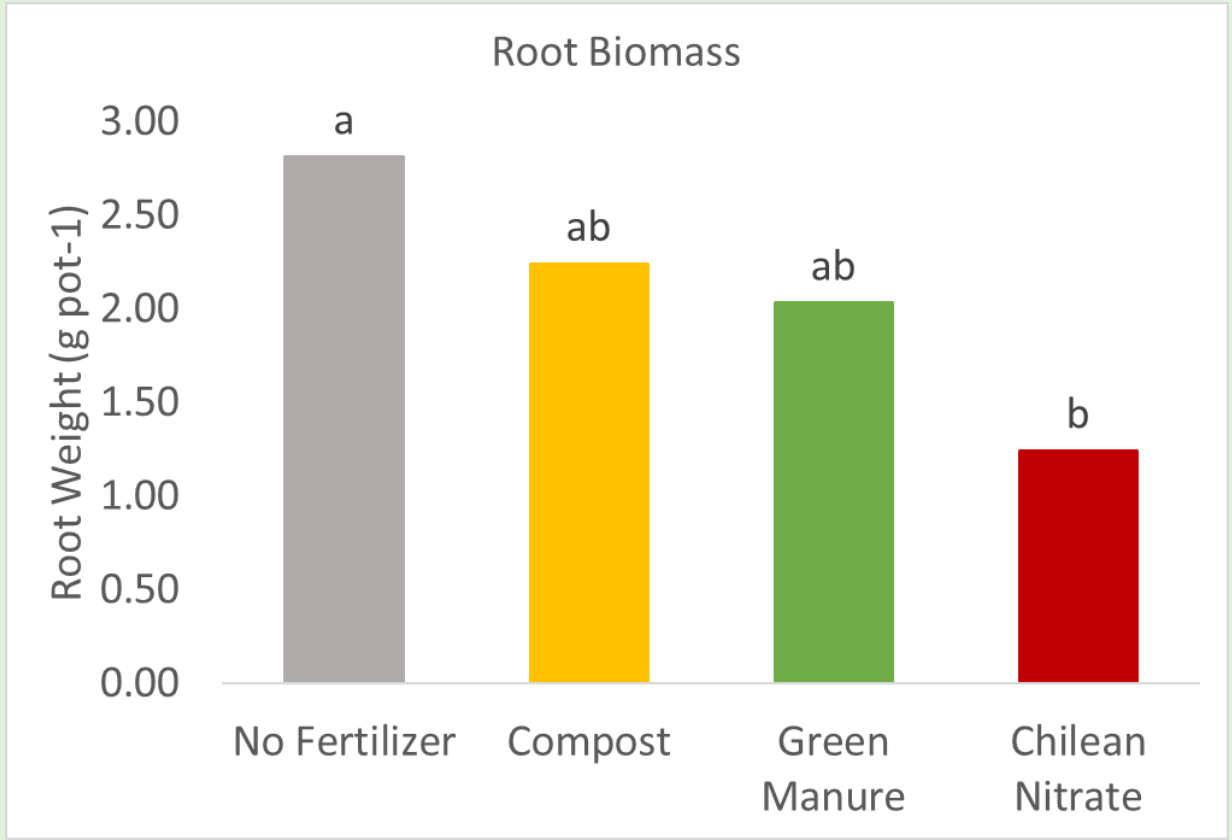
Oat Growth and Development: Growth Stages



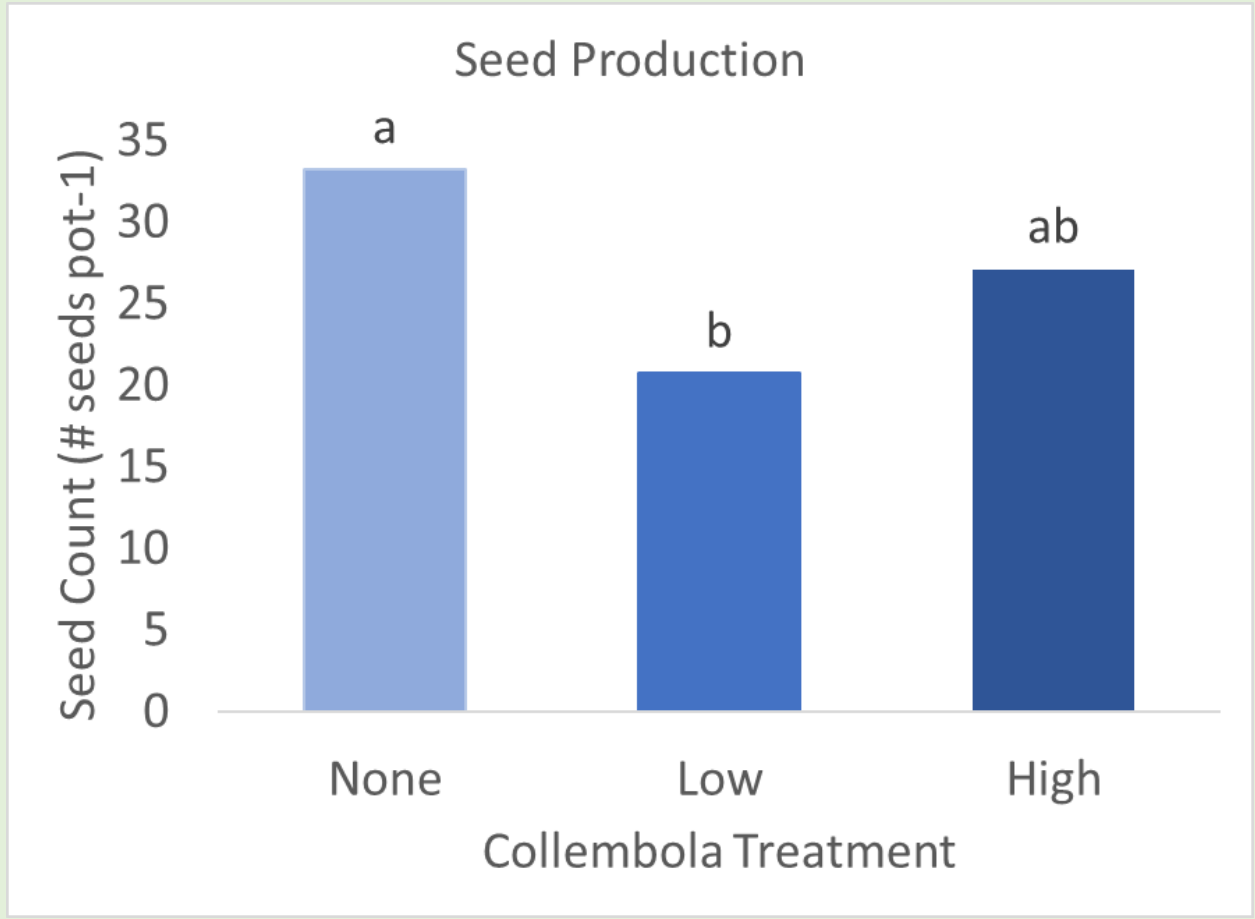
When collembola were present, fertilizer did not have an effect

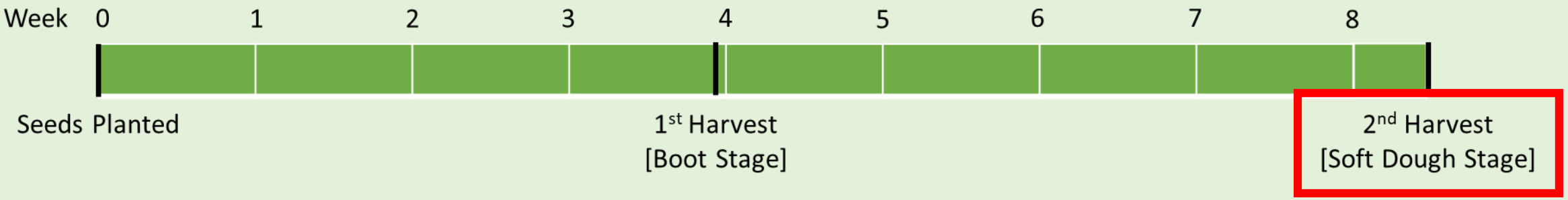
1st Harvest: Oat Biomass



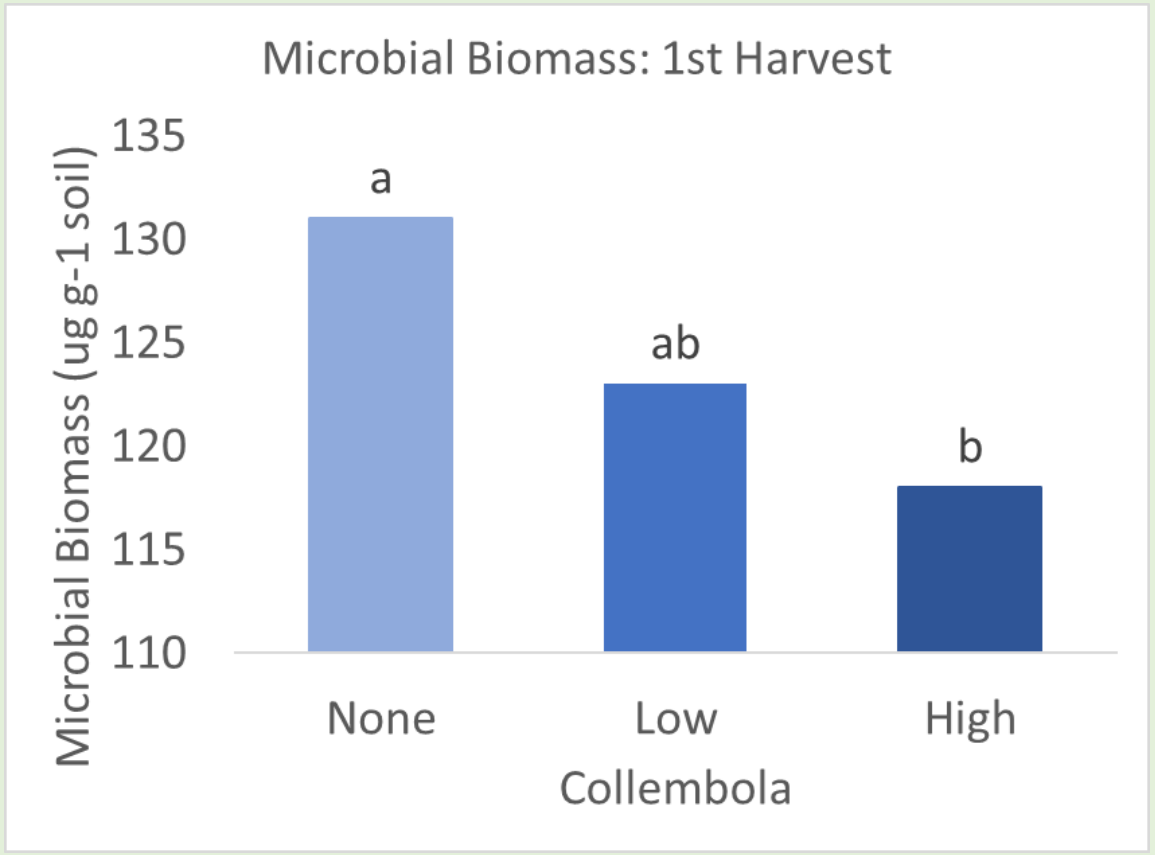


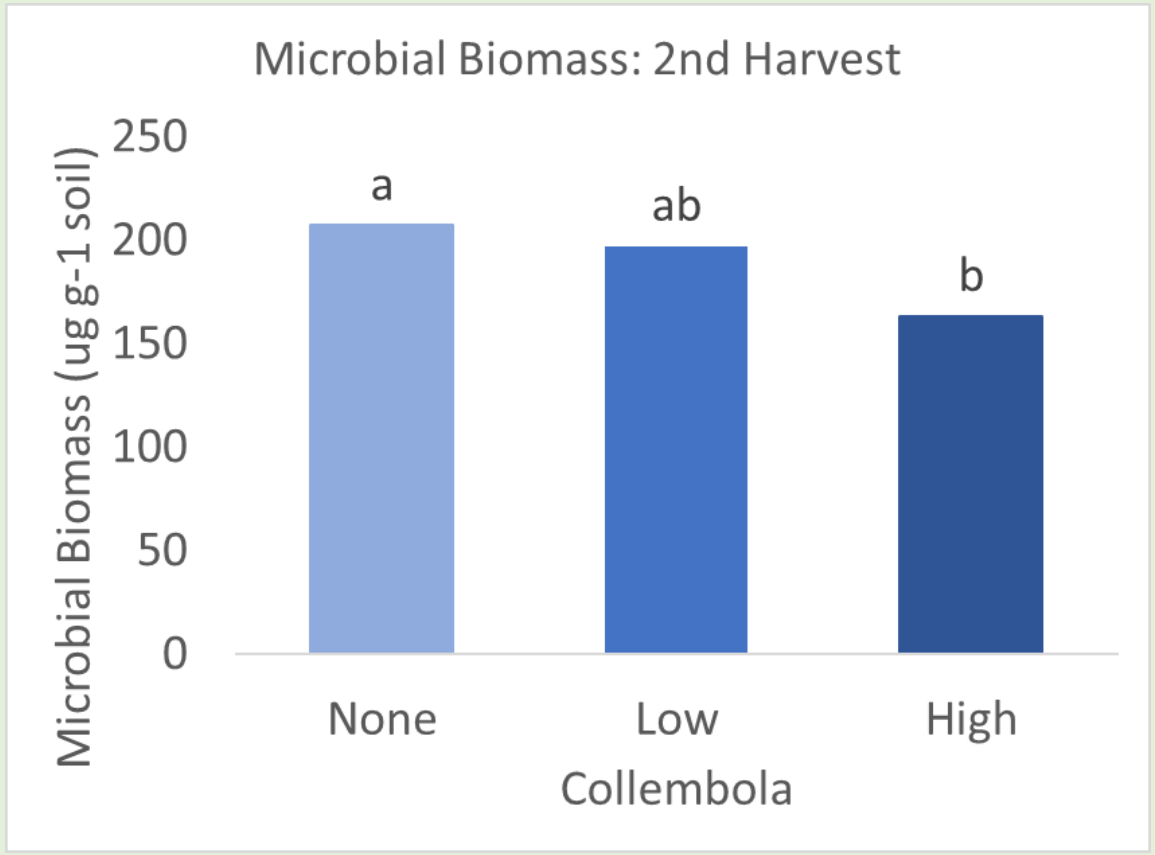
2nd Harvest: Oat Biomass



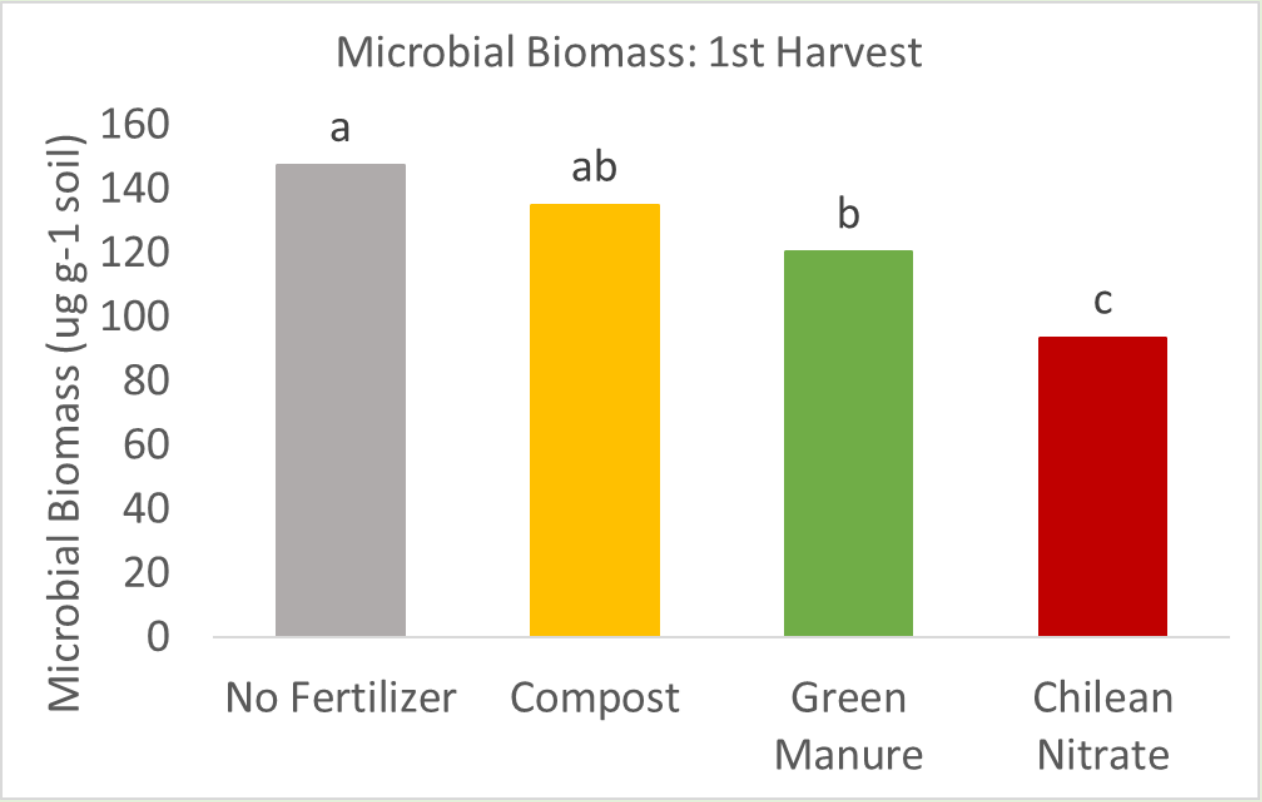


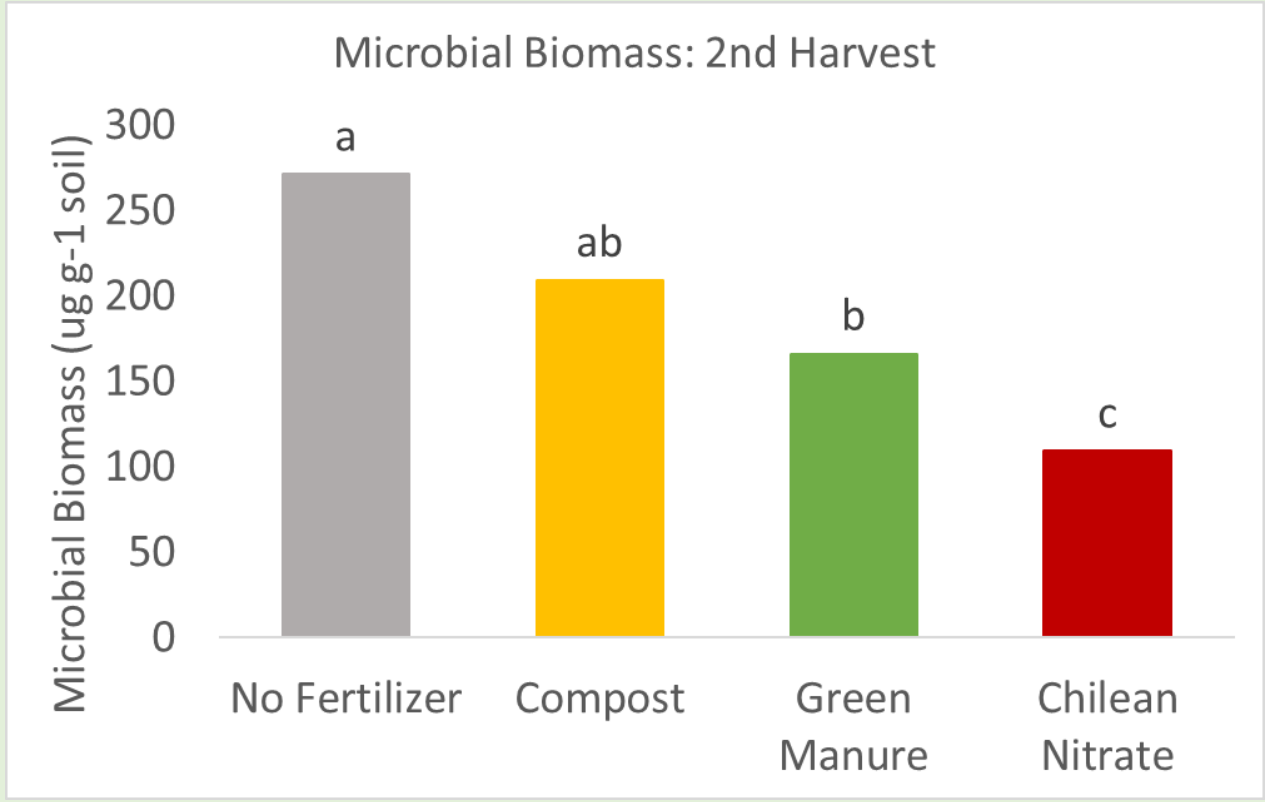
Collembola Effects on Microbial Biomass





Fertilizer Effects on Microbial Biomass





1st & 2nd Harvests: Microbial Enzymes

- Enzymes help make fertilizers available to plants by releasing nutrients
- 1st Harvest: Collembola affected 4 out of 5 microbial enzymes
    - nitrogen cycling enzyme (chitin)
    - amino acid enzymes
    - phosphorus enzymes
    - carbon cycling enzyme (lignin)
- 2nd Harvest: Collembola did not effect any of the enzymes

Main Take-Aways

- The “plant availability” of fertilizers is an important factor in choosing fertilizers, because of plant-microbe competition for resources
- Collembola (microarthropods) in soil may provide flexibility with fertilizer choice
- Collembola impact soil functioning and plant growth

Acknowledgements

- Cornell Atkinson Center Small Grants Program
- Entomology Department Recruitment Fellowship
- Summer Scholar Program- Perla Carmenate (Iowa State)
- Bill Minns (for alfalfa)
- Wickings Lab