

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

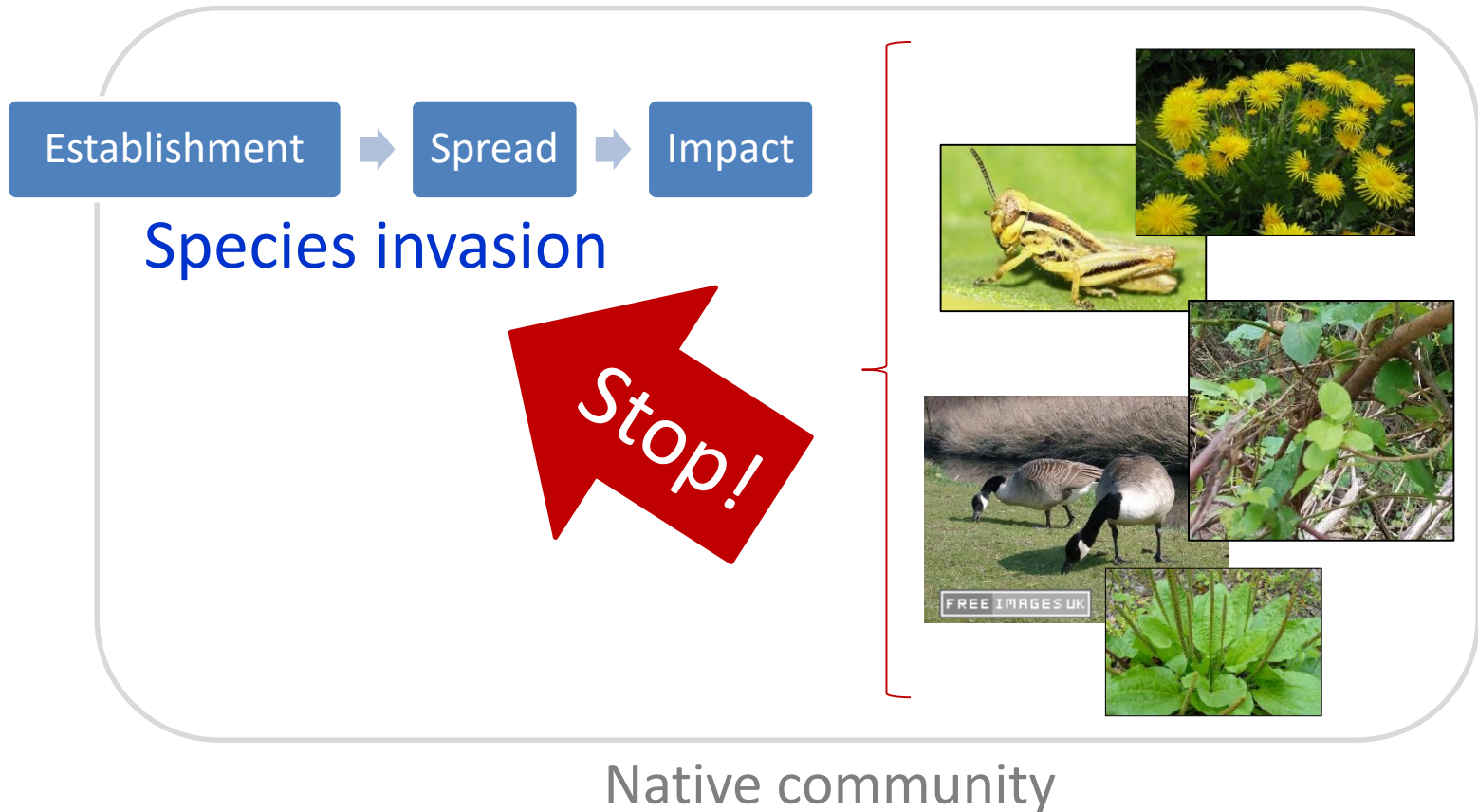


Alina Avanesyan and William Lamp

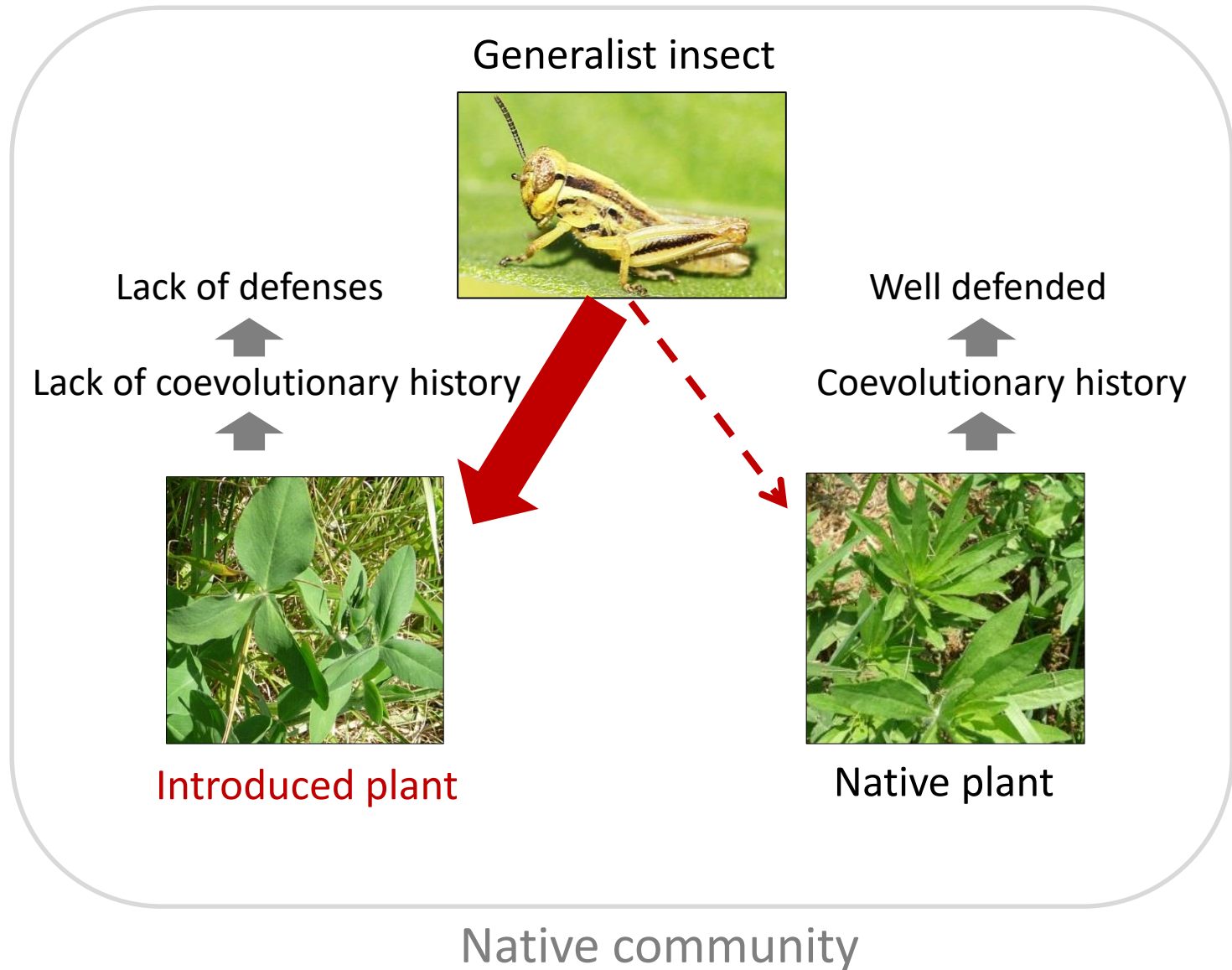
Department of Entomology, University of Maryland

# 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?

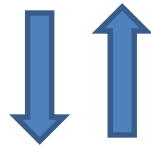
What mechanisms underlie these  
novel interactions?

# 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

Grasshopper feeding preferences

Intact plants

Leaf segments

Field

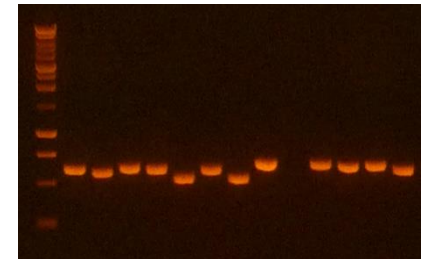
Greenhouse



Plant DNA detection within grasshopper gut contents

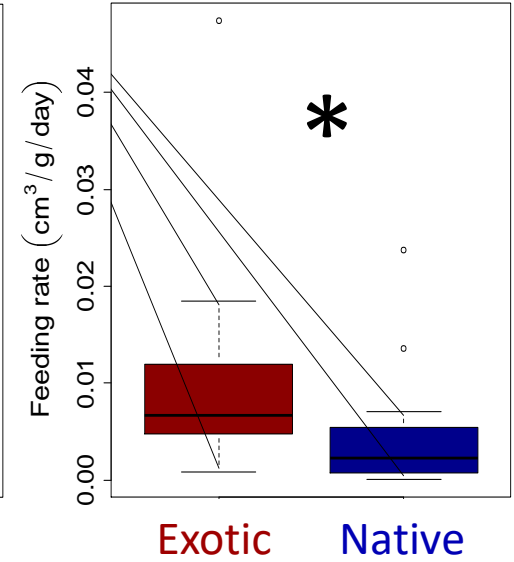
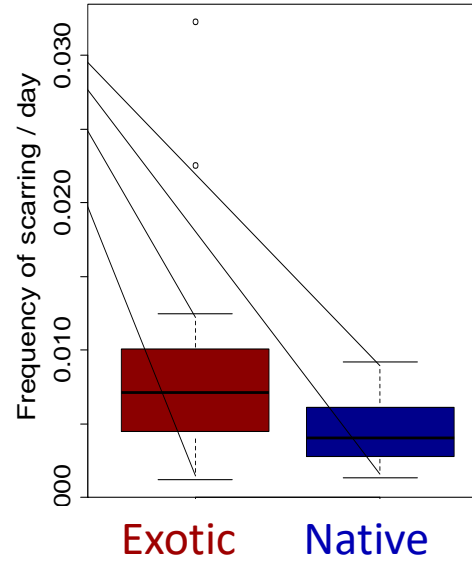
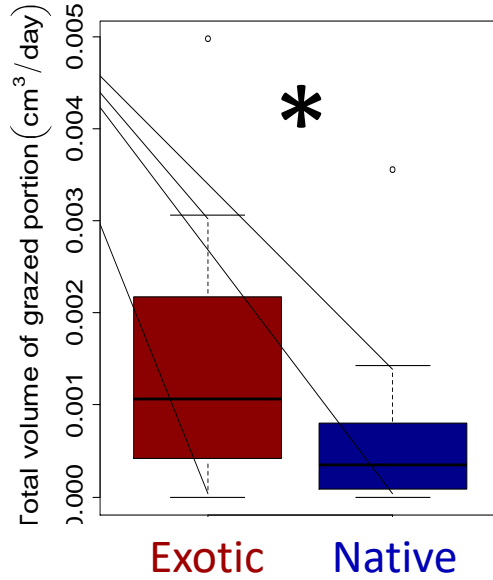
Protocol

Ingested plants

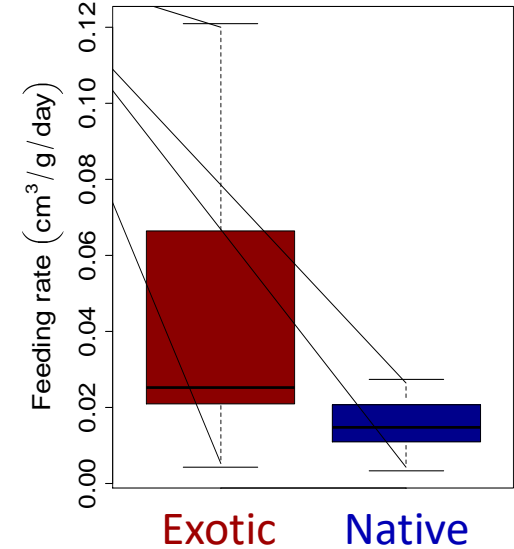
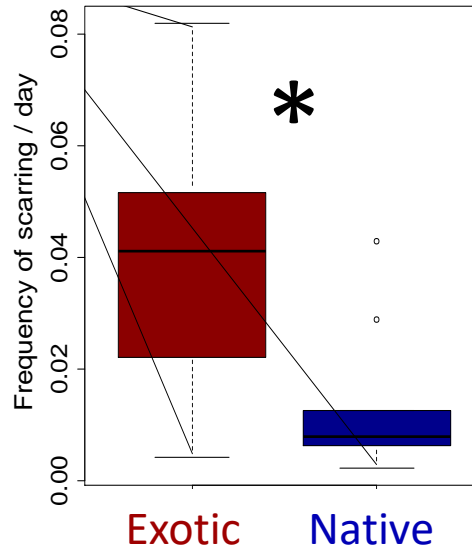
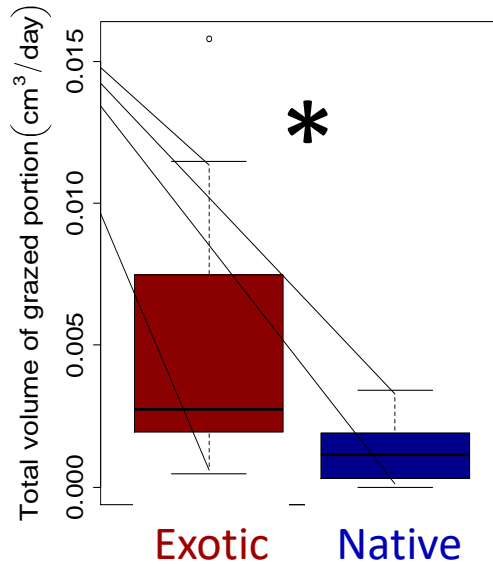




Field



Greenhouse



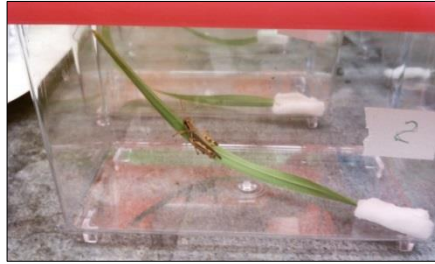
➤ Grasshopper food consumption and feeding activity were greater on exotic grasses;

\*  $p < 0.05$

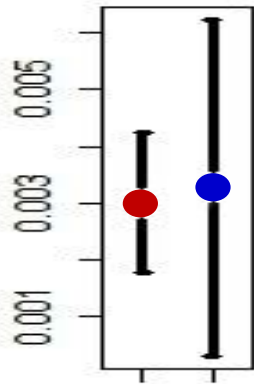




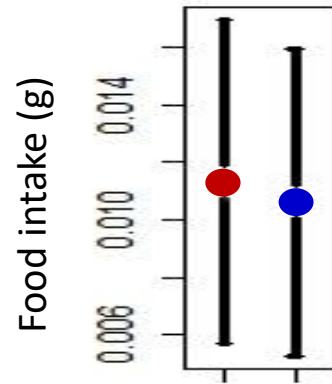
# Lab Assays: Food Consumption



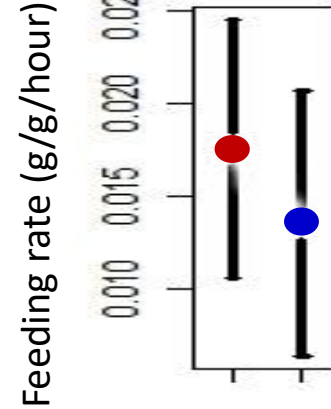
Total volume of grazed portion (cm<sup>3</sup>)



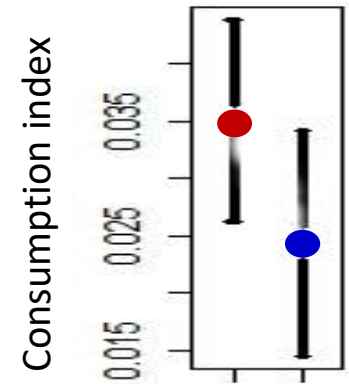
Exotic Native



Exotic Native



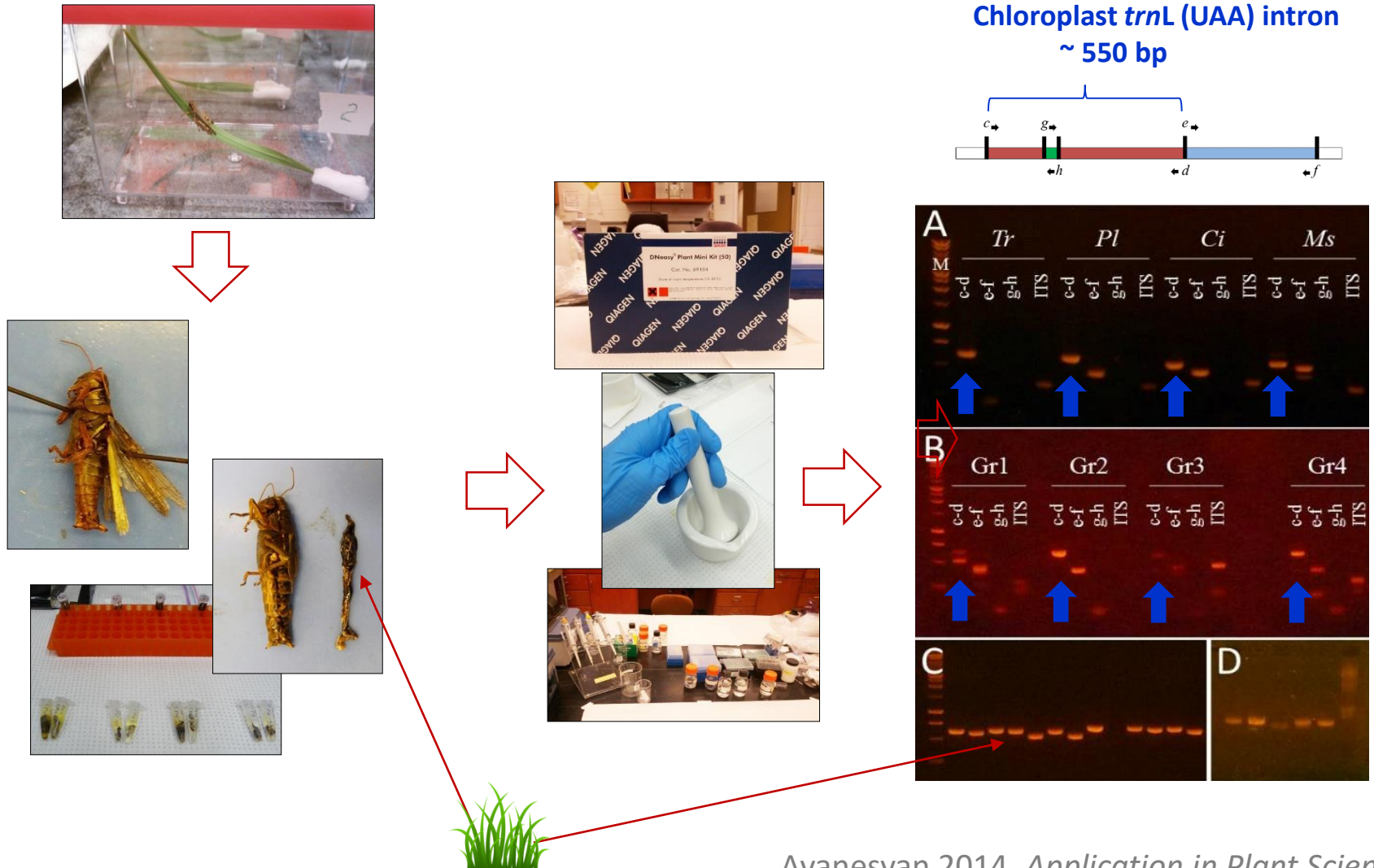
Exotic Native



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)

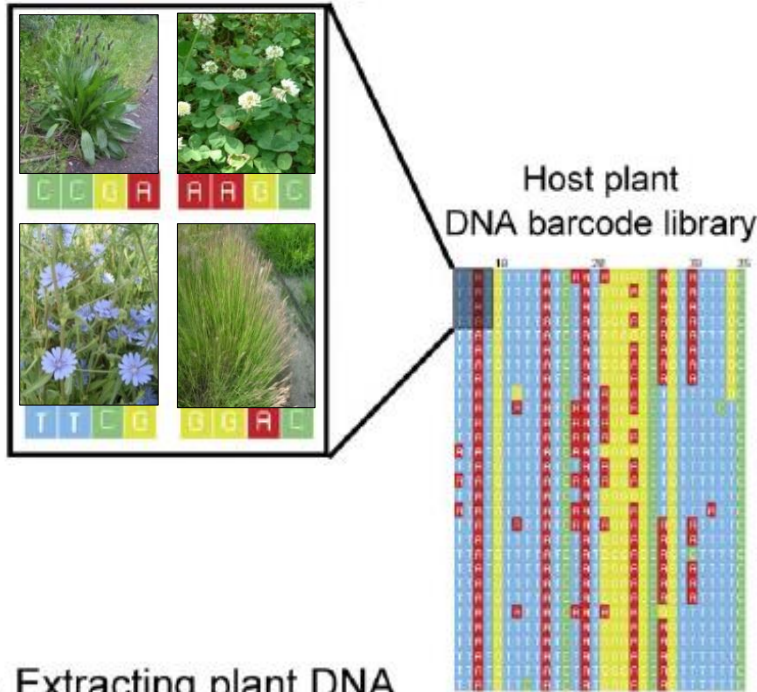


Western Maryland  
Research and Education Center (MD)



# Host Plant Identification

A. Assembling a host plant DNA barcode library

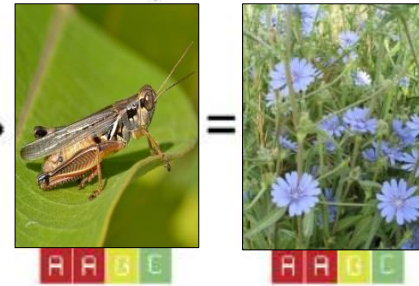


B. Extracting plant DNA from insect herbivores



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

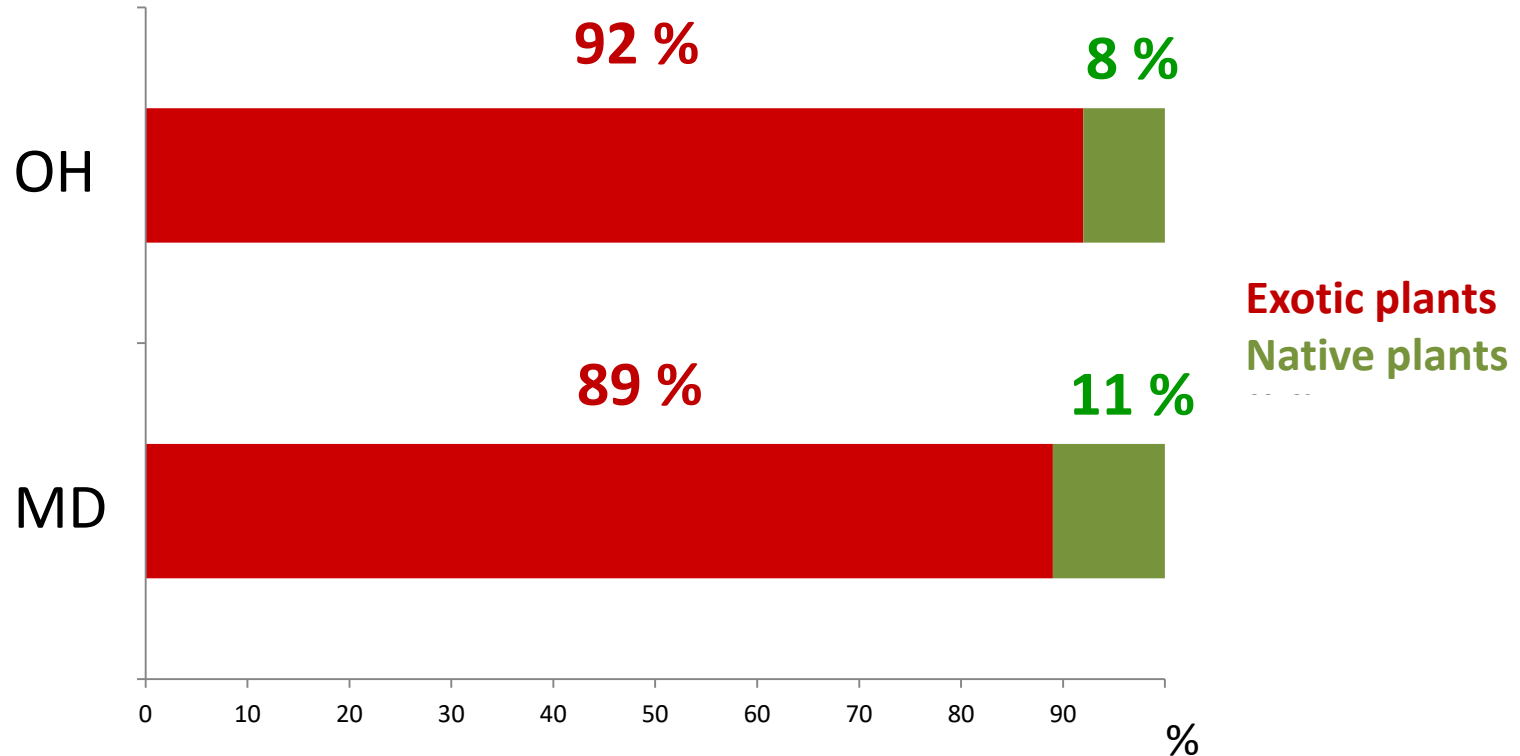
D. Matching DNA sequences and host plant identification



- 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)

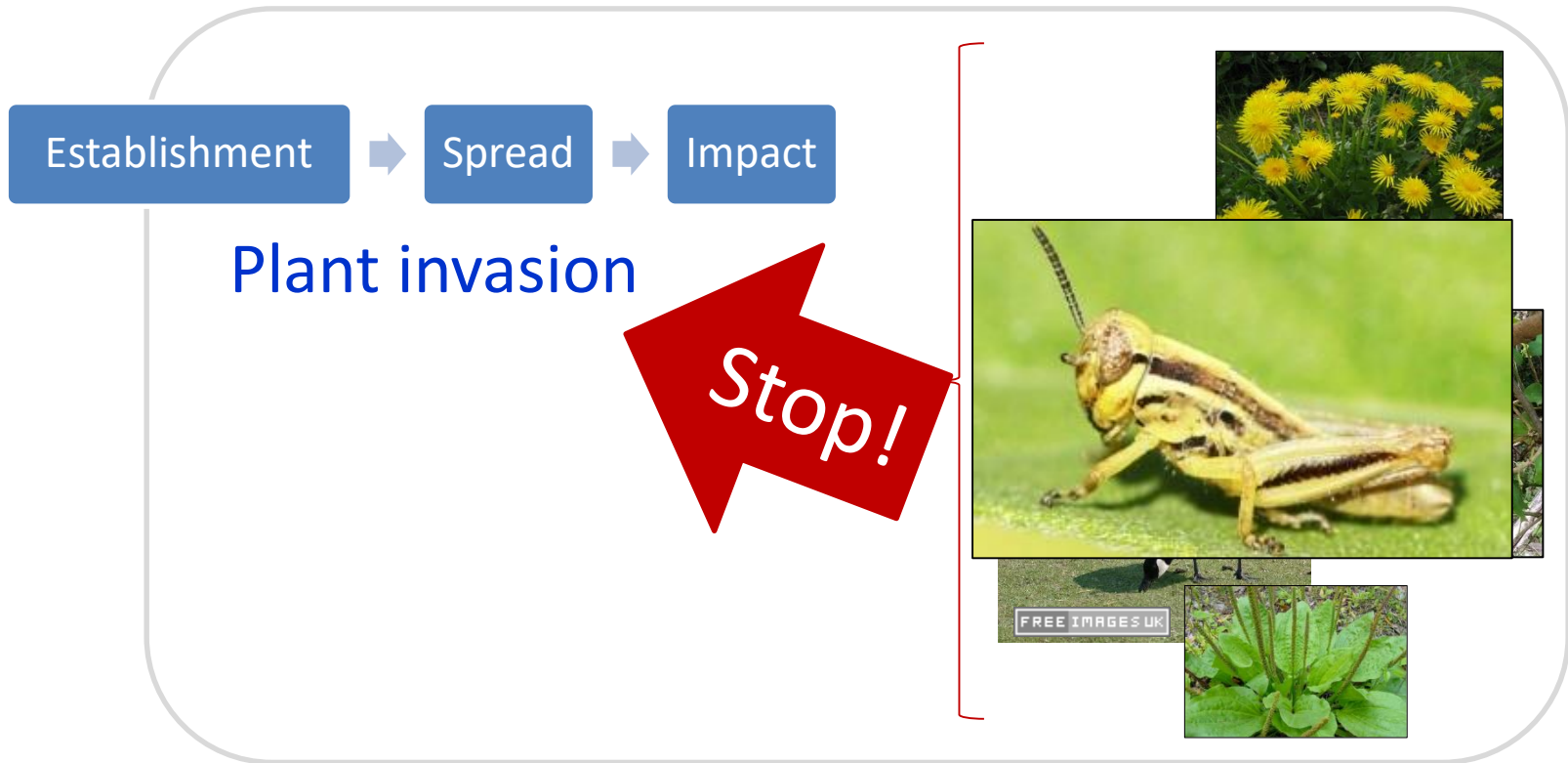
Exotic  $\geq$  Native



molecular approach (DNA barcoding of ingested plant material)

Exotic > Native

# Application to Biotic Resistance



Native community



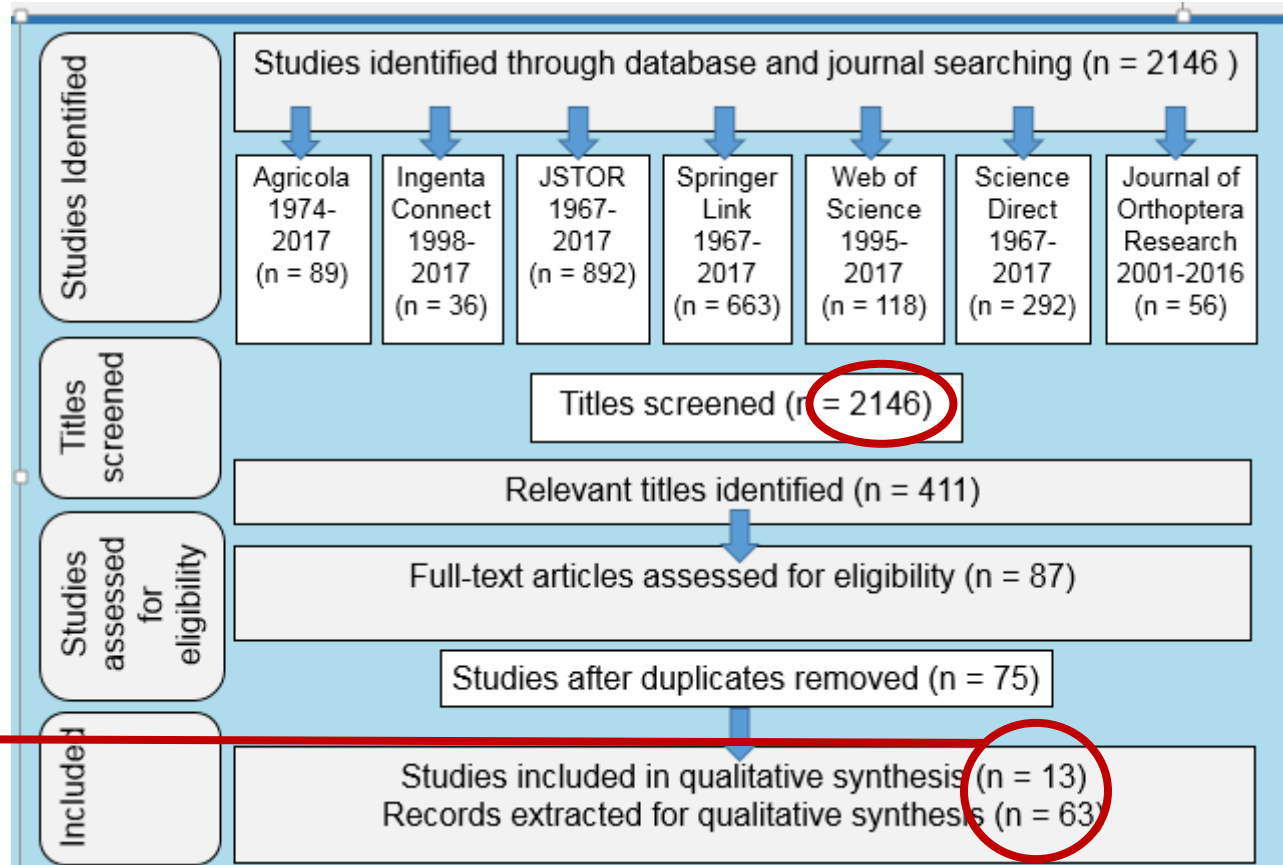
Do all the acridid grasshoppers prefer to feed on exotic plants?



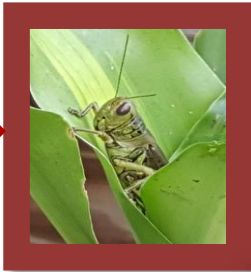
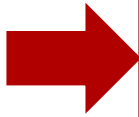
# Should I Eat or Should I Go?

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

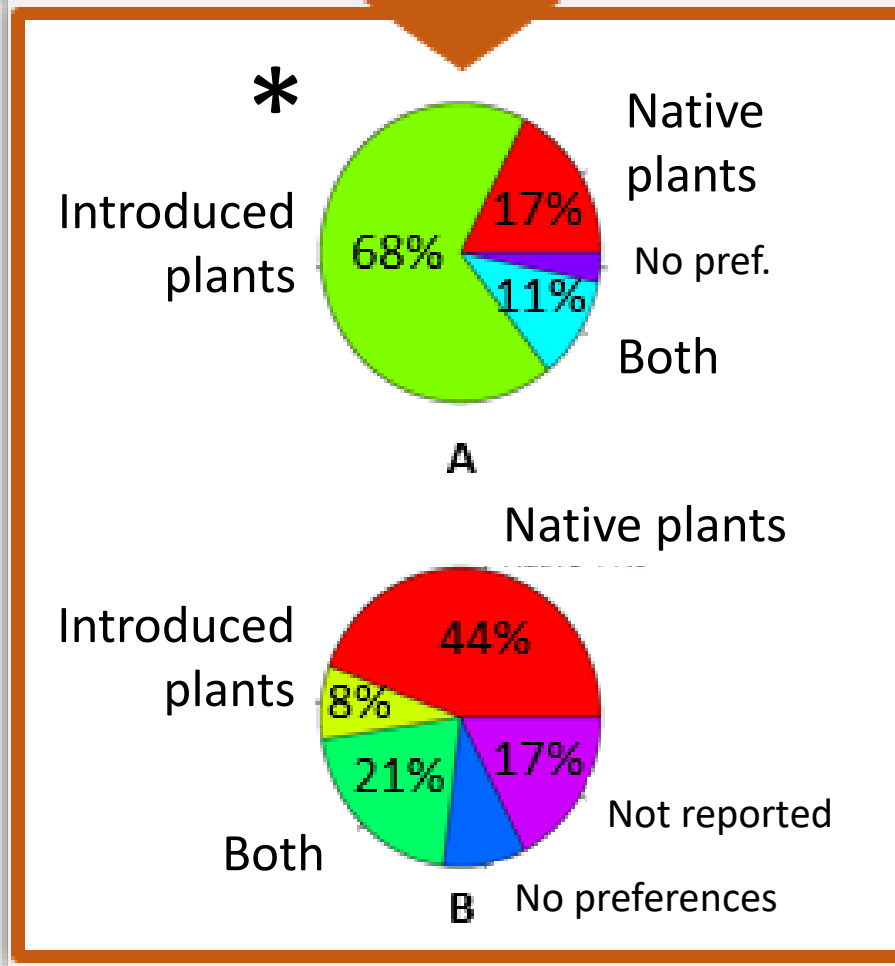
Systematic Review and Meta-analysis



for 28 North-American grasshopper species

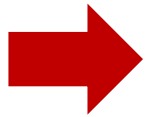


## Acridid grasshoppers prefer to feed on introduced plants

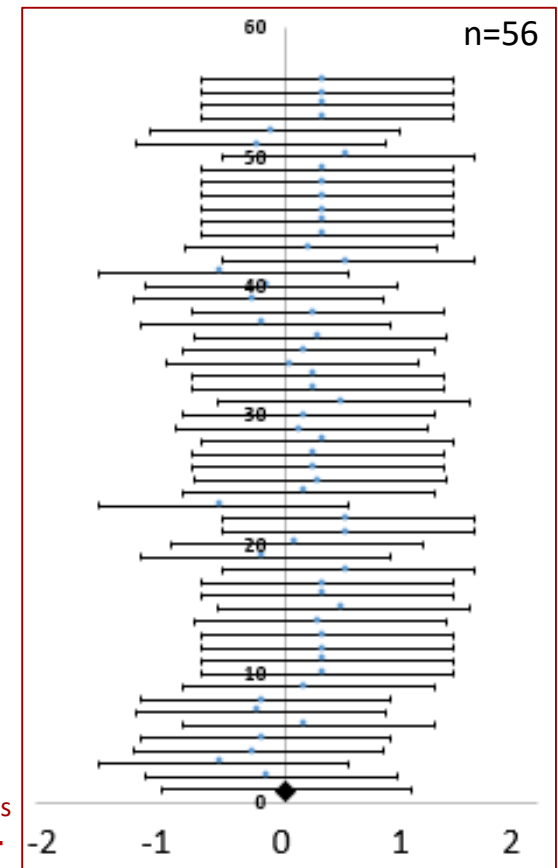
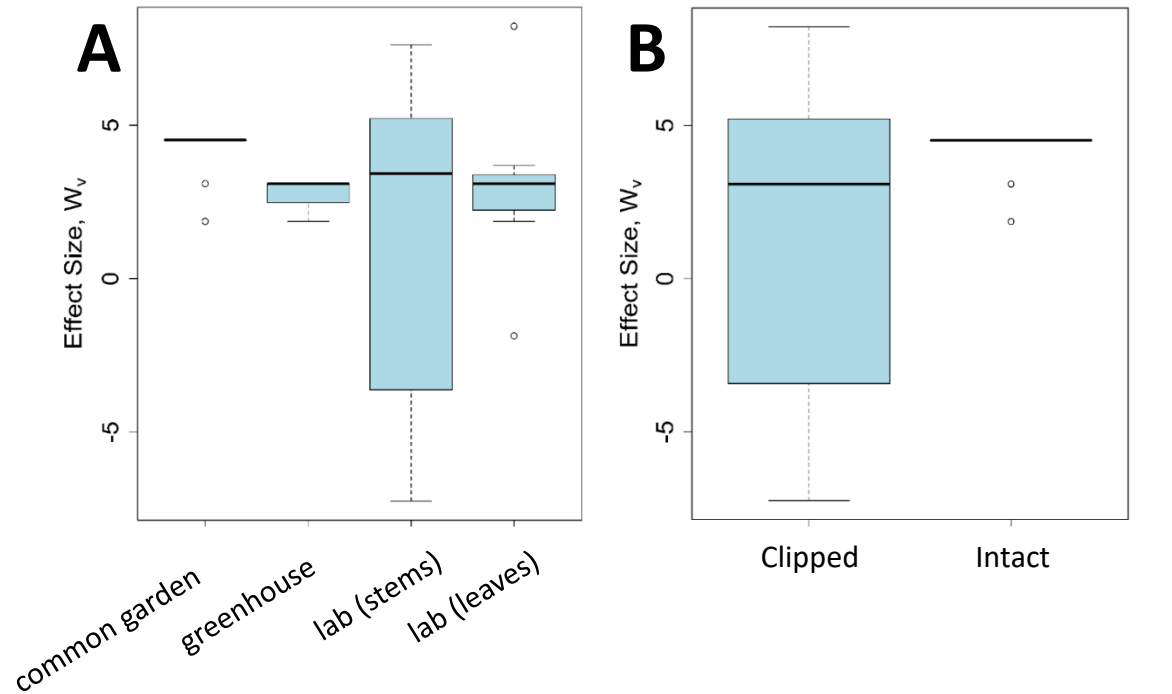


➤ Most preferred plants

➤ Least preferred plants



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



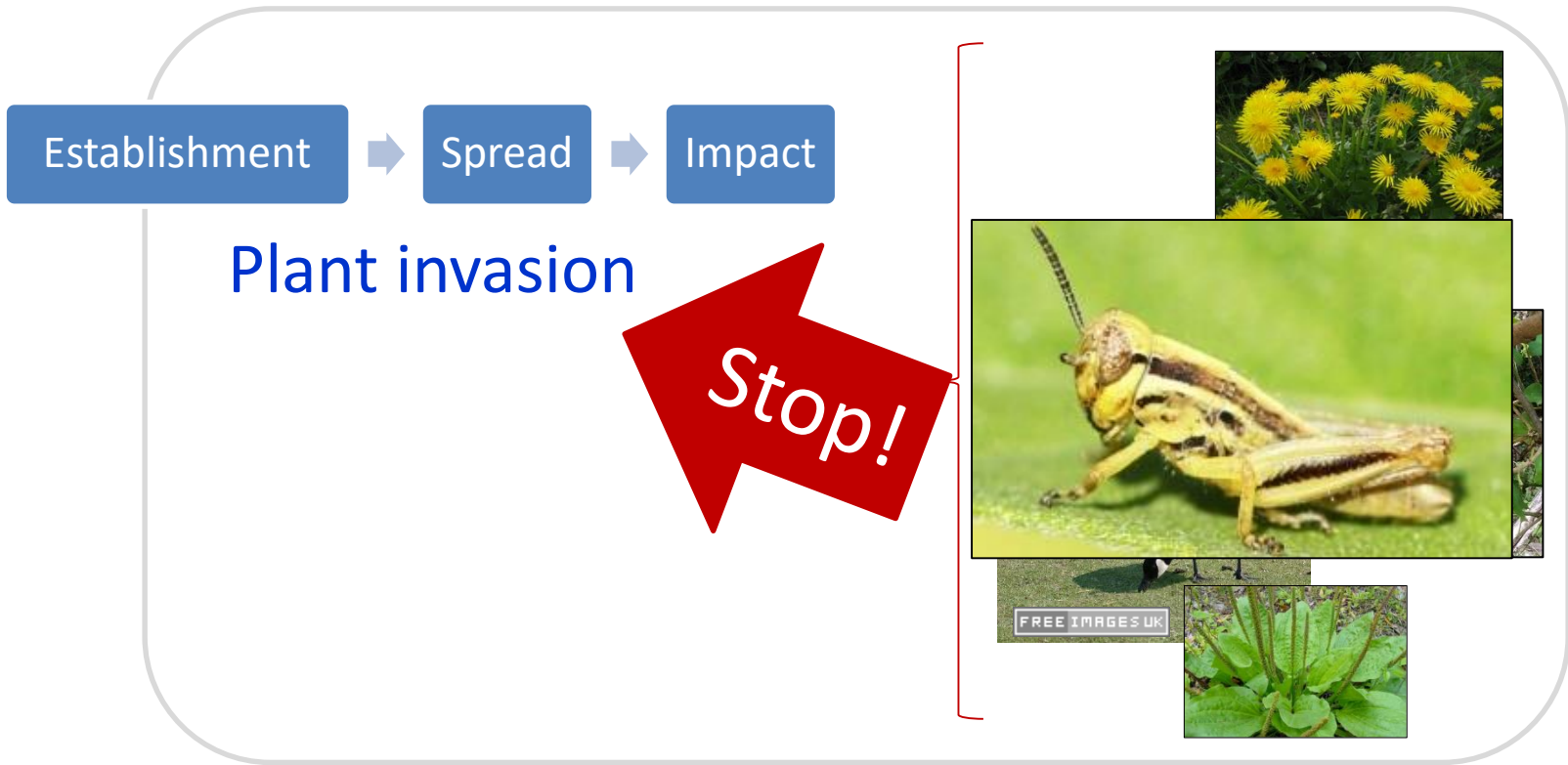
**Preference Metric** = 
$$\frac{n_{\text{most preferred exotic plant species}} - n_{\text{most preferred native plant species}}}{n_{\text{total plant species offered}}}$$



Most of the preferred plants are highly invasive

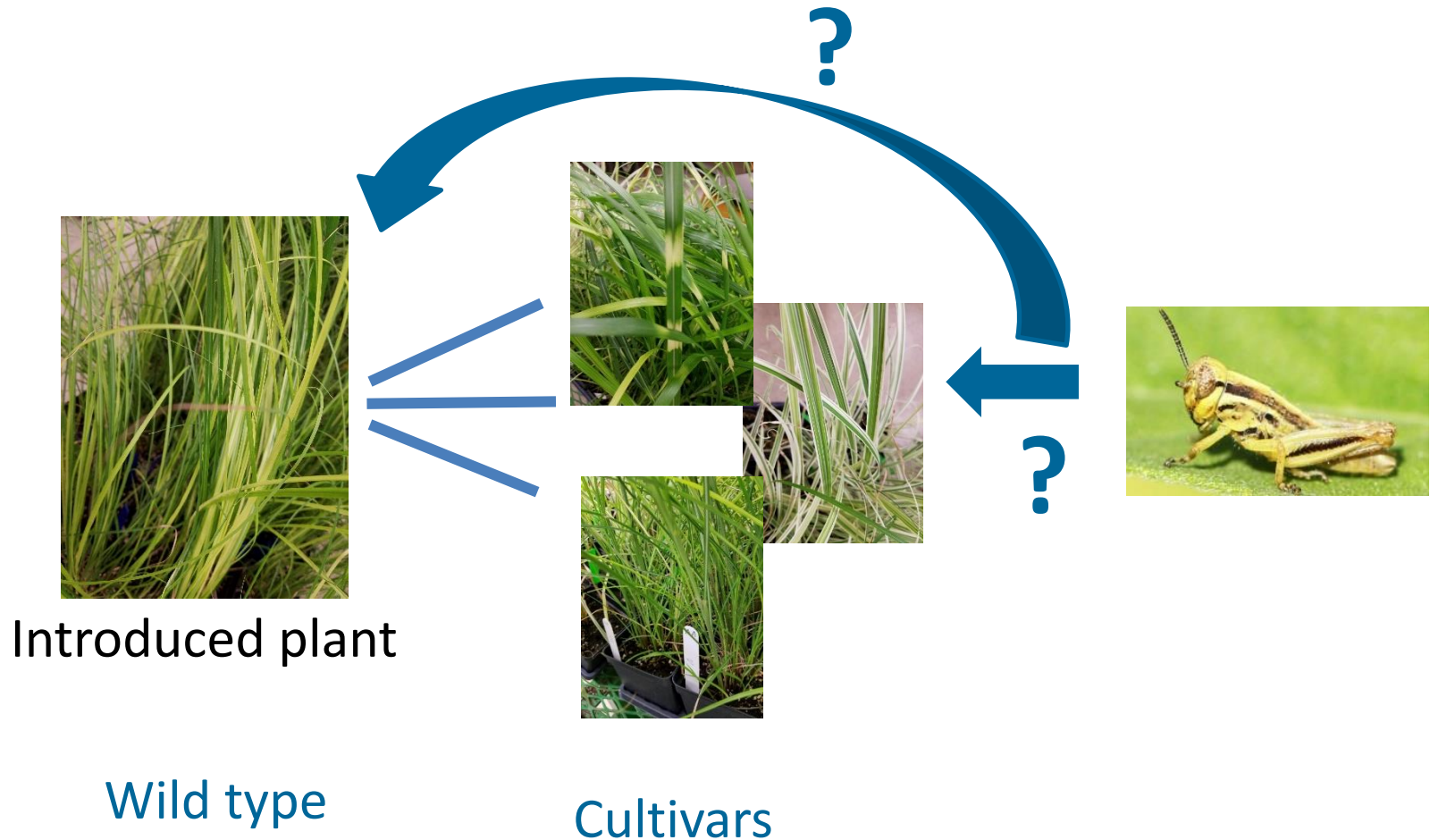
- ❖ 20 introduced plant species (out of 22) were reported as “the most preferred”
- ❖ 12 species showed high or middle invasive rank
- ❖ *Bromus inermis* (smooth brome) and *Schedonorus arundinaceus* (tall fescue) are among the most preferred (for 50% grasshopper species)

# Application to Biotic Resistance



Native community

# Grasshoppers and Introduced Plants





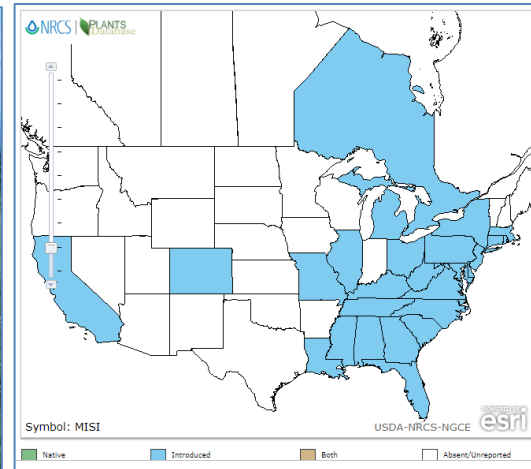
# Interactions between *Melanoplus* grasshoppers and *Miscanthus sinensis* varieties





# *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)

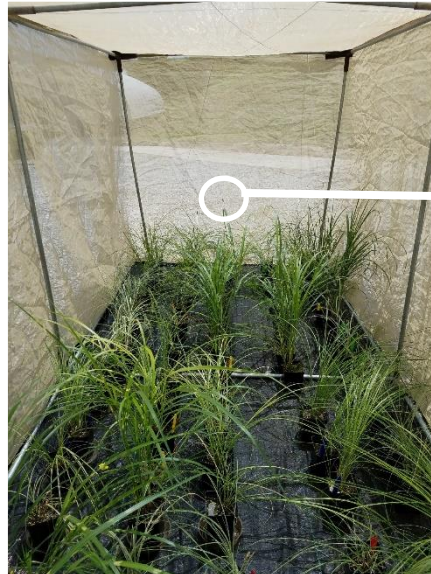


# Field Experiments

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

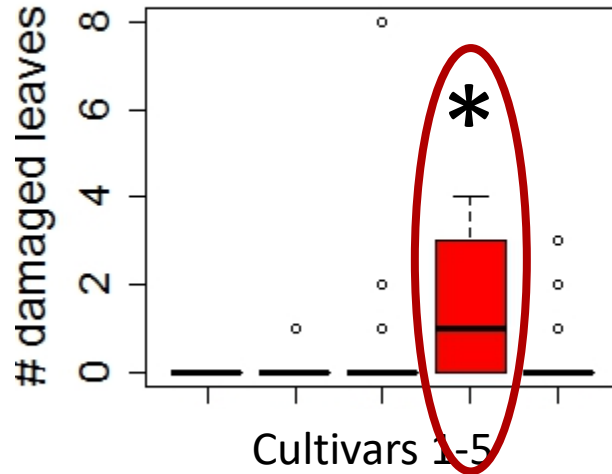


# Greenhouse experiments

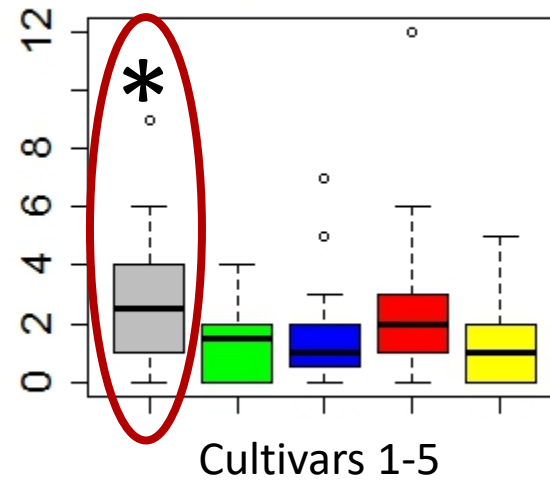




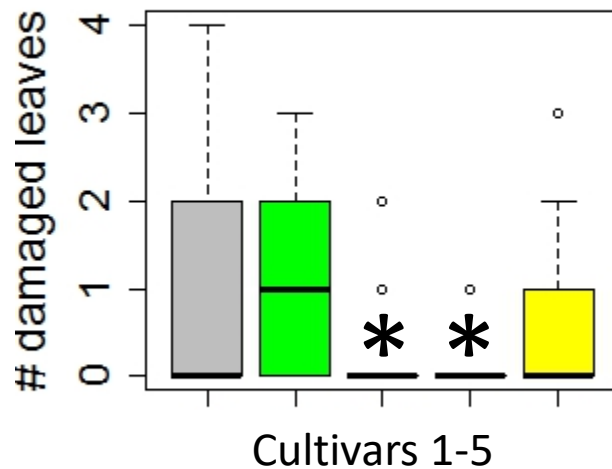
**July 12, 2018**



**Aug 3, 2018**



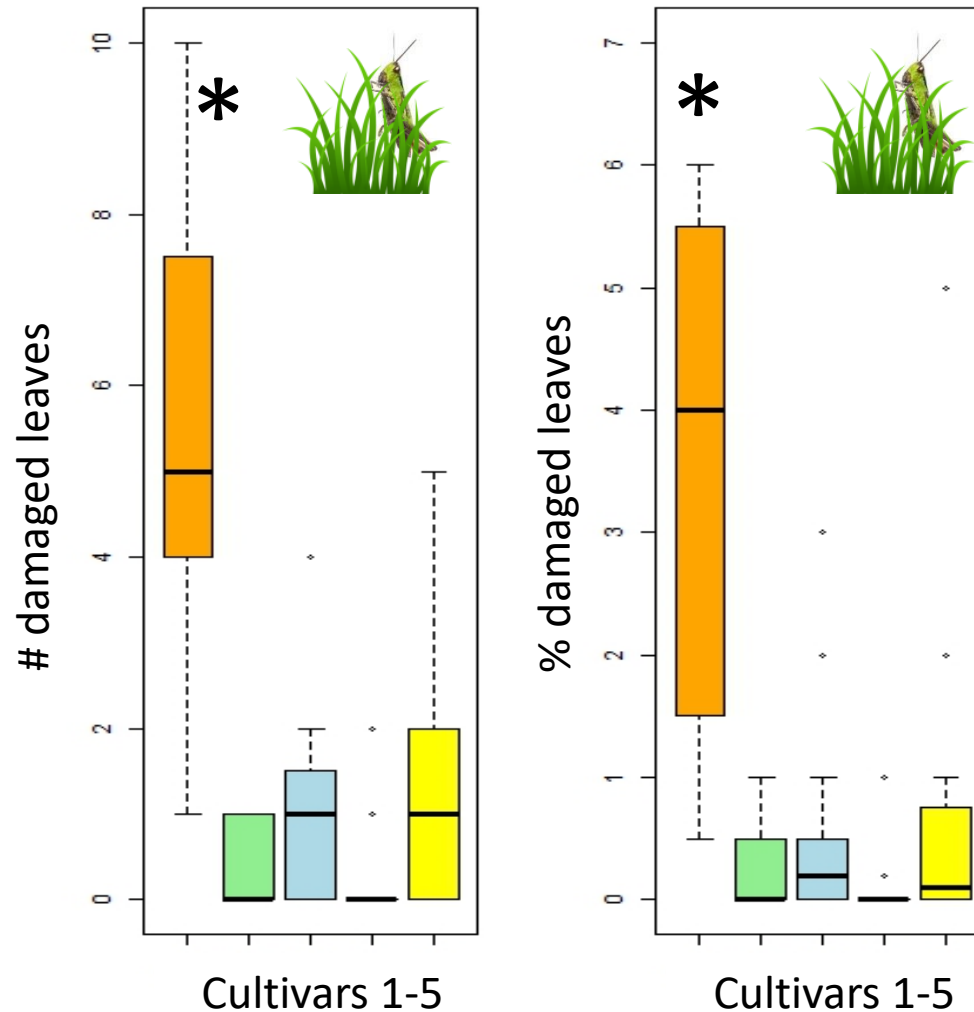
**Aug 22, 2018**



Herbivore  
damage: field

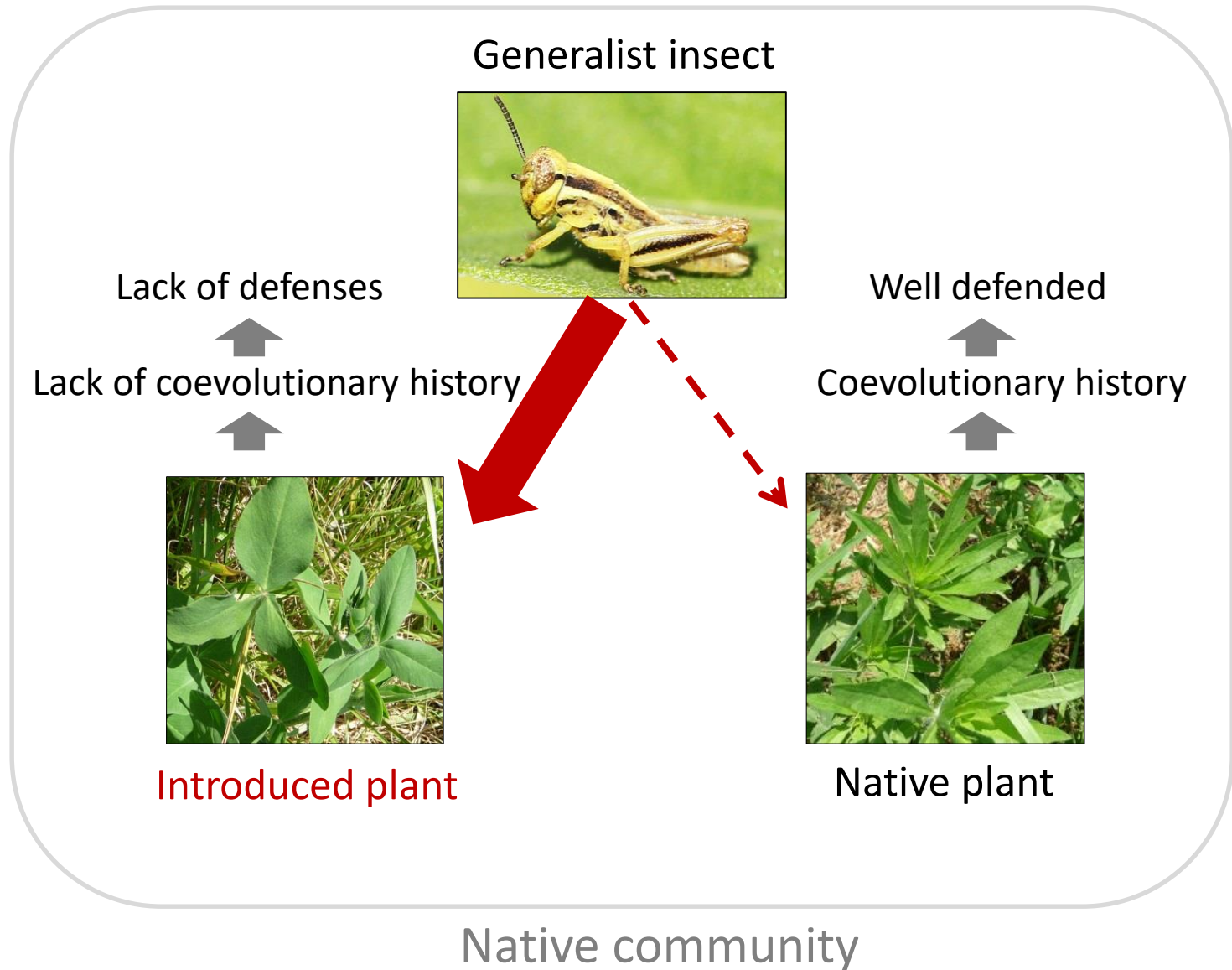
- Grasshoppers feed on all the cultivars showing preference for some of them

# Herbivore Damage: Greenhouse



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

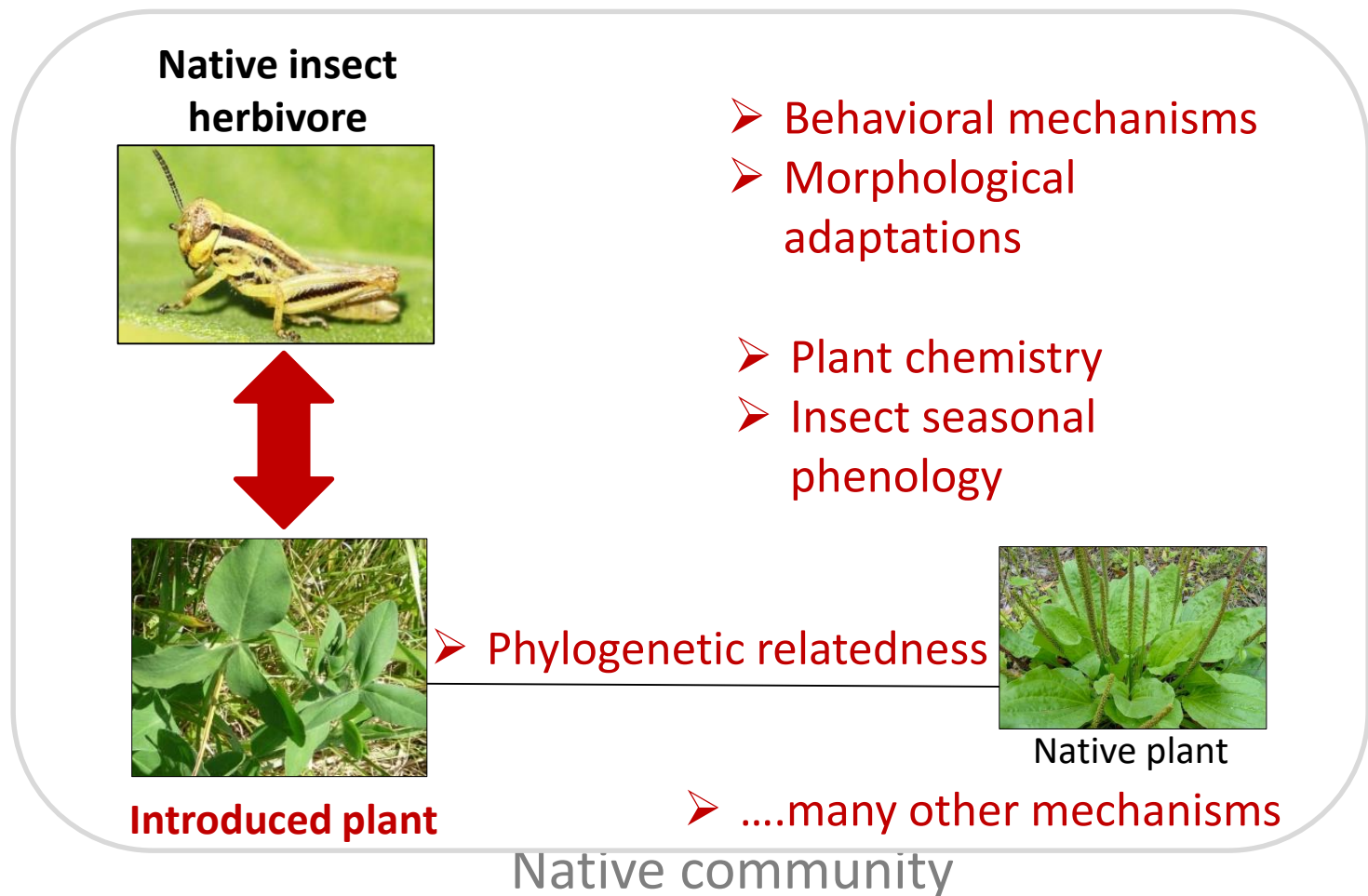
# Biotic Resistance Hypothesis

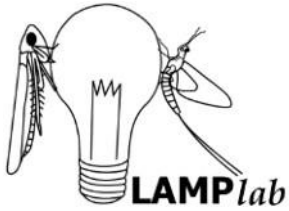




# Summary

## Biotic resistance mechanisms?





# *Many thanks!!*

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

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## **Research Greenhouse Complex:**

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