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# Cautions and Considerations for Using Drones to Spray Herbicides

**Bryan Young**
*Purdue University*

# Who Are You?

Custom UAV application pilot
Farmer UAV application pilot
Farmer considering hiring a custom UAV application
Farmer considering purchasing and becoming a UAV application pilot

# Spray Drone Capabilities and Challenges

**What's the Benefit?**

- Terminology
- Pros/Cons of spray drone use
- Spray parameters compared to traditional sprayers

**Spray Operations**

- Spray drone configurations and calibration
- Field operations setup
- Will herbicides work using drones?

**Regulations, Labels, Insurance**

- Federal Aviation Administration
- Pesticide labels:  U.S. EPA and State Lead Agencies
- Not your normal farm insurance

# Terminology

While some people refer to these systems as ‘drones’, the term only refers to the aircraft itself. The phrase ‘Unmanned Aerial System’ or UAS refers to

# Terminology

Remotely Piloted Aerial Application Systems (RPAAS)
Unmanned Aerial Vehicles (UAV)
Small Unmanned Aerial System (SUAS)
Remotely Piloted Vehicle (RPV)
Remotely Piloted Aircraft (RPA)
Remotely Operated Aircraft (ROA)
Unmanned Aerial System (UAS)
Unoccupied Aerial Vehicle (UAV)
Uninhabited Aerial Vehicle (UAV)

# Advantages of Spray Drones

Relatively low cost compared to ground equipment

Navigate challenging field sizes, shapes, terrains, soil conditions, crop stages

Less water carrier to haul

Reduced pesticide waste?

Limited parts and required maintenance

# Burcucumber in Corn


Jeff Burbrink, Purdue Univ.

**Wet weather during the spring sometimes posed a problem for the Wilsons when they wanted to terminate cereal rye ahead of no-tilled corn. They bought this 60-foot-wide Top Air ATV sprayer and pull it with a John Deere Gator to get through wet spots and terminate rye in a timely manner without damaging their fields or getting stuck.**

Cover Crop Strategies
https://www.covercropstrategies.com/articles/245-no-tillers-stay-flexible-to-get-the-most-from-cereal-rye

Challenges with Spray Drones

Rapidly evolving technology with variable configurations

Limited payload for spray solution

Is 2 GPA good enough for herbicide activity?

Navigating the FAA licensing

Labor intensive per acre (takes 2 to spray legally)

Pesticide label directions not specific enough for spray drones

# Aerial Application Equipment

Photo credit: General Aviation News

## Fixed-wing

- Capacity:
  90 to 790 gal
- Speed:
  124 to 143 mph
- Boom Orientation:
  No greater than
  70% of wingspan
- Ferrying Distance:
  Often long

Photo credit: Botse Aviation

## Single-rotor

- Capacity:
  20 to 60 gal
- Speed:
  50 to 62 mph
- Boom Orientation:
  No greater than
  70% of rotor length
- Ferrying Distance:
  Long or short

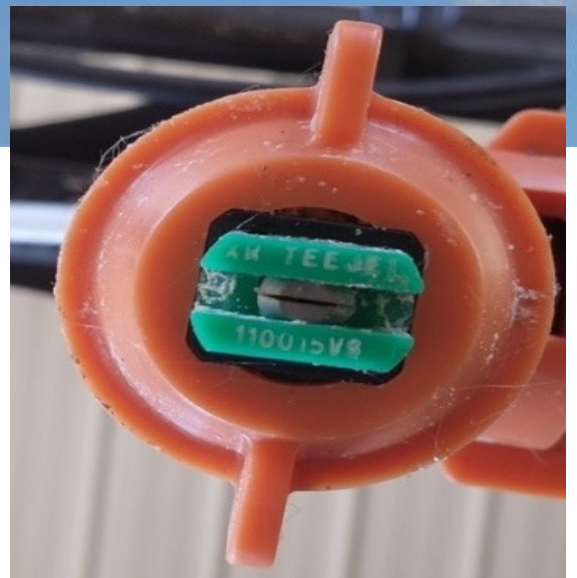
Photo credit: Made-In-China

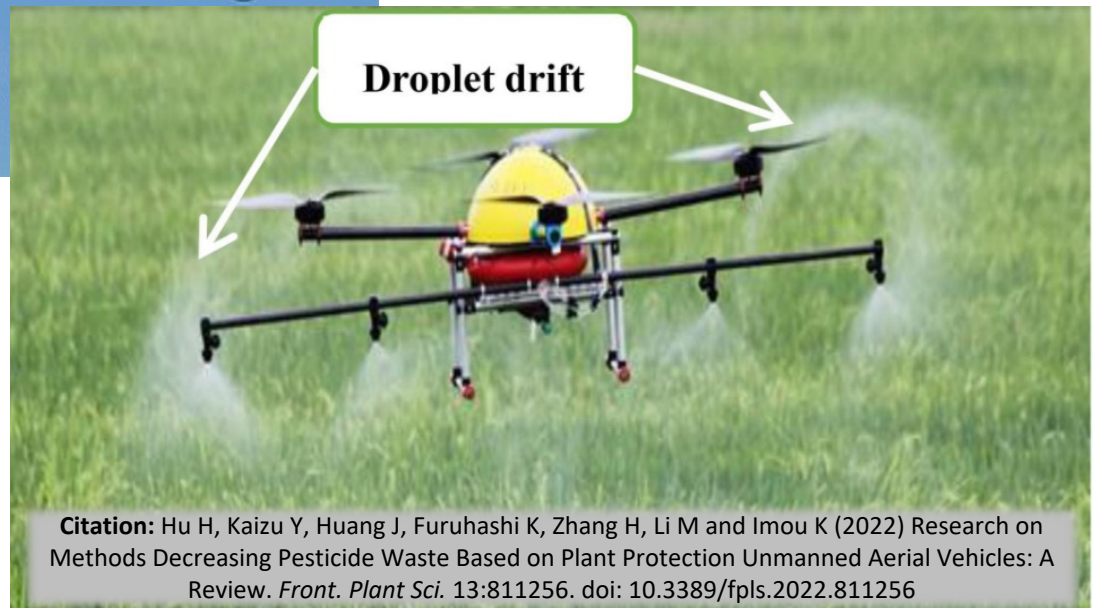
## Multi-rotor

- Capacity:
  2.6 to 18.5 gal
- Speed:
  6 to 30 mph
- Boom Orientation:
  Varies between
  models
- Ferrying Distance:
  Short

# Spray Drone Variations

## *Linear Boom*




**Citation:** Hu H, Kaizu Y, Huang J, Furuhashi K, Zhang H, Li M and Imou K (2022) Research on Methods Decreasing Pesticide Waste Based on Plant Protection Unmanned Aerial Vehicles: A Review. *Front. Plant Sci.* 13:811256. doi: 10.3389/fpls.2022.811256

# Spray Drone Variations

*Nozzles at Rotors*

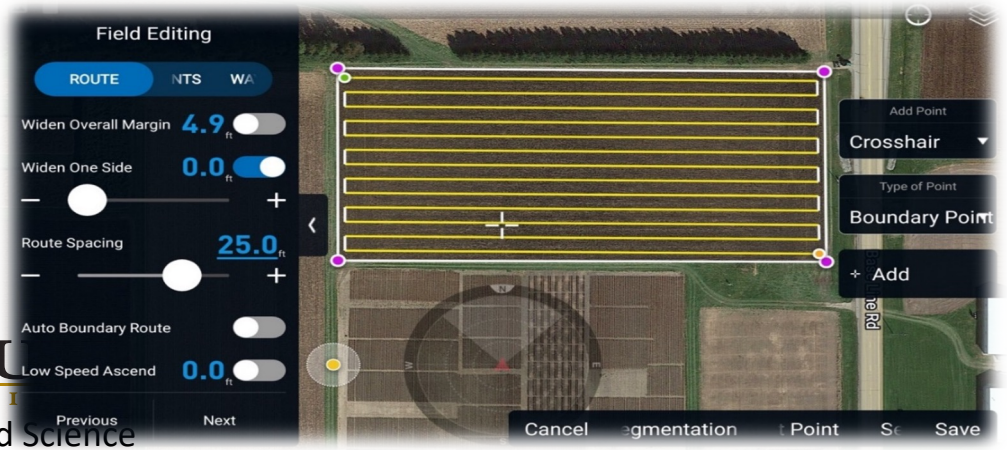
# Spray Drone Variations

## *Rotary Nozzles at Rotors*

*aka* “Controlled Droplet Applicators” (CDAs)


# Pre-Flight Checks

- ❑ Set/inspect field boundaries
- ❑ Check for <u>any</u> obstacles
  - Extending tree limbs
  - Power lines
  - Irrigation equipment
- ❑ Identify staging area with best line-of-sight



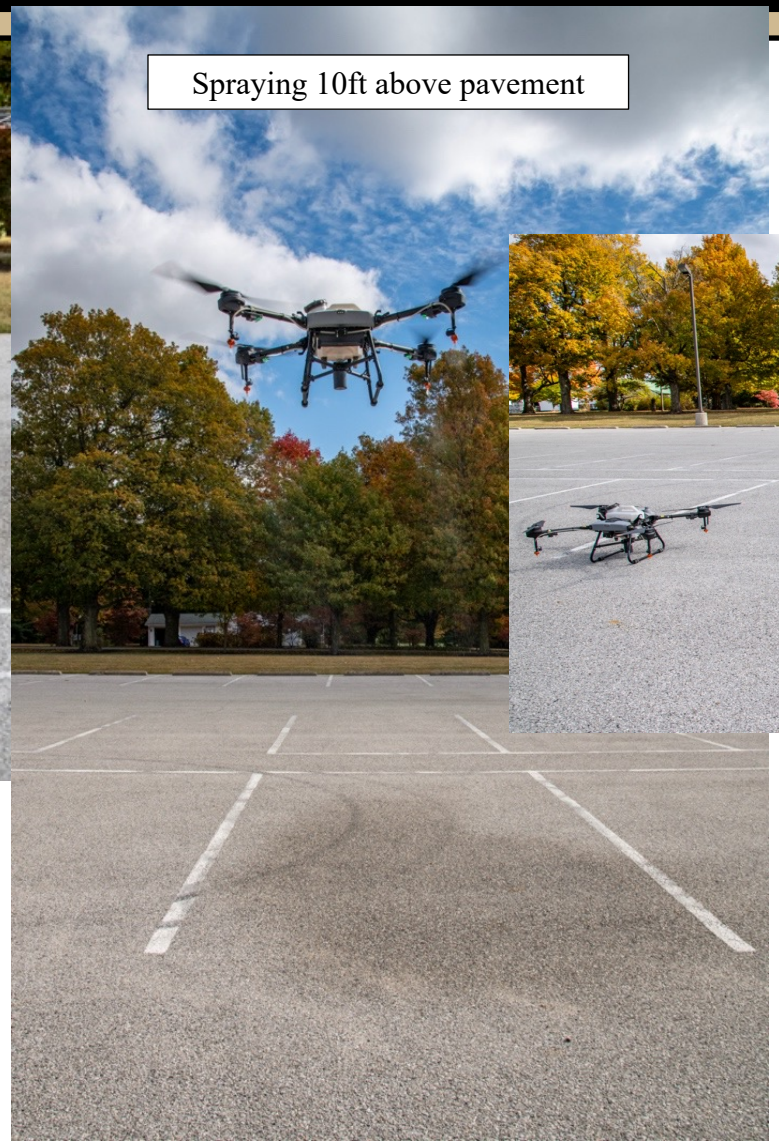

This is an example of a difficult field to fly due to the rolling hills and the potential to lose contact and visual line of sight with the drone. The operator may have to fly half of the field from this end of the field and find another vantage point to fly the rest of the field.

# Pre-Spray Checks

- ❑ Chemical compatibility at low carrier volume (2 *vs* 15 GPA)
- ❑ Start with clean/calibrated sprayer
  - Correct GPM output
  - Confirmed spray swath

# Spray Height and Swath Determination

Spraying 5ft above pavement



Spraying 10ft above pavement

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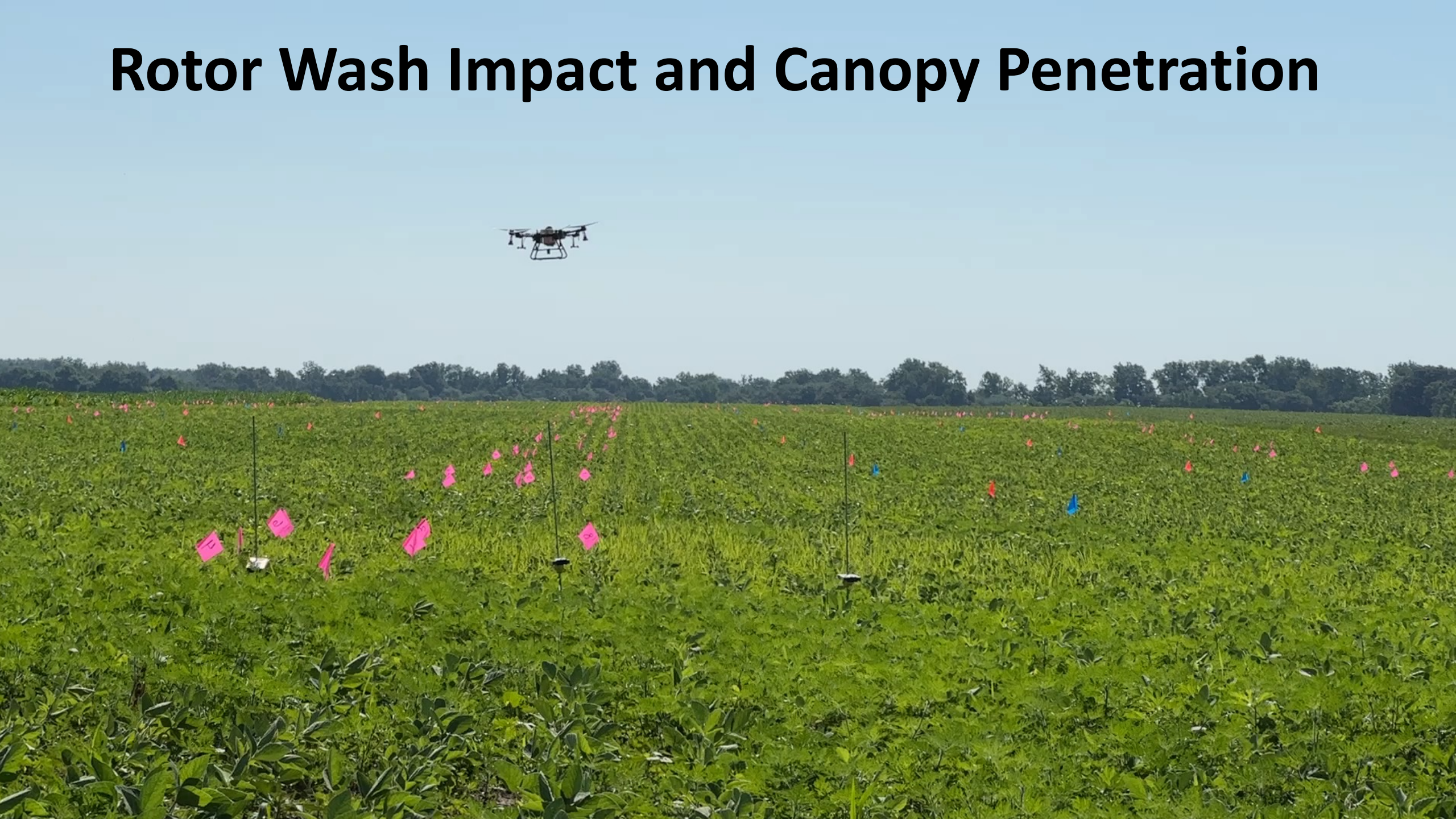
# Rotor Wash Impact and Canopy Penetration



# Daily Spray Operations

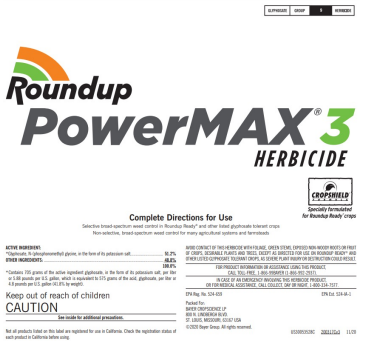
- If 55 lbs or greater, NOTAM required 24 hours prior to application
- If you want to cover significant acres, a sophisticated setup improves time efficiency.

# Pesticide Labeling for Drone Application


## ***Meeting Conclusions***

- Must improve alignment of regulations, pesticide labeling, and drone technology development
- Drones must currently follow aerial application label requirements
- ***Can*** drone applications follow current product label requirements? **NO**
- Supplemental labels may be necessary, but presents significant challenge

DO NOT APPLY THIS PRODUCT USING AERIAL APPLICATION EQUIPMENT EXCEPT UNDER CONDITIONS SPECIFIED ON THIS LABEL OR ON SEPARATELY PUBLISHED SUPPLEMENTAL LABELING FOR THIS PRODUCT.

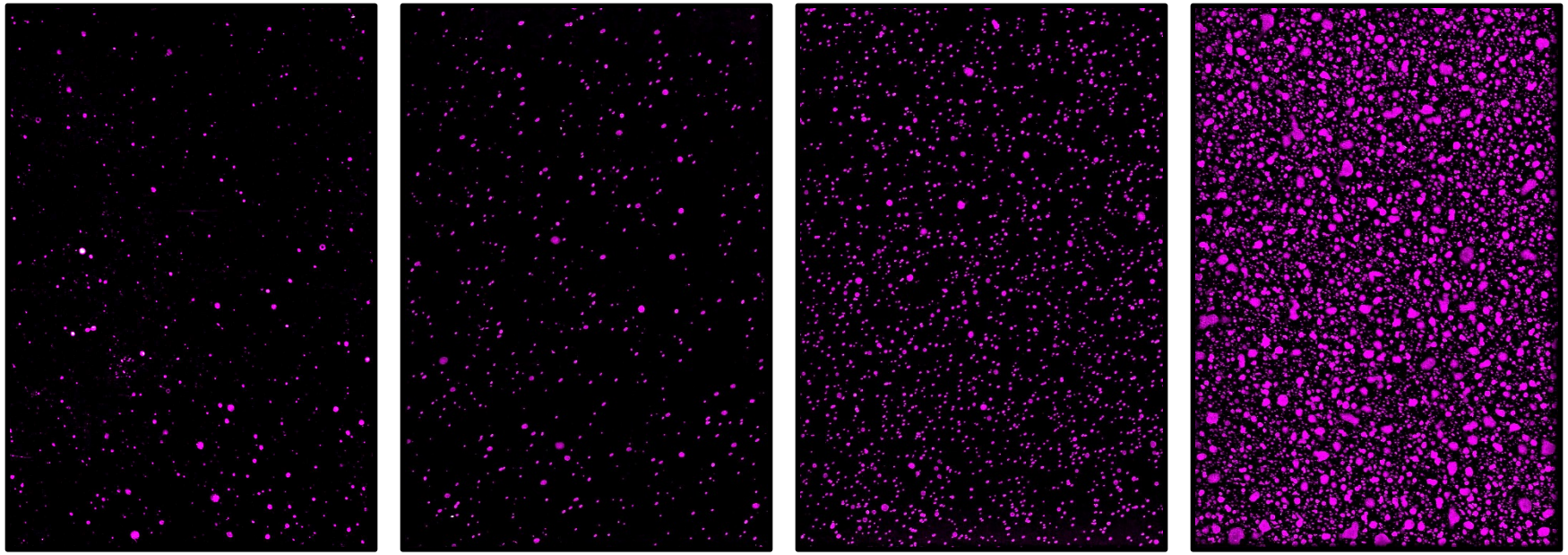


# Labeling Conflicts

| Product Label | Manned Aircraft | Drone Practice |
|---|---|---|
| **Applicator PPE** | As directed on the label | FAA doesn't want Pilot directly involved with pesticide handling |
| **Wingspan/rotor diameter ratio to boom length** | Boom spans ~70% of wingspan | Several boom and nozzle types/configurations |
| **Nozzle orientation** | Backwards; parallel to airstream | Parallel with rotor wash? |
| **Travel speed** | 50 to 140 mph | 5 to 30 mph |
| **Droplet size** | "Apply the largest droplets that provide sufficient coverage and control" | Medium or larger droplets may not always be possible |
| **Boom height** | 10ft or less | Higher increases swath width |
| **Wind speed** | 2 to 10 mph | Can rotor wash reduce impact of wind? |
| **Carrier volume** | 3 to 15 GPA | Less than 3 GPA ideal |
| **Tank mixtures** | As directed on the labels | Low carrier volumes; weak spray systems; poor to no agitation |

# Spray Coverage

*(top of spray card; center of drone)*

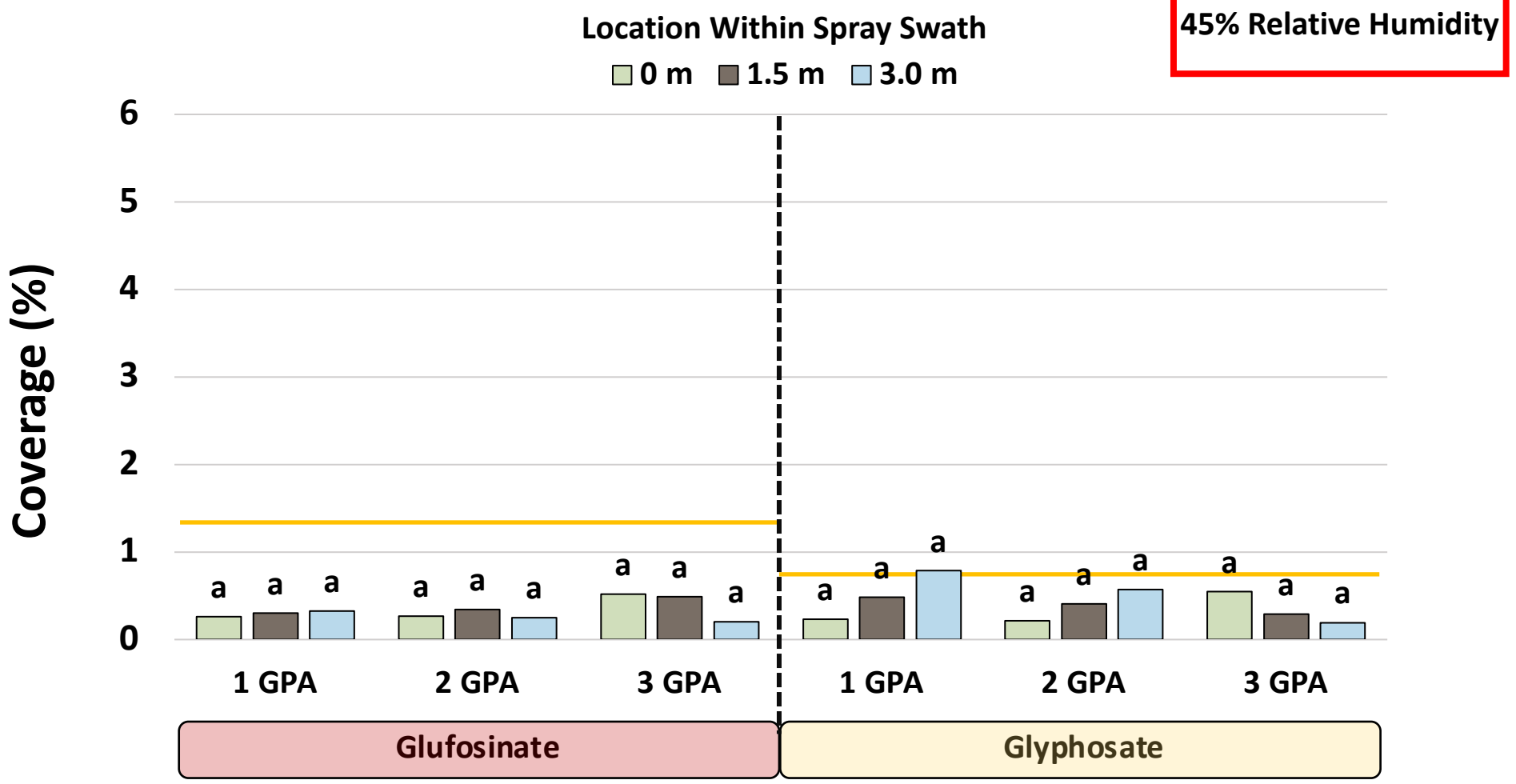


| 1 GPA | 2 GPA | 3 GPA | 15 GPA |
|---|---|---|---|
| 7.2% | 12.2% | 47.1% | 62.3% |
| Drone | | | Hand Boom |

Hunter Medenwald
*Purdue University*

# Spray Coverage
*(Underside of spray card)*

32°C
45% Relative Humidity




Hunter Medenwald
*Purdue University*

# Can UAV Application Be?

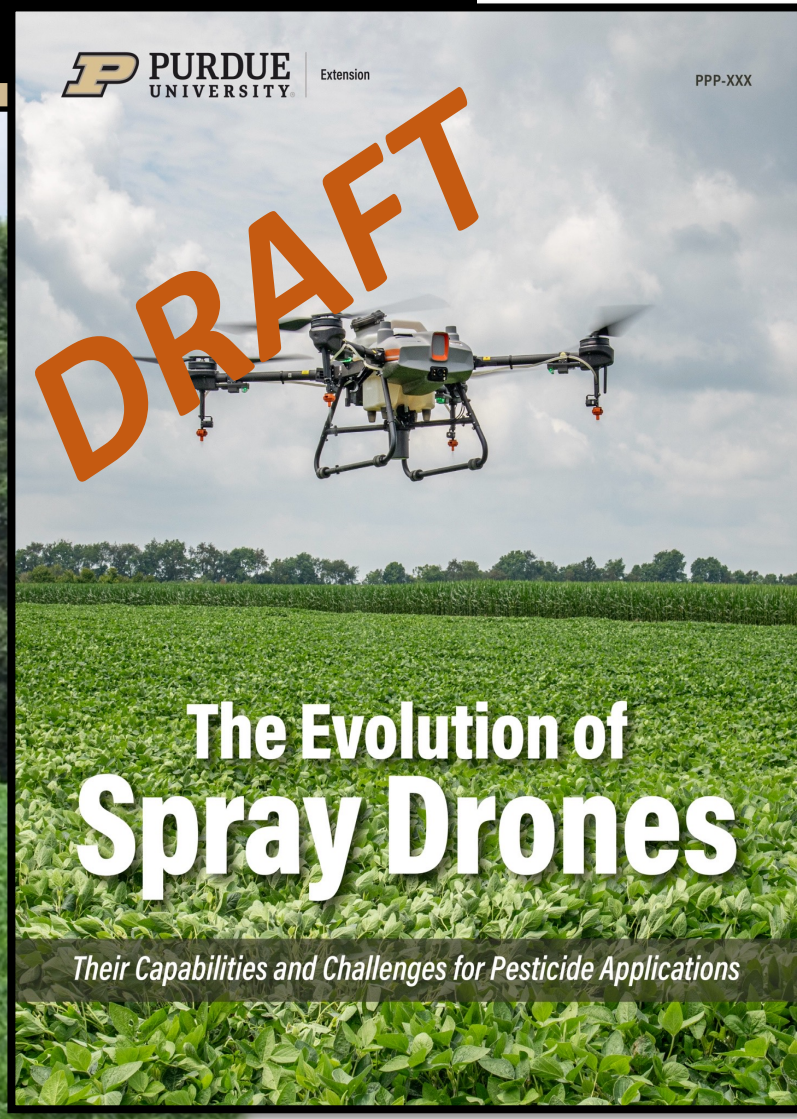
***Questions needing answers:***

- ✓ Will we arrive at a “standard” drone configuration that meets some performance expectations?
- ✓ How/when will the pesticide labeling issue be resolved?
- ✓ Who’s liable if a product not clearly labeled for drone application doesn’t perform?
- ✓ What’s the easiest way to confirm swath width and calibration for new pilots?
- ✓ Can anyone explain how drone applications might work when basic manufacturers are promoting up to 20 GPA for ground applications?

# Considerations Before Purchasing a Drone

- ❑ Timely applications may justify the cost
- ❑ Enough acres to justify expense
- ❑ Labor availability during the time of year you anticipate drone applications
- ❑ Comfort with new computer and precision ag operating systems
- ❑ Insurance costs

# Questions?

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