Digital Ag INNOVATION LAB

Fertilizer Application and Sprayer Technology

Presentation Agenda

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- Introduction to Speaker
- Intro to the Digital Innovation Lab Team
- Sprayer Technology
  - Partnering with Industry to Update Sprayer Evaluation and Standards
  - Growing Season Sprayer Technology Study
  - Digital Ag and ISU Outreach Spray Drone Research Work
- Fertilizer Technology
  - Return to need to Calibrate Dry Spreaders
- Questions

Doug Houser
Digital Ag Extension Specialist

Digital Ag INNOVATION LAB

- **Focus** –Communication on digital tools and solutions that can solve problems and improve key Ag Technology adaption.

- **Part of the Digital Ag Innovation Lab at Iowa State** –
  - Robust group of ag engineers and specialists dedicated to researching and developing technology for digital ag.
- **Career** in the Ag Business for over 40 years including over 30+ years with Corteva with their precision ag teams.
  - On-farm experience and knowledge of the importance of technology and precision farming for today's agricultural industry.

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Digital Ag Innovation Lab: *Why We Do What We Do*

- Our mission is to **advance agriculture** through the **innovative use of technology**.
- Our impact is measured by **economic development** within our industry, **jobs created** in the Midwest, and **innovations licensed** to partners.
- We are passionate about driving successful **public-private partnerships** that enhance **ISU**, grow our **economy**, and drive value into **Iowa agriculture**.

Our Team's Core Capabilities

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- **Highly Skilled Technical Staff:**
  - **45+ professional staff** and **10 - 15 graduate students** focused on innovations in off-road machinery and digital agronomy.

1. **Advanced Sensing & Algorithms:** Digital signal processing, dielectrics, LiDAR, NIR, machine vision, supervised and unsupervised machine learning.
2. **Machine Controls:** MBSD control system development, virtual engineering and dynamic simulation modeling, innovative methods for controls development.
3. **Digital Agronomy:** Remote sensing, crop physiology, soil health, sustainability, precision spray technology.

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Standard Evaluation Methodology of Targeted Application Technologies

ASABE AIM July 29, 2024

Targeted Spraying Technology
Smart or Precision Spraying

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- Definition:
  - Use of sensors and/or data to apply chemicals on a selected target

  - Benefits:
    - Help to reduce the quantity of chemicals applied on non targets which is beneficial for the environment and for the cost of spraying
    - Leverages:
      - Nozzles to activate when a selected target is identified
      - GPS—identifies on a map when spraying was activated
      - Imagery Processing—Some systems use machine learning to identify the selected target
      - Sensors capture the air temperature, time, wind speed, and used to identify target

Targeted Application Evaluation Goals

- Document performance characteristics of Targeted Application Technology in a realistic, non-OEM specific methodology.

- Key performance indicators include:
  1. Validate application coverage applied to the target.
  2. Quantify area of application coverage for a single target.
  3. Validate performance of the detection system.

Overview of Test Configuration

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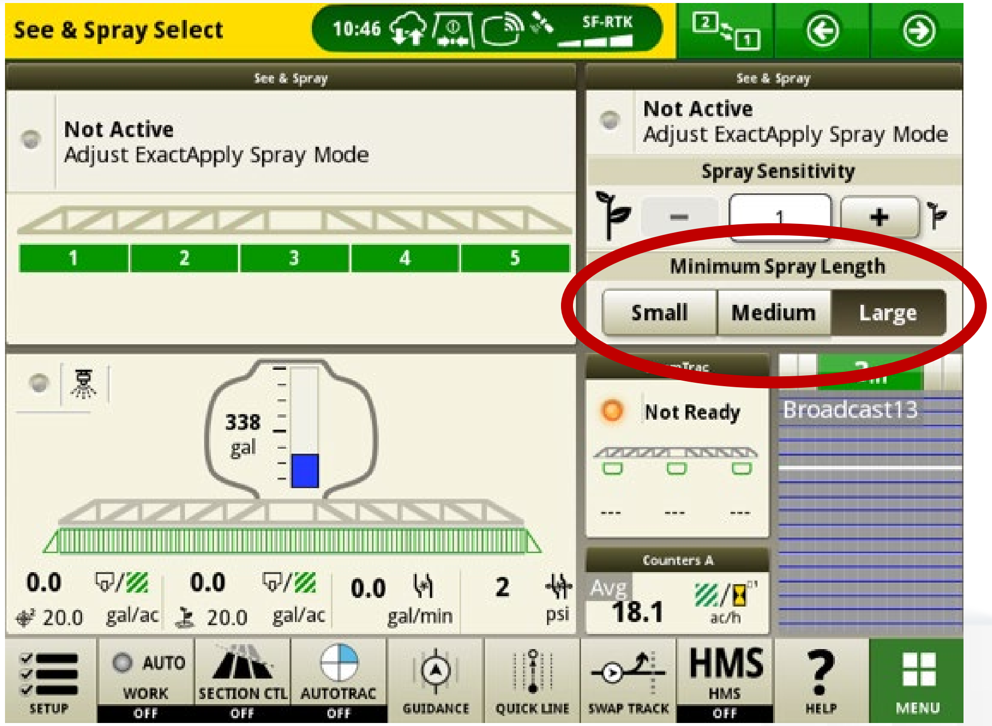
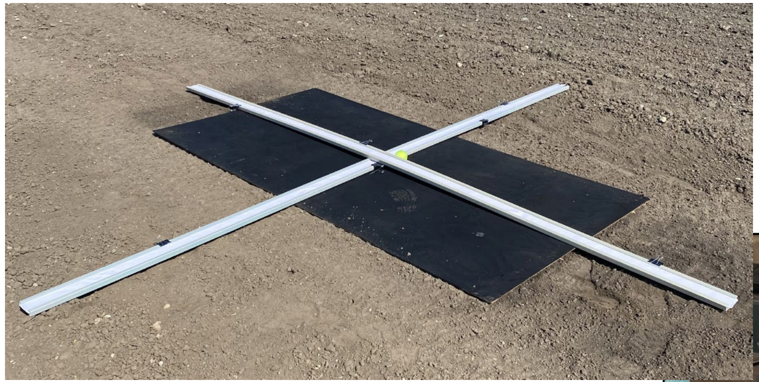
- Commercially available sprayer with targeted application technology
  - PS3DQ0005- 0.5 GPM at 40 PSI
- Testing was conducted in an open field with no vegetation
  - Five non-live targets (2 per boom section and 1 under center frame)
- Ground speed set at 12 MPH, Boom height set at 26 inches, Application rate set at 20 gal/ac
- Tested 2 different spray length settings- small and large



Spray Target and Coverage Analysis

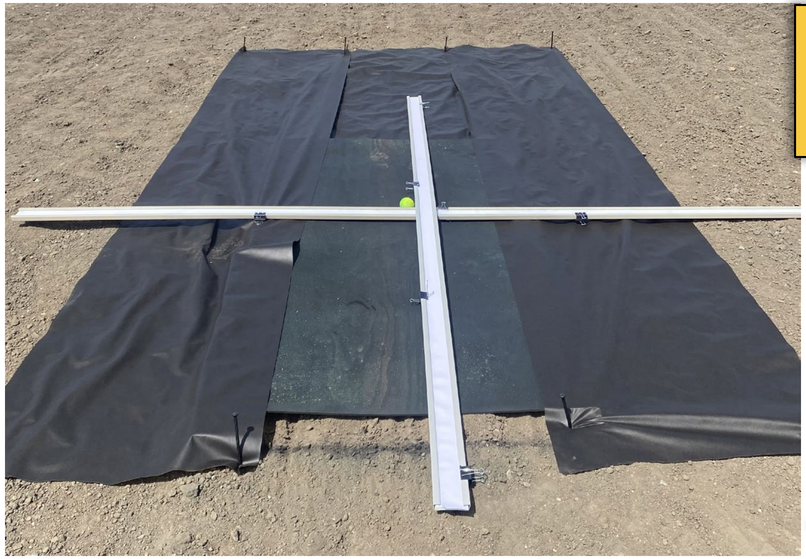
- Yellow tennis ball served as the surrogate target for testing.
  - Other live crops could also have been used.
  - Only requirement is that the spectral or physical characteristics align with the OEM technology configuration.

- Length and Width of the spray pattern were documented using 12 ft (3.7m) x 3 in (0.076 m) white bond paper.
  - Blue dye (32 oz/100 gallons) was added to the spray tank to mark coverage on paper target.
  - Coverage was analyzed using a Swath Gobbler (https://www.betterfieldstudies.com/swath-gobbler)



Spray Target and Coverage Analysis

- Spray paper can't cause a triggering event
- Use of water sensitive paper would cause a triggering event at the start of the paper



Direction of Travel

Context Photos from Test Execution

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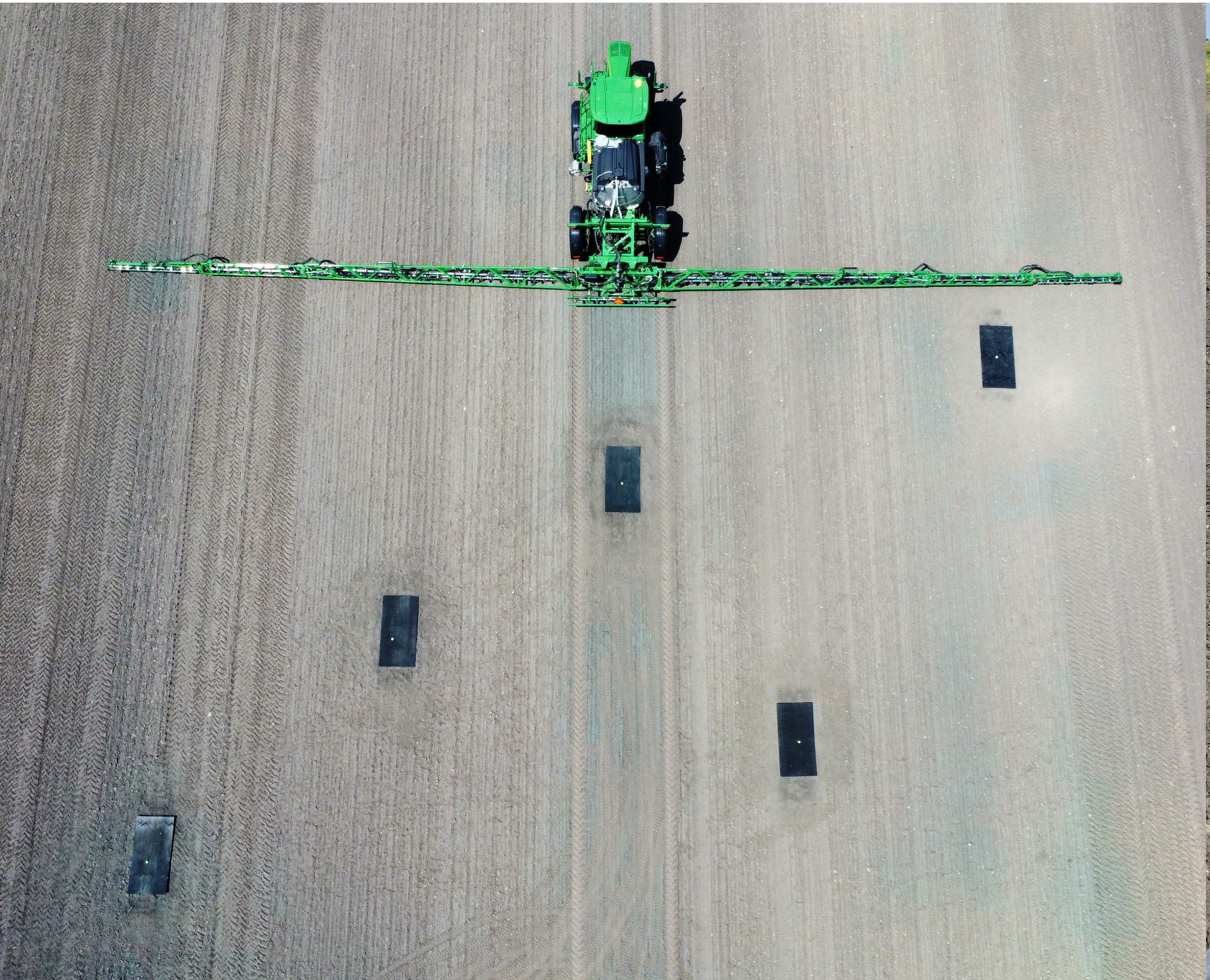
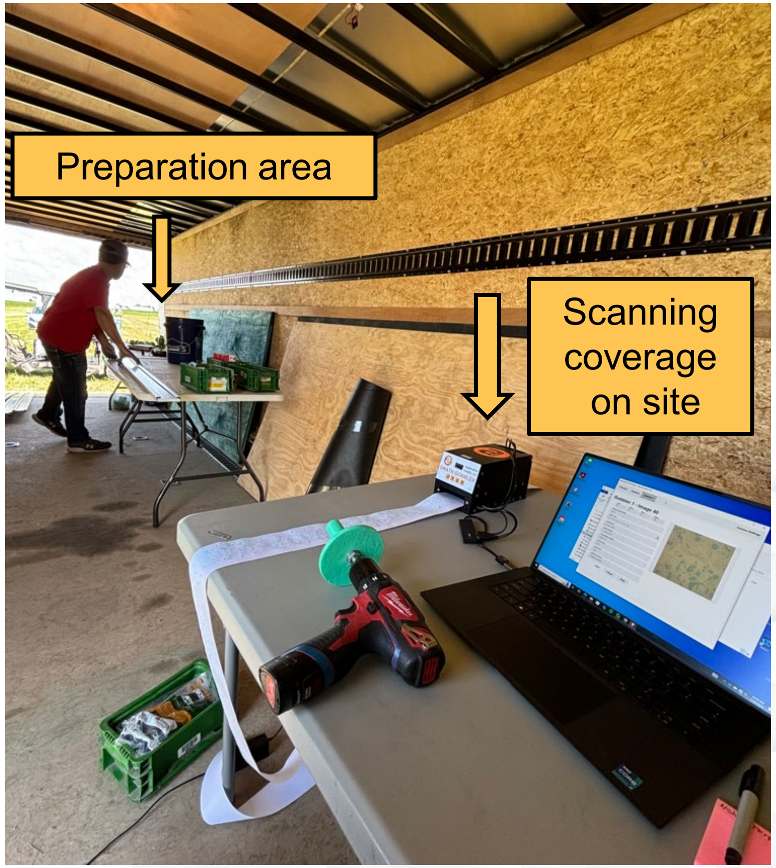


Spray Target and Coverage Analysis



Selected Spraying Key Take Aways

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- This technology is advancing very rapidly
- Our experience has demonstrated if the sprayer is setup correctly and in proper conditions it works as expected
- A lot more work is being focused on nozzle selection and efficacy

Growing Season Spraying Study

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Field 1 Prescription & Heat Map

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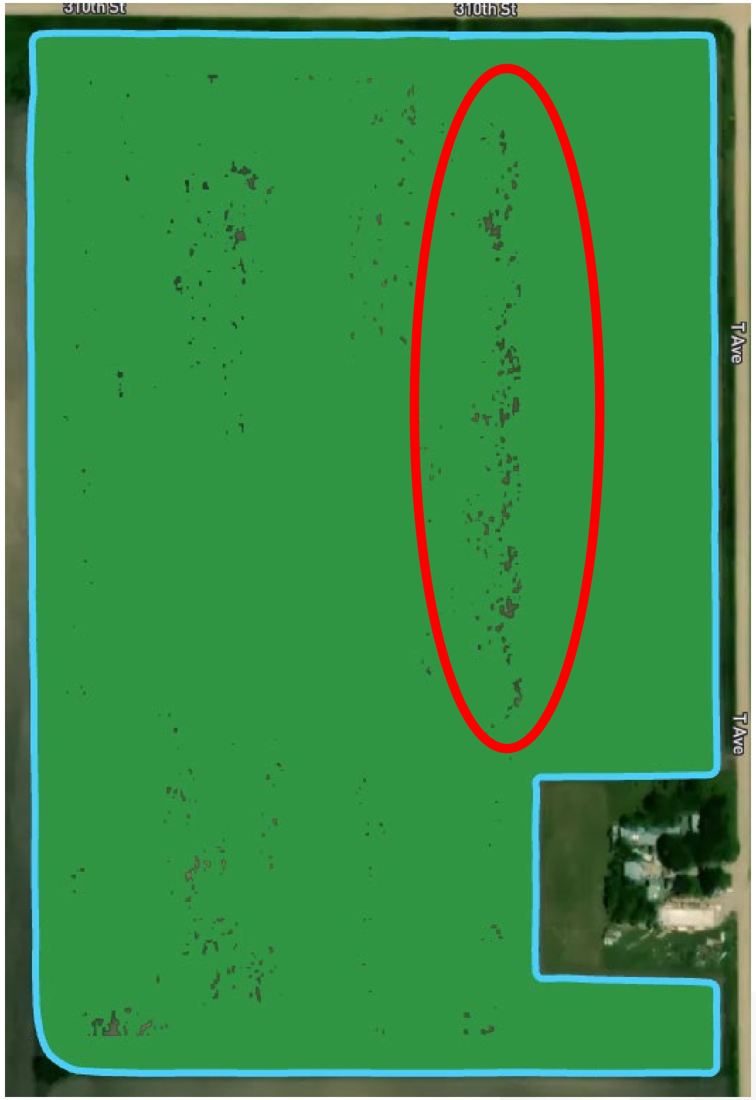

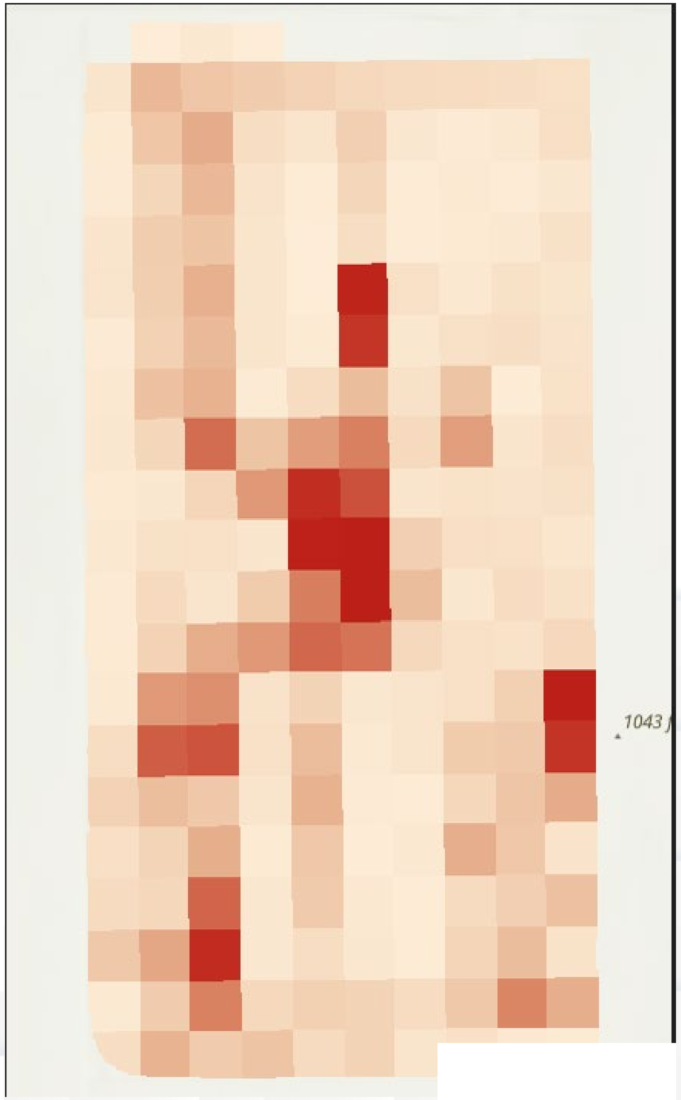

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Targeted Sprayer Efficacy: What Matters?

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- Droplet Formation
- Pattern Formation
- Droplet Delivery
- In-field Efficacy
- Continue developing database for Weed Identification

Impact of Selected Sprayer Coverage Benchmarking and Analysis

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- **Accurate Applied Rate**
  - Precise geo-spatial application
  - Crisp edge of area coverage

- **Optimal Nozzle and Application Height Selections**
  - Narrow nozzle (increased herbicide savings) vs. wide nozzle (increased coverage quality)
  - Down draft implications on pattern delivery

- **Coverage Quality**
  - Complete weed coverage in canopy environments

Using John Deere See & Spray with RX

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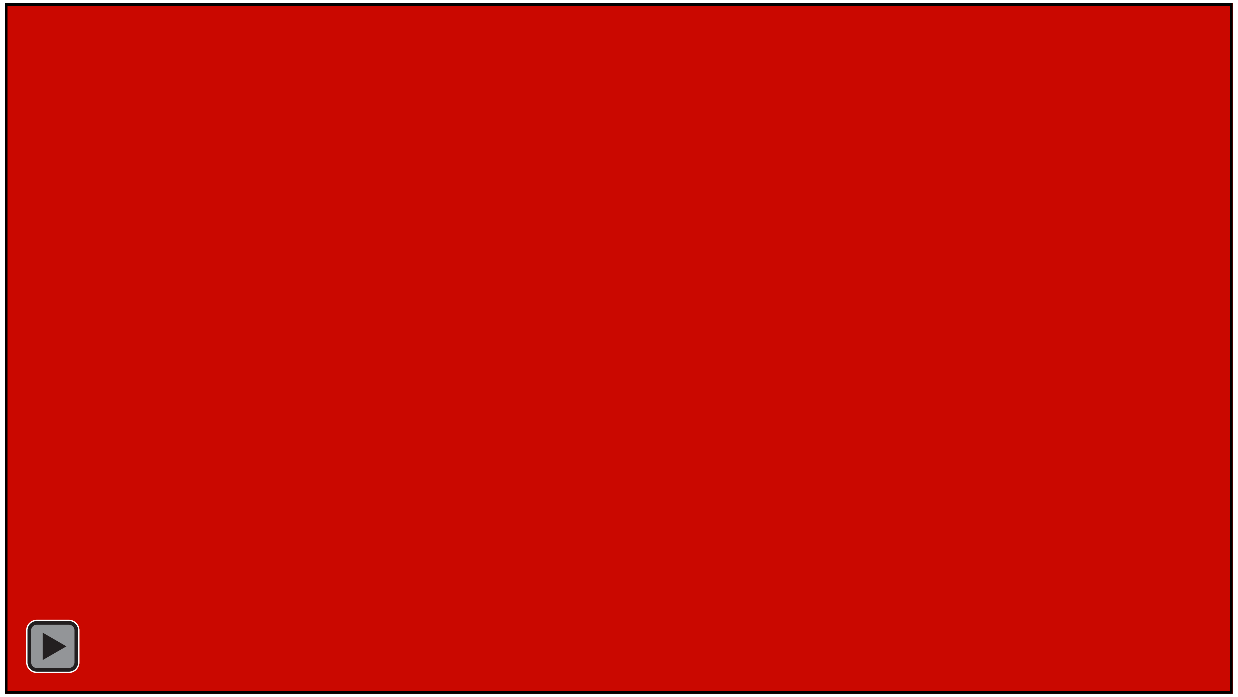
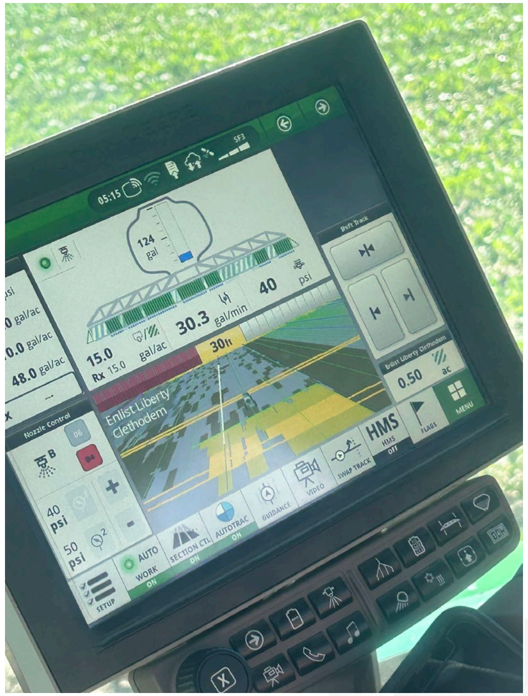
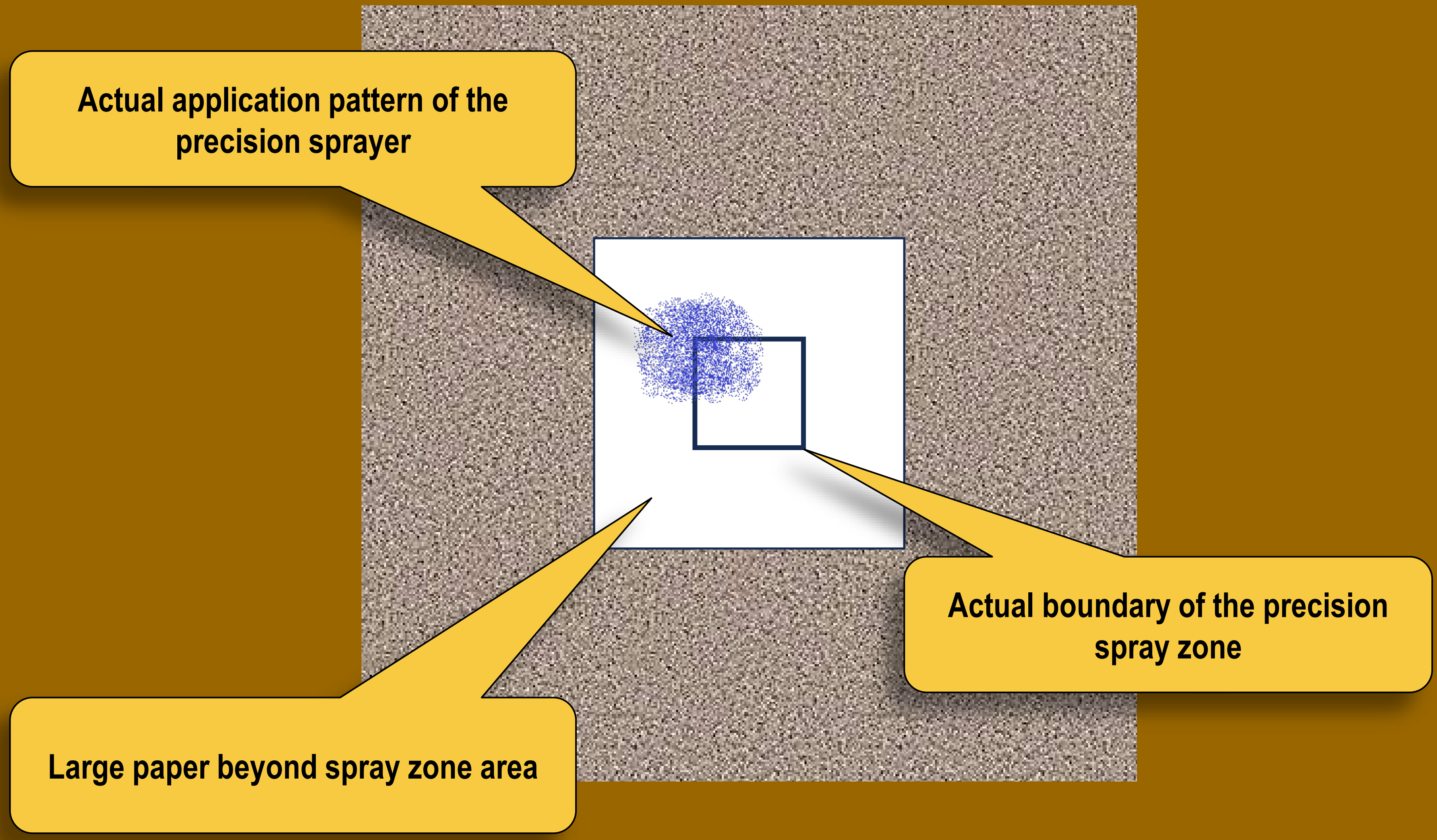
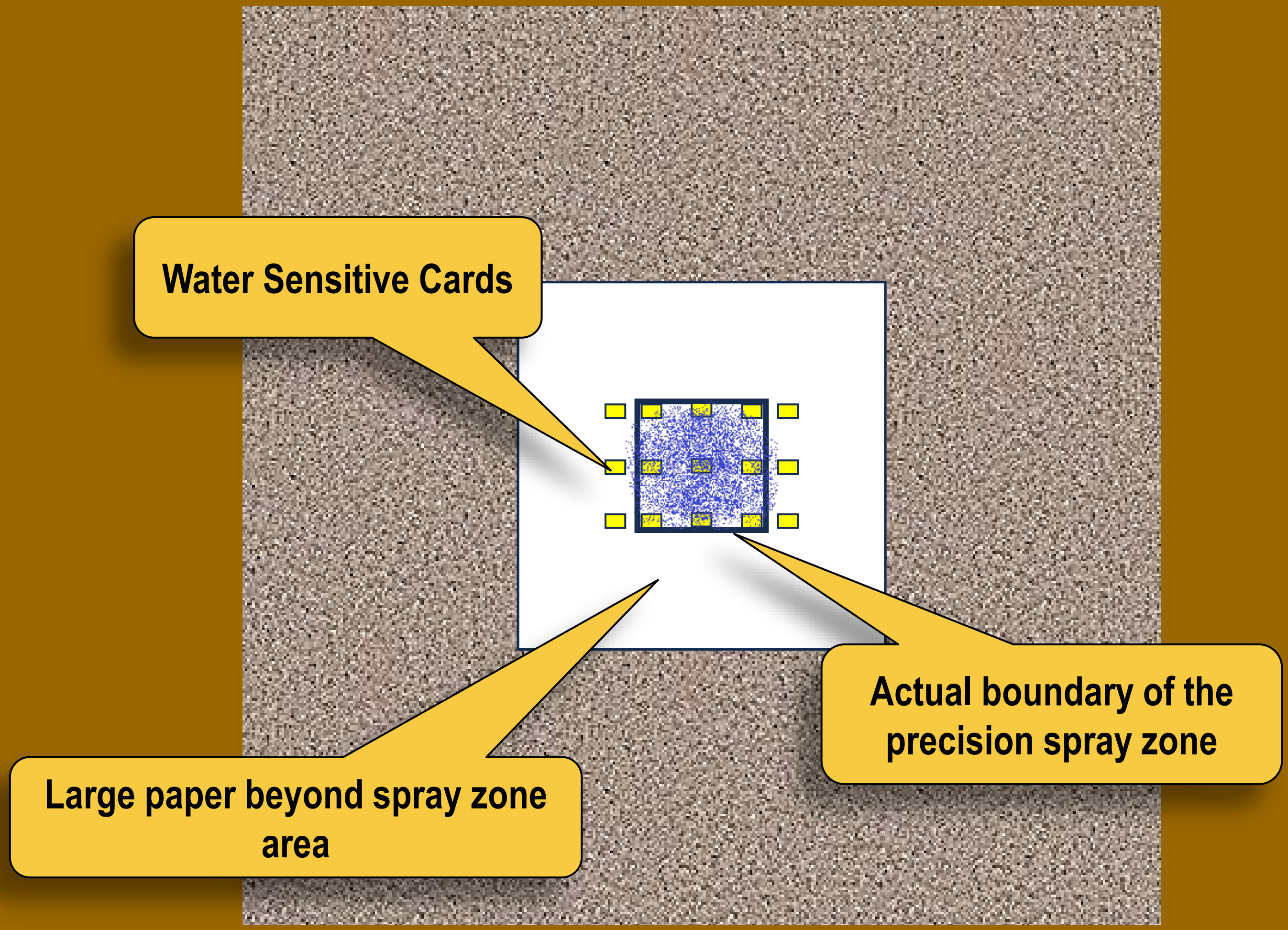
- Prescription application on June 30th.
- Boots on ground collecting weed count data.






Actual application pattern of the precision sprayer
Actual boundary of the precision spray zone
Large paper beyond spray zone area


Water Sensitive Cards
Actual boundary of the precision spray zone
Large paper beyond spray zone area

Coverage & Spray Pattern
Spray Card Data Collection Example

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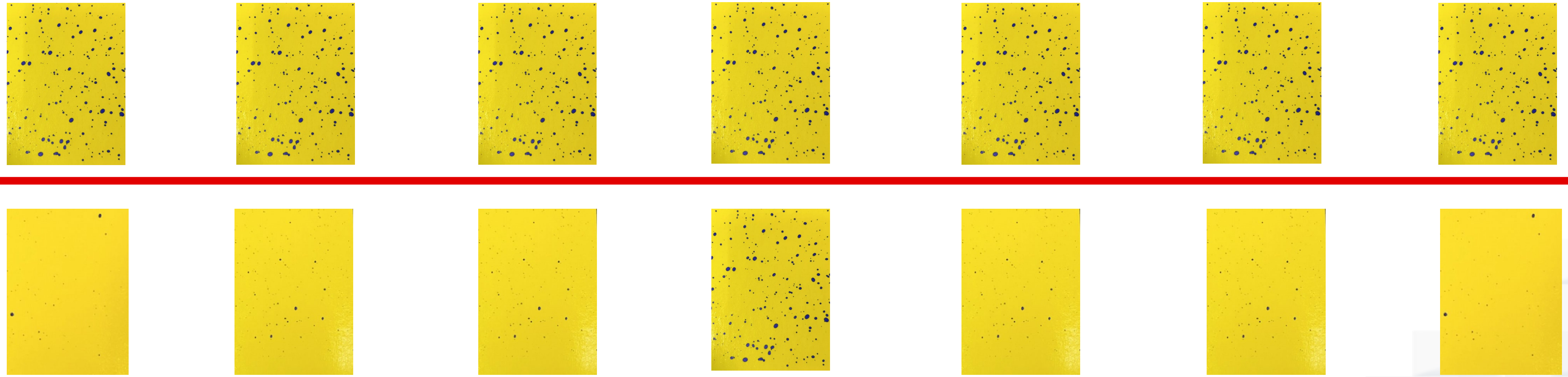
Top Row – Excellent Spray Pattern Example
Bottom Row – Poor Spray Pattern Example



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Boots on Ground Weed Count Data

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Field: Add Calculate Selection: Select By Attributes Zoom

	FID *	SHAPE *	Block	Treatment	Data_
1	63	Point ZM	3	Broadcast	Small -3/4". Dead 7-9
2	64	Point ZM	3	Broadcast	Medium 1.5" dead 7-9
3	65	Point ZM	3	Broadcast	Large -2" dead 7-9
4	66	Point ZM	3	Broadcast	Large- 4" dead 7-9
5	67	Point ZM	3	Broadcast	Medium, -1.5. Dead 7-9
6	68	Point ZM	3	Broadcast	Medium-1.75. Dead 7-9
7	69	Point ZM	3	Broadcast	Large -2.5. Dead 7-9
8	70	Point ZM	3	Broadcast	Large - 2" dead 7-9
9	71	Point ZM	3	Broadcast	Large - dead 7-9
10	72	Point ZM	3	Broadcast + Pre	Large. Dead 7-9
11	73	Point ZM	3	Broadcast + Pre	Large - 2". Dead 7-9

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Starting to Work with Spray Drones

Precision Spray Technology

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- Rapid Evolution of Spray Technologies
  - Reduce Chemical Usage
  - Precision Placement
  - Prescription Mapping
  - Increase Chemical Efficacy
- Capacity & Viability Increasing
  - Large Farms
  - Second-Pass Post & Late Season Escapes
- The success of a high precision spraying system is the cumulative outcome of numerous individual factors.
- Understanding the variables (machine and uncontrolled environmental factors) will impact customer acceptance.

Determine Capabilities of Spray Drones

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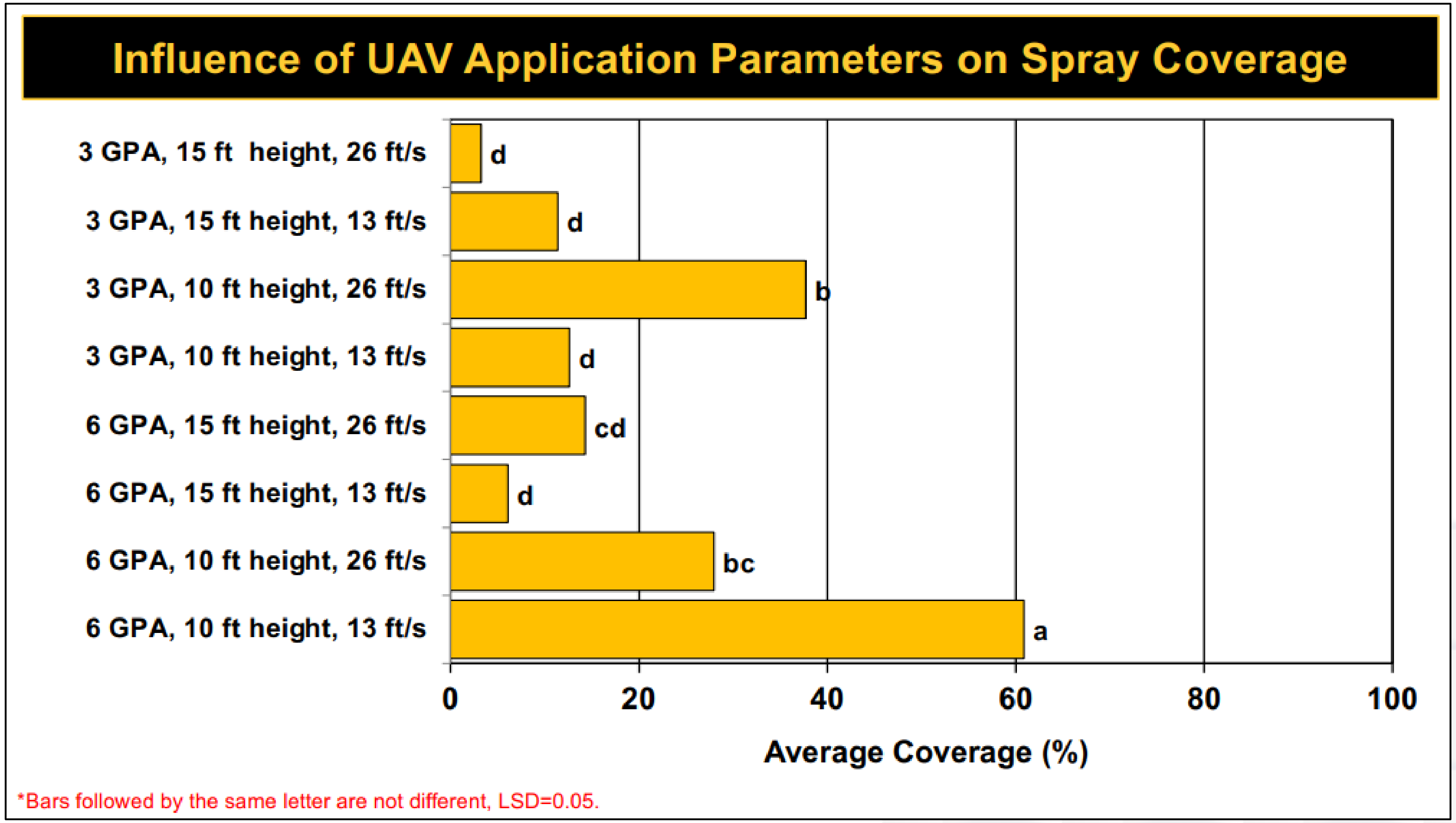
- Factors that can be controlled:
  - Nozzle Selection
  - Speed
  - Spray Height
  - Canopy Penetration
  - Swath Width/Overlap



University of Missouri, 2024

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Spray Drone Global Adoption

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- It's unknown how many drones and acres are being used in the US.
  - In 2021 China had >120,000 drones spraying 175.5 million acres.
  - US has >180 million acres of corn and soybeans alone.
- DJI was projecting spray drone sales for 2024 to be over 4,000 units in the US.
- Brazil has increasing interest in spray drone's applications.

Improving the agronomics & practical application of dry fertilizer

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Topics to Discuss

- Why are we seeing more issues with dry fertilizer today?
  - Example issues documented with imagery
- Discuss increased use of dry fertilizer
- Review key concepts governing dry product application
- Not going to cover, but extremely important to know
  - SGN sizing
  - Crush test

Why so many calls regarding poor spread quality in recent years?

Applying more dry product than we have in the past

- New/updated products
- Flexibility with timing
- Machine capacity

The need for quality

- Maintained equipment
- Proper equipment setup
- Good operators that care
- Quality product

What happened?


Sulfur Distribution Problem

Why strive for high quality?

- Advantages
  - Even spread pattern
  - Consistent agronomic performance
  - Right product, right place, right time
  - Happy clients!
- Disadvantages
  - Poor/variable crop performance
  - Over/under applied areas
    - Water quality impacts, wasted $, lost yield
  - Unhappy clients

Physical properties impacting spread

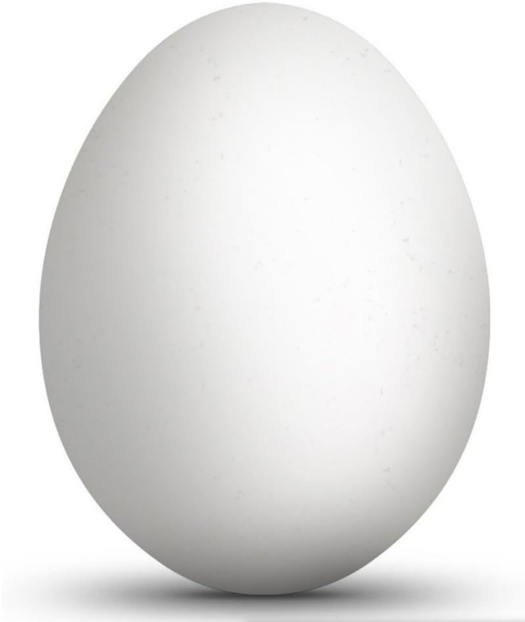
- Particle Size
  - (referred to as granule size)
- Particle Density
- Bulk Density
- Particle Shape
- Crushing Strength
- Flowability
- Coefficient of friction

Laws of physics for fertilizer application

What determines how far a fertilizer particle is thrown?

1. Initial speed of the particle
2. Initial height & trajectory of the particle
3. Mass of the particle
4. Shape of the particle

Interactions of Material Properties & Spreader Speed

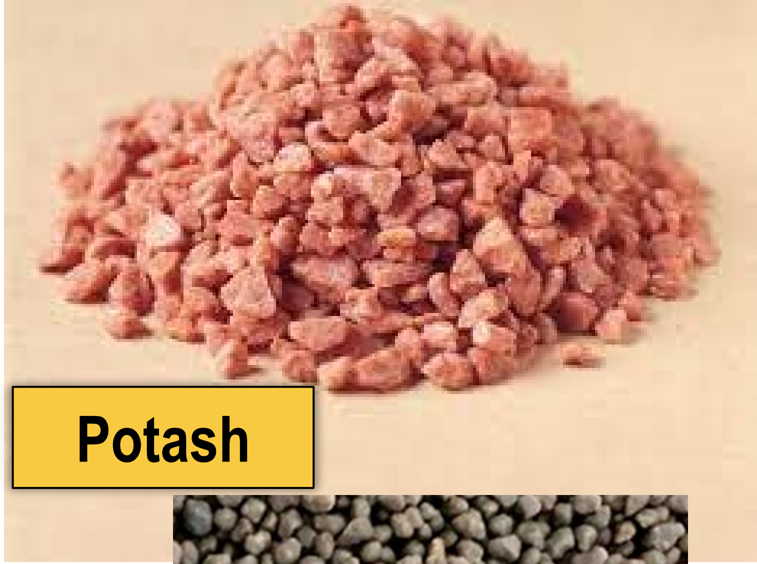


Spread width is dictated by the material properties, not the machine settings.

Avoidable Issues #1

Pan test your spread width and *shape*

Variability in Fertilizer Shape and Structural Integrity



Expectations for spreader calibration

- Pattern calibration is required for every **product** every **year** and at major **application rate** changes

AND

- When product conditions change due to **formulation or environment**
- **COV of 20% or less should be the target for a dry fertilizer applicator.**

    Note: A typical liquid applicator has a COV of less than 3%

Pan testing for spread pattern

Tips for Fertilizer Applications

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- Ensure all machines are pan tested for major fertilizers and common application rates each year.
- Be thoughtful of in-field rate changes. Rate changes of 2x or more are going to create a higher risk profile for pattern shifts.
- Know your customers. Those that are managing closer to the inflection point on fertility curves are going to be more susceptible to pattern inaccuracy.
- Leverage air booms when needed for more precise application.

Wrap Up

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- Selective Spraying Technologies are changing very rapidly due to imagery recognition systems powered by AI Training Databases
- Current drivers:
  - Set standardize spray pattern standards
  - Leverage more platforms for applying inputs; spray and imagery drones
  - Continue to refine calibrations on dry spreaders

Resources

- New Leader testing components
  - Pan test kit: 313960
  - Crush/SGN test kit: 308907
- Bulk density scale
  - Barn door ag: https://barndoorag.com/fertilizer-density-scale-fe8000/
  - FE8000 or similar

https://www.extension.iastate.edu/digitalag/dry-fertilizer-setup-and-calibration-resources

Resources

https://www.extension.iastate.edu/digitalag/dry-fertilizer-setup-and-calibration-resources

- Physical Properties of Granular Fertilizers and Impact on Spreading
  - https://ohioline.osu.edu/factsheet/fabe-5501
- Spinner-Disc Spreader Set Up and Calibration
  - https://ohioline.osu.edu/factsheet/fabe-561
- Correcting Irregular Spread Patterns
  - https://ohioline.osu.edu/factsheet/fabe-562
- Proper Spinner-Disc Spreader Operation, Terms and Definiti
  - https://ohioline.osu.edu/factsheet/fabe-563