Estimating the tolerance of native and exotic grasses to grasshopper herbivory

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Plants and Insect Herbivores

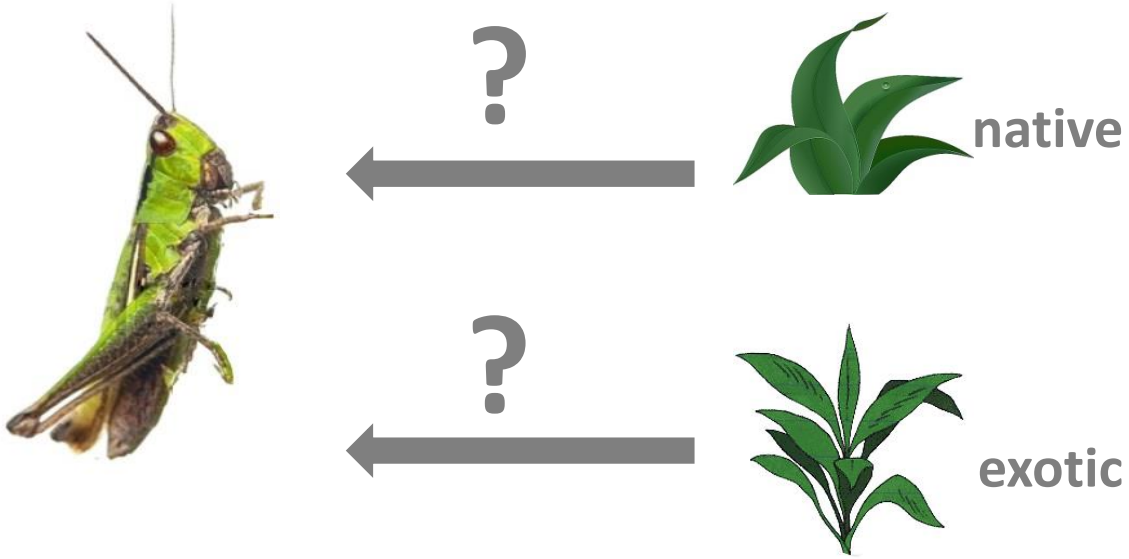
Plants and Insect Herbivores

A herbivore attacks a plant

The plant defenses respond

Plants and Insect Herbivores

Different defense strategies



Evolution of Increased Competitive Ability Hypothesis

Native plant

Exotic plant

defenses

growth and reproduction

increased competitive ability

Enemy Release

Native community

Exotic community

Evolution of Increased Competitive Ability Hypothesis

Exotic plant

defenses

growth and reproduction

increased competitive ability

Predictions:

Plant resistance
the ability of a plant to decrease herbivore damage

E < N

Plant tolerance
the ability of a plant to maintain fitness while sustaining herbivore damage

E > N

Exotic community

Study Organisms

Native grasses

Andropogon gerardii
Big Bluestem

Bouteloua curtipendula
Side oats Grama

Exotic grasses

Miscanthus sinensis
Chinese Silver Grass

Bothriochloa ischaemum
Yellow Bluestem

Melanoplus spp.
(Orthoptera: Acrididae)
Nymph

Estimating Plant Tolerance

- Physiological components of plant tolerance:
  growth rate, storage capacity, photosynthetic rates, nutrient uptake etc.
  Rosenthal & Kotanen 1994

- **Plant compensatory growth in terms of aboveground plant biomass** is one of the fundamental and commonly used measurements for plant tolerance to herbivory, especially in grasslands
  Rosenthal & Kotanen 1994; Atwood & Meyerson 2011; Leis & Morrison 2011

- Estimating biomass should be non-destructive, accurate, and easy to implement
  Redjadj et al. 2012

Research Questions/Hypotheses

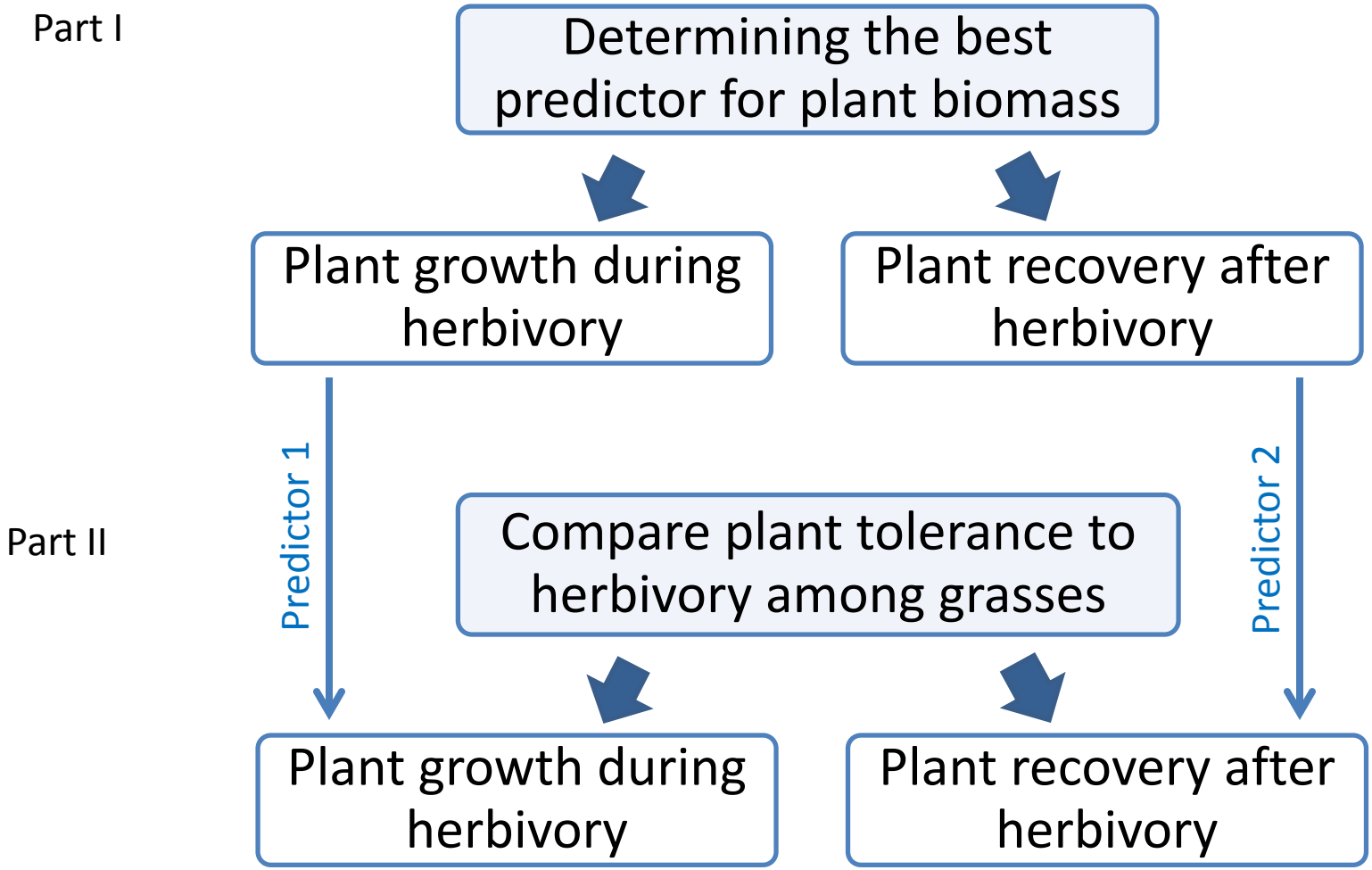
RQ1. What is the best predictor for aboveground biomass in native *Andropogon* and *Bouteloua* and exotic *Miscanthus* and *Bothriochloa* grasses?

H1. Plant height explains the greatest amount of variation in plant biomass during herbivory and during the plant recovery.

RQ2. Do exotic grasses and native grasses differ in their tolerance to grasshopper herbivory?

H2. Exotic grasses demonstrate greater tolerance to grasshopper herbivory than native grasses.

Experimental Design

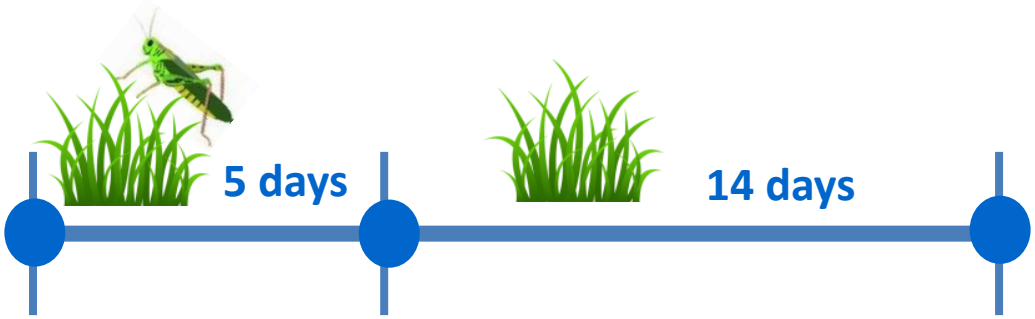


The Best Predictors for Plant Biomass

30 extra plants planted for each species

Part I

The Best Predictors for Plant Biomass



Predictor variables:

- height
- number of leaves
- [height × number of leaves]

Biomass:

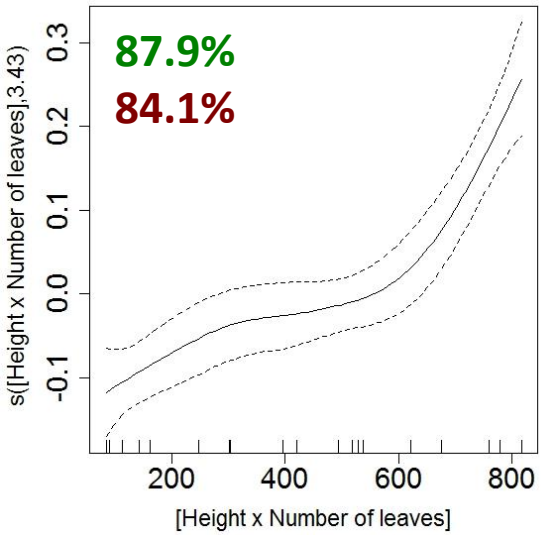
- wet
- dry

Plant growth → **Predictor 1**

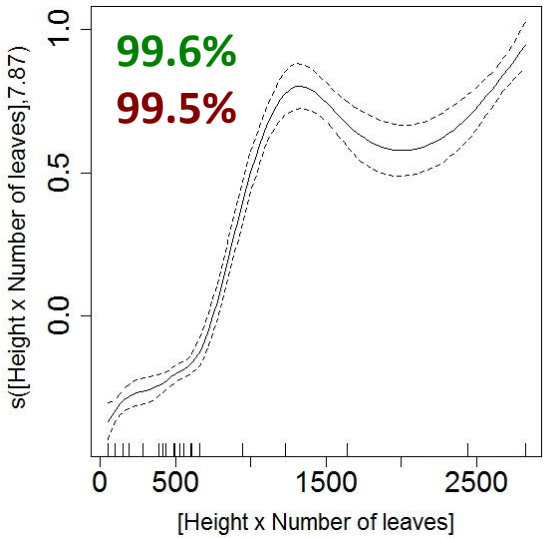
Plant regrowth → **Predictor 2**

Part I

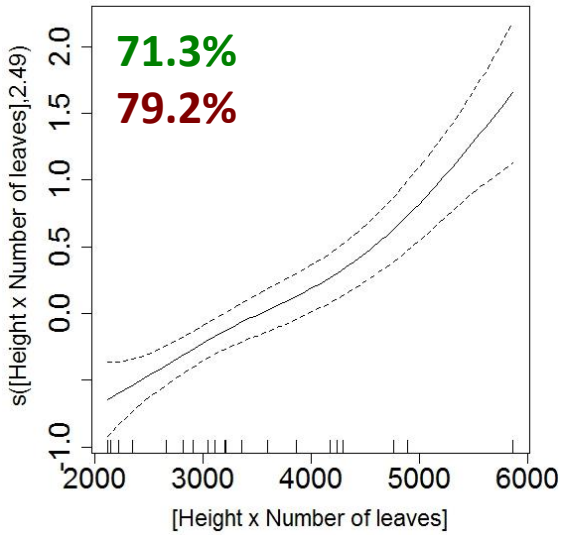
Growth Rate: [Height × Number of leaves]



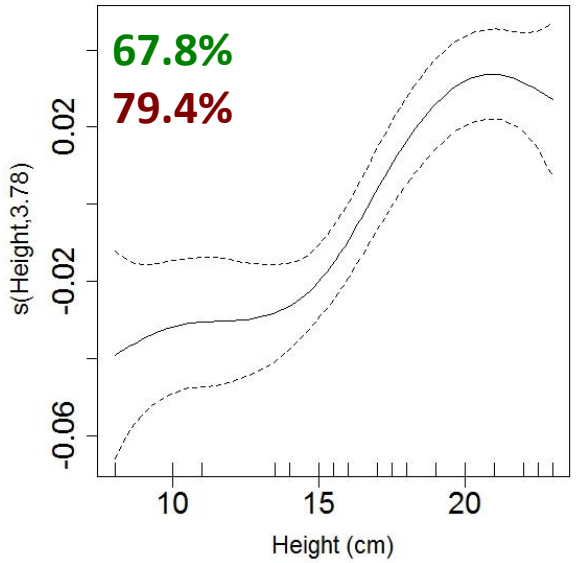
Andropogon gerardii

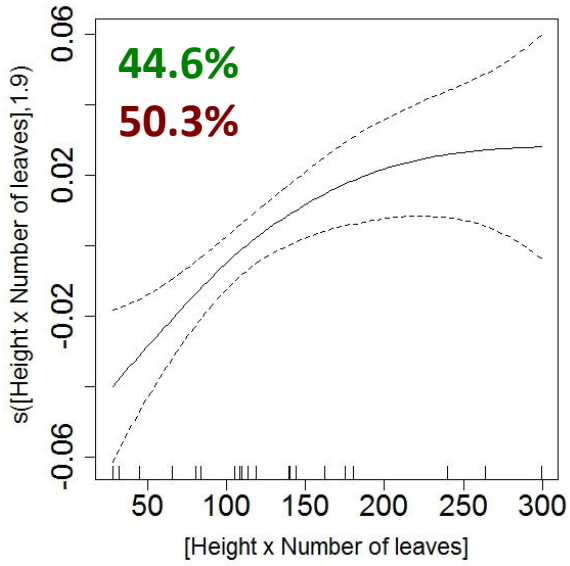


Bouteloua curtipendula



Bothriochloa ischaemum

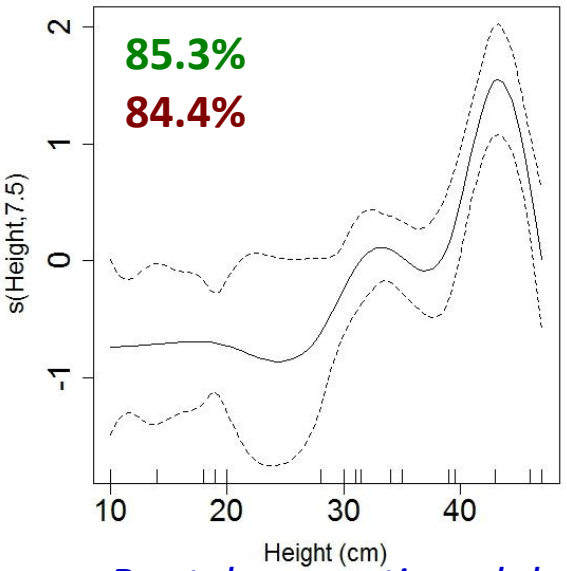




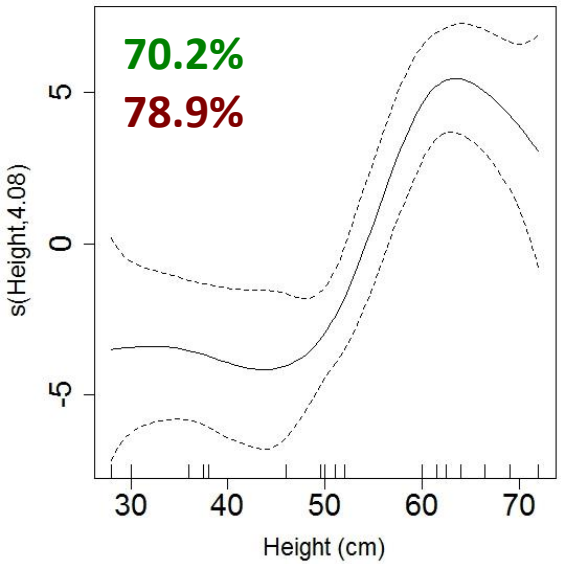
Miscanthus sinensis

wet
dry

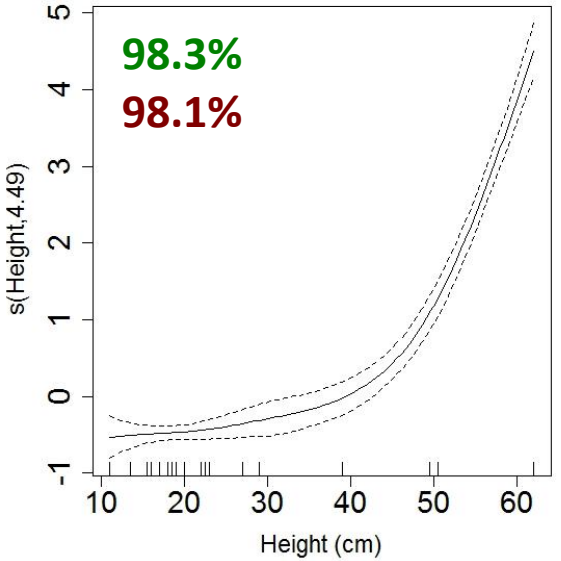
Regrowth Rate: Height



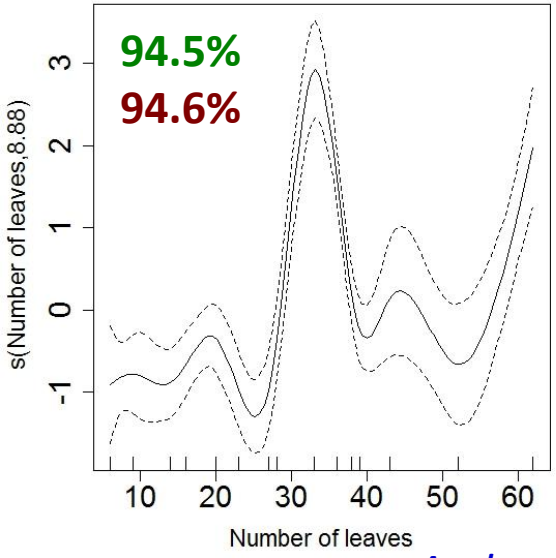
Bouteloua curtipendula

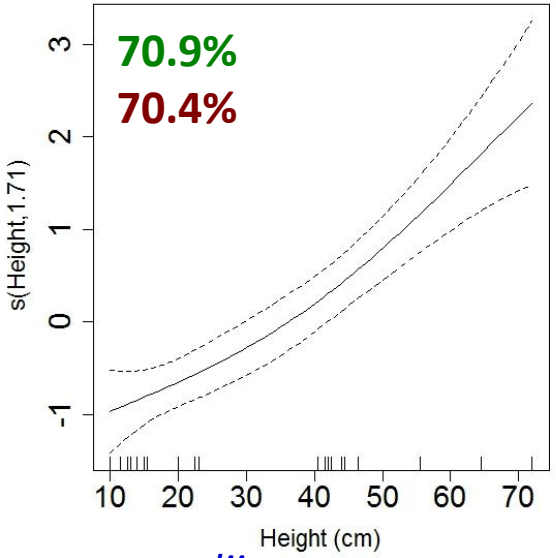


Bothriochloa ischaemum



Miscanthus sinensis





Andropogon gerardii

wet
dry

Grasshopper Herbivory Assays

Field

University of Cincinnati
Center for Field Studies

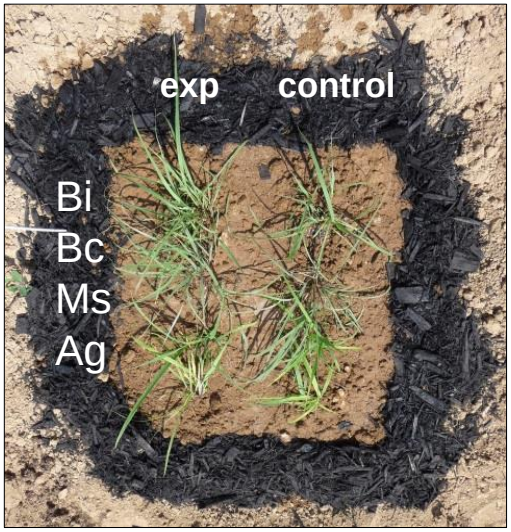
Western Maryland
Research and Education Center

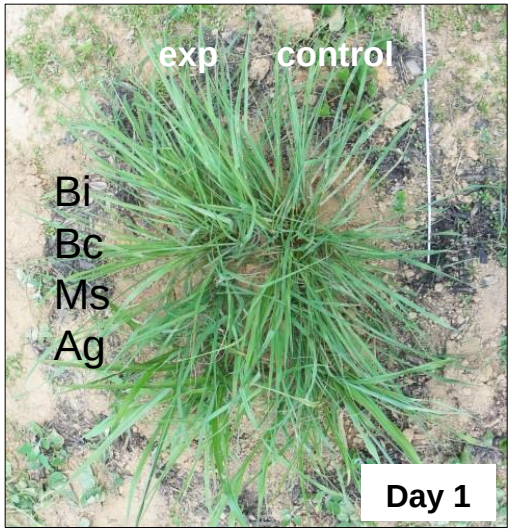
Greenhouse

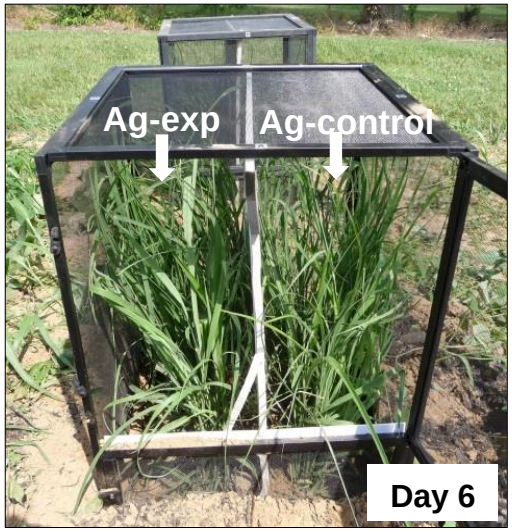
University of Cincinnati
Greenhouse

Part II

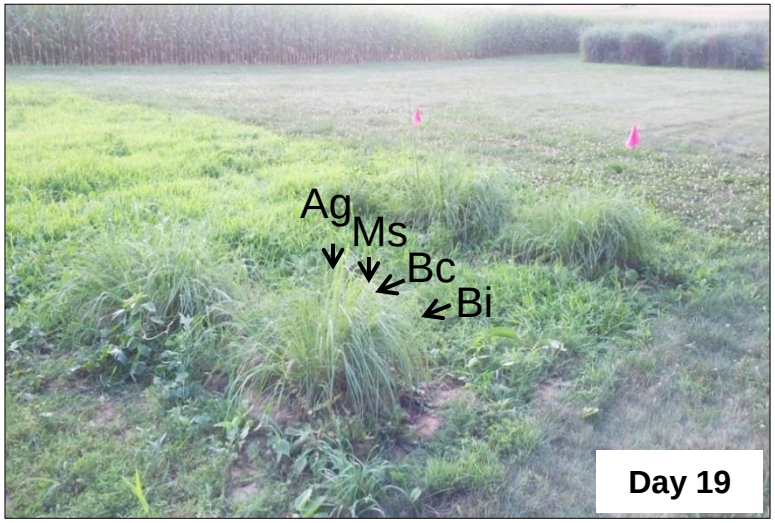
Grasshopper Herbivory Assays: Field





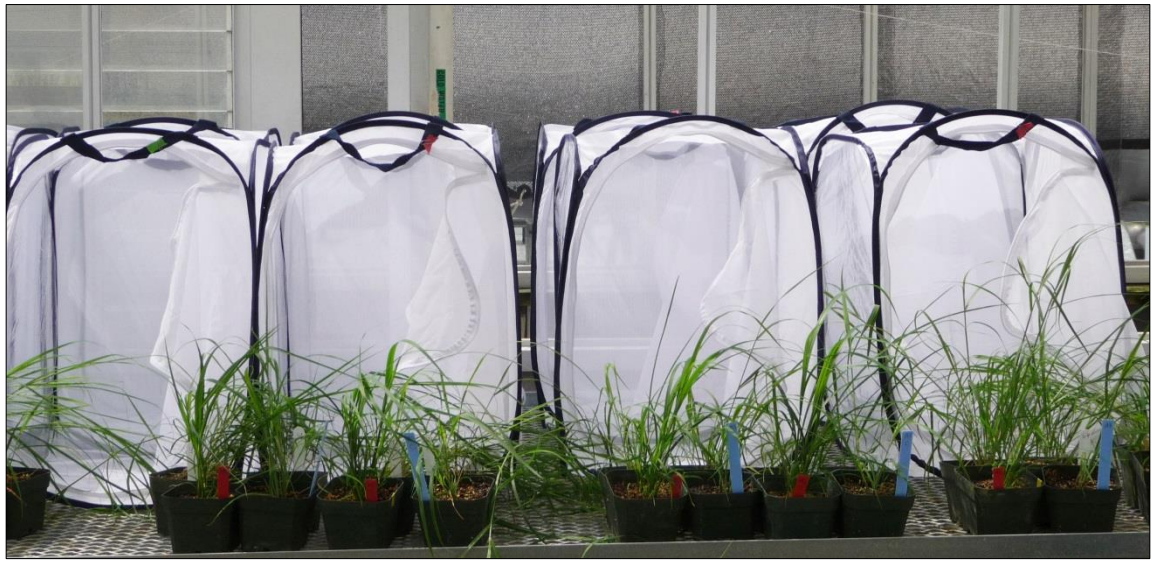


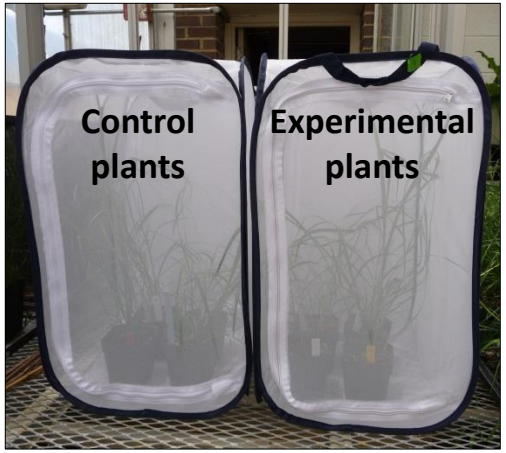
Plant growth



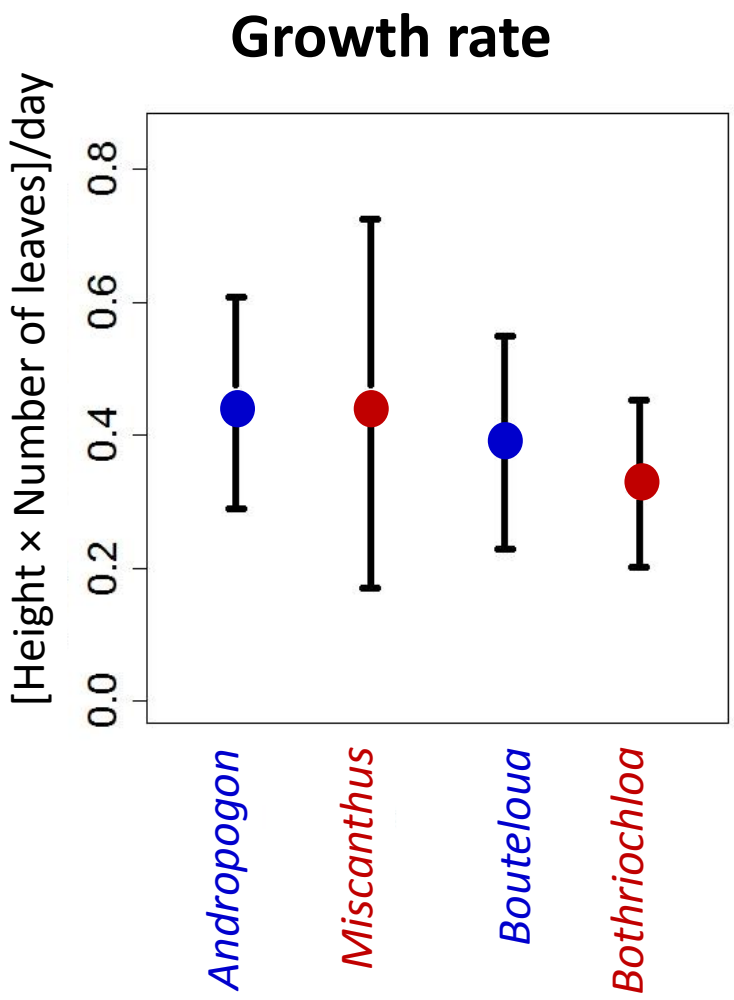
Plant regrowth

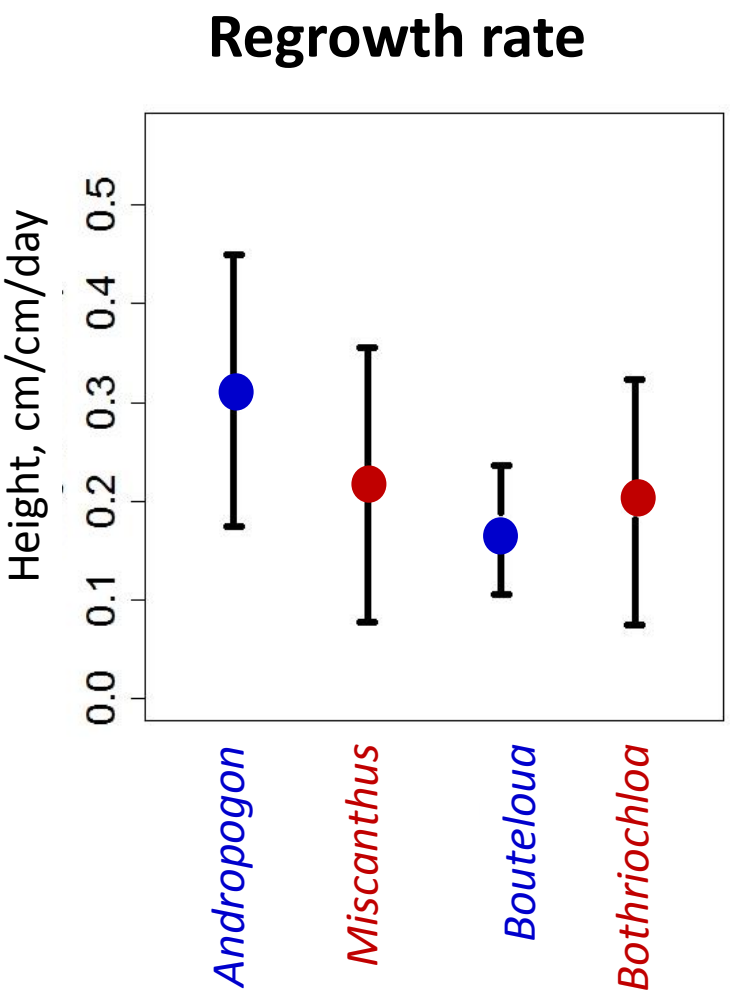
Grasshopper Herbivory Assays: Greenhouse





Plant Tolerance: MD, OH, UC Greenhouse





- Both growth and regrowth rate did not differ significantly among native and exotic plants.

Conclusions

RQ1. What is the best predictor for aboveground biomass in native *Andropogon* and *Bouteloua* and exotic *Miscanthus* and *Bothriochloa* grasses?

H1. Plant height explains the greatest amount of variation in plant biomass during herbivory and during the plant recovery.

Plant growth during herbivory: H1 wasn't supported

[height × number of leaves] explained the greatest amount of variation in biomass for most plant species

Plant regrowth after herbivory: H1 was supported

Plant height explained the greatest amount of variation in biomass for most plant species

Conclusions

RQ2. Do exotic grasses and native grasses differ in their tolerance to grasshopper herbivory?

H2. Exotic grasses demonstrate greater tolerance to grasshopper herbivory than native grasses.

Plant growth during both herbivory and a subsequent regrowth period did not differ among plant species

<u>Possible explanations:</u>

- Exotic plant species might not yet demonstrate the strong allocation from defenses to growth, as predicted by the EICA hypothesis, at least at the current time

Future Directions

- To apply parametric models and by converting height and [height × number of leaves] into biomass, compare changes in aboveground biomass during and after herbivory

- To explore a trade-off between resistance and tolerance to grasshopper herbivory in exotic *Miscanthus* and *Bothriochloa* grasses

Thank you!

University of Cincinnati:
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Roger Ruff

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Dr. William Lamp

Wieman Wendel Benedict Award 2011, 2012, 2013
University of Cincinnati