Developing regionally-adapted, resilient alfalfa germplasm pools

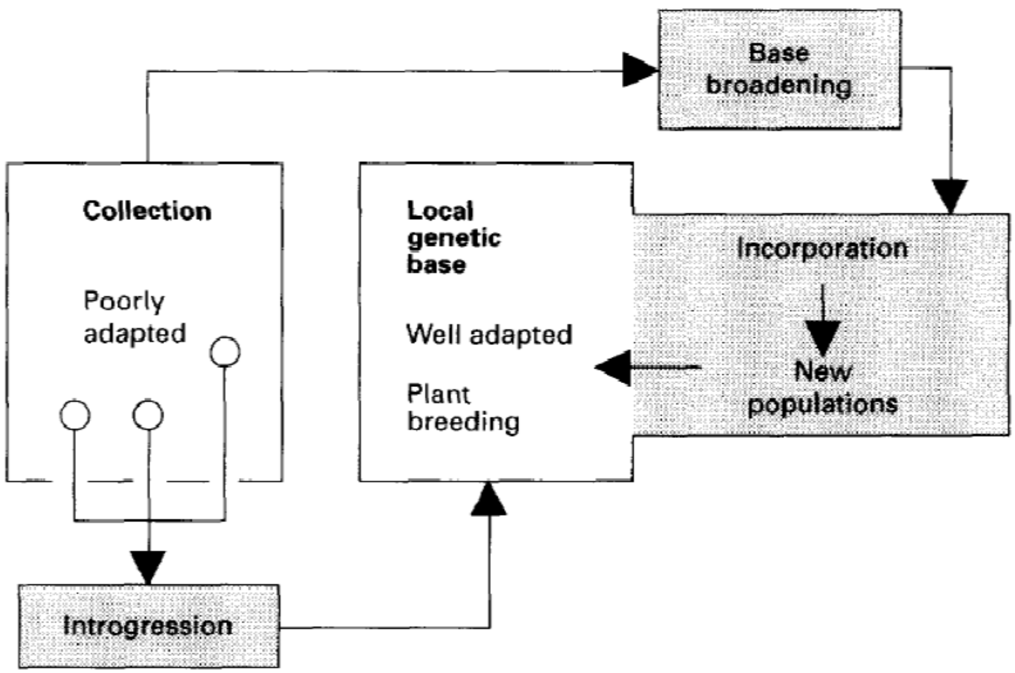
Charlie Brummer and Dan Putnam, Univ. of California, Davis
Heathcliffe Riday, USDA-ARS, Madison, WI
Don Viands and Julie Hansen, Cornell Univ.
USDA-NIFA-AFRP Project Number 2017-70005-27117

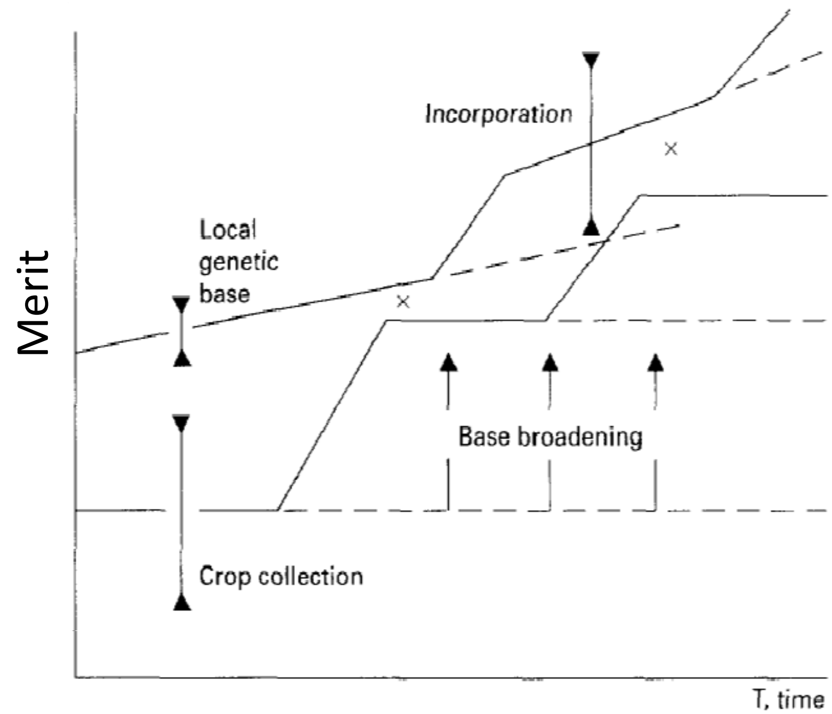
INTROGRESSION AND INCORPORATION. STRATEGIES FOR THE USE OF CROP GENETIC RESOURCES

By N. W. SIMMONDS

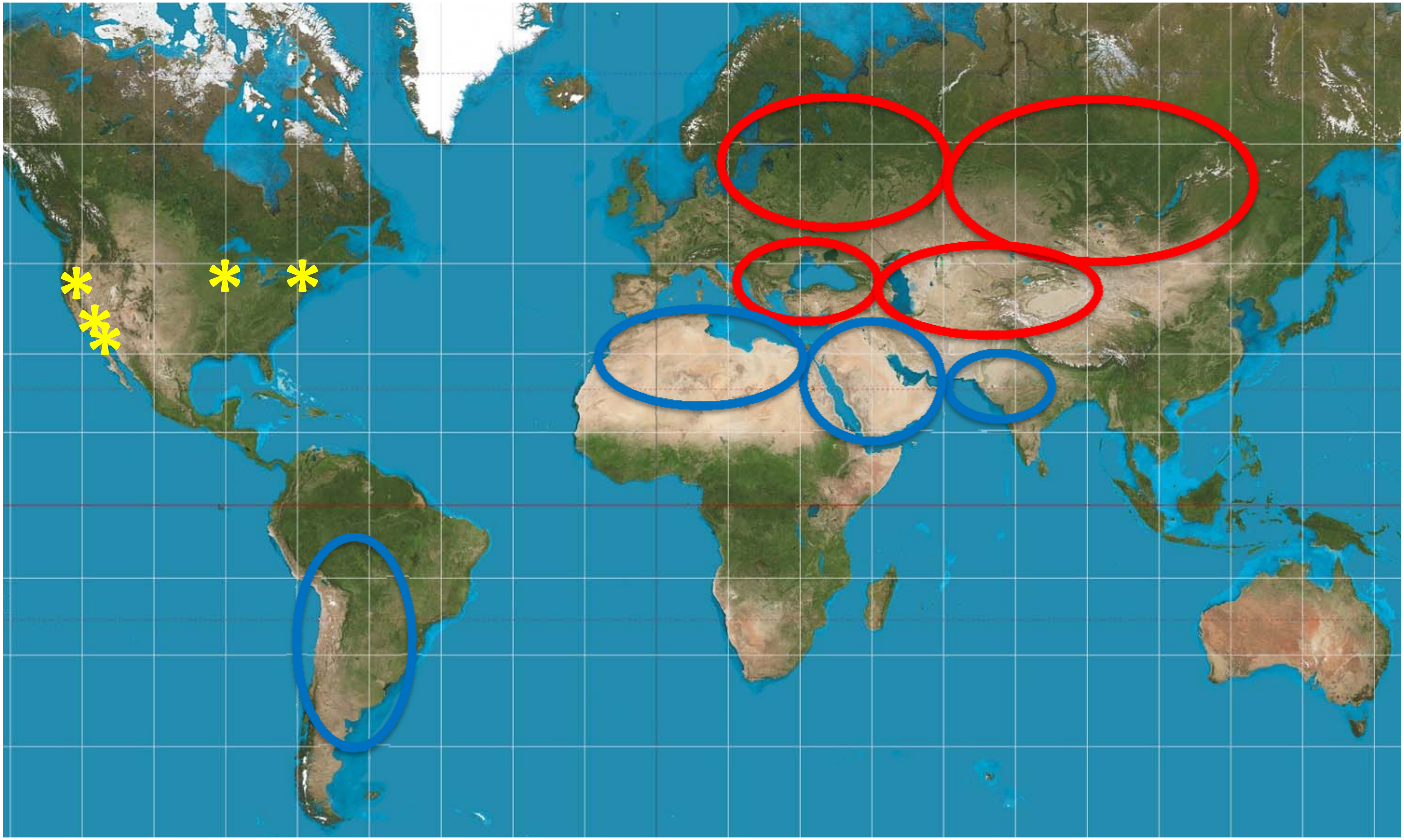
University of Edinburgh, Institute of Ecology and Resource Management,

Biol. Rev. (1993), **68**, *pp.* 539–562





To summarize, then, the fundamental needs of an effective 'Incorporation' ('Base-broadening') programme are: large scale; wide range of entries; independence of local base; rough, quick, cheap mass-selection methods adapted to the biology of the crop; enhanced recombination; continuity over a long time-scale.



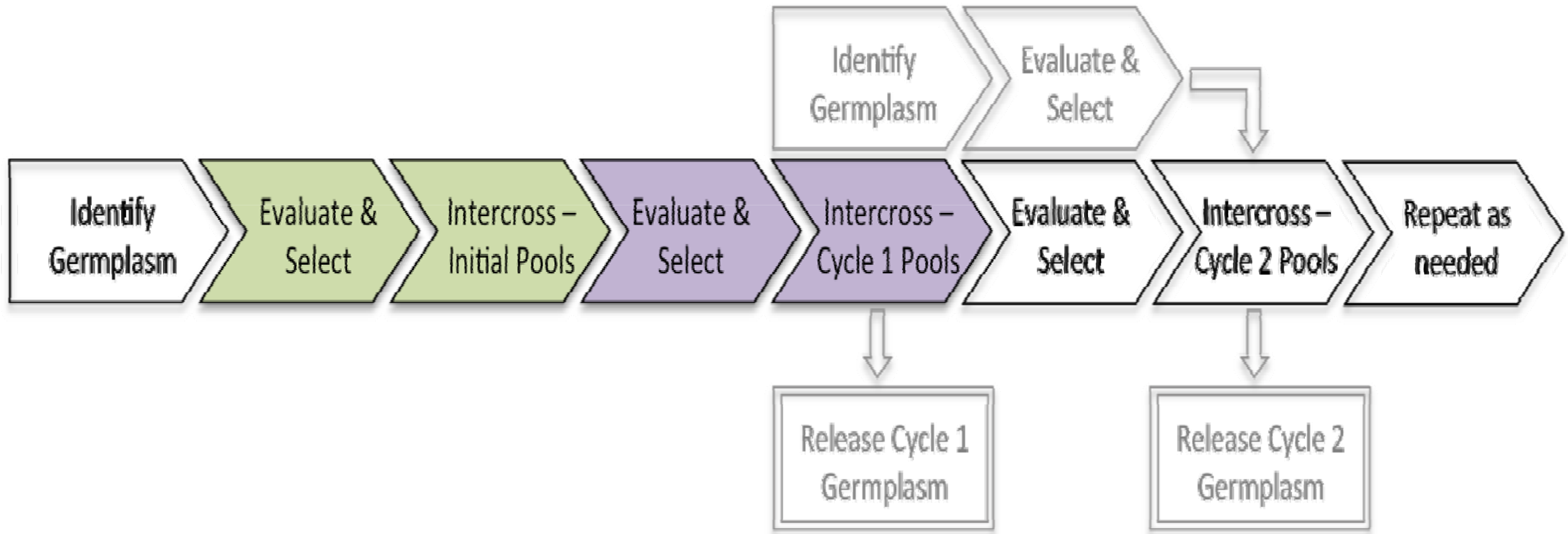
Selection and Evaluation:

Ithaca, NY; Arlington, WI; Tulelake, CA

El Centro, CA; Fresno, CA; Davis, CA

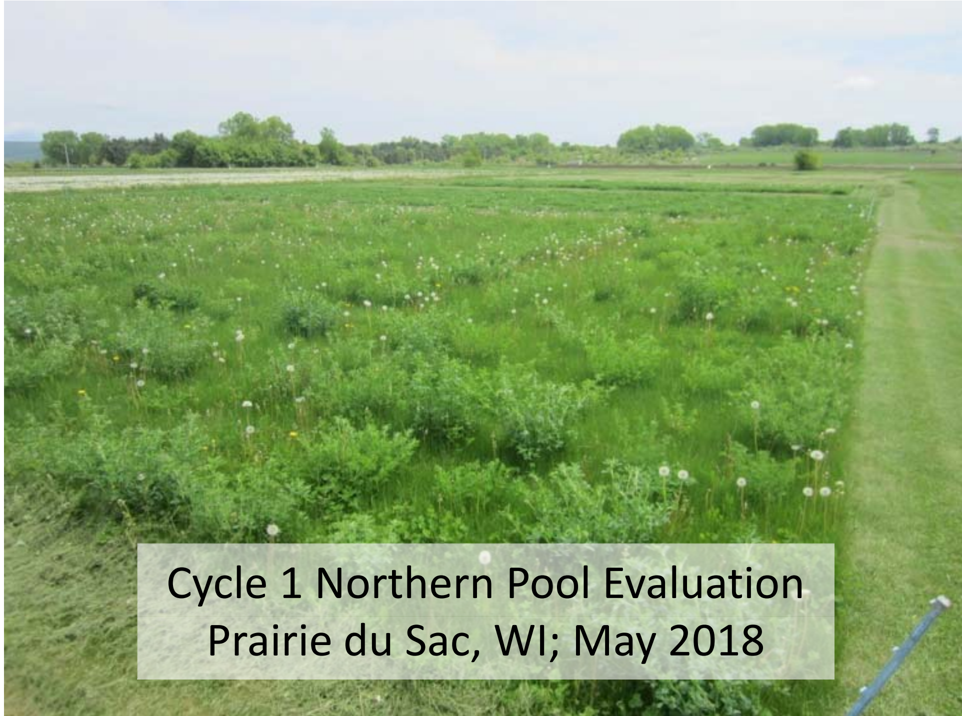
Northern Pools: FD 1-5

Southern Pools: FD 6-11



Evaluating Cycle 1 Northern Pools
Evaluating new accessions to add to Northern Pools
Evaluating accessions to develop Cycle 1 Southern Pools

Genetic diversity evaluation using SSR and GBS-SNPs underway



Cycle 1 Northern Pool Evaluation
Prairie du Sac, WI; May 2018

Cycle 1 Northern Pool Evaluation
Ithaca, NY; May 2018

Southern Germplasm Evaluation
El Centro, CA; April 2018

Cycle 1 Northern Pool Evaluation
Tulelake, CA; May 2018

A Decision Support Tool for Predicting Alfalfa Yield and Quality to Enhance Resource Use Efficiency

Isaya Kisseka, UC Davis

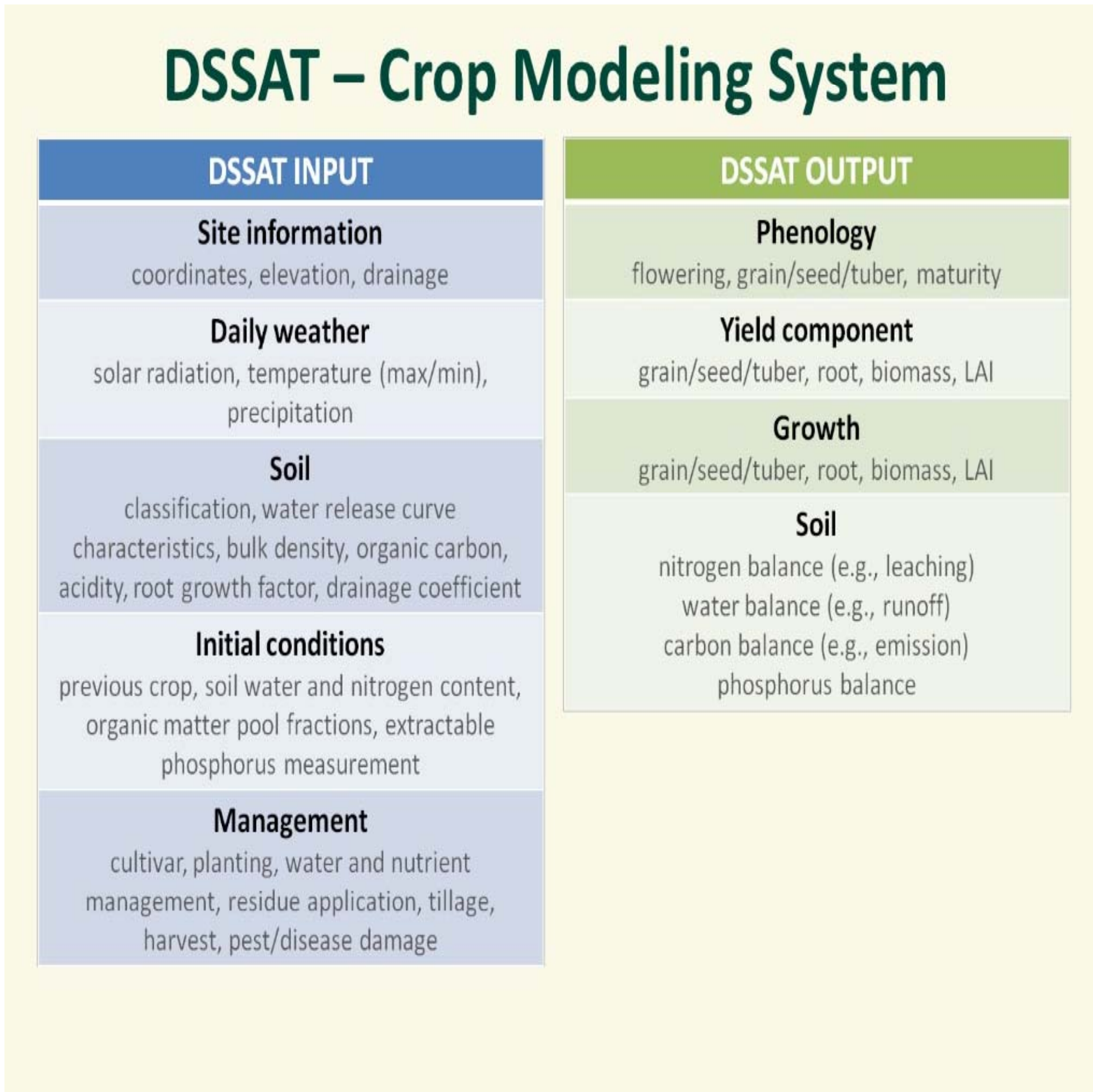
Michael Ottman, Univ. of Arizona

Kenneth Boote, Univ. of Florida

Jessica Torrion, Montana State Univ.

Gerrit Hoogenboom, Washington State Univ.

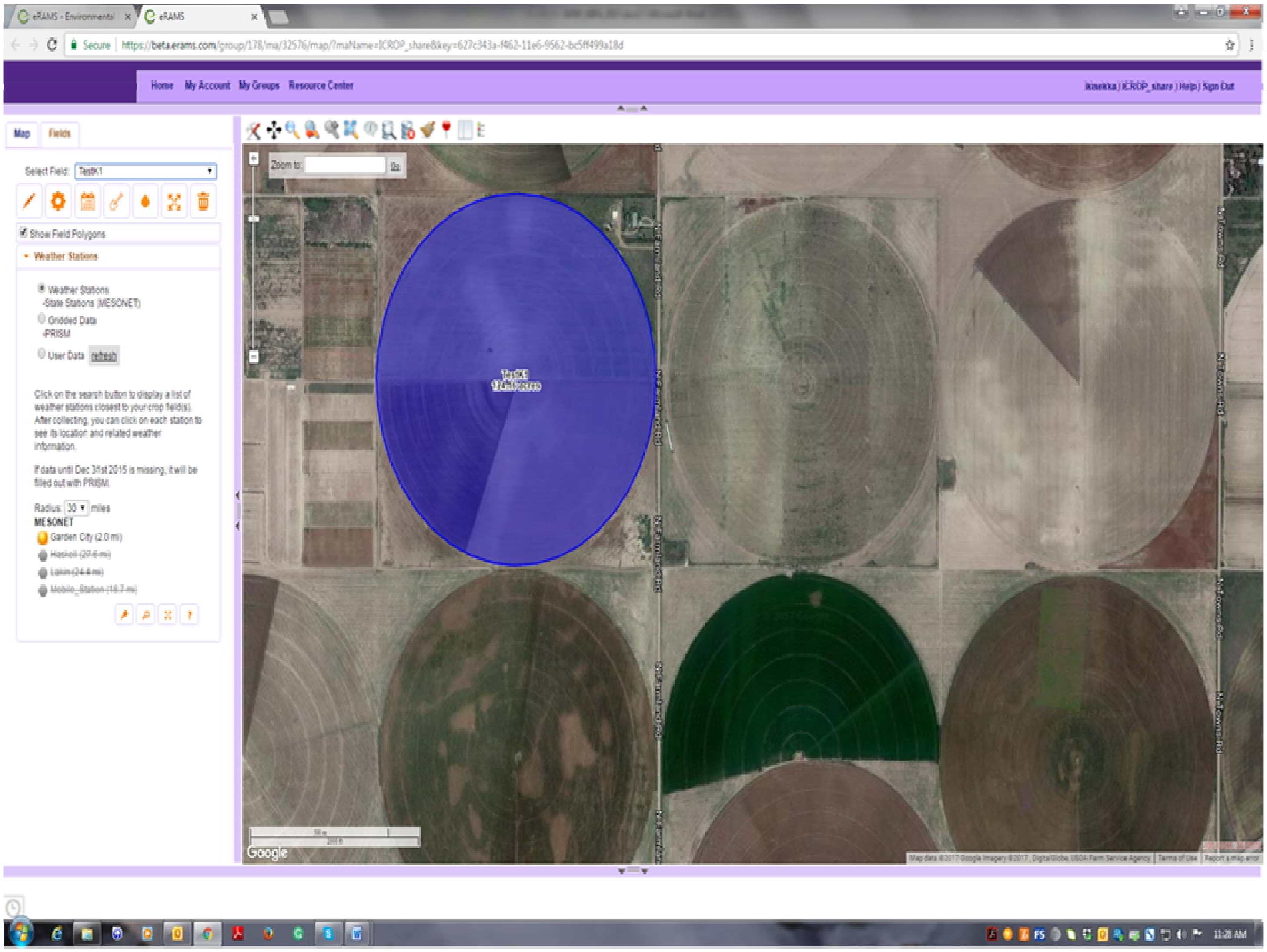
Develop an Alfalfa Crop Growth Model within DSSAT (Decision Support System for Agrotechnology Transfer)



Conduct experiments to generate new data for model development, calibration, and evaluation

- Tucson, AZ
- Kalispell, MT

Integrate the new alfalfa crop model into iCrop decision support tool



Disseminate information locally through extension programming locally and nationally

Local

National

eXtension

America's Research-based Learning Network®

Development of Grazing Recommendations and On-Farm Decision Tools for Managing Alfalfa-Grass Mixtures in Southeastern, U.S.

- 2017 NIFA Alfalfa Forage Research Program
- University of Georgia, Auburn University, and the University of Florida
- 2 year evaluation

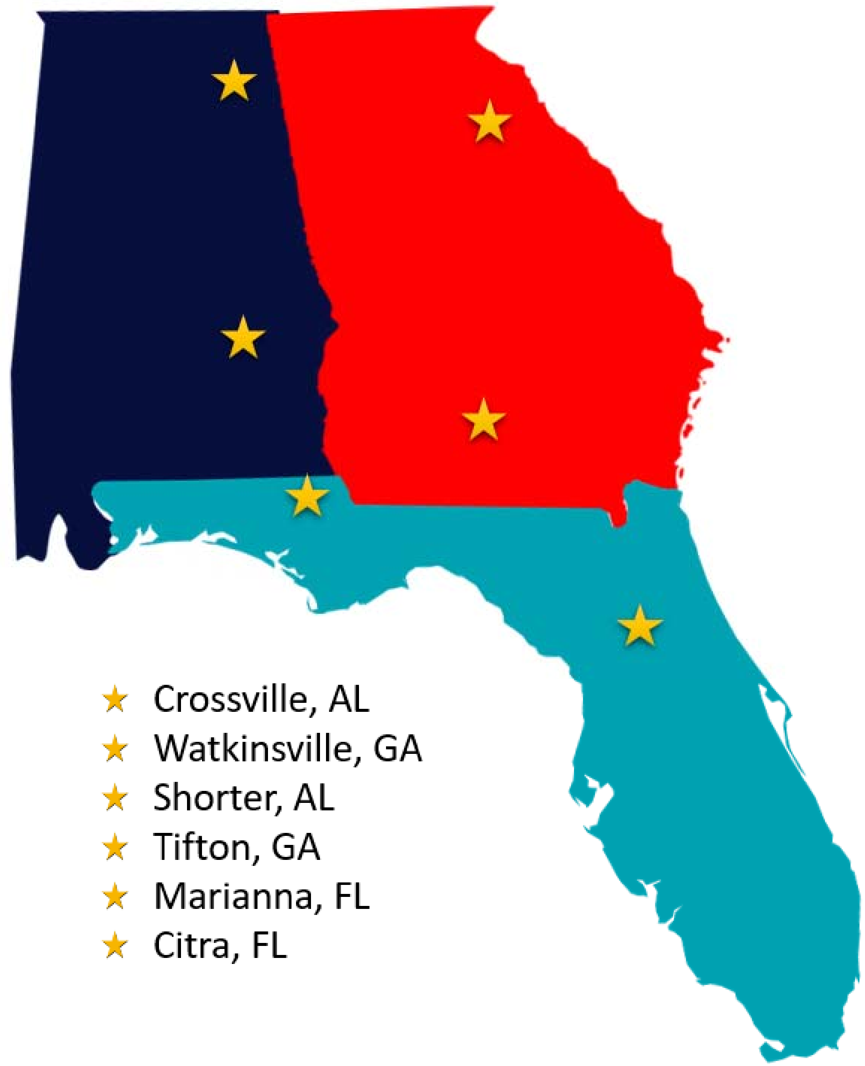
USDA

United States Department of Agriculture
National Institute of Food and Agriculture

J.Tucker, K. Mullenix, C. Prevatt, J. Dubeux, E. Rios

UGA extension

- Three states – 6 locations
- Three varieties of Alfalfa based on location
  - *'Bulldog 505'*
  - *'Bulldog 805'*
  - *'UF2015Alf-Pers'*
- Harvest Frequency
  - *2,4,6 weeks*
- Harvest Height
  - *2,4,6 inches*



UGA extension

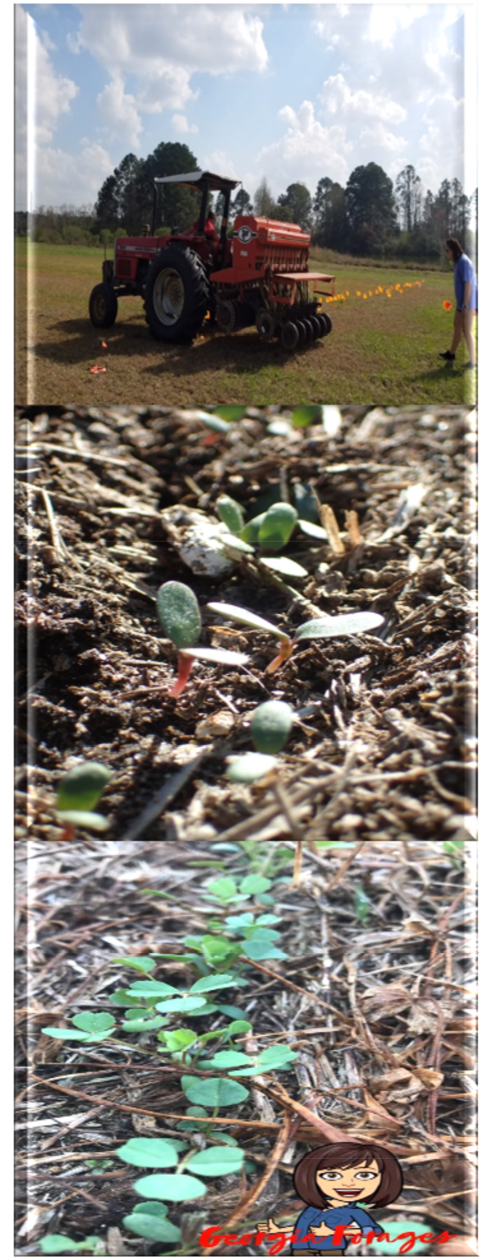
Benefits of Work

- Begin to define alfalfa grazing metrics in the Southeast when utilizing Bermudagrass/Alfalfa mixtures
- Serves as preliminary data to be utilized in larger grazing projects for confirmation (if funded)
- Extension tools will offer producers user-friendly decision aids to help make economic and agronomic management decisions.

UGA extension

Current Progress

- Georgia: established November 2017
  - *Southern: re-established Feb. 2018*
- Alabama: established November 2017
  - *Northern: re-established Feb. 2018*
- Florida: established December 2017
  - *Bermudagrass competition was too high and seed availability limited replanting*
  - *Will replant both locations in Fall 2018*



UGA extension

- Students hired at Auburn University and University of Georgia
- Project introduced and presented at “Alfalfa in the South” workshops (4)
- Highlighted and Tifton site visit during workshop/field day May 9, 2018

UGA extension

Bacterial Stem Blight of Alfalfa: Connection with Frost Damage, Development of Resistant Germplasm, and Mapping Resistance Genes

Steve Orloff

Deborah Samac, USDA-ARS
Long-Xi Yu, USDA-ARS
Rob Wilson, University of California

Objectives

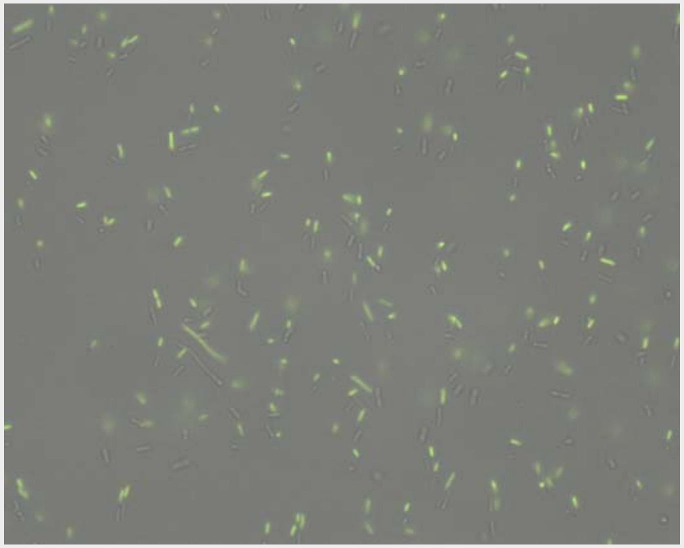
1. Obtain information on the extent of bacterial stem blight damage occurring in commercial alfalfa production fields, the association of disease with frost damage, and the relationship of disease with bacterial populations.
2. Identify DNA markers and candidate genes associated with disease resistance loci.
3. Develop germplasm with enhanced resistance to bacterial stem blight.

Bacterial stem blight

- Associated with frost damage
- Can reduce first harvest by 50%
- Will disease resistance reduce frost damage?
- Pathogen: *Pseudomonas syringae* pv. *syringae*

Pathogen Research

- Develop a fact sheet on BSB
- Survey growers in CA, UT, MT, CO, ND
- Follow pathogen populations in new seedings
- Pathogen collection from six field sites, 2 years
  - Genetic and pathogenic diversity
- GFP-marked strains



Genetics and Genomics Research

- Identified R and S plants in ‘Maverick’ and ‘ZG9830’
- F1 mapping populations developed
- Phenotyping F1 plants
- Genotyping by sequencing to identify resistance loci
- Recurrent selection from diverse gemplasm sources using standard protocol

Resistant

Susceptible

Developing an Attractant for *Lygus hesperus* Derived from Host Plant Volatile Compounds

Zainulabeuddin Syed[1], and Johanne Brunet[2], Ricardo Ramirez[3]

[1] University of Kentucky, Lexington, KY 40456
[2] Department of Biology, Utah State University, Logan, Utah 84322
[3] USDA-ARS, Department of Entomology, University of Wisconsin, Madison, WI 53706

Objectives:

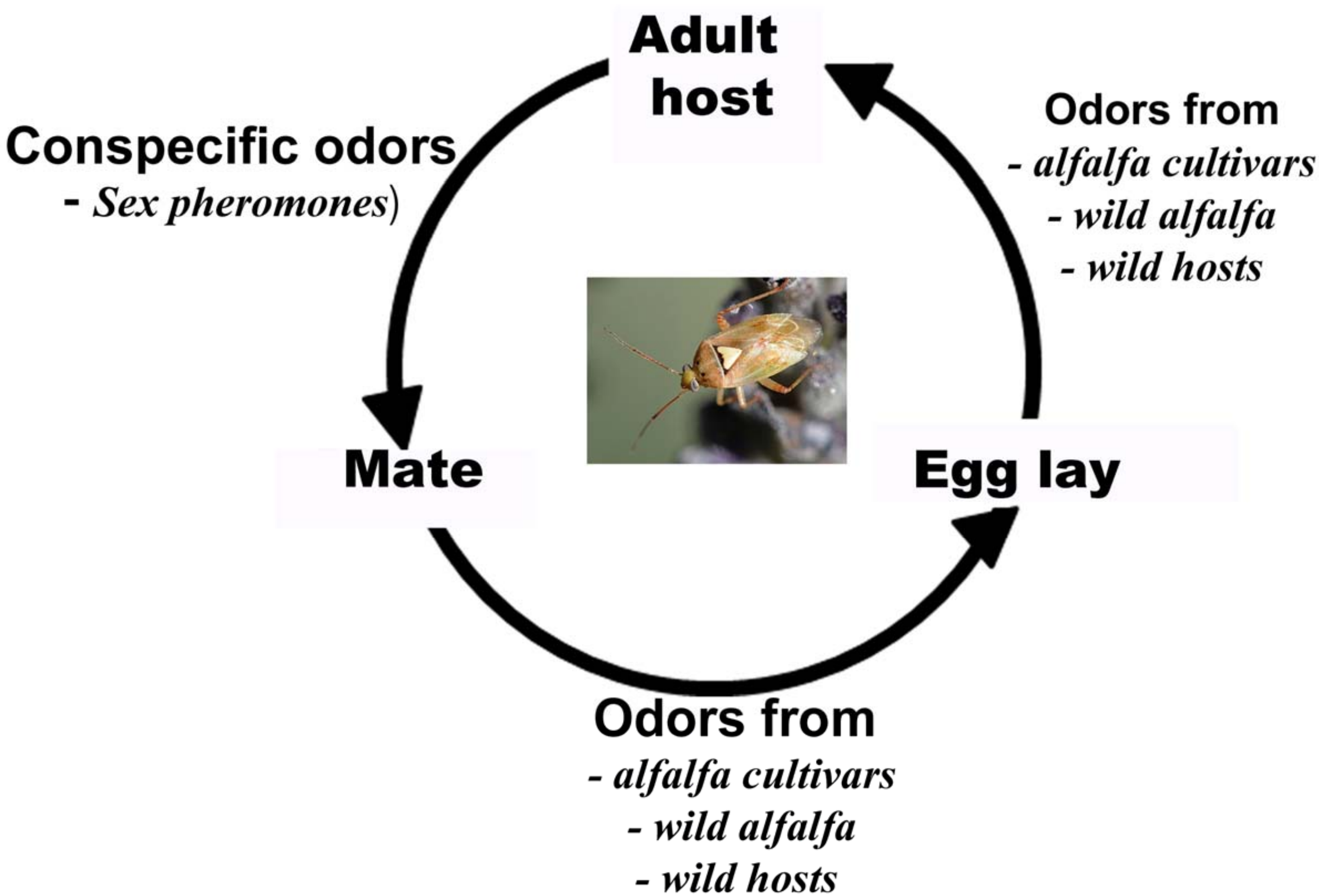
Isolate and identify the headspace volatiles of selected wild host plant species of *Lygus hesperus*, two wild-alfalfa subspecies and cultivated alfalfa host plants.

Behavioral response of male and female *L. hesperus* to live plants and VOC profiles.

Isolation and identification of biologically active volatile constituents

Behavioral analysis of the active compounds; and development of appropriate blends for potential field application.

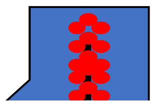
Presentation of research results to the scientific community and to alfalfa seed industry and seed producers. Development of appropriate extension program to make the results available to the farmers.

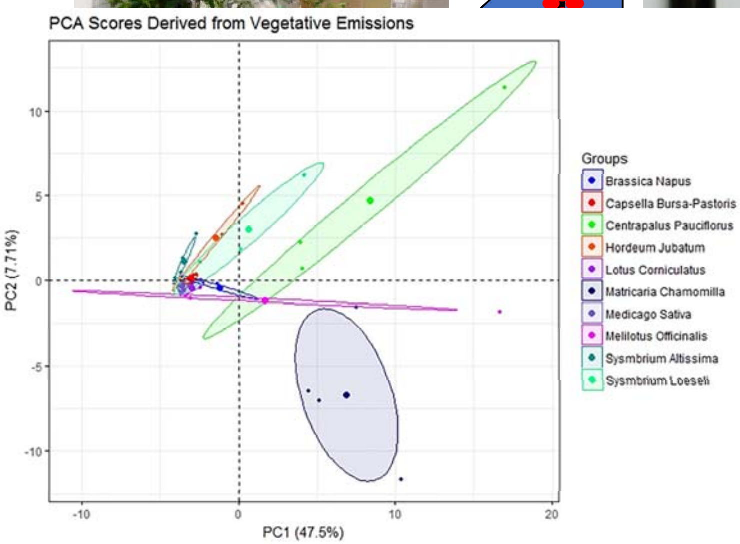

Adult host
Odors from
- alfalfa cultivars
- wild alfalfa
- wild hosts
Conspecific odors
- Sex pheromones)
Mate
Egg lay
Odors from
- alfalfa cultivars
- wild alfalfa
- wild hosts

Identifying the attractants (=bait)

Signals

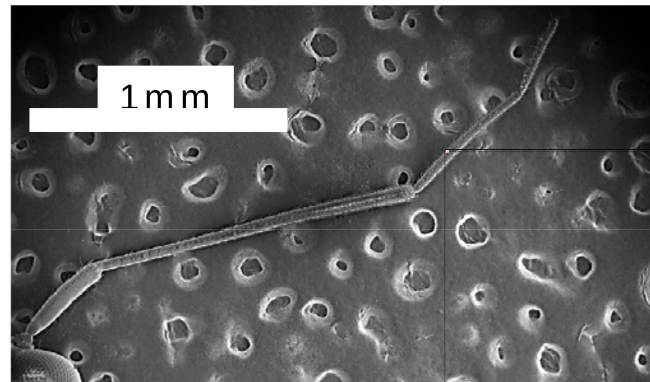
What they smell?

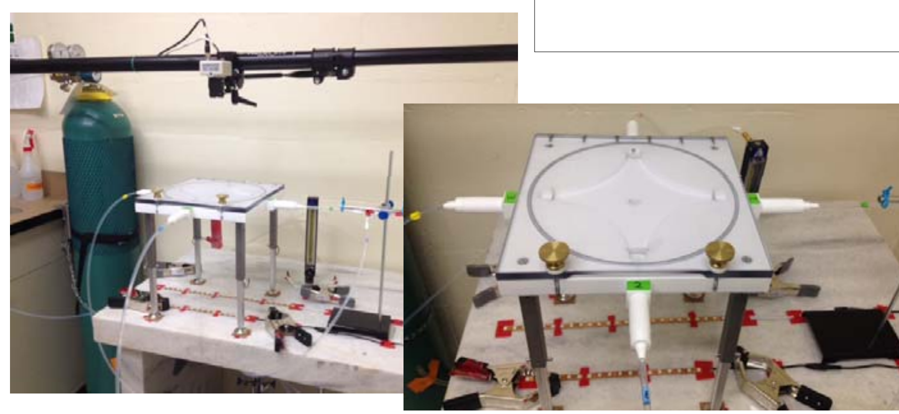




Reception

How they smell?





Progress to date:

- Adults and nymphs collected from the field & established in the lab.
- 24 plant species collected from Utah and Wisconsin, and established in the glass house (e.g.,) tall tumble mustard, prickly Russian thistle, Queen Anne’s lace, common groundsel, shepherds purse, yellow sweet clover, fox-tail barley, horseweed, *Chenopodium murale* and *C. album*.
- GC-MS analysis
- Ultrastructural studies of the olfactory structures

WASHINGTON STATE UNIVERSITY
EXTENSION

Determining Genetic Factors That Influence Forage Quality In Alfalfa

Steve Norberg, WSU; Long-Xi Yu, ARS;
David Combs, UW, Glenn Shewmaker, UI;
Guojie Wang, OSU; Don Llewellyn, WSU,
Steve Fransen, WSU; Edzard van Santen, UF

AGRICULTURE | YOUTH & FAMILIES | HEALTH | ECONOMY | ENVIRONMENT | ENERGY | COMMUNITIES







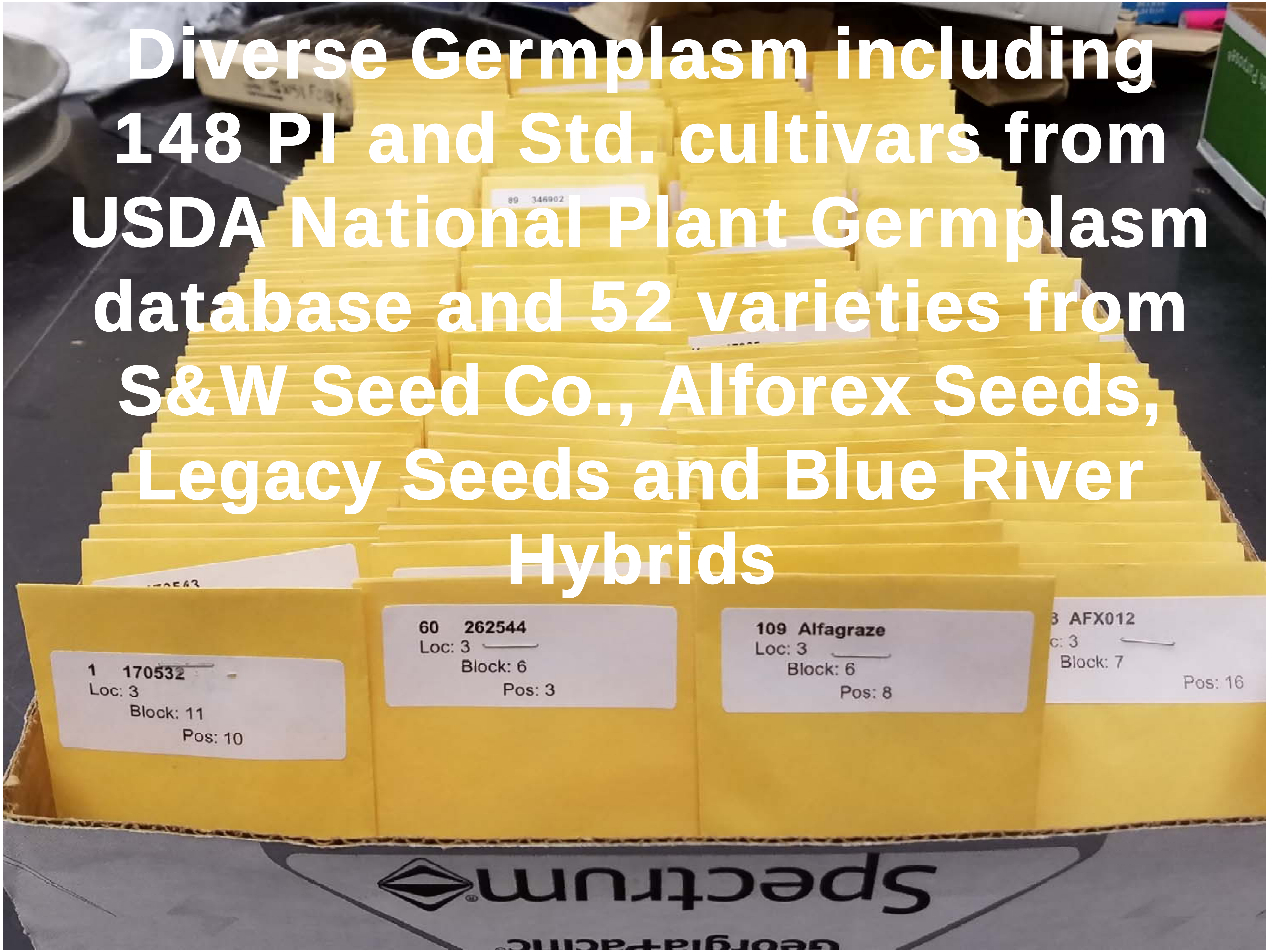
Objectives

1) Determine quality at first harvest of 200 alfalfa plant introductions and varieties at three locations in the PNW
2) Quantify the genetic diversity of alfalfa that is related to forage quality
3) Identify genetic areas associated with forage quality
4) Extend the knowledge gained

Materials and Methods

- Grow 200 varieties from diverse germplasm at three locations in PNW in an augmented design using vernal and Alforex 360 as checks in 11 blocks per location
- DNA analysis of germplasm
- Fiber analysis including NDF, NDFD24, NDFD30, NDFD48, kd, iNDF, TTNDFD
- Determine genetic areas and molecular markers related to fiber quality

Diverse Germplasm including 148 PI and Std. cultivars from USDA National Plant Germplasm database and 52 varieties from S&W Seed Co., Alforex Seeds, Legacy Seeds and Blue River Hybrids




All three locations are planted and include: Prosser, WA, Union OR, Kimberly, ID with results to follow

Identifying Factors to Optimize Establishment of Alfalfa Interseeded in Corn

Mark Renz[1], William Osterholz[1], John Grabber[2], Kim Cassida[3], Erin Burns[3], Jessica Williamson[4], and Dave Bjorneberg[2]

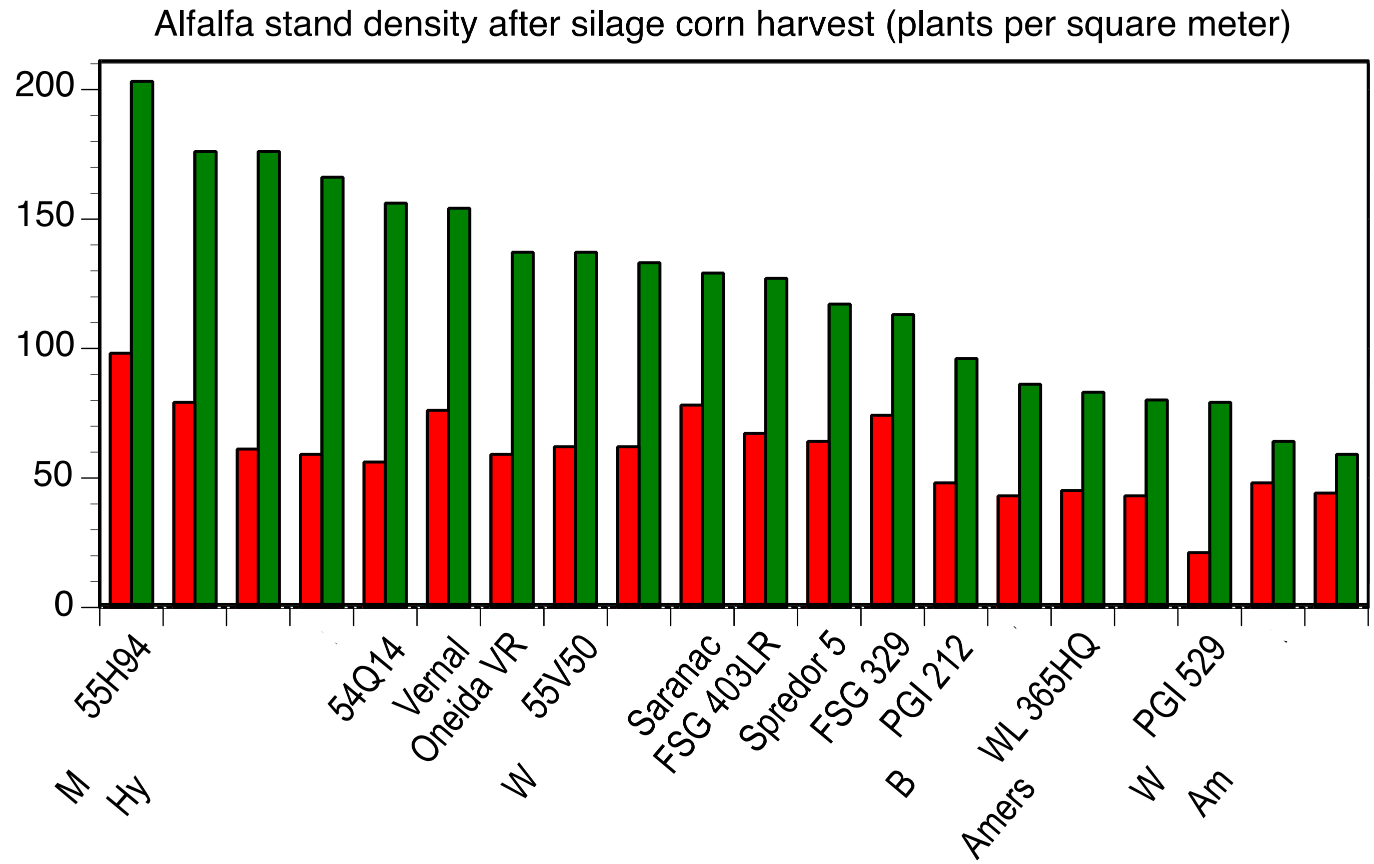
[1]University of Wisconsin, [2]USDA-Agricultural Research Service, [3]Michigan State University, and [4]Penn State University

Overall Goal: Develop reliable methods to establish alfalfa in silage corn to protect soil and jumpstart full alfalfa production the following year

- Alfalfa planted into corn interrows
- Corn silage harvested, alfalfa remains as a cover crop
- Following year(s) alfalfa harvested as a forage crop
- Unfortunately, alfalfa typically has poor survival when interseeded into corn

Wisconsin studies have identified several keys to successful establishment of interseeded alfalfa:

1. **Seed adapted varieties**
2. **Treat alfalfa with prohexadione (PHD), fungicide and insecticide**
3. **Others…**



Control

PHD

PHD + Fungicide + Insecticide

AFRP project goal: Identify management practices and environmental conditions needed to ensure successful establishment of interseeded alfalfa in diverse production environments

- **Approach:**
  - **Conduct replicated experiment station and on-farm trials at multiple locations in Pennsylvania, Michigan, Wisconsin, and Idaho during 2018 and 2019**

- **Management factors:**
  - **Variety of interseeded alfalfa (conventional vs. glyphosate resistant)**
  - **Silage corn population (experiment station 70K vs. 90K per ha; on-farm cooperators select population)**
  - **Prohexadione (±) treatment of alfalfa**
  - **Fungicide and insecticide (±) treatment of alfalfa**
  - **Wheel traffic (±) on alfalfa during corn harvest (experiment station)**

Data collection and analysis

- **Crop responses to management factors**
  - **Crop height and alfalfa leaf damage/defoliation**
  - **Stand density of interseeded alfalfa during and after corn production**
  - **Dry matter yield of corn silage**
- **Growth environment data**
  - **Soil texture, organic matter, available water, pH, inorganic N, etc**
  - **Air temperature and precipitation/irrigation**
- **Statistical analyses**
  - **Mixed model ANOVA of experiment station data**
  - **Random forest regression of all data to identify management and environmental factors most affecting alfalfa survival and corn yield**

Outreach

- **Field days, newsletters, budget spreadsheet, extension update meetings, state and regional conferences, extension websites, bulletins, and videos**

Overhauling Alfalfa Weevil Management in Irrigated Southwest Desert Alfalfa

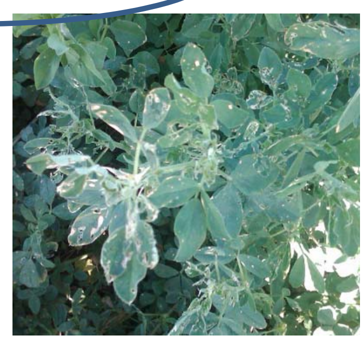
Field defoliation from alfalfa weevils

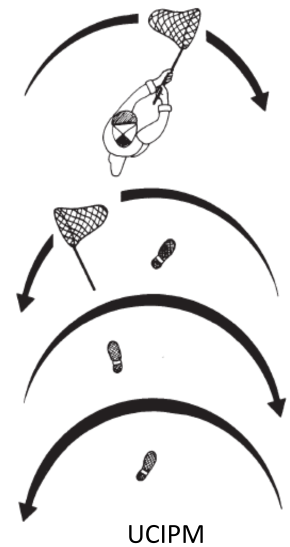
Adult damage to stem and leaflet

Ayman Mostafa, PhD
UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE & LIFE SCIENCES
Cooperative Extension
Field Crops

Management of Egyptian Alfalfa Weevil

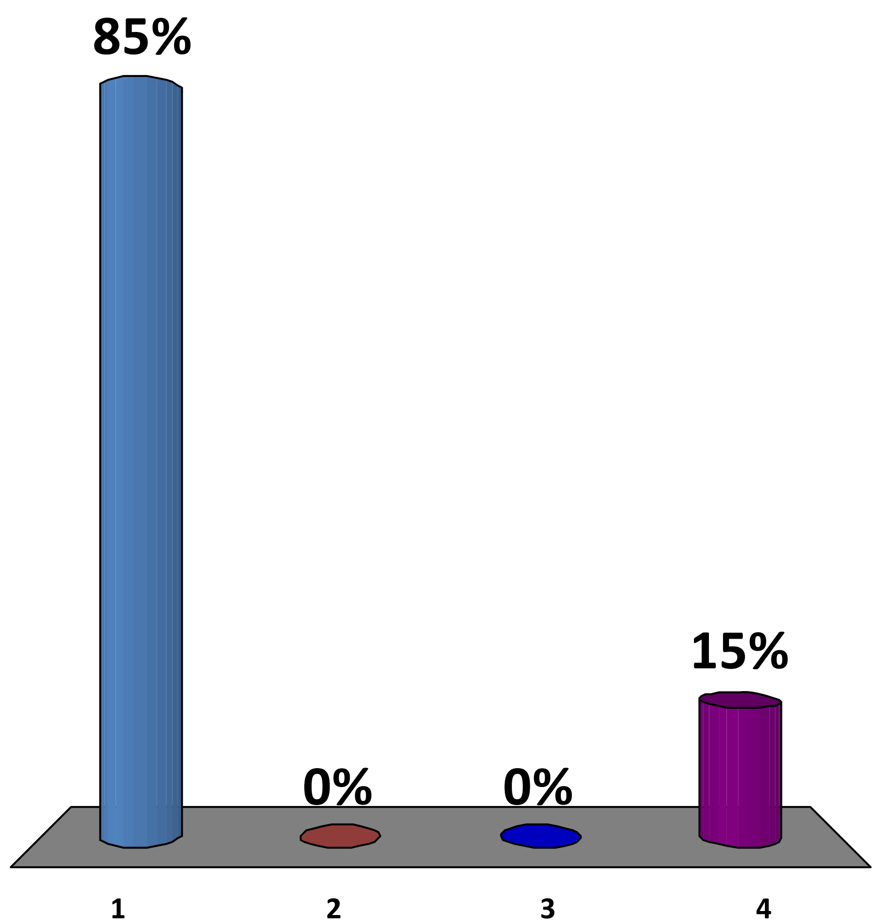
- **Monitoring**
  - Sampling should begin after temperatures have dropped below 42° F (usually January)
  - Sweep net samples should be conducted in ≥ 4 areas in the field (5 sweeps / area)
  - Control measure taken when an average of 15-20 larvae / sweep are found





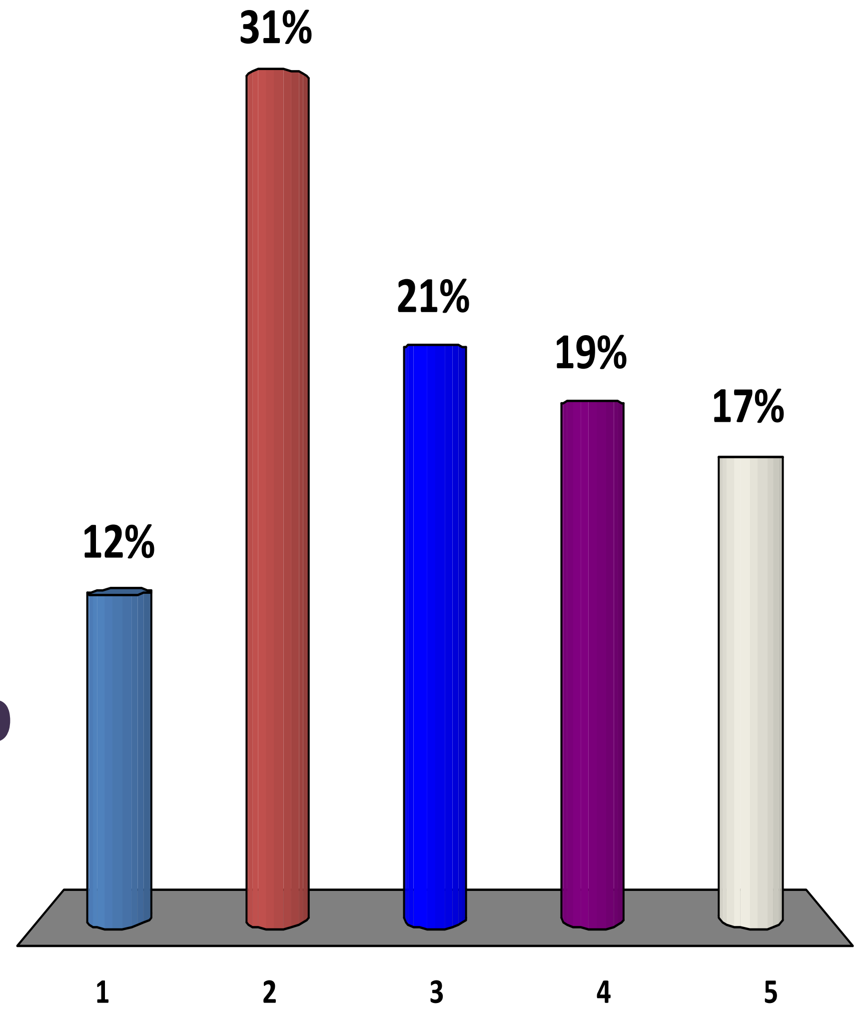
How did you decide when using insecticide treatment for alfalfa weevil

1. Follow threshold
2. Spray when spray for aphids
3. Spray preventively because they cause damage at the same time of year
4. Other



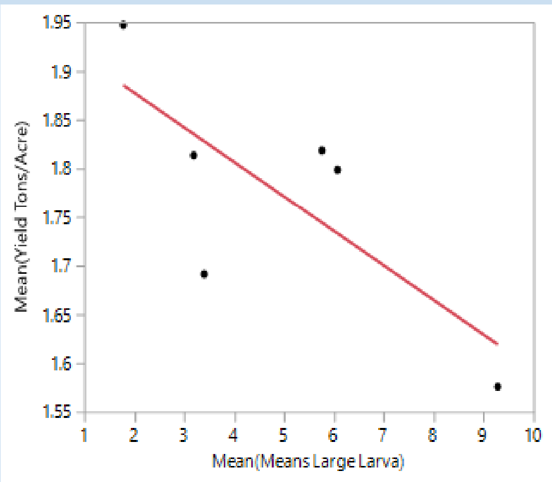
If using threshold when applying insecticide treatment for alfalfa weevil, what is this threshold

1. **15-20 larvae/sweep**
2. **10-14 larvae/sweep**
3. **9-5 larvae/sweep**
4. **Less than 5 larvae/sweep**
5. **Other**



Weevil Threshold Trial Results
Relationship between larval population & yield

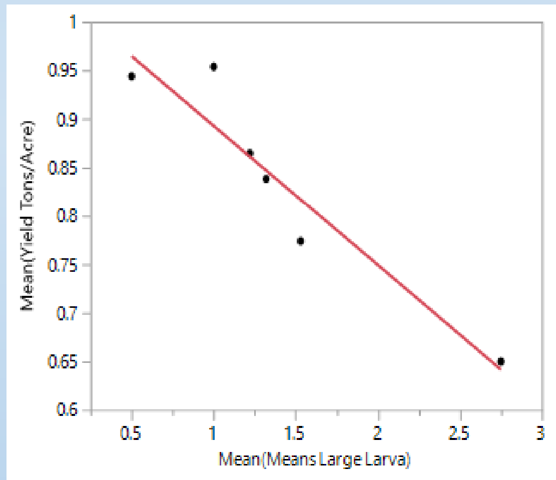
2014



9 Larvae per sweep resulted in 0.36 ton loss equal to $72; based on $200/ton hay

R^2: 0.568   p: 0.0834

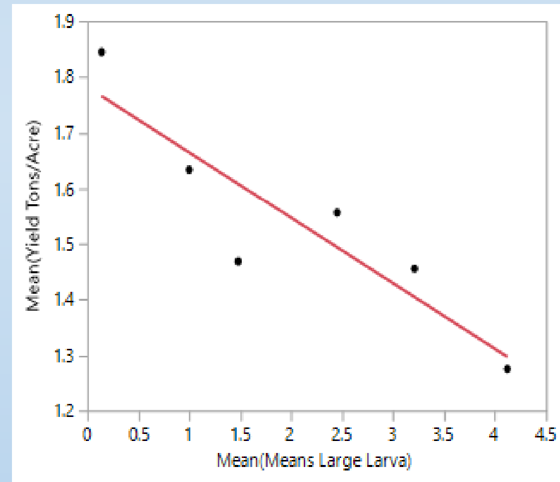
2015



3 Larvae per sweep resulted in 0.42 ton loss equal to $84; based on $200/ton hay

R^2: 0.905   p: 0.0035

2017



4 Larvae per sweep resulted in 0.48 ton loss equal to $96; based on $200/ton hay

R^2: 0.817   p: 0.0133

- Temperature-dependent?
- Latitude
- Weather pattern

LIDAR and Photogrammetry to Map Alfalfa Yield and Quality Using Unmanned Aircraft Systems

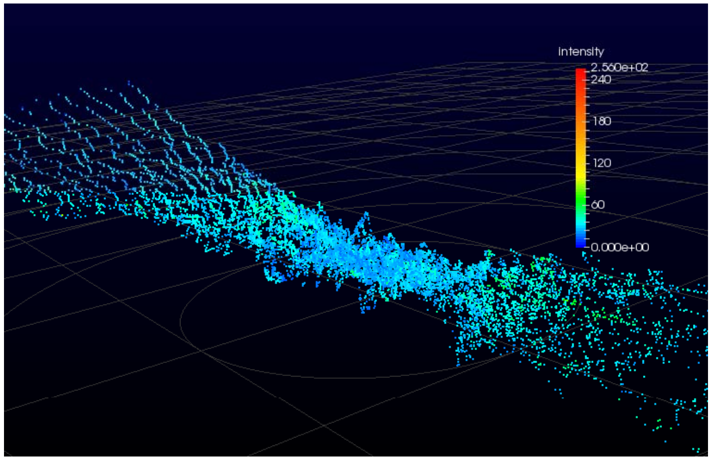
Joseph Dvorak, Luis Pampolini, Ben Goff,
Joshua Jackson, Michael Sama
Presenter: Joseph Dvorak

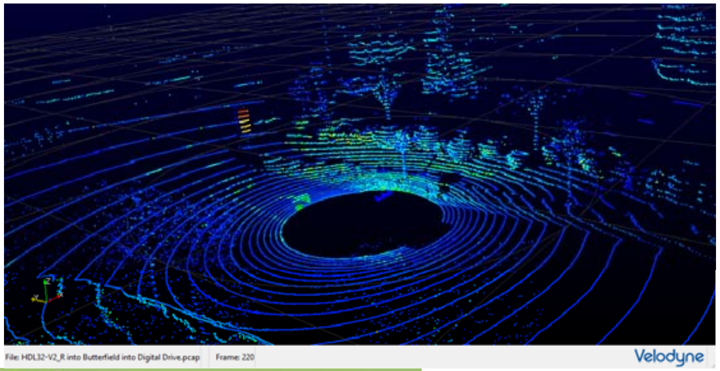
North American Alfalfa Improvement Conference

Biosystems & Agricultural Engineering

Why are we doing this?

- Provide producers with whole field estimates of yield and quality to aid harvest decisions
- Yield is based on density and volume of plant canopy
- Quality is highly influenced by maximum plant height (see PEAQ method)
  - Plant maturity is a secondary factor
- These factors are directly observable from airborne sensor platforms
- LIDAR -> LIght Detection And Ranging
  - Creates a point cloud representation of scanned objects
- Photogrammetry
  - Stitching many 2D images to create 3D models.





What are we doing?

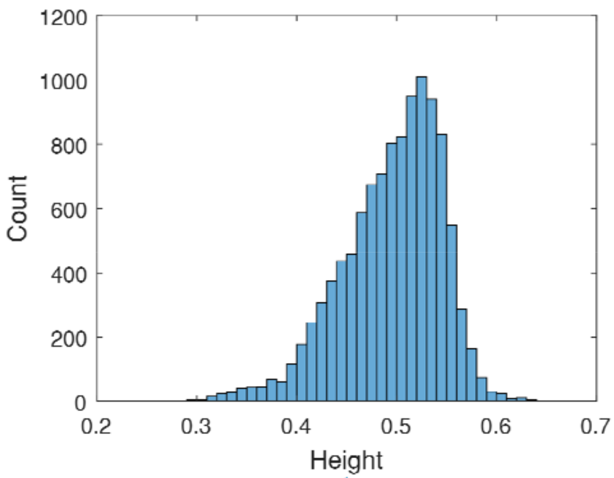
So far:

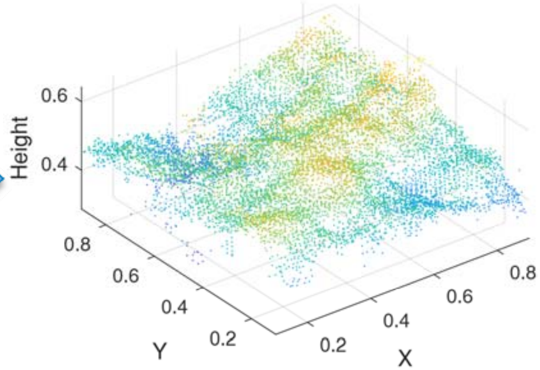
- Sample weekly with 20 quadrats all growing season
- Last year – all photogrammetry
- Focus on sampling quadrats
  - Establish optimal performance
- Processing – local, not global

Coming up:

- Test different field scanning methods
- Fly the LIDAR system
- Tests in areas with wheeled traffic damage – machinery management
- Tests in reduced lignin varieties
  - Does PEAQ work in reduced lignin?
- Comparisons with PA, GA, and across cuttings

Current Work





Sample	F5T13
Location	KY
Date	July 11, 2018
Cutting	3rd
Yield (kg/ha)	4130
NDF (%DM)	38.35
ADF (%DM)	28.40
CP (%DM)	16.18
Weed (1-5)	< 5%
Disease (1-5)	< 5%
Insect (1-5)	< 5%
Manual Max Canopy Height (cm)	68
Manual Average Canopy Height (cm)	55
Maturity	4: Late Bud
Stand Density	54
Photo. Max Canopy Height (cm)	64
Photo. Average Canopy Height (cm)	50
Photo. Min Canopy Height (cm)	29
Points within Quadrat	10905

Conclusion and Upcoming Work

- We are creating a large data set of both manual and sensor based measurements.
  - Starting statistical processing
- Photogrammetry canopy does not normally include ground in thick alfalfa – will likely need Ground Control Points
- LIDAR measurements will be started this next cutting in Kentucky
- Publications on direct outputs
  - reduced lignin
  - wheeled traffic
- Publications on sensor methods
  - optimal
  - on-farm applications

Managing selfing rates in alfalfa seed production fields

Johanne Brunet
USDA-ARS VCRU
Dept. of Entomology
University of Wisconsin-Madison

Collaborators

Heathcliffe Riday USDA-ARS Dairy Forage Research Center, Madison WI

Doug Walsh Washington State University, Prosser Washington   PNW

Oli Bachie County Director, University of California Cooperative Extension – Imperial County UCANR
CA IMPERIAL VALLEY

Jacob Wenger   Assistant Professor of Entomology- Department of Plant Sciences- Fresno State University
CA CENTRAL VALLEY

Goal and Background

Goal: Identify management practices that reduce selfing

Background: selfing can be >30% ; Inbreeding depression can be substantial and can decrease seed yield and forage yield (decreased germination and seedling survival).

Management practices: Pollinators; Flower density and plant density: fertilizer, water, disease, pests, weeds.

Methodology

- 30 alfalfa seed production fields : 10 PNW (Walsh); 10 Central Valley (Wenger) and 10 Imperial Valley (Bachie) of California.
- Gather Management practices
- Collect seeds and leaves from 50 plants per field; Genotype 320 seeds per field (40 mothers * 8 seeds) at 12 microsatellite loci.
- Estimate field selfing rates. Identify each seed as self or outcross by comparing genotypes of mothers and seeds in progeny arrays.

Selfing rate and management practices

- Variation in selfing rates

  11 fields: 8.6 – 23 % selfing

- Variation in pollinators (CA) HB; LCB; Both
- Variation in floral density
- Variation in other management practices
- Regressions of variables with selfing rate
- Develop best management practices to reduce selfing in alfalfa seed production fields