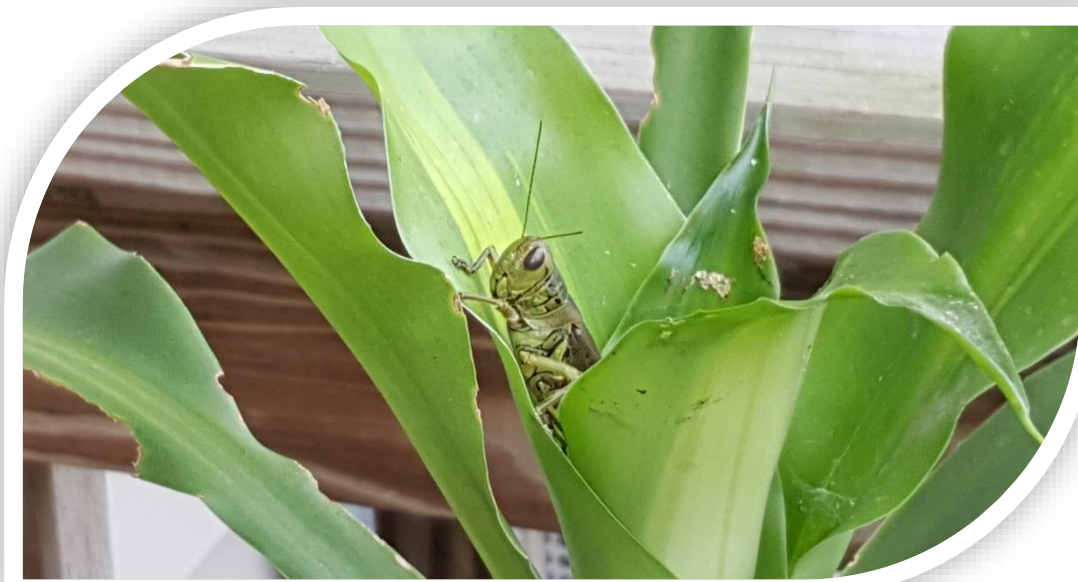


# Feeding preferences of native acridid grasshoppers for novel host plants: a case study of biotic resistance

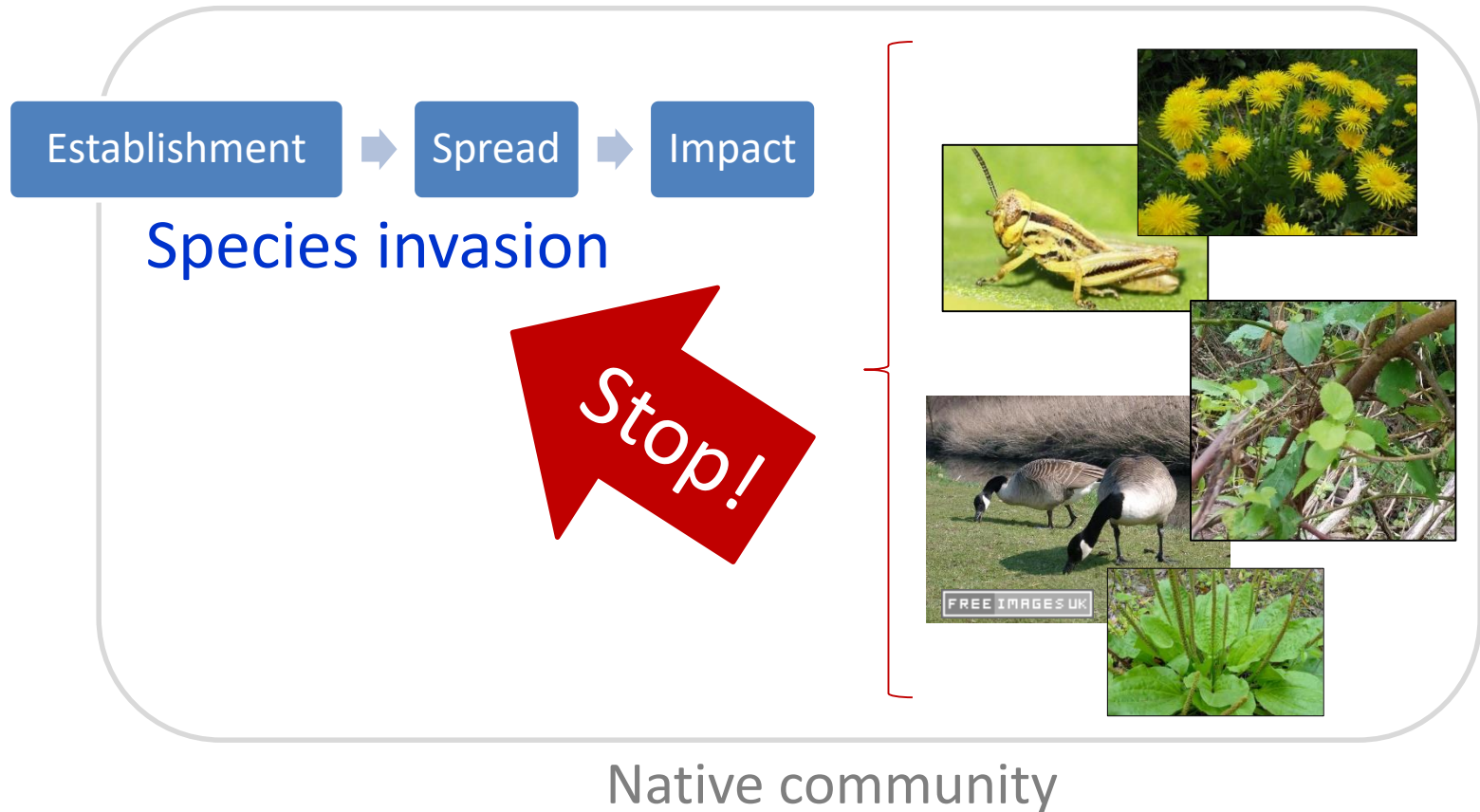


Alina Avanesyan and William Lamp

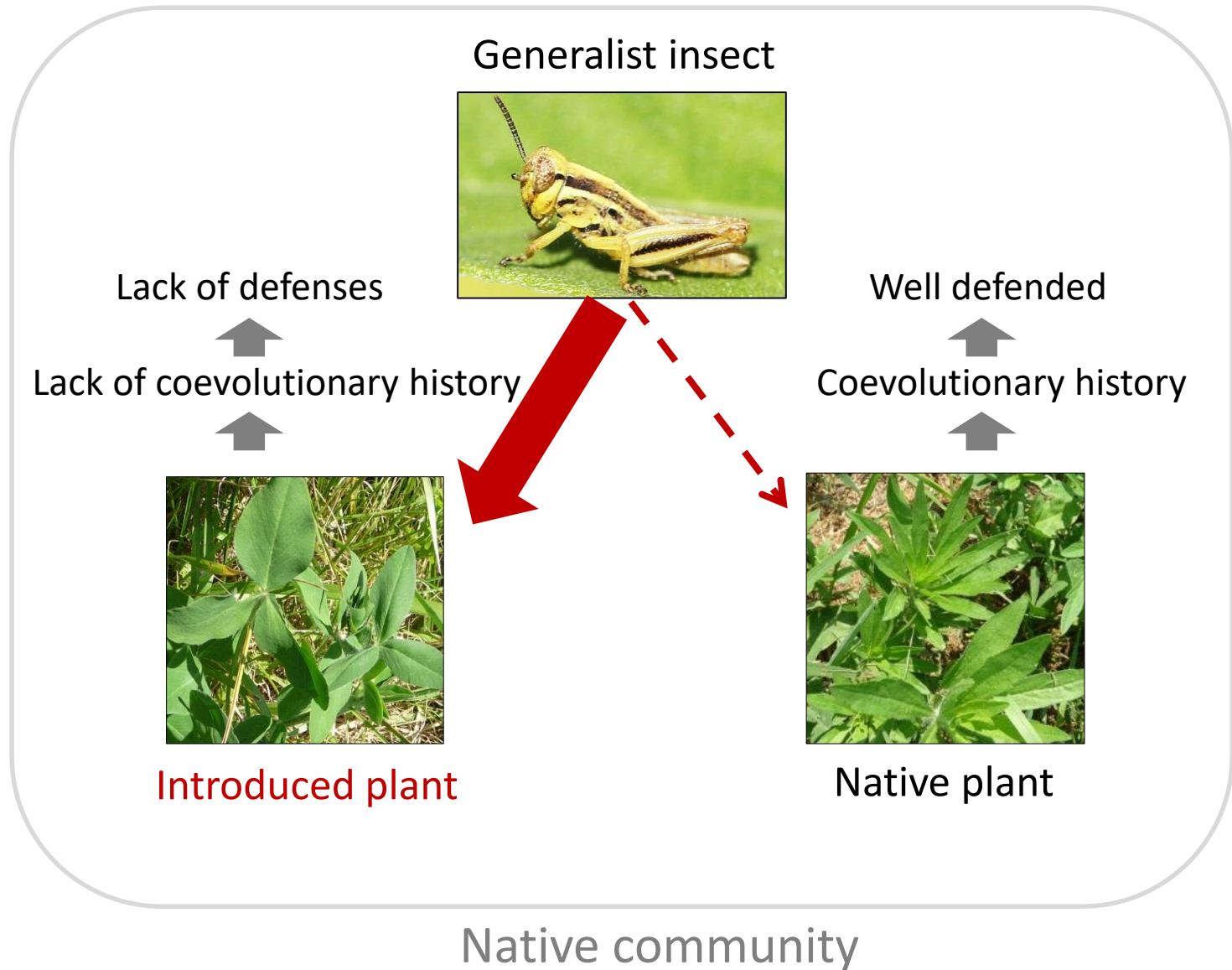
Department of Entomology, University of Maryland

# Biotic resistance

- "the ability of resident species in a community **to reduce the success of exotic invasions**" (Levine et al., 2004) – i.e. competition, parasitism, herbivory, or predation, etc.



# Biotic Resistance Hypothesis



Biotic resistance



Introduced species fail to establish  
in a new range



Why?

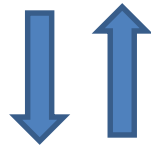
What mechanisms underlie these  
novel interactions?

# Study system

*Melanoplus*  
grasshoppers  
(Orthoptera:  
Acrididae)



Native



Grasses  
(Poaceae)



Native and Exotic

➤ How do native insect herbivores respond to their novel host plants?

➤ How do native and exotic plants respond to native insect herbivores?

# Outline

- **Ph.D. research:** *Melanoplus* grasshoppers on native vs. exotic grasses
- **Review:** Acridid grasshoppers and their novel host plants
- **Current research:** *Melanoplus* grasshoppers and *Miscanthus sinensis* cultivars



# Experimental Design

Plant responses,  
grasshopper feeding

Intact  
plants

Field



Greenhouse



Leaf  
segments



Molecular confirmation  
of diet

Protocol

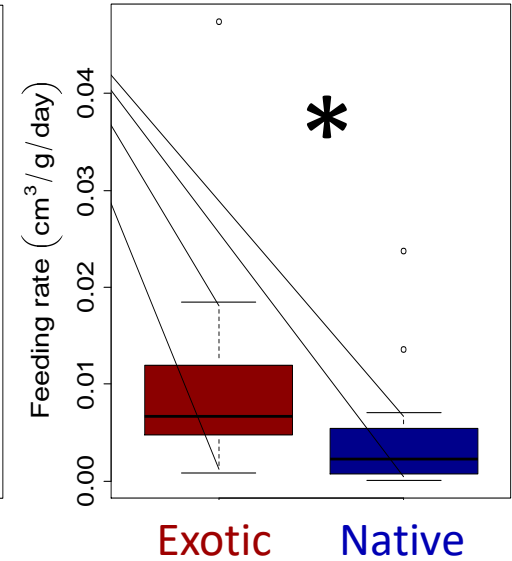
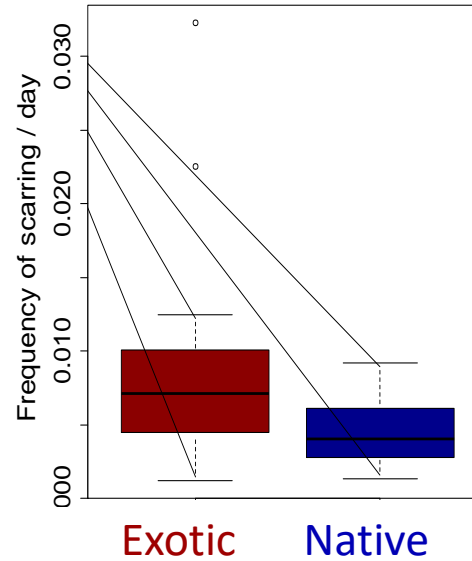
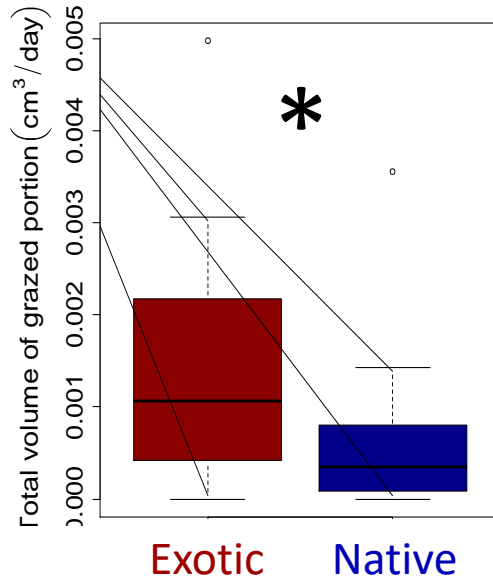


Ingested  
plants

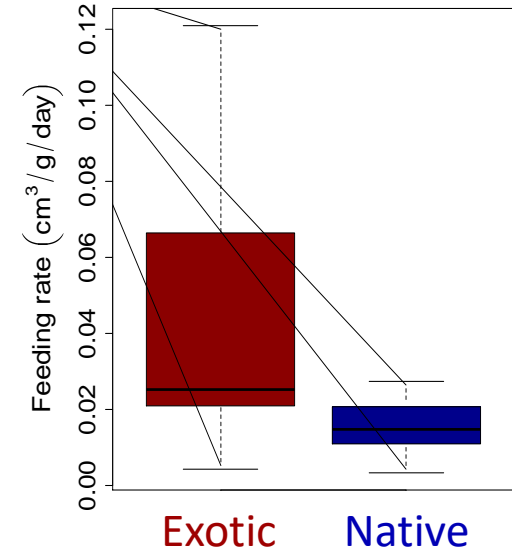
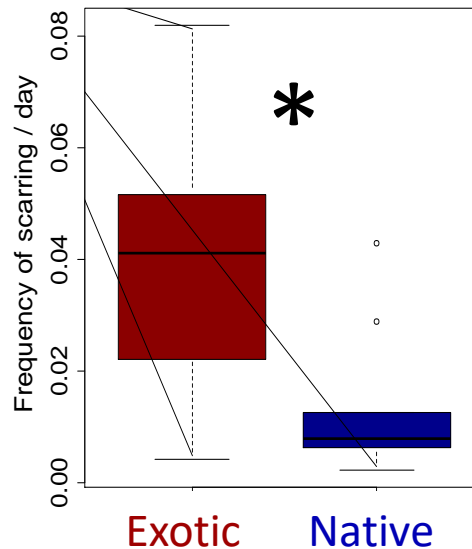
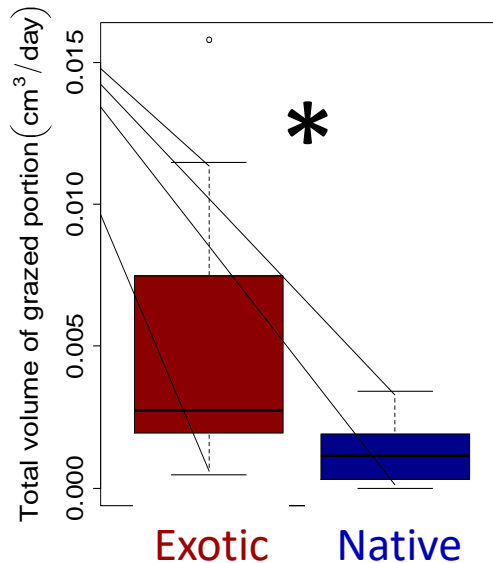




**Field**



**Greenhouse**



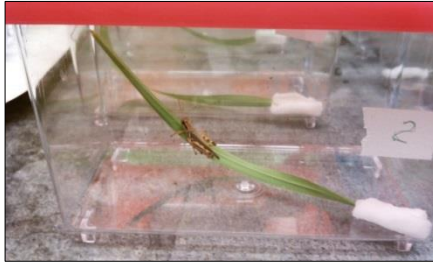
- Grasshopper food consumption and feeding activity were greater on exotic grasses;

\*  $p < 0.05$

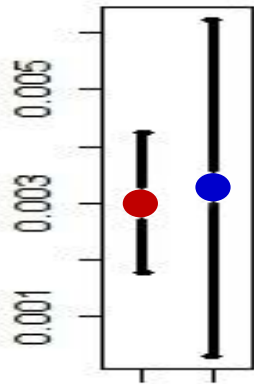




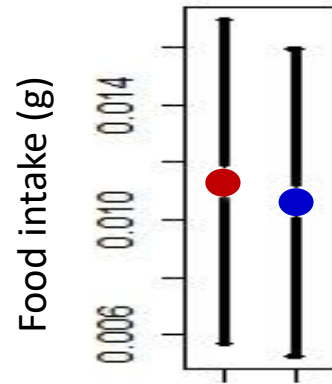
# Lab Assays: Food Consumption



Total volume of grazed portion (cm<sup>3</sup>)

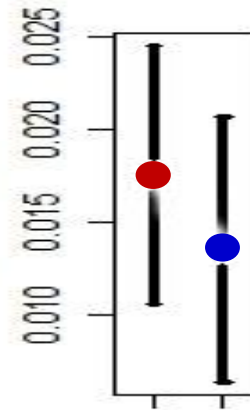


Exotic Native



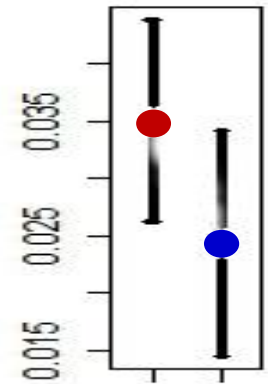
Exotic Native

Feeding rate (g/g/hour)



Exotic Native

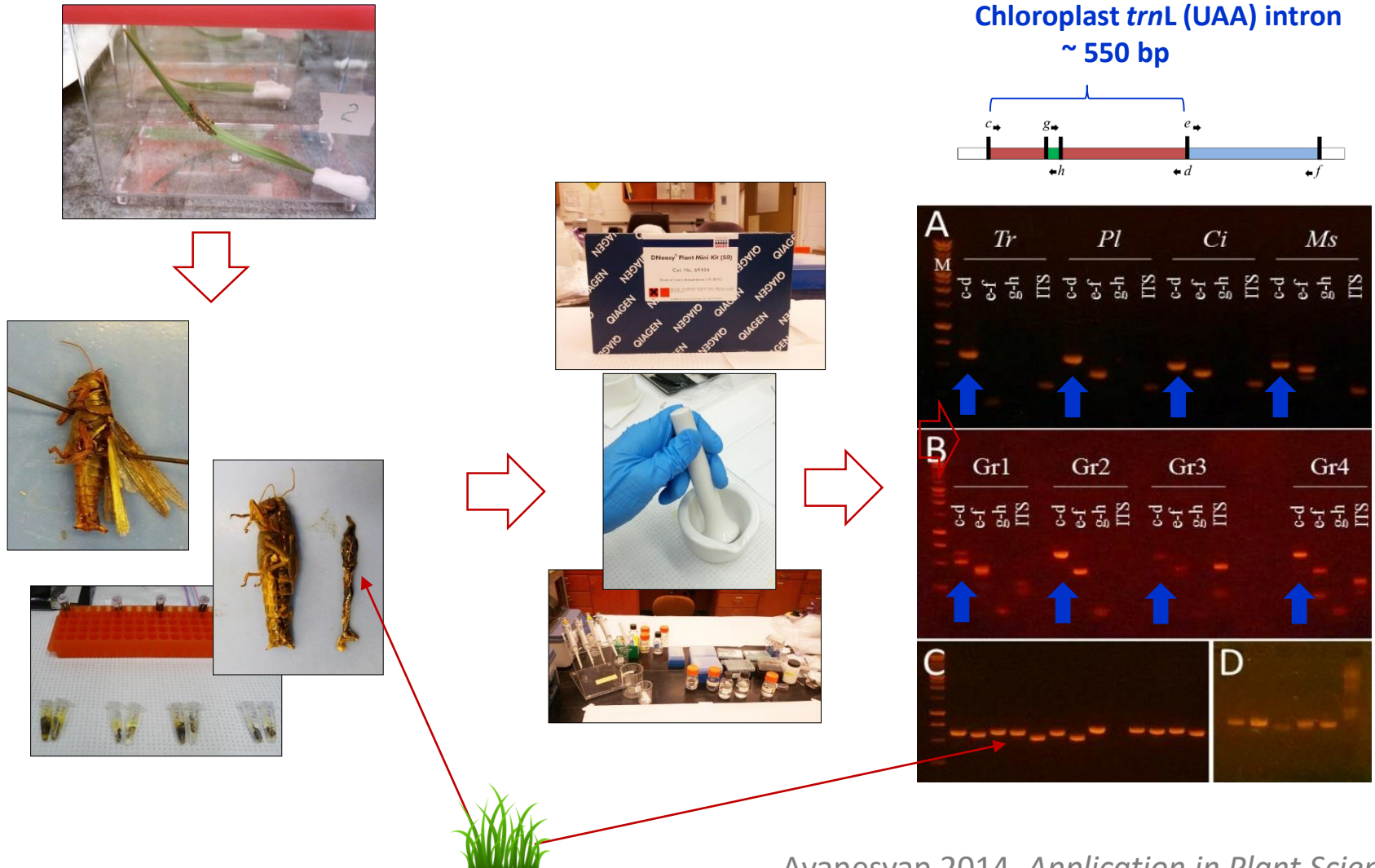
Consumption index



Exotic Native

- Grasshopper food consumption did not differ on the leaves clipped from native and exotic grasses ( $p > 0.05$ )

# Molecular Confirmation of Diet



# Molecular Confirmation of Diet



Cincinnati Center  
for Field Studies (OH)

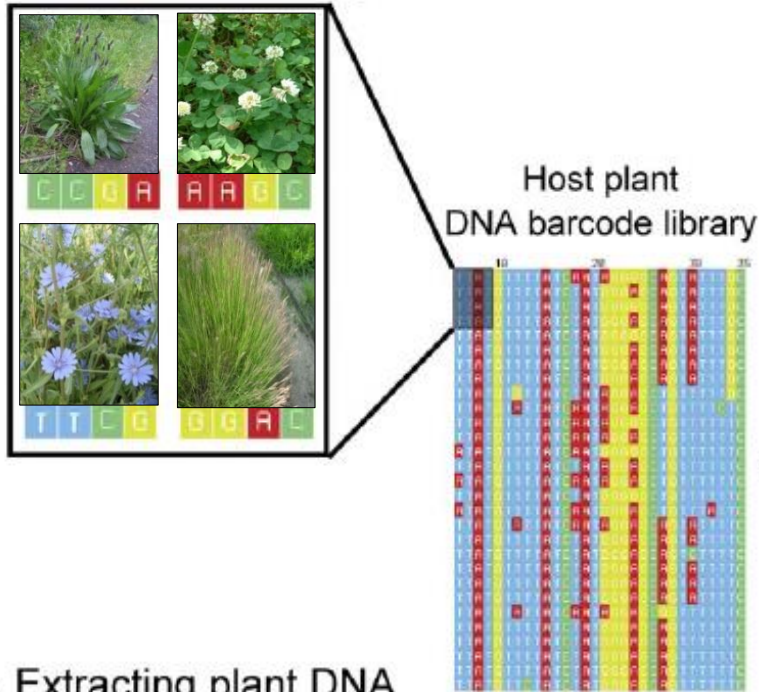


Western Maryland  
Research and Education Center (MD)



# Host Plant Identification

## A. Assembling a host plant DNA barcode library

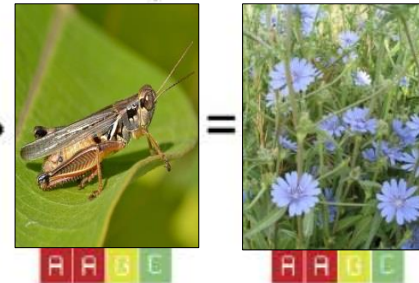


## B. Extracting plant DNA from insect herbivores



## C. Comparing extracted DNA with sequences in the DNA barcode library

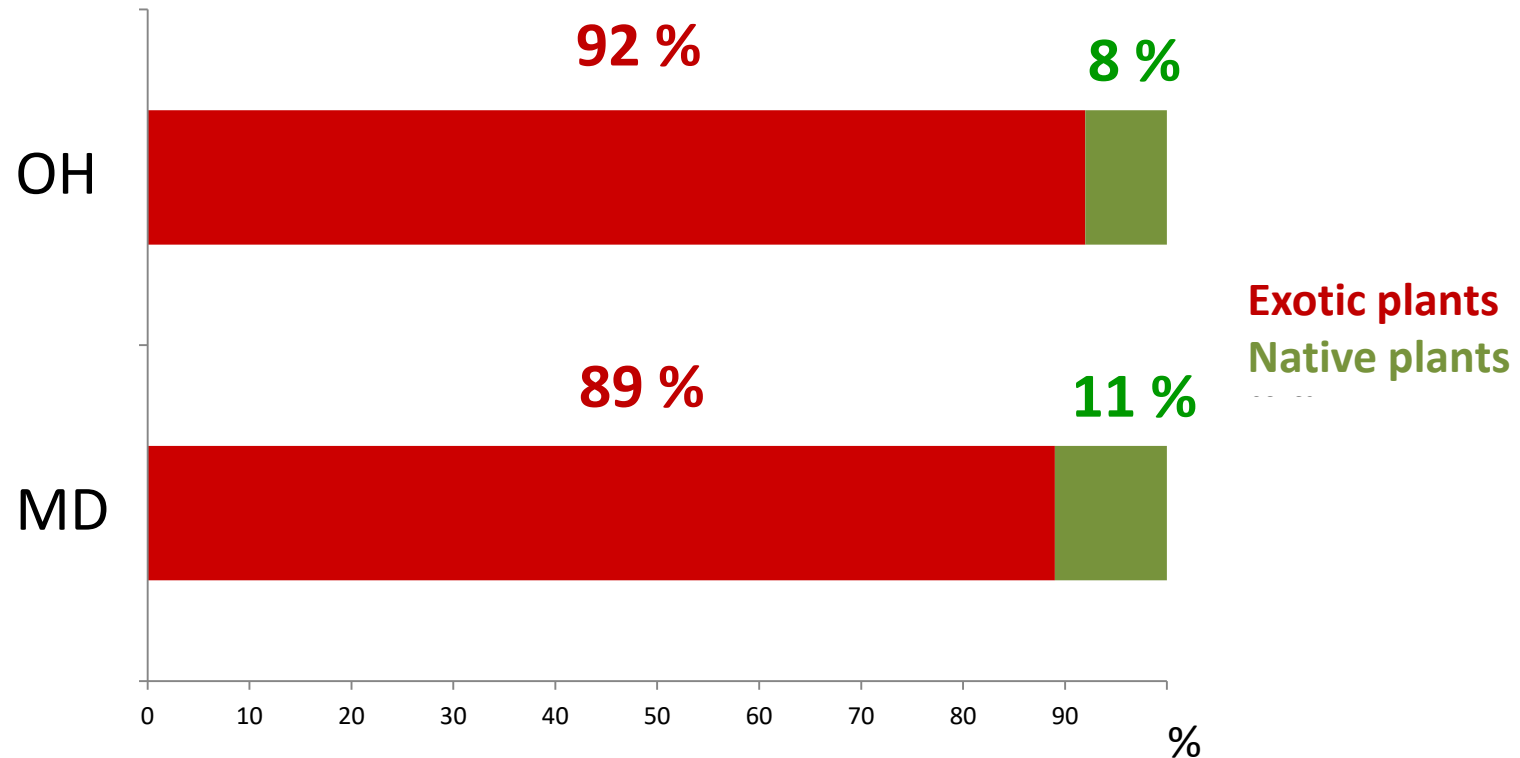
## D. Matching DNA sequences and host plant identification



- Plant ID
- Plant Origin



# Proportions of Ingested Plants



- Grasshopper gut contents contained greater numbers of exotic plant species at both field sites ( $p < 0.0001$ , Binomial test)



Do *Melanoplus* grasshoppers have feeding preferences for native and exotic grasses?



behavioral approach (feeding activity, consumption, assimilation)

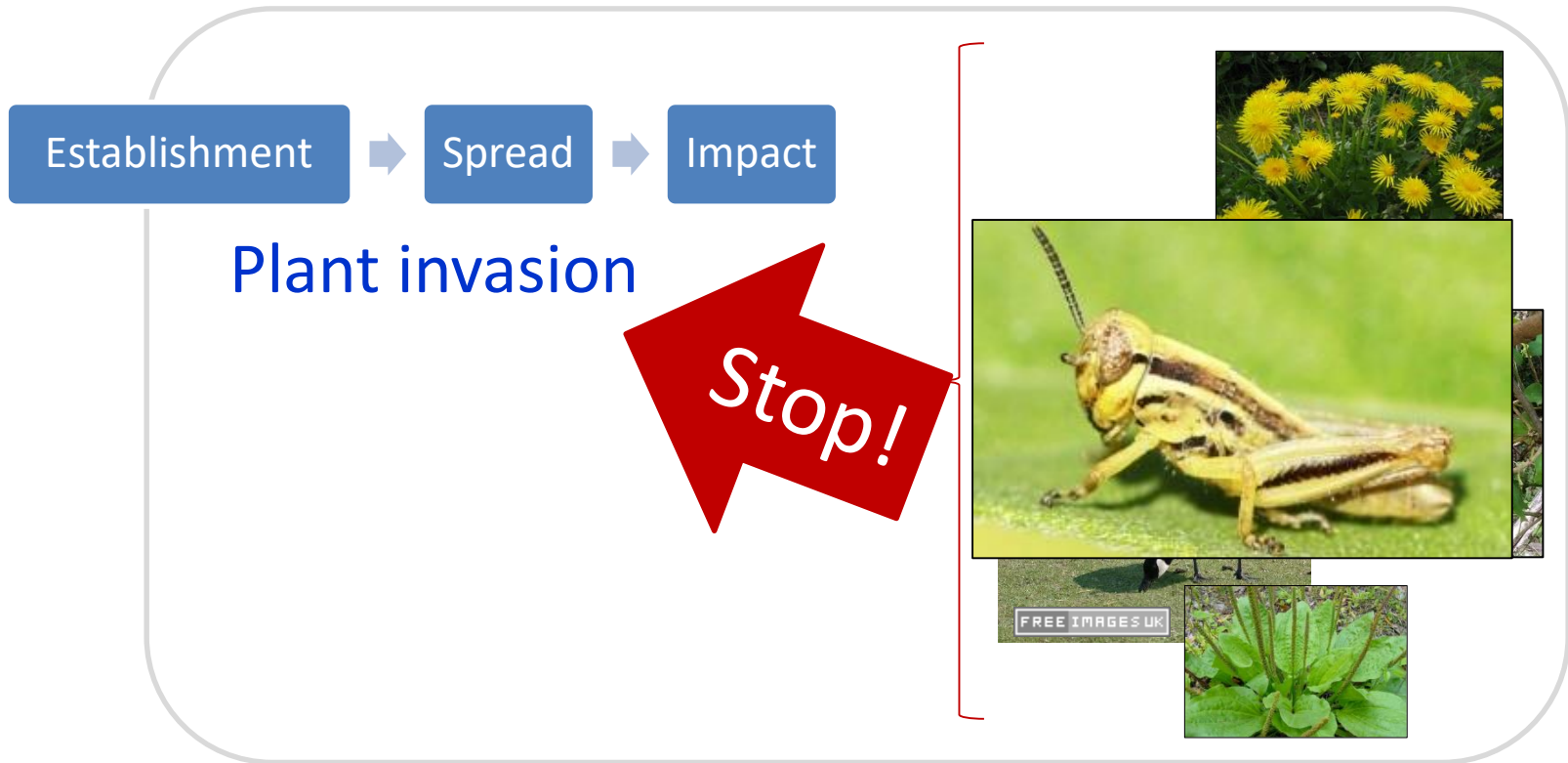
Exotic  $\geq$  Native



molecular approach (DNA barcoding of ingested plant material)

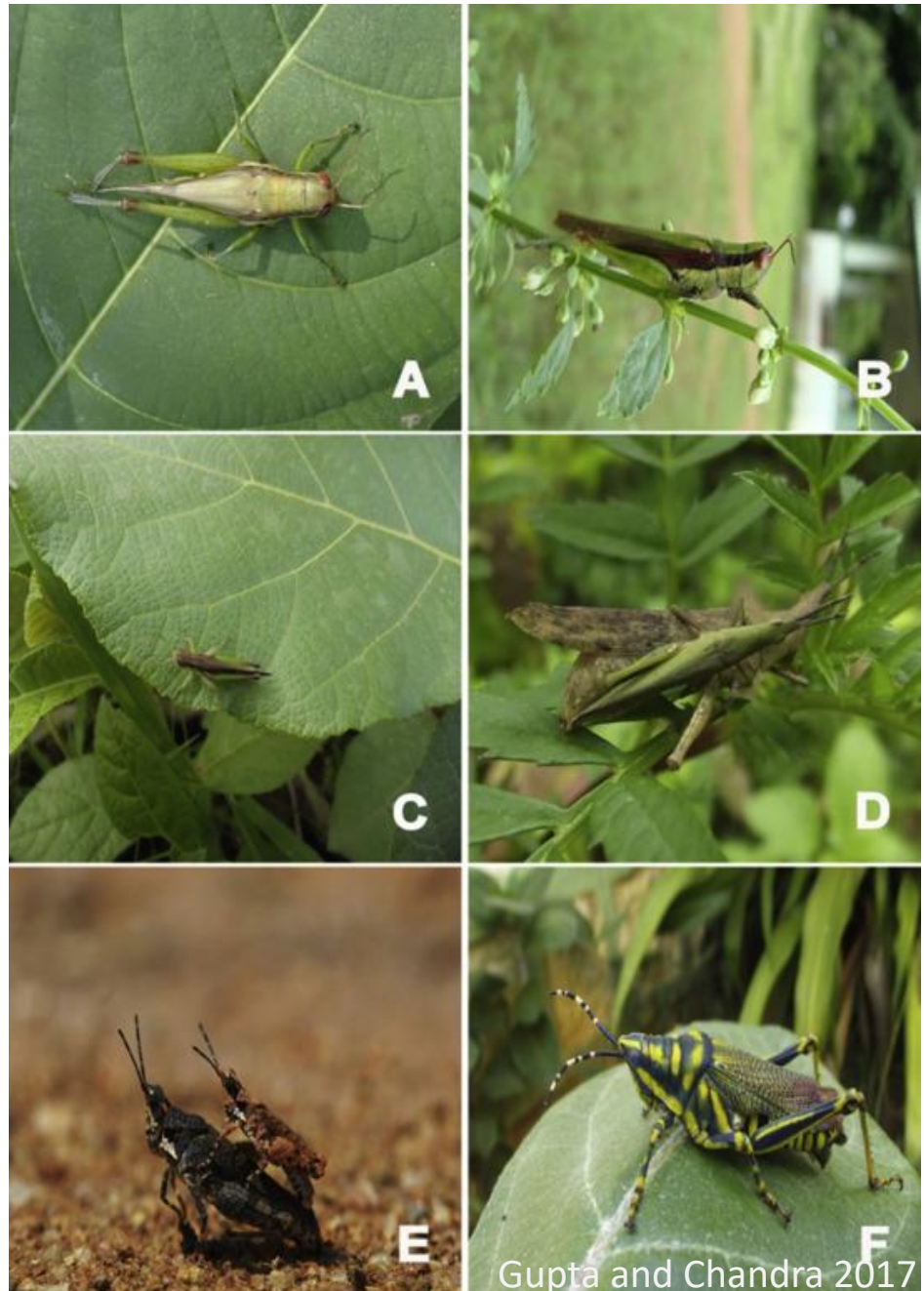
Exotic > Native

# Application to Biotic Resistance





Do all the acridid grasshoppers prefer to feed on exotic plants?

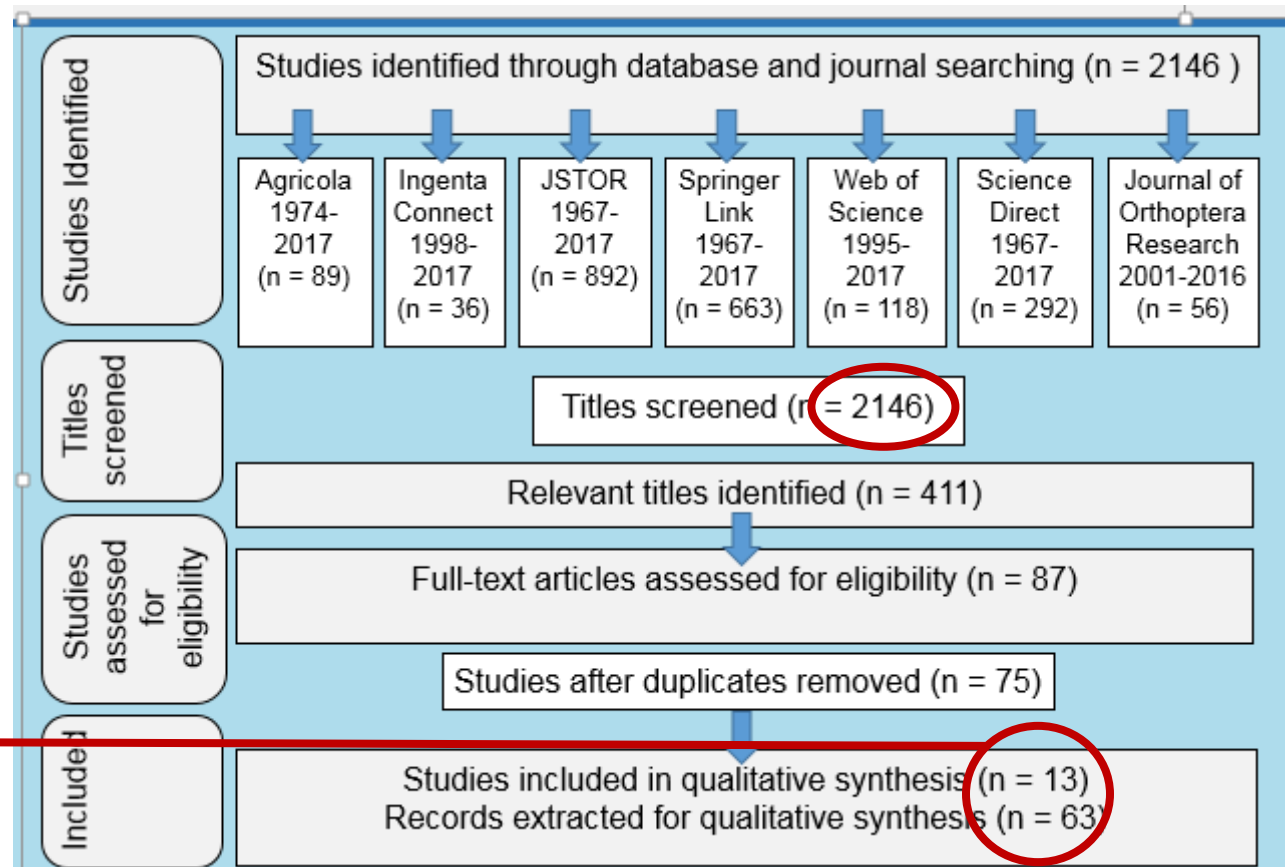


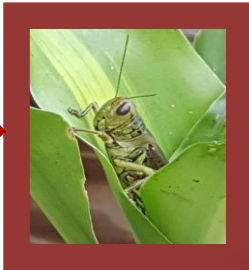
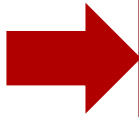
# Should I Eat or Should I Go?

## Acridid Grasshoppers and Their Novel Host Plants: Potential for Biotic Resistance

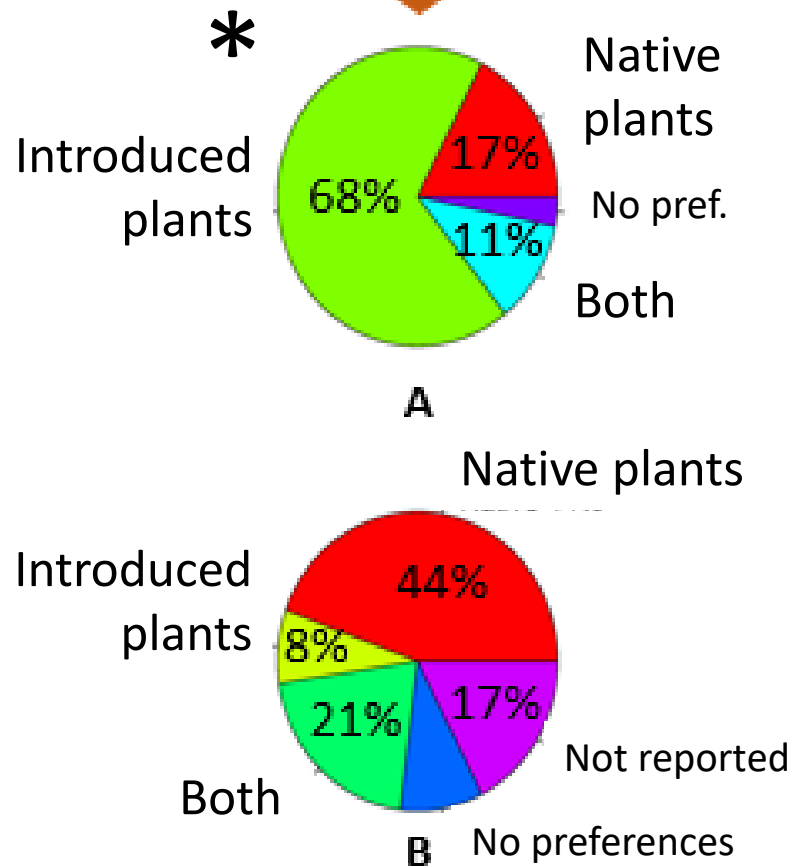
### Systematic Review and Meta-analysis

for 28 North-American grasshopper species



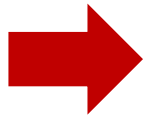


Acridid grasshoppers prefer to feed on introduced plants

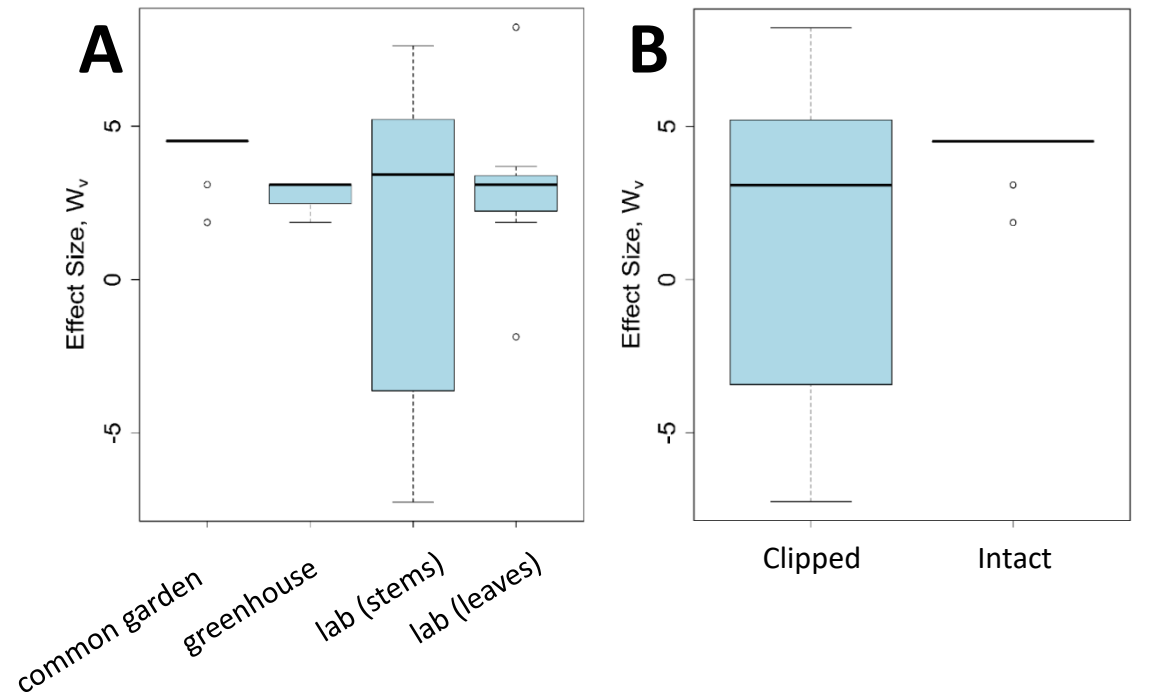


➤ Most preferred plants

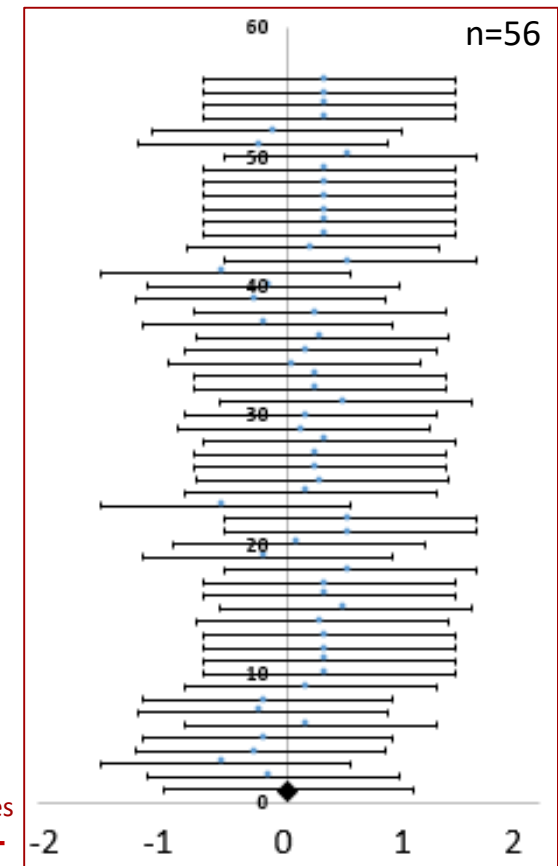
➤ Least preferred plants



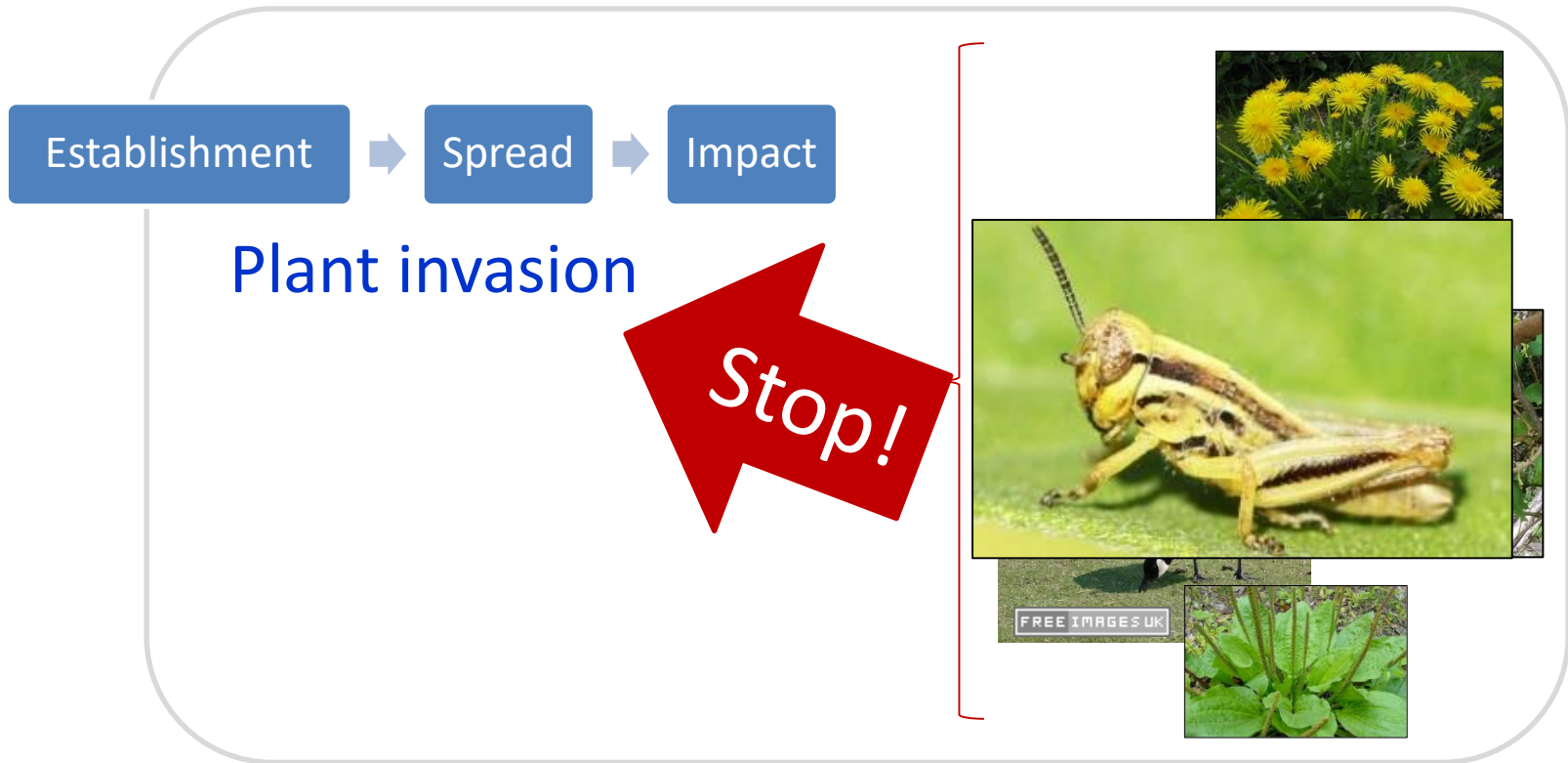
Acridid grasshoppers prefer to feed on introduced plants regardless the experimental conditions or plant material offered



$$\text{Preference Metric} = \frac{n_{\text{most preferred exotic plant species}} - n_{\text{most preferred native plant species}}}{n_{\text{total plant species offered}}}$$

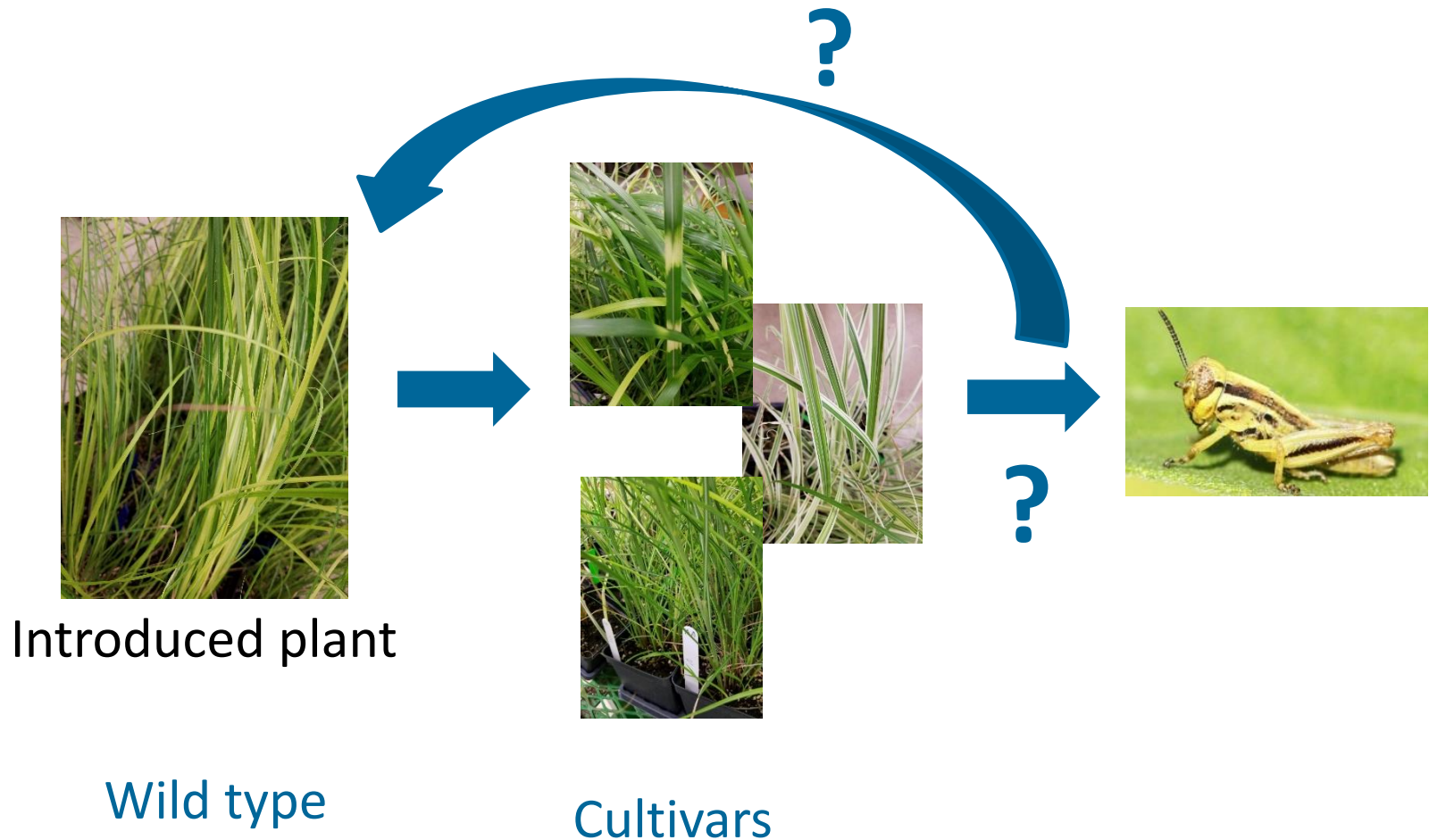


# Application to Biotic Resistance



Native community

# Grasshoppers and Introduced Plants





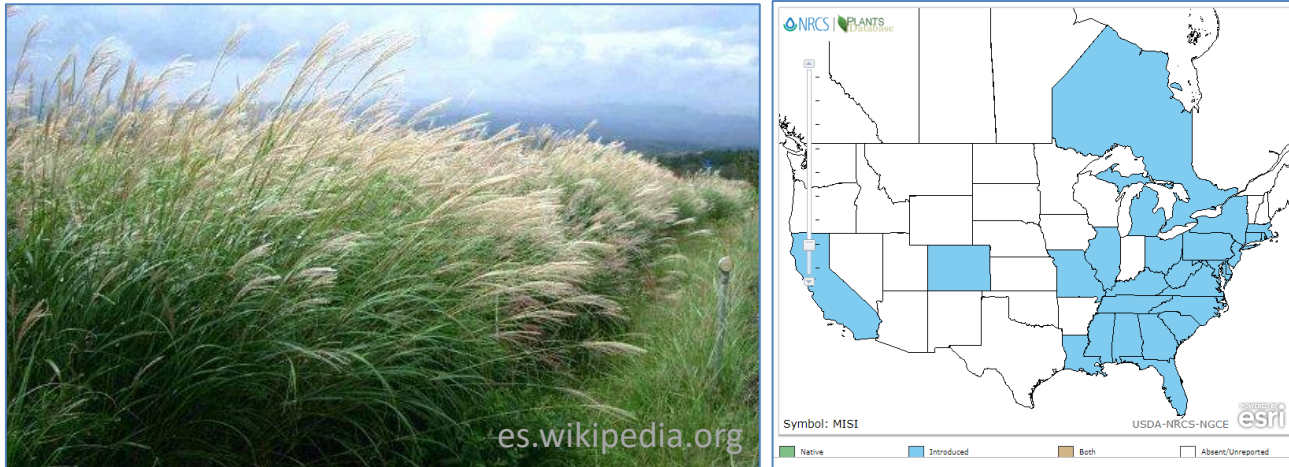
# Interactions between *Melanoplus* grasshoppers and *Miscanthus sinensis* varieties





# *Miscanthus sinensis* Andersson

## Chinese silvergrass



- Native to Japan
- 1893: introduced to Asheville NC; 1894: Washington DC
- 1940: naturalized populations in New York, Washington DC, Florida, West Virginia
- 2018: reported in 27 states
- disturbed areas, open fields, forest understories (in Maryland)

# *Miscanthus sinensis* varieties



*M. sinensis* 'Zebrinus' (ZE)



*M. sinensis* 'Dixieland' (DI)



*M. sinensis* 'Autumn Anthem' (AA)



*M. sinensis* 'Gracillimus' (GR)



*M. sinensis* 'Morning Light' (ML)



# Field Experiments

- 5 cultivars
- 30 plants/cultivar
- measured plant growth and leaf damage at 4 time points

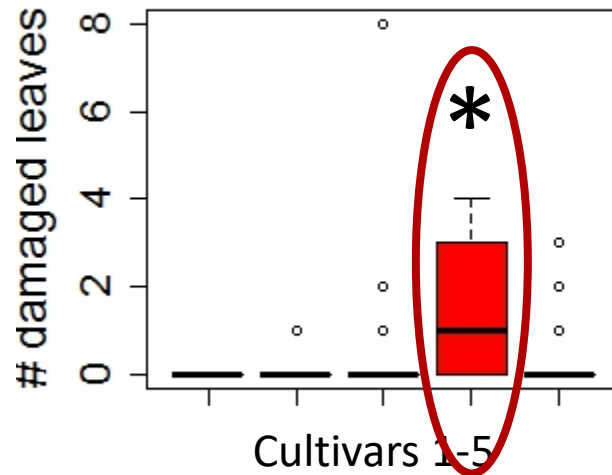


# Greenhouse experiments

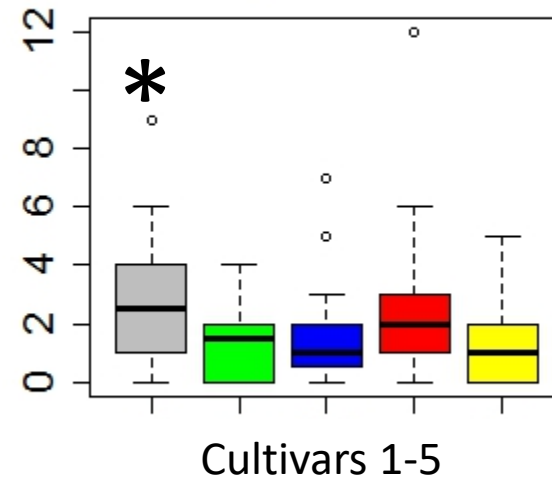




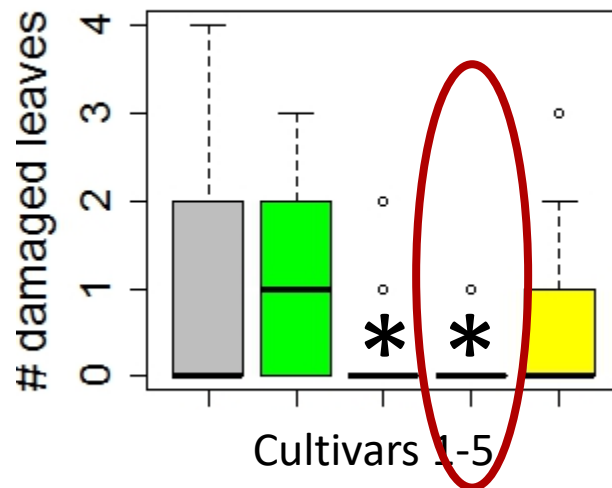
**July 12, 2018**



**Aug 3, 2018**



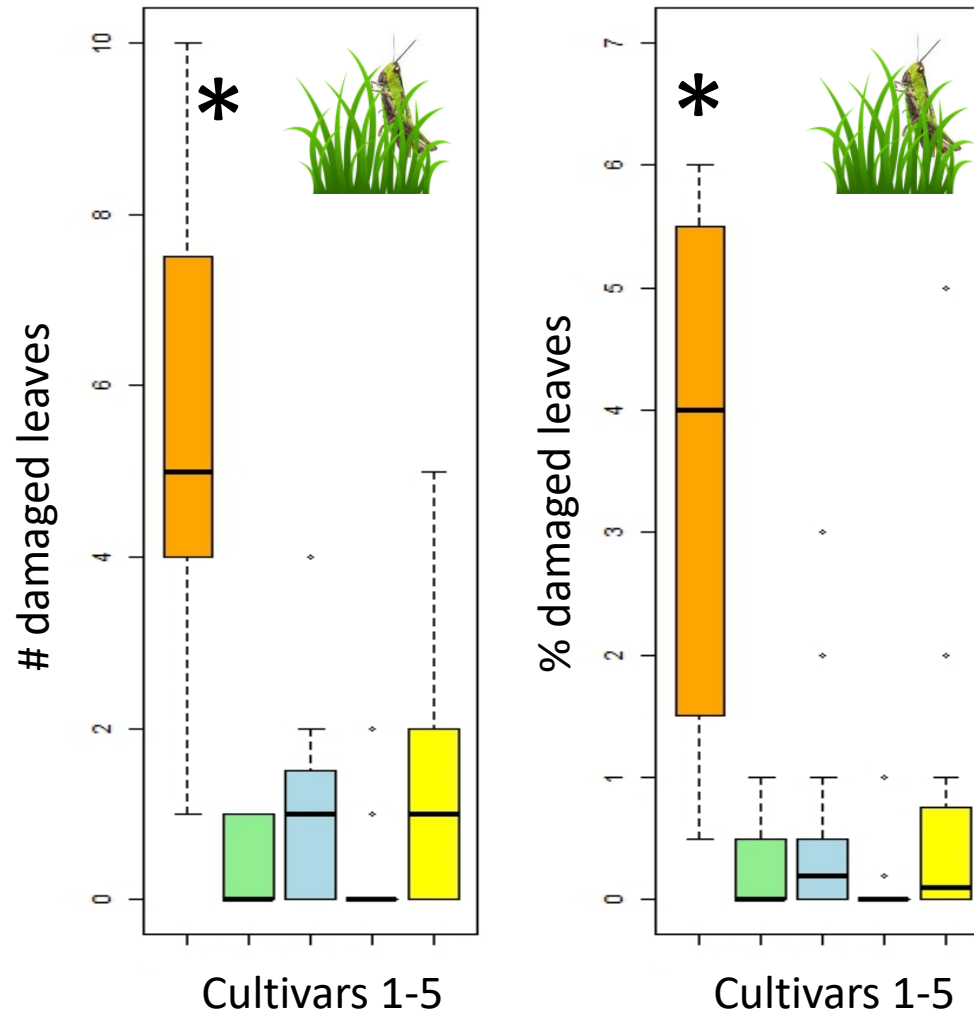
**Aug 22, 2018**



Herbivore  
damage: field

- Grasshoppers feed on all the cultivars showing preference for some of them

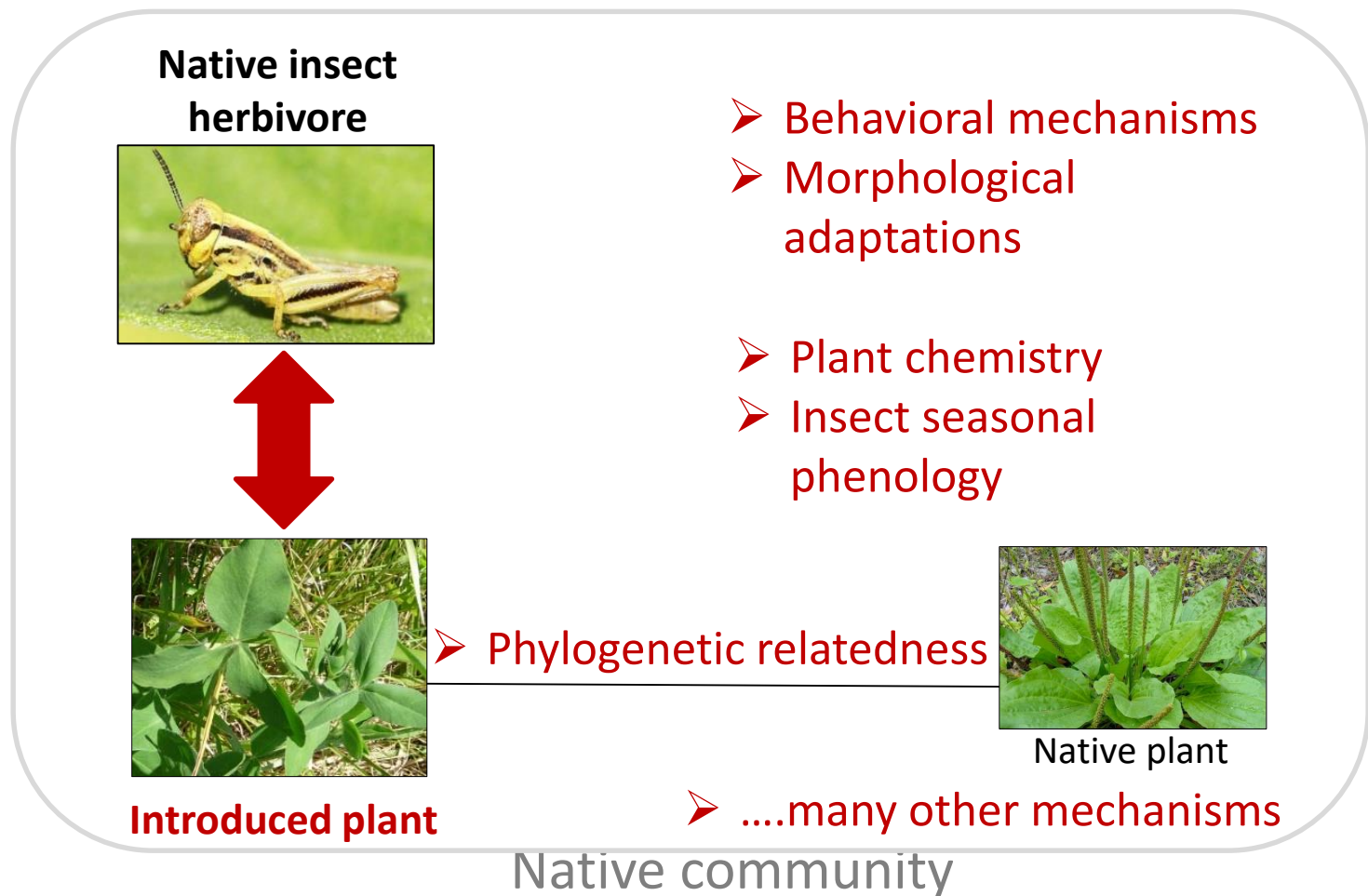
# Herbivore Damage: Greenhouse



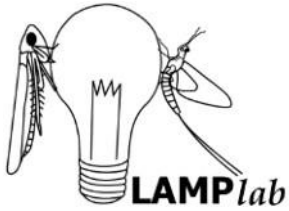
- Grasshoppers feed on all the cultivars showing preference for some of them

# Summary

## Biotic resistance mechanisms?







# ***Many thanks!!***

## **Bill Lamp and The Lamp lab:**

Becca Wilson, Becca Eckert, Brock Couch, Chloe Garfinkel, Dylan Kutz, Morgan Thompson, Kimmy Okada, Kevin Clements, Nina McGranahan



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Leslie Pick's lab  
Todd Waters



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The Culley lab  
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Stephen Matter  
George Uetz  
Angelo Randaci  
Roger Ruff

## **Western Maryland Research and Education Center:**

Ryan McDonald

## **Research Greenhouse Complex:**

Meghan Holbert