Weed species extracts as an effective and environmentally friendly strategy to control insects and deer in soybean

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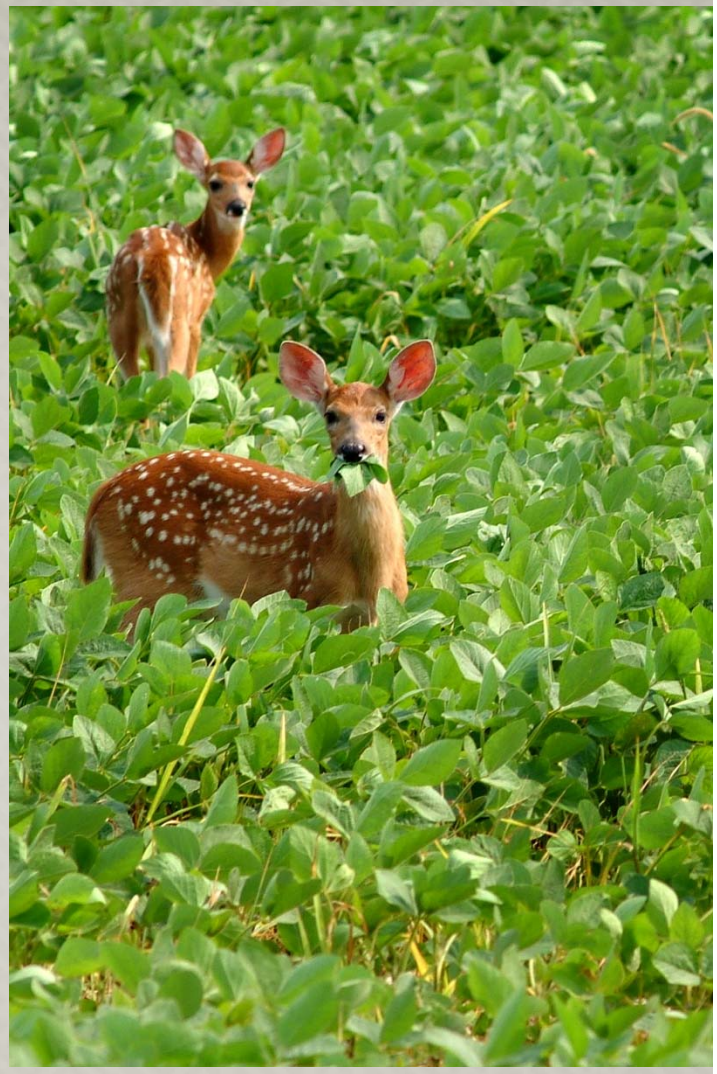
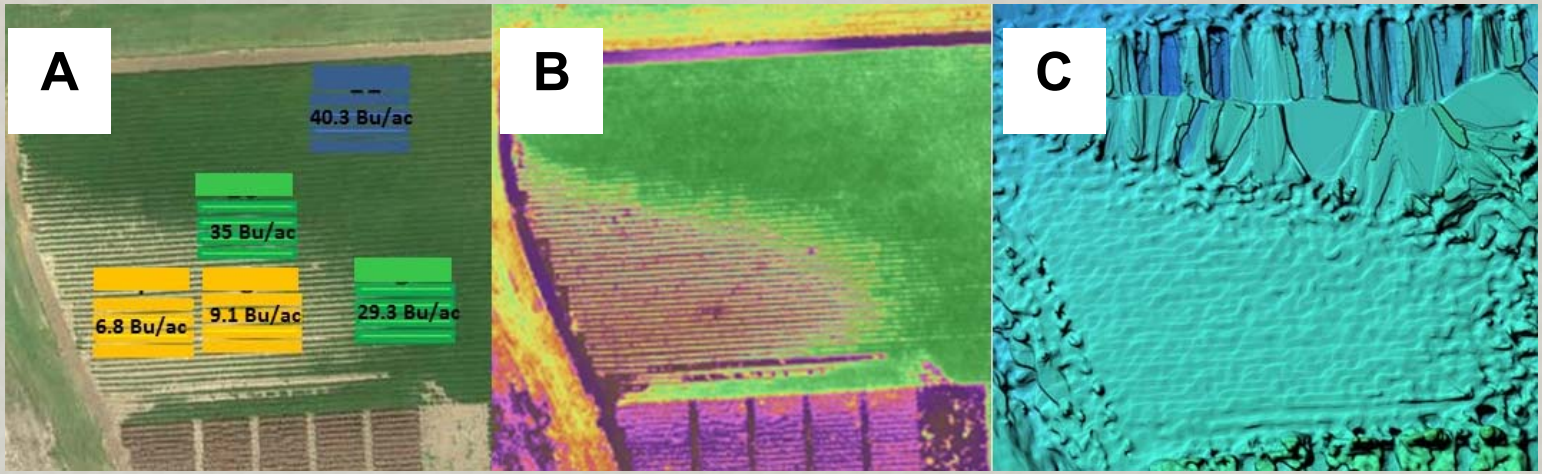
Soybean losses from herbivores

- Economic losses from high-density herbivores
- White-tailed deer
  - $68/ha or 43% financial losses
  - 70% ($4.5 billion) of the wildlife-caused crop losses (Miller et al. 2015)



Soybean losses from herbivores

- White-tailed deer
  - 2017 study: Soybean plots planted near low deer density
    - 80% yield reduction



Yields (panel A), thermal imaging (panel B), and 3D structural signature (panel C) in soybeans following low (blue), medium (green), and high (yellow) deer damage as measured with an unmanned aerial vehicle.

    - 25% shorter, 90% visual damage, 50% lesser biomass

Soybean losses from herbivores

- White-tailed deer
  - Current deer control strategies
    - Fences and repellents (Cauteren et al. 2006)
    - Fencing – expensive and labor-intensive
    - Repellents – low efficacy

Soybean losses from herbivores

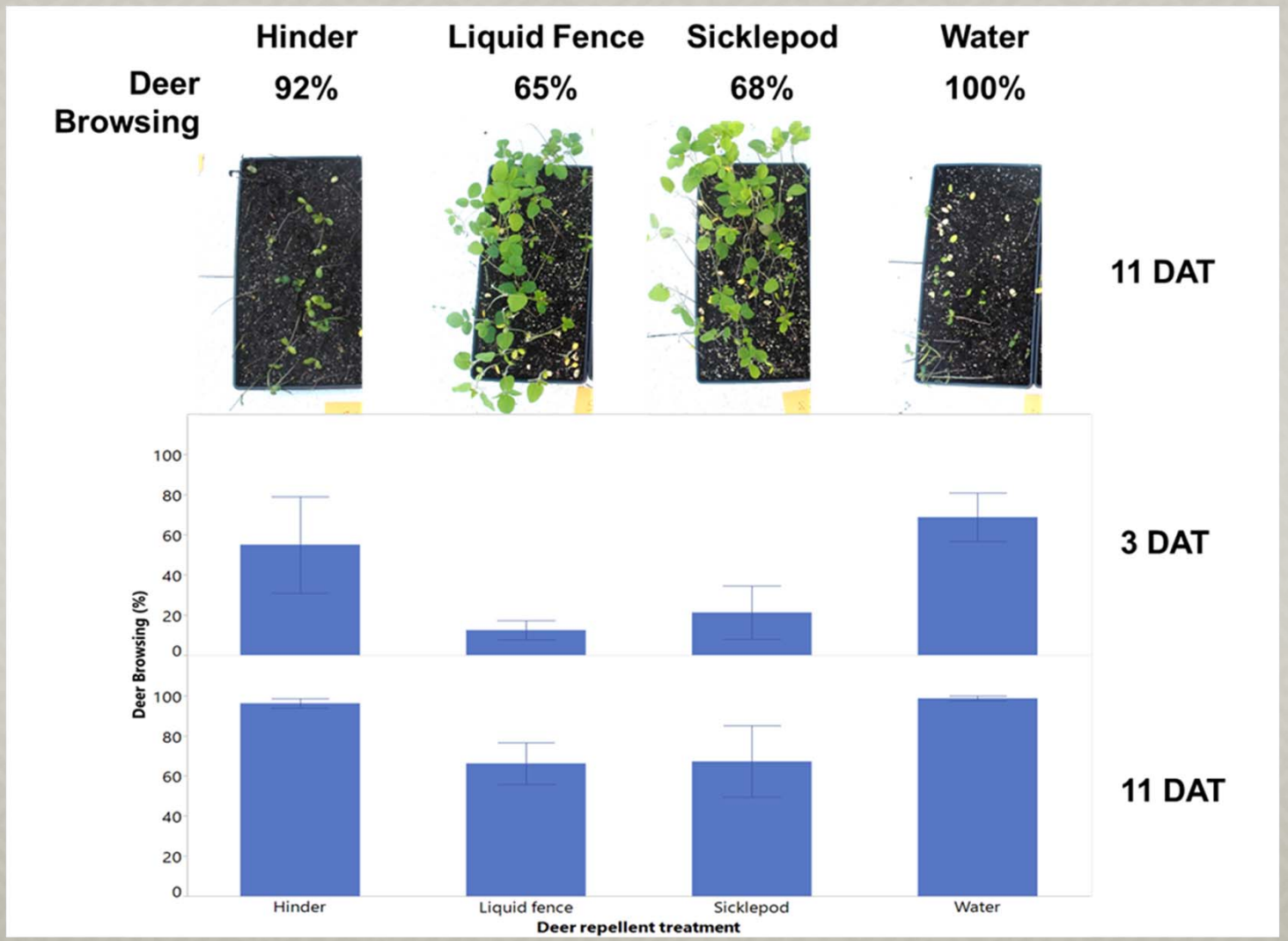
- Insect herbivory
  - Complete crop loss
  - 40% yield and pods/plant reduction
    - soybean aphids and loopers
  - Insecticides – expensive and not environment friendly

Weeds a resource for anti-herbivore traits

- Use certain weed species in formulating deer repellent or bioinsecticide
- Lack of study on anti-herbivore compounds in weeds
  - Activity and effectiveness of anti-herbivore compounds
- Preliminary study: Anti-herbivore property of sicklepod
  - MSU Captive Deer Facility & R.R. Foil Plant Sc. Research Center
  - Diet selection trial using sicklepod extracts

Preliminary data

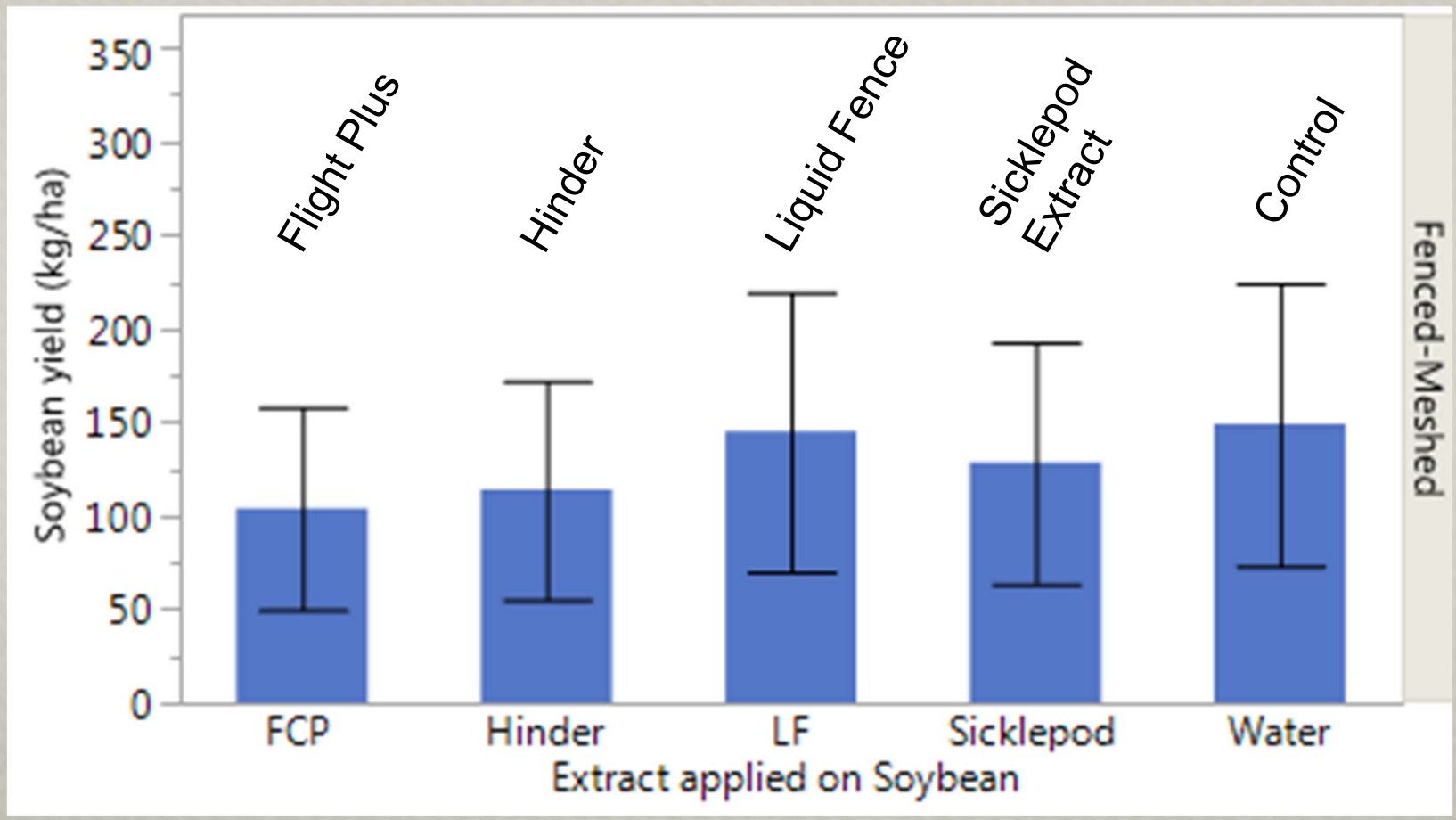
- Control soybean plants consumed completely
- More effective than Hinder



Sicklepod extract trail in MSU Captive Deer Facility

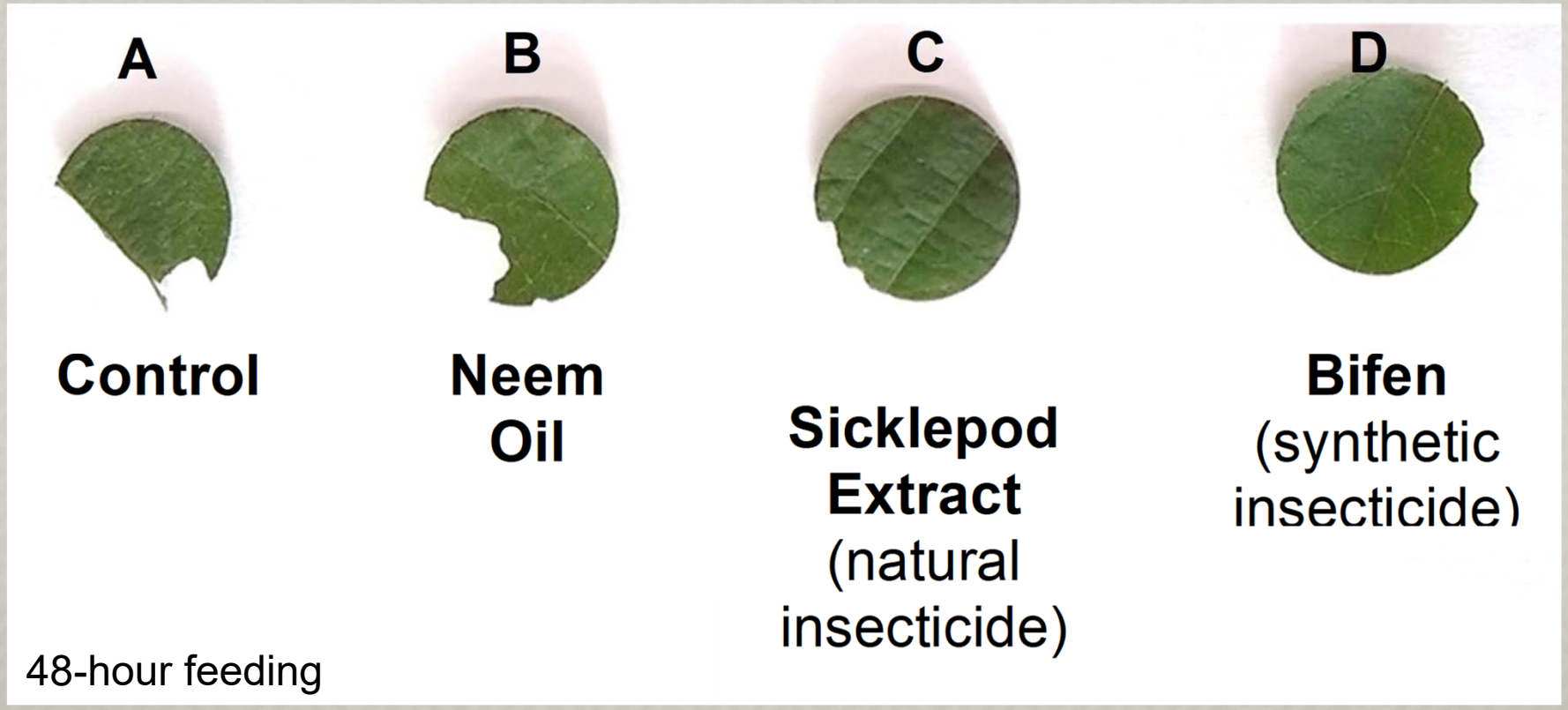
Preliminary data

- Sicklepod extract did not reduce soybean yields in comparison to commercial deer repellents



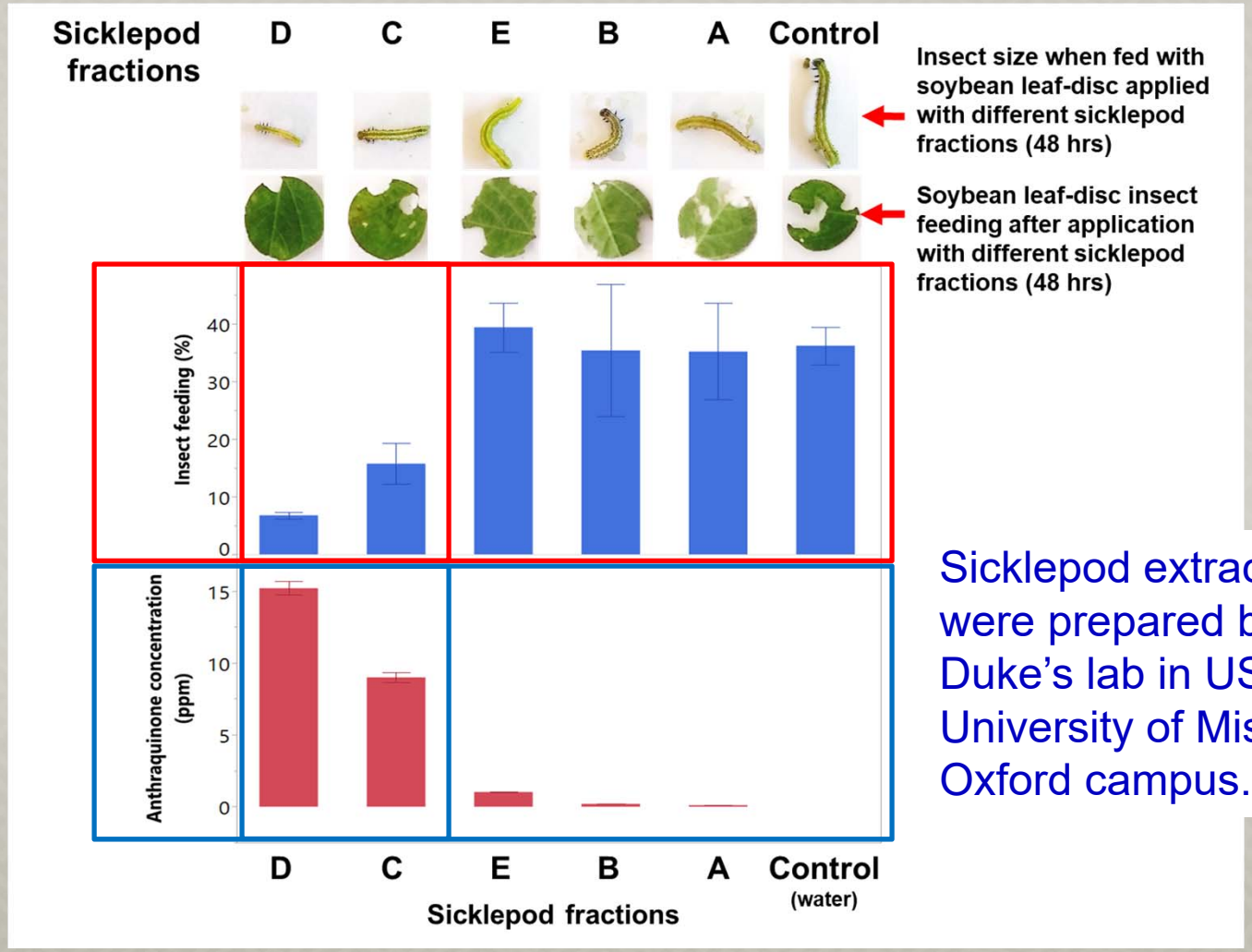
Preliminary data

- Sicklepod extract and Bifen (synthetic insecticide) similar efficacy



Preliminary data

- Sicklepod extract fractions (A, B, C, D, and E) on insect feeding of soybean leaves



Sicklepod extract fractions were prepared by Steve Duke's lab in USDA at the University of Mississippi, Oxford campus.

Preliminary data

- 2022 Study: Field trials (deer & insect)

- Prepared plant extracts of three weed species
  - sicklepod, coffee senna, and hemp sesbania
- Extracts applied on soybean plants (V4, 8-inch stage) at Andrew's Forestry and Wildlife Experiment station with high deer density

Preliminary data

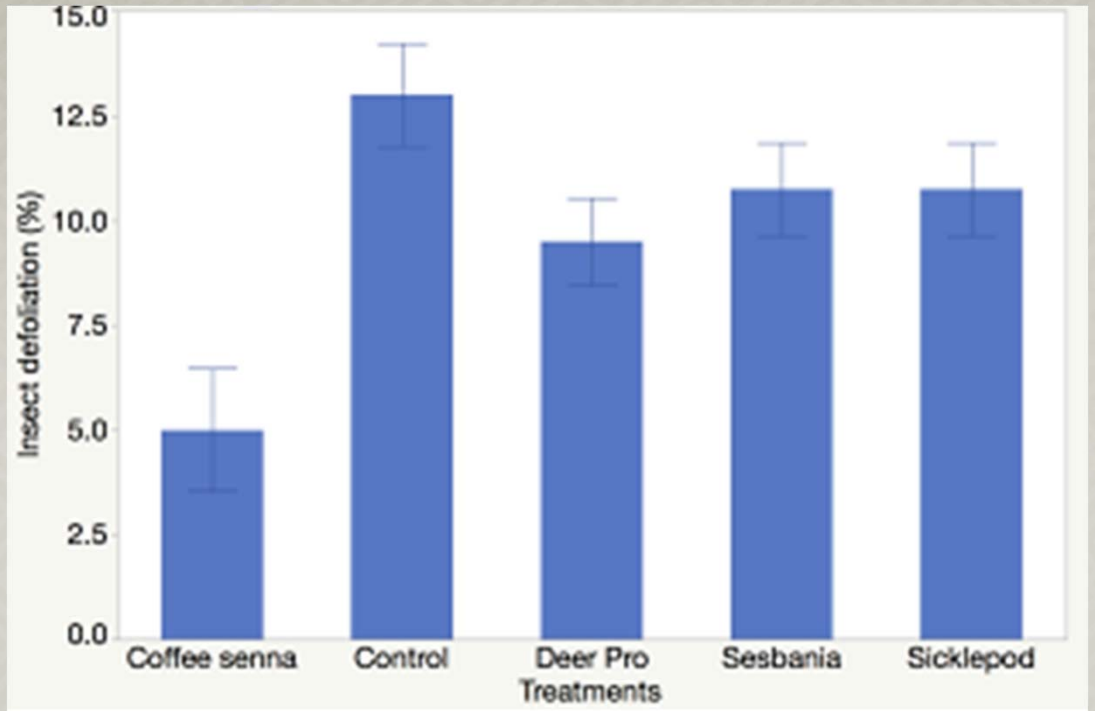
- 2022 Study: Field trials (deer & insect)

Trial camera images of deer browsing our soybean fields

- Deer and insect herbivory damage (weekly)
- Trail cameras set to take photographs every minute
- UAV flyovers to quantify soybean damage from herbivory in treatments and controls

Preliminary data

- 2022 Study: Field trials (deer & insect)

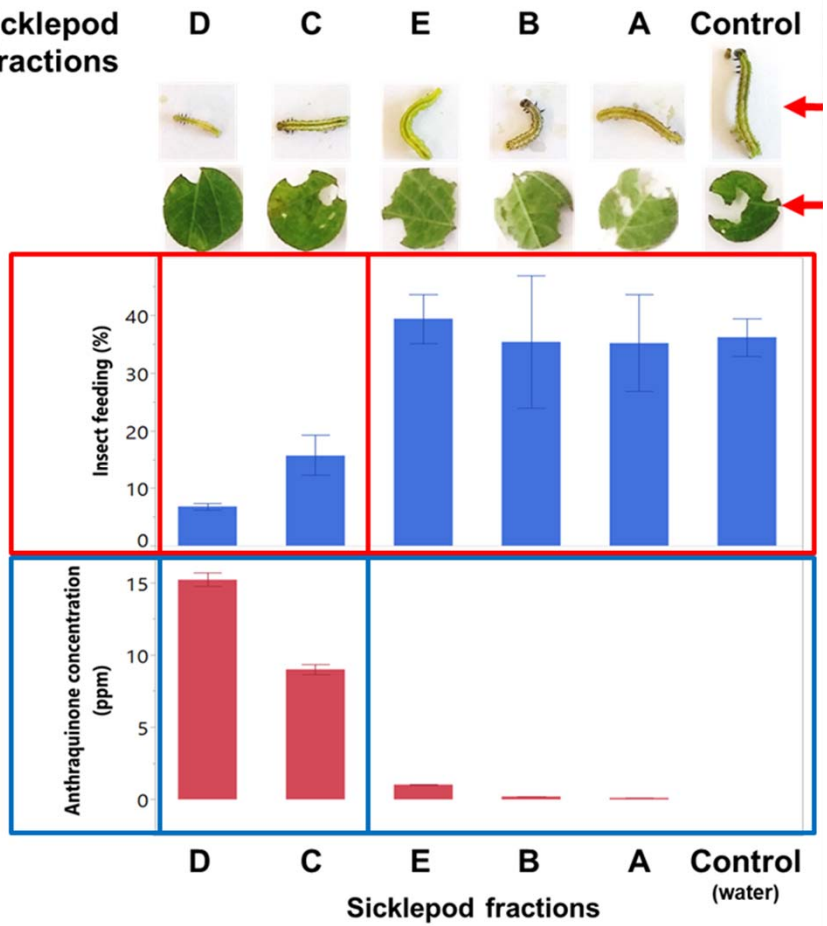


Insect defoliation (%) among treatments in the field experiment at Pontotoc, MS. Coffee senna treated soybean leaves were significantly less defoliated (lesser leaf holes) than other treatments were 2.5 times less defoliated than control (soybean applied with water).

- Current insect defoliation data
  - Insect defoliation from 4 to 15%.
  - Coffee senna treated soybean leaves significantly less defoliated (lesser leaf holes from insect feeding) than other treatments
- In the lab (leaf-disc assay)
  - Coffee senna extract: 1/3 soybean looper mortality
  - Hemp sesbania extract: 2/3 soybean looper mortality

Proposed objectives

- Objectives (2023)
  1. Identify specific anti-herbivory compounds
     - HPLC and mass spectrometry
     - Sicklepod, coffee senna, hemp sesbania weeds



  2. Genetic regions linked to anti-herbivory compounds
     - QTL analysis and molecular markers
     - Markers will be used in future soybean breeding experiments in the greenhouse to select soybean lines with natural insecticidal and deer repellent properties

Questions?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