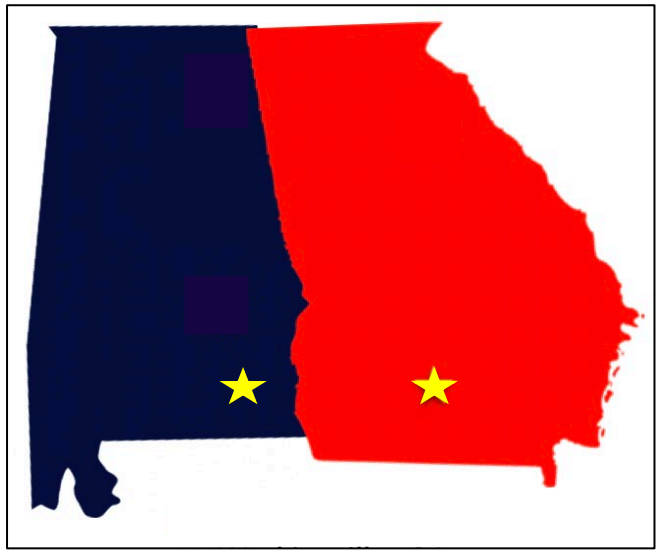
Alfalfa Nutrient Preservation, Utilization and Cycling in Sustainable Southeastern Livestock Systems:
Digestibility Effects on Beef Cattle in the Deep South



NIFA ASAFS
2021-06151

United States Department of Agriculture
National Institute of Food and Agriculture

Jennifer J. Tucker, M. Kimberly Mullenix, Chris Prevatt, Liliane S. da Silva, Sandra L. Dillard, Todd Callaway, and Lisa L. Baxter

UNIVERSITY OF GEORGIA EXTENSION

Alabama Extension
ALABAMA A&M & AUBURN UNIVERSITIES

CLEMSON COOPERATIVE EXTENSION

Objective

Characterize the digestive kinetics of steers while evaluating the effects of conserved forage type on *in vivo* digestibility and nutrient balance of beef cattle systems in the Deep South

Question:

Can dry matter digestibility (DMD) increase with the addition of alfalfa into perennial forage mixtures in the Deep South?

Experimental Design

Completely Randomized Design

4 replicates (n = 4)

- Steers (avg 412.4 kgs +/- 41.2 kgs)

3 diets

- Alfalfa-bermudagrass (ABG) baleage
- Alfalfa baleage
- Bermudagrass (*Cynodon dactylon)* hay

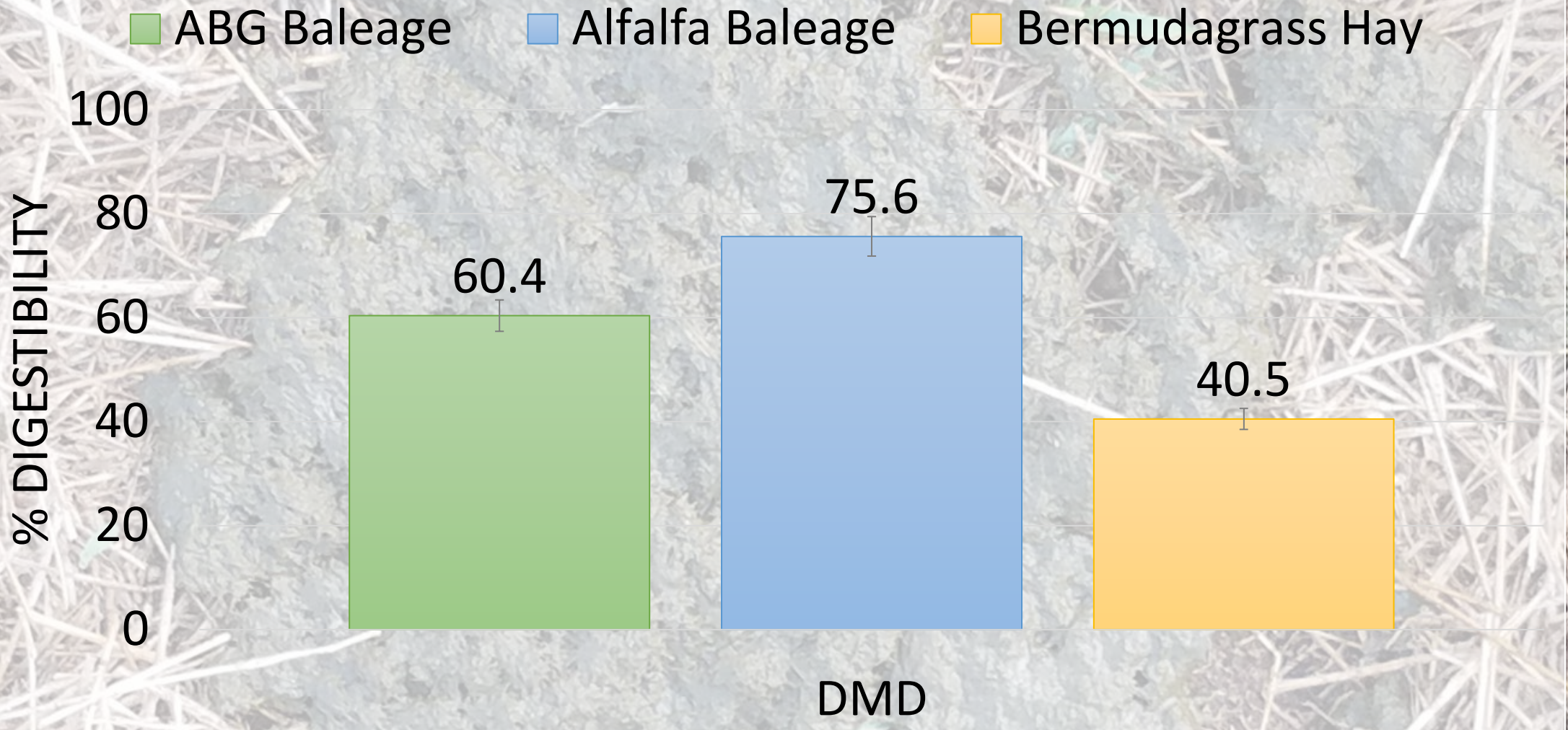
3 periods

- 1 diet / period due to potential spoilage
- 21-day adaptation + 5-day collection phase

Collection & Analysis

- **Feed and ort analysis**:
  - Feed intake and refusal weights
  - Feed nutritive value:
    - NDF, ADF, ADL, DM, CP
- **Collection phase analysis:**
  - Total fecal weights
  - Urine
  - Rumen fluid
- **Digestibility:**
  - Dry matter (DMD)
  - Neutral detergent fiber (NDFD)
  - Acid detergent fiber (ADFD)
  - Crude protein (CPD)
- **Steers**
  - Initial BW and final BW were measured each period

Dry Matter Digestibility



Average dry matter digestibility values (DMD) of each of the three different diets: alfalfa-bermudagrass (ABG) baleage; alfalfa baleage, and bermudagrass hay

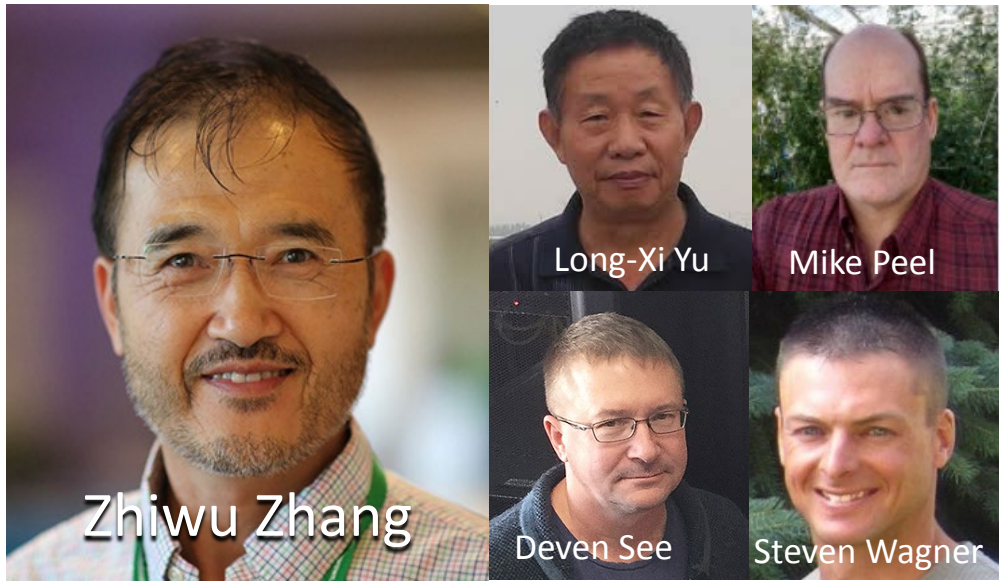
- Alfalfa-based products are an option for beef cattle producers in the Southeast to:
  - Diversify feeding strategies
  - Use Nutrient-rich Forage additives to increase digestibility
  - Increasing returns to the operation
- Alfalfa can enhance Southeastern Beef Systems!

UNIVERSITY OF GEORGIA EXTENSION

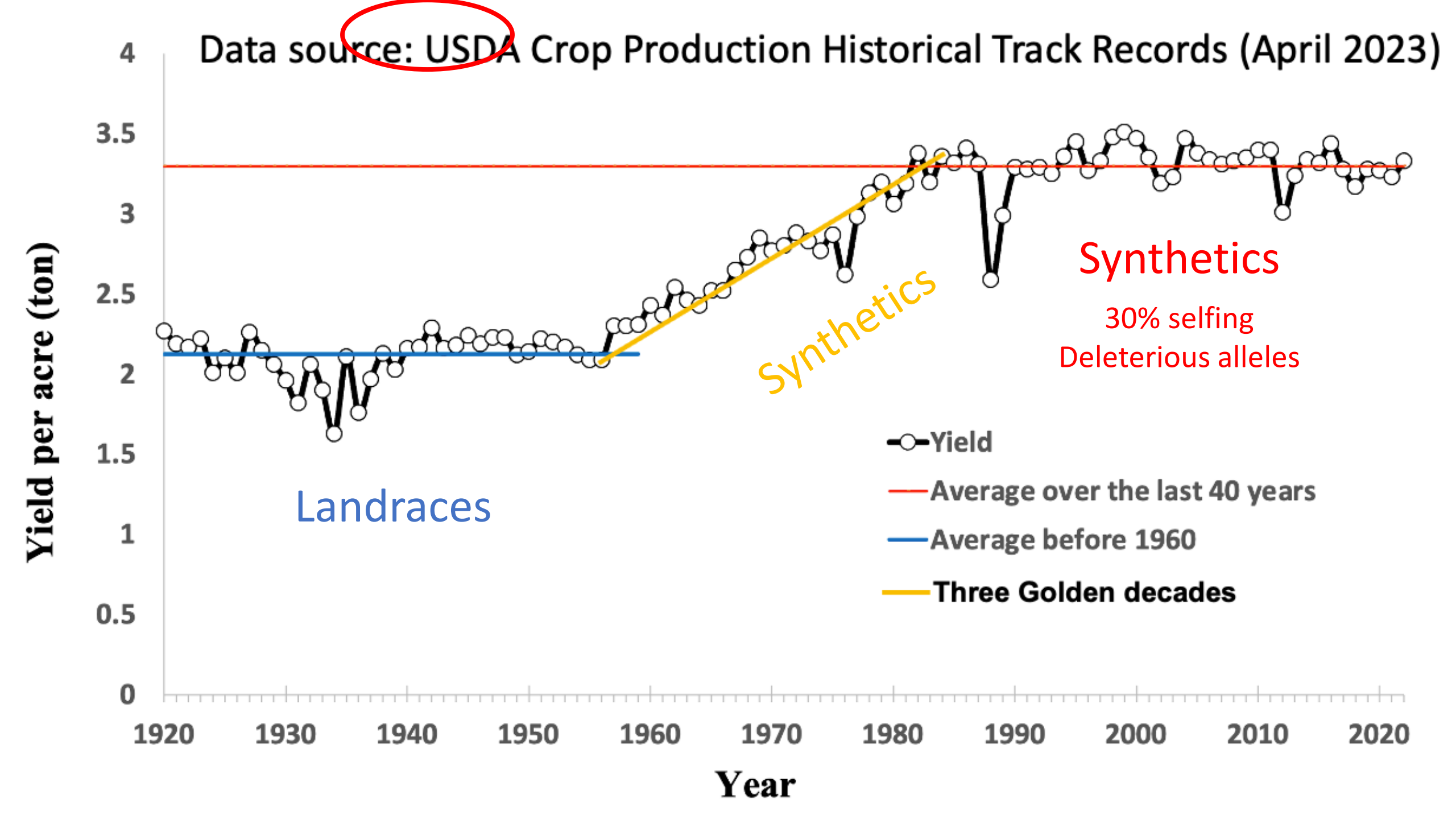
ALFALFA IN THE SOUTH

extension ALABAMA A&M & AUBURN UNIVERSITIES

Development of 200 Alfalfa Inbred Lines with Five Generation of Self-Pollination



Award number: 2018-70005-28792 (9/1/2018-8/31/2022)


Data source: USDA Crop Production Historical Track Records (April 2023)
Yield per acre (ton)
4
3.5
3
2.5
2
1.5
1
0.5
0
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year
Landraces
Synthetics
Synthetics
30% selfing
Deleterious alleles
Yield
Average over the last 40 years
Average before 1960
Three Golden decades

Breeding schemes to overcome the plateau

Cultivars (50 plants)

Six plants)

V_y

V_G V_B Variance Between

V_W Variance within

Residual error

V_E Variance of Environment

Minimization

- Clones
- **Inbreds**
- Homozygous

$$R = \frac{ih\sigma_G}{t}$$

Plant Biotechnology Journal

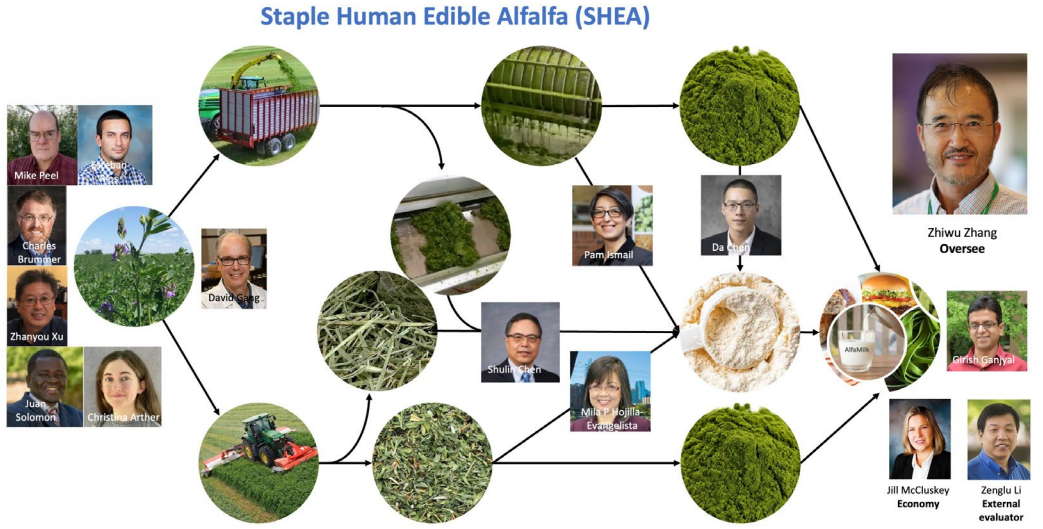
Plant Biotechnology Journal (2022) **20**, pp. 613–615 doi: 10.1111/pbi.13770

Brief Communication

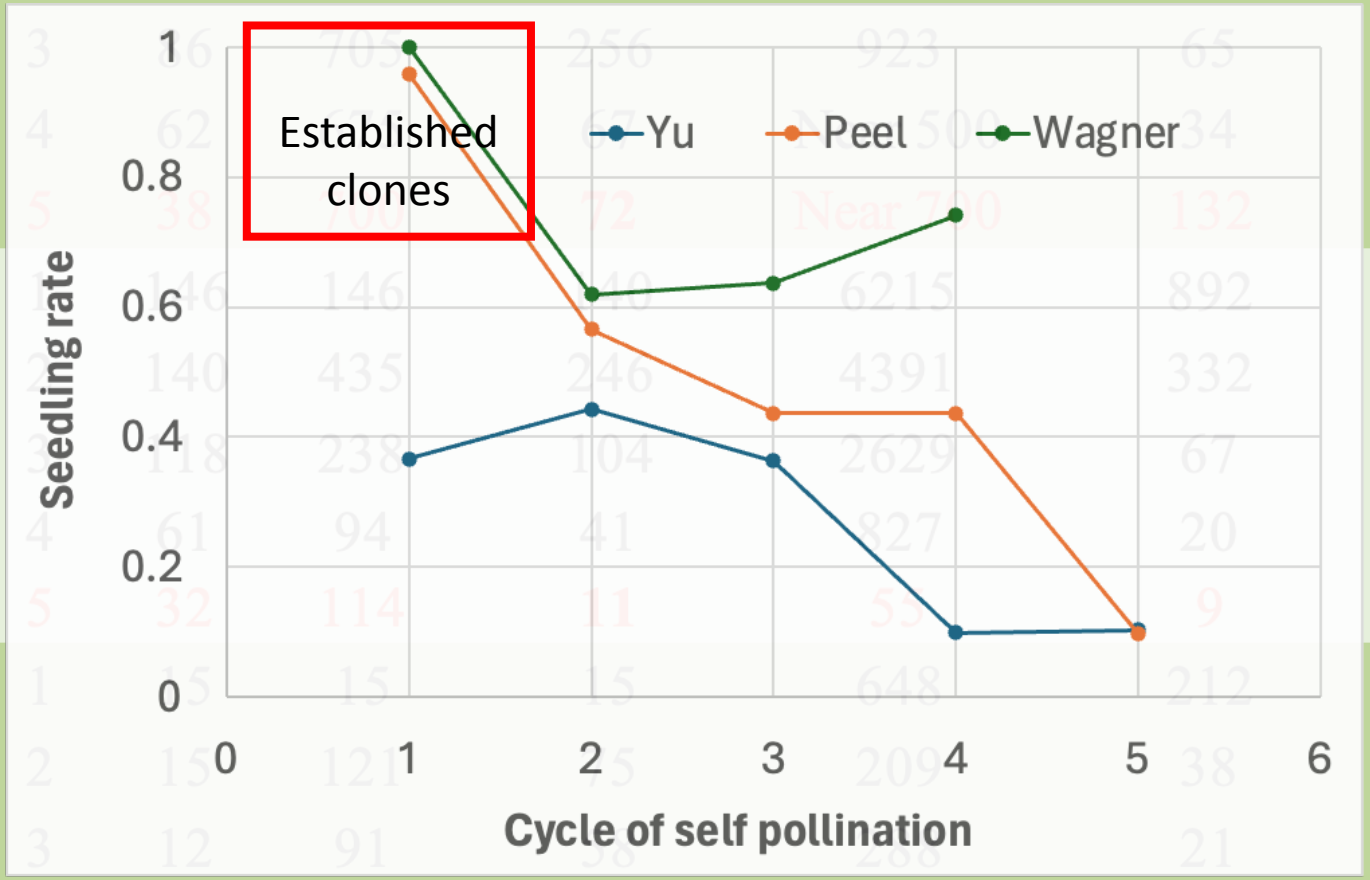
Construction of genic male sterility system by CRISPR/Cas9 editing from model legume to alfalfa

Qinyi Ye, Xiangzhao Meng, Hong Chen, Jiale Wu, Lihua Zheng, Chen Shen, Da Guo, Yafei Zhao, Jinling Liu, Qixia Xue, Jiangli Dong* and Tao Wang*

State Key Laboratory of Agrobiotechnology, College of Biological Sciences, China Agricultural University, Beijing, China

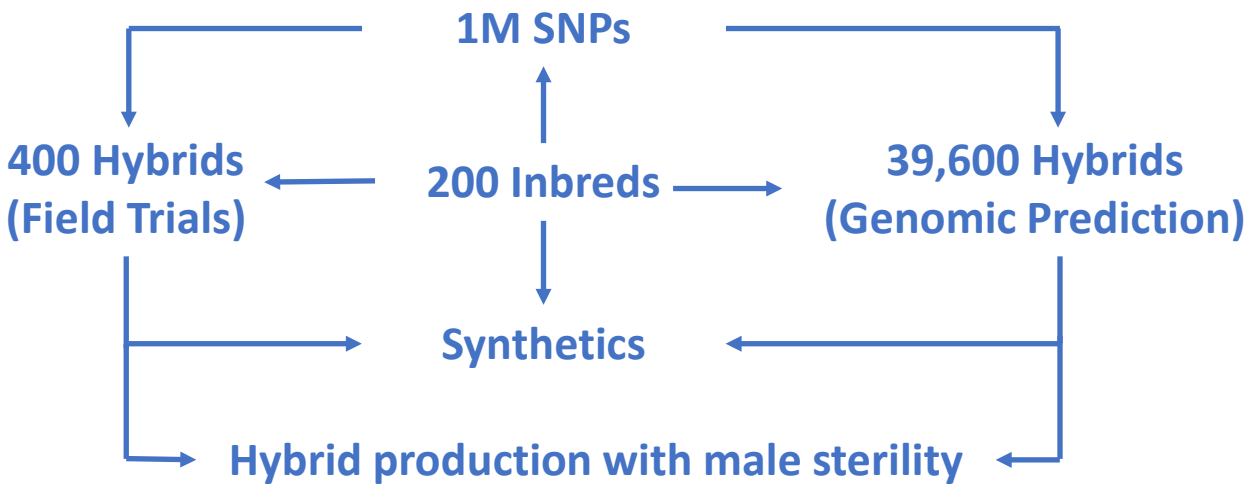


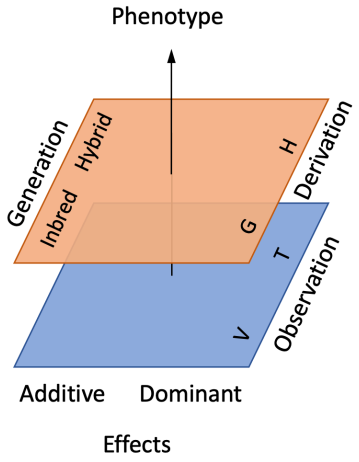
State	Self	Lines	Plants	Plants with Seeds	Max Seed Number	AVG Seed Number
Yu	1	114	798	292	2077	205
	2	101	565	250	1186	70
Peel	4	9	81	60	270	21
Wagner	5	7	300	NA	NA	NA
Total			5,078			

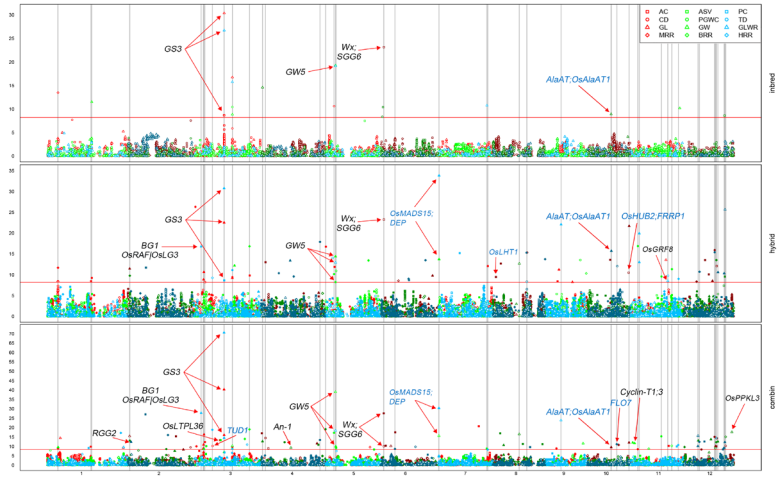


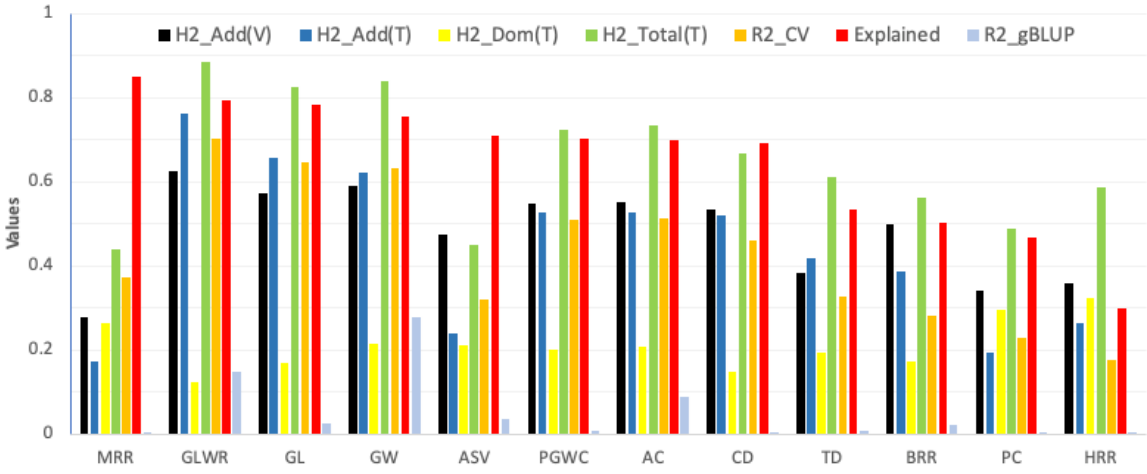
⬅ The largest alfalfa selfing in history!

Next generation synthetics and true hybris



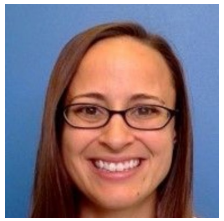






Solving the Mystery of Alfalfa Autotoxicity: Causes & Solutions

Kim Cassida
Associate Professor/Extension Specialist,
Dept. of Plant, Soil and Microbial Sciences



Sarah Lebeis
Associate Professor, Dept. of Plant,
Soil and Microbial Sciences

Paige Baisley
PhD Candidate, Crop and Soil Science

Virginia Moore
Assistant Professor, Plant Breeding &
Genetics Section

(Undersander et al. 2015).

Autotoxicity is a type of **intraspecific allelopathy** that results in **establishment failure** or **low stand productivity** due to poor germination, seedling death, abnormal taproot development, yield loss, and/or decreased persistence.

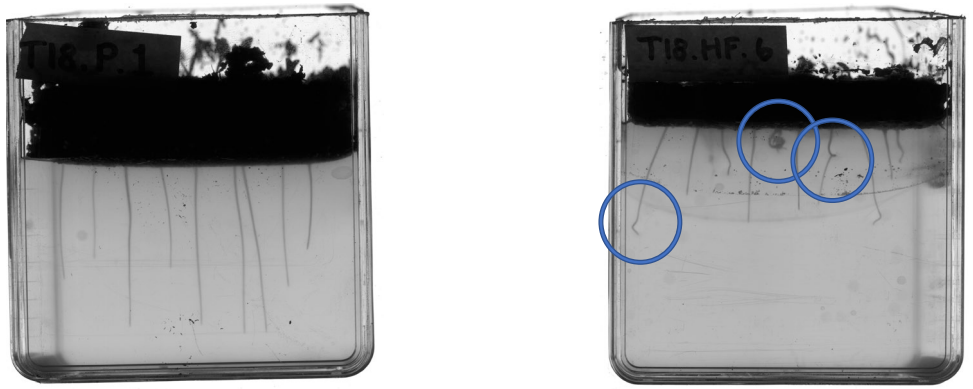
Obj. 1: Identify causative compounds responsible for alfalfa autotoxicity.

We will:

- **Identify causative compounds** responsible for alfalfa autotoxicity.
- **Quantify presence of targeted metabolites** in autotoxic alfalfa plant tissue and root exudates.
- **Determine autotoxicity thresholds** in field soil for identified compounds.

Control Soil

Alfalfa Soil



Extract concentration	0 g/L	10 g/L	20 g/L	30 g/L	40 g/L
Scans of Agar Flask					
Avg. Root Length (mm)	34.94 a	29.96 a	18.58 b	19.21 b	17.21 b
Avg. Root Diameter (mm)	0.53 b	0.53 b	0.63 a	0.64 a	0.67 a
Avg. % Abnormal Roots	6 a	17 a	58 b	69 b	73 b

Alfalfa seedlings grown for 4 days in soil-on-agar bioassay with different concentrations of alfalfa leaf extract. Extract concentrations left to right: 0g/L, 10g/L, 20g/L, 30g/L, 40g/L.

Obj. 2: Evaluate impact of environmental and management factors on autotoxicity.

- **Characterize microbiome communities** in autotoxic and non-toxic field soils.
- Determine whether autotoxins exuded during **primary nutrient stress** reduce growth of replanted alfalfa.
- Determine whether soil microbial communities associated with nutrient stressed plants contain **microbes capable of degrading autotoxins**.

Obj. 3: Evaluate and select alfalfa genotypes for reduced autotoxin production and improved autotoxin tolerance.

- **Divergent recurrent selection** for autotoxic compound production and susceptibility
- Rapid assay using alfalfa extract
- Family-bulk genotyping to develop **genomic prediction** model

Current Activities

Starting Fall 2024

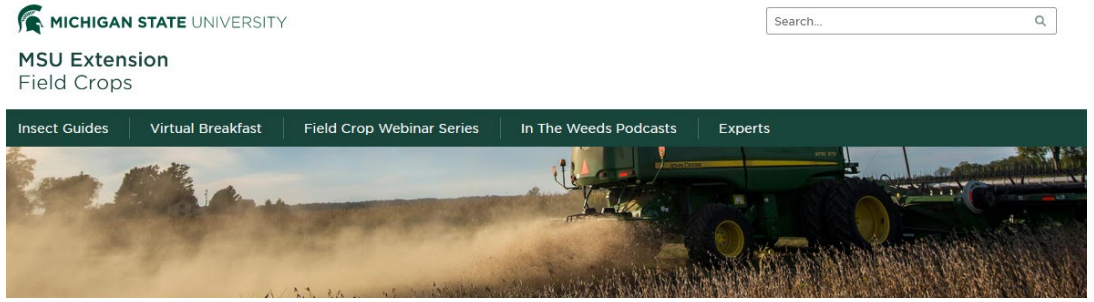
Refining **phenotyping protocol** & identifying **base populations**

Divergent recurrent selection: **high & low production** of autotoxic compounds

Divergent recurrent selection: **resistance & susceptibility** to autotoxicity

Obj. 4: Engage alfalfa producers in extension education about autotoxicity.

- **Online bulletin** explaining autotoxicity
- **Annual factsheets** reporting research progress
- **Video** on autotoxicity
- Presentations at producer **meetings and field days**
- **Webinars and podcast** episodes
- Integration into **courses and trainings**
- Encourage producer use of **bioassay tool** through MSU Plant Diagnostics



Alfalfa Autotoxicity

August 13, 2020 - Kim Cassida

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The MSU Extension Field Crops Virtual Breakfast weekly discussion for August 13, 2020, focuses on Alfalfa Autotoxicity, presented by Dr. Kim Cassida, MSU Forage Specialist. Following Dr. Cassida's presentation, MSU specialists give updates and answer questions on insect pests and diseases and current conditions.

The compatibility and contribution of natural enemies in western US alfalfa management

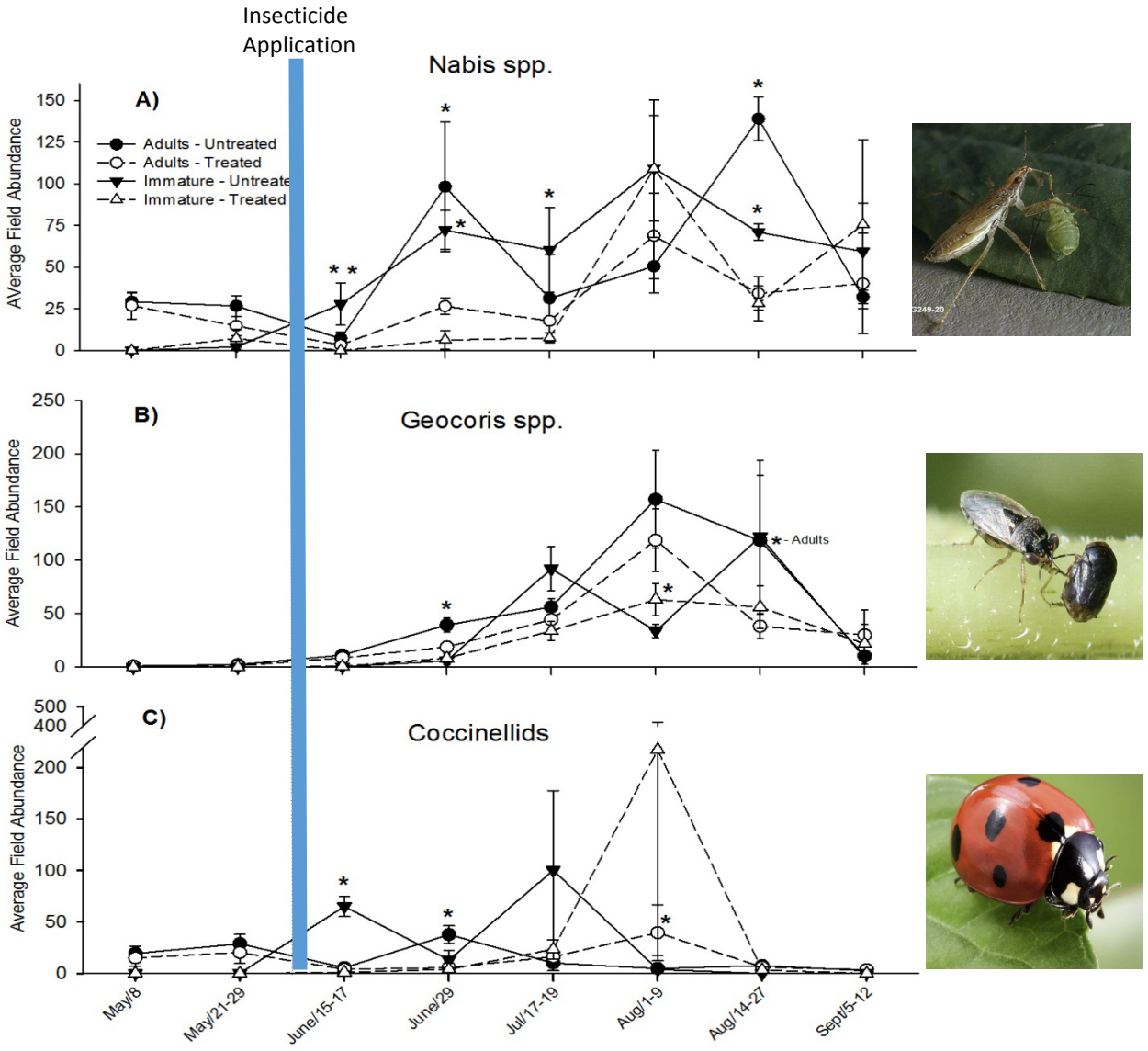
Ricardo Ramirez, PhD
New Mexico State University
Entomology, Plant Pathology, & Weed Science

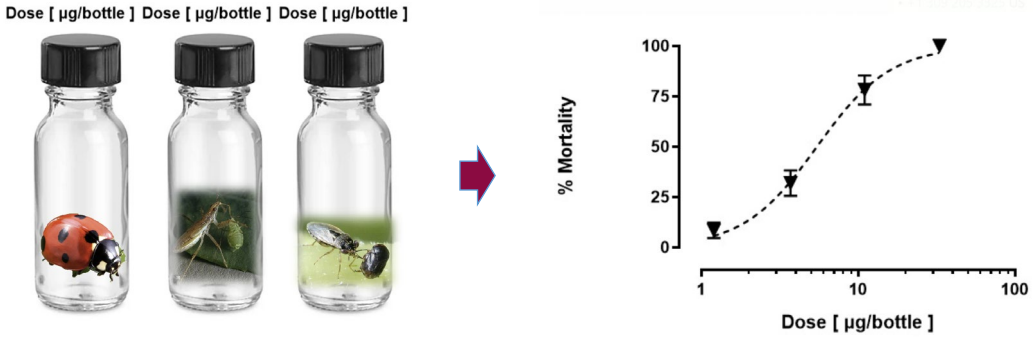
Scott Bernhardt
Utah State University
Biology/Entomology

Ryan Larsen
Utah State University
Ag Economics and Extension

Ayman Mostafa
University of Arizona
Extension Entomology

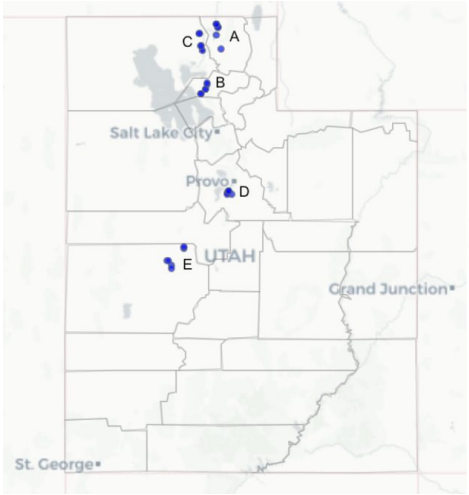
Obj. 1. Determine impacts of insecticides on the strength of biological control

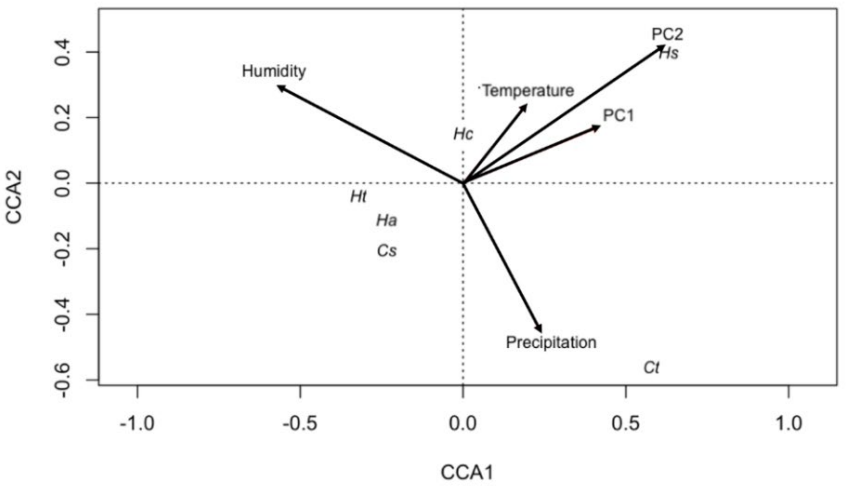




- After spray, some predator populations shift.
- Predators like big-eyed bug escape spray applications effects.
- New modes of action may reduce predator mortality (bottle assays).

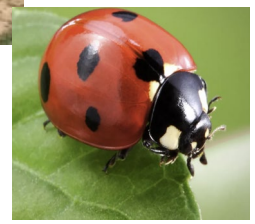
Obj. 2. Evaluate the relationship between western landscapes and environmental factors on natural enemies





- 3 lady beetle species primarily occupy ag and urban habitats with low temps.
- Native convergent lady beetle made up 56% of the lady beetle community.

Obj. 3. Establish economic thresholds for alfalfa pests in the West that incorporate the value of natural enemies



$$\max_{x}[\rho \cdot y - c(x)]$$

$$s.t.: y = f(y^0, S, NE)$$

$$S = g(x, S_0, NE_0)$$

$$NE = h(x, S_0, NE_0)$$

- Thresholds based on maximizing net return subject to yield and cost constraints
- From evaluating natural enemies the equations will include NE

Obj.4. Develop and disseminate a regional IPM strategy that utilizes natural enemies in decision making