Spray Deposition and Efficacy of Cotton Harvest-Aid Applications with a Spray Drone and Ground Sprayer

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Introduction

- The application of Unmanned Aerial Systems (UAS) have been increasing rapidly in agriculture
- Multiple UAS platforms are available commercially today for aerial application of crop protection products **(drone sprayers)**
- Drone sprayers offer several potential benefits: *spot-spray applications, timely applications in wet fields, improved canopy penetration, etc.*

Cotton Defoliation

- Cotton harvest aids are used to remove foliage, enhance boll opening and inhibit regrowth
- Along with traditional ground sprayers, aerial application of cotton harvest-aids with manned aircraft is common in the southeastern US
- Increased interest recently among growers and commercial applicators in utilizing spray drones for defoliating cotton
- Limited information is available on spray performance and efficacy of cotton harvest-aid applications with spray drones

Hypothesis

Spray drones will exhibit an improved spray deposition and efficacy of harvest-aids compared to a ground sprayer

Objective

To evaluate and compare the spray deposition and efficacy of harvest-aids applied with a spray drone and ground sprayer

Methods and Materials

- **Location**: Midville, GA (UGA Research Farm)

- **Drone Sprayer**:
  - DJI Agras T40 (DJI Technologies)
  - 10.5 gallon tank, rotary atomizers
  - Application height: 8 ft
  - Flight Speed: 10 mph

- **Ground Sprayer**:
  - 6700 John Deere Self-propelled sprayer
  - 60-ft boom, 20 in. nozzle spacing
  - Ground speed: 8 mph

Methods and Materials

- **Study Treatments:**
  - Drone Sprayer
    - 3 GPA & 5 GPA
  - Ground Sprayer
    - 5 GPA & 10 GPA
- Each treatment (sprayer and volume) was replicated four times
- Each strip measured 8 rows wide (24 ft) and 350 ft long
- For harvest-aid applications, experimental design was organized into blocks

Data Collection

Spray Deposition:

- Using water-sensitive paper (WSP) placed at fixed top, middle, and bottom heights of the canopy across the swath (8 rows).

Defoliation Efficacy:

- Defoliation (%), open bolls (%), desiccation (%), and regrowth (%) was recorded 10 days after application.

Yield and Fiber Quality:

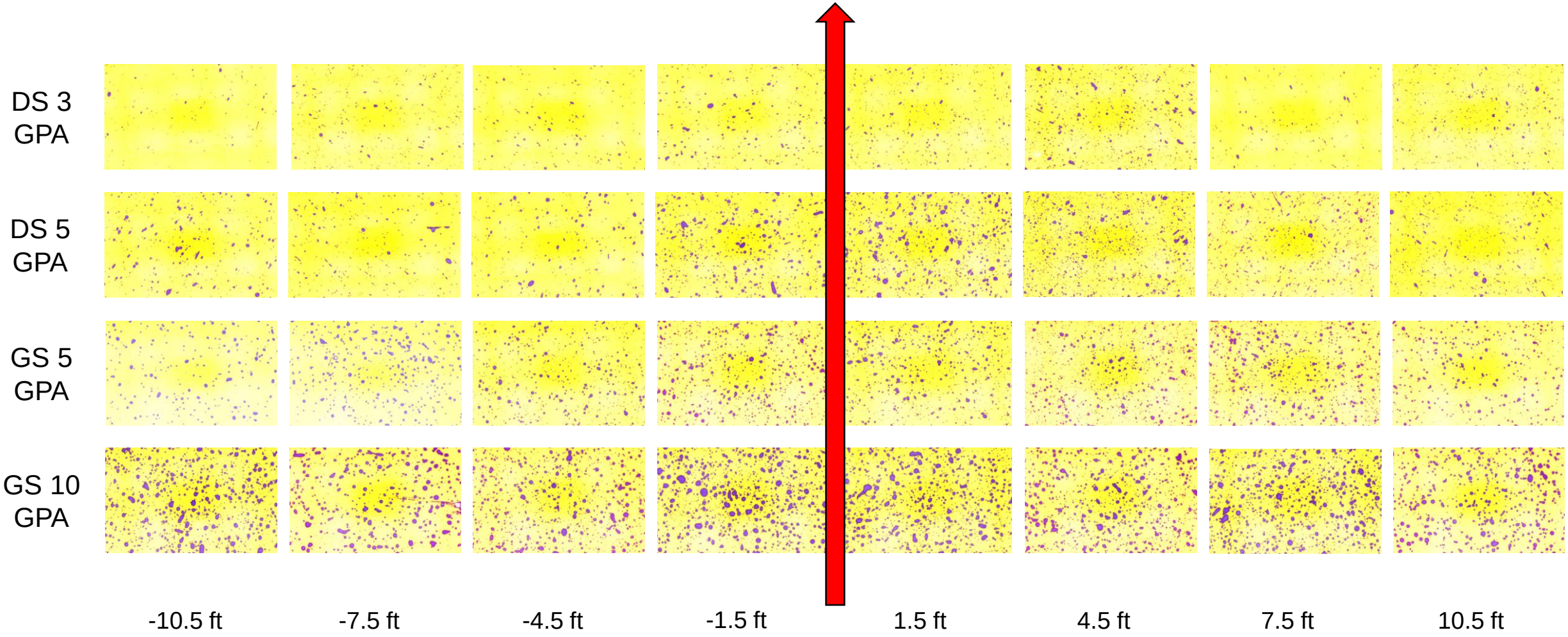
- Yield was recorded by harvesting middle 4 rows within each plot. Cotton samples were taken from each plot to assess lint and fiber quality.

Data Analysis

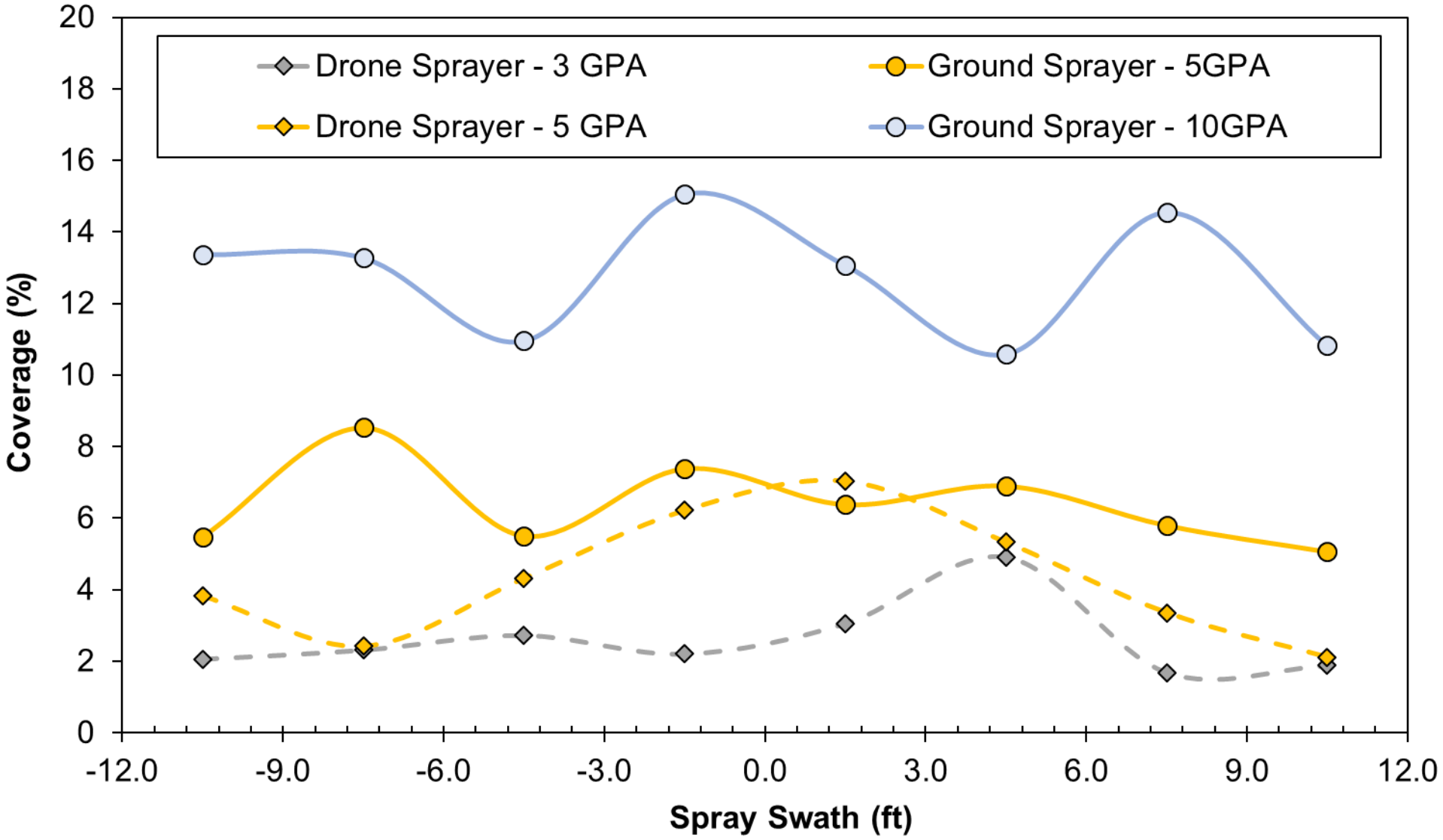
- WSP were analyzed using the SprayX DropScope instrument (Sao Paulo, Brazil)
- Spray coverage (%) by each position within the canopy and across the swath was determined from the replicated data
- All statistical analysis was conducted using JMP Pro 16.0 (SAS Institute, NC)
- Data were subjected to ANOVA using $\alpha=0.05$. Means were separated using the Student's t-test ($p \leq 0.05$)

Results

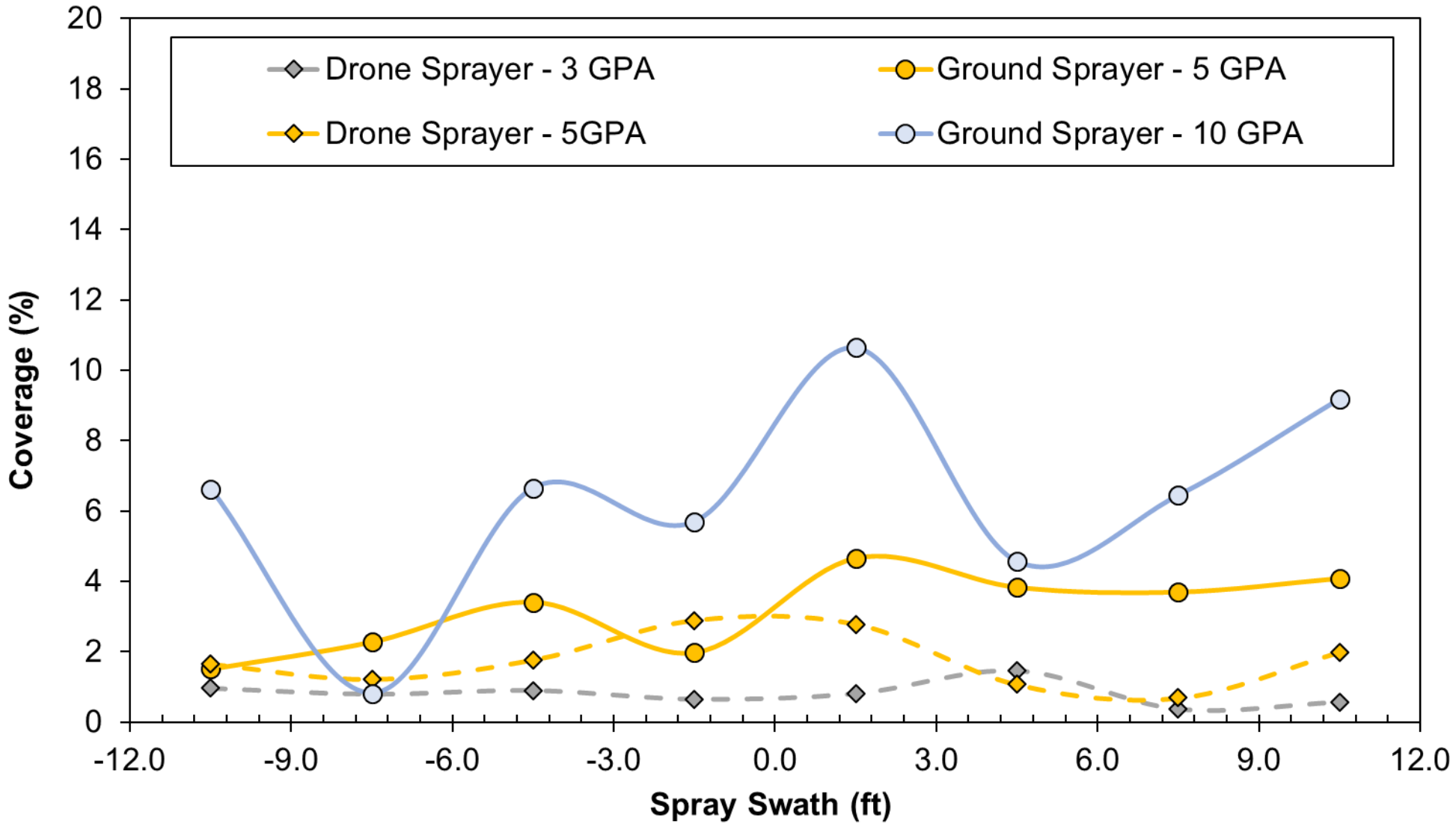
Top Canopy Position



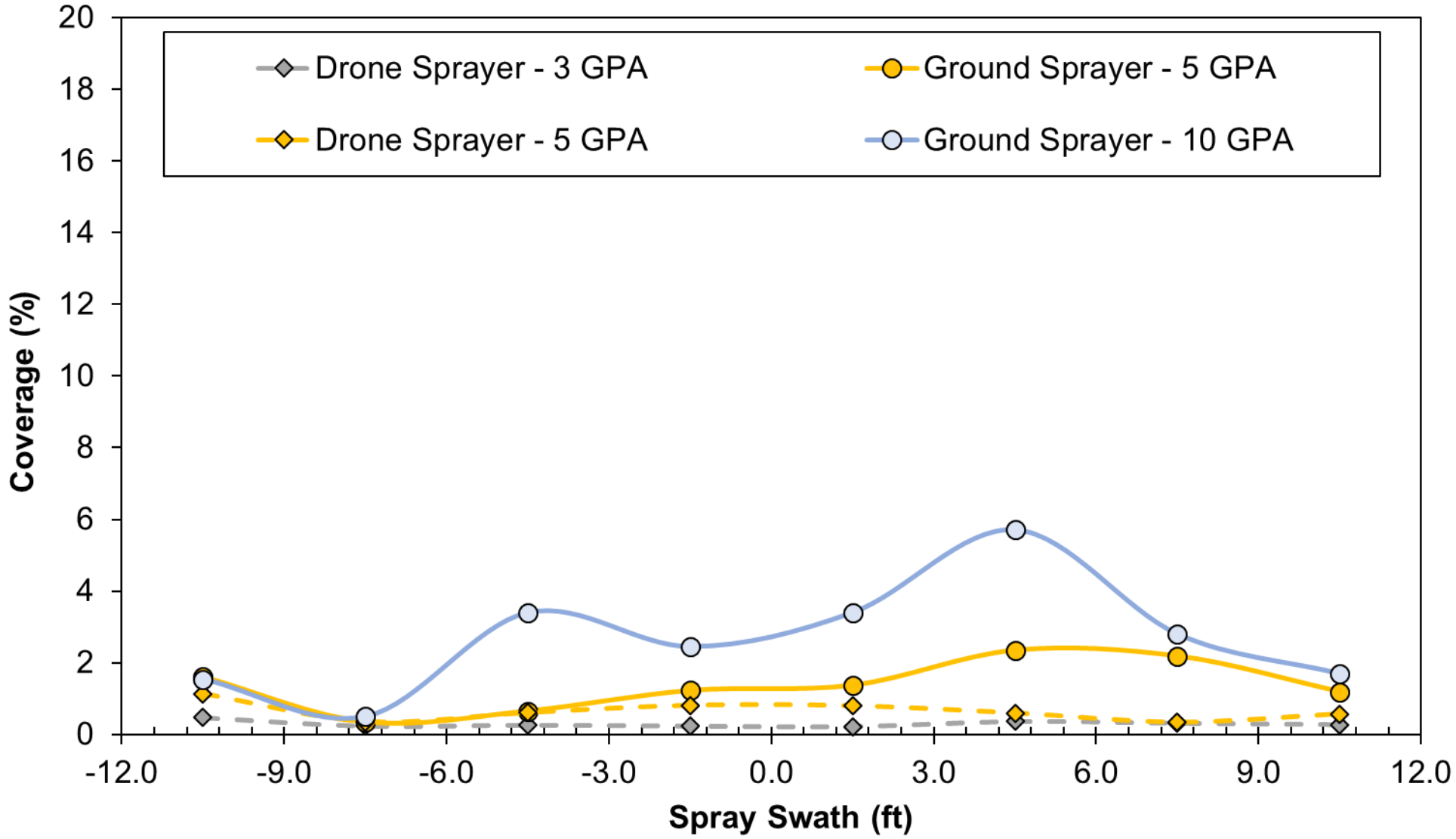
Spray Deposition – Top Canopy



Spray Deposition – Middle Canopy



Spray Deposition – Bottom Canopy



In-Swath Spray Deposition and Uniformity

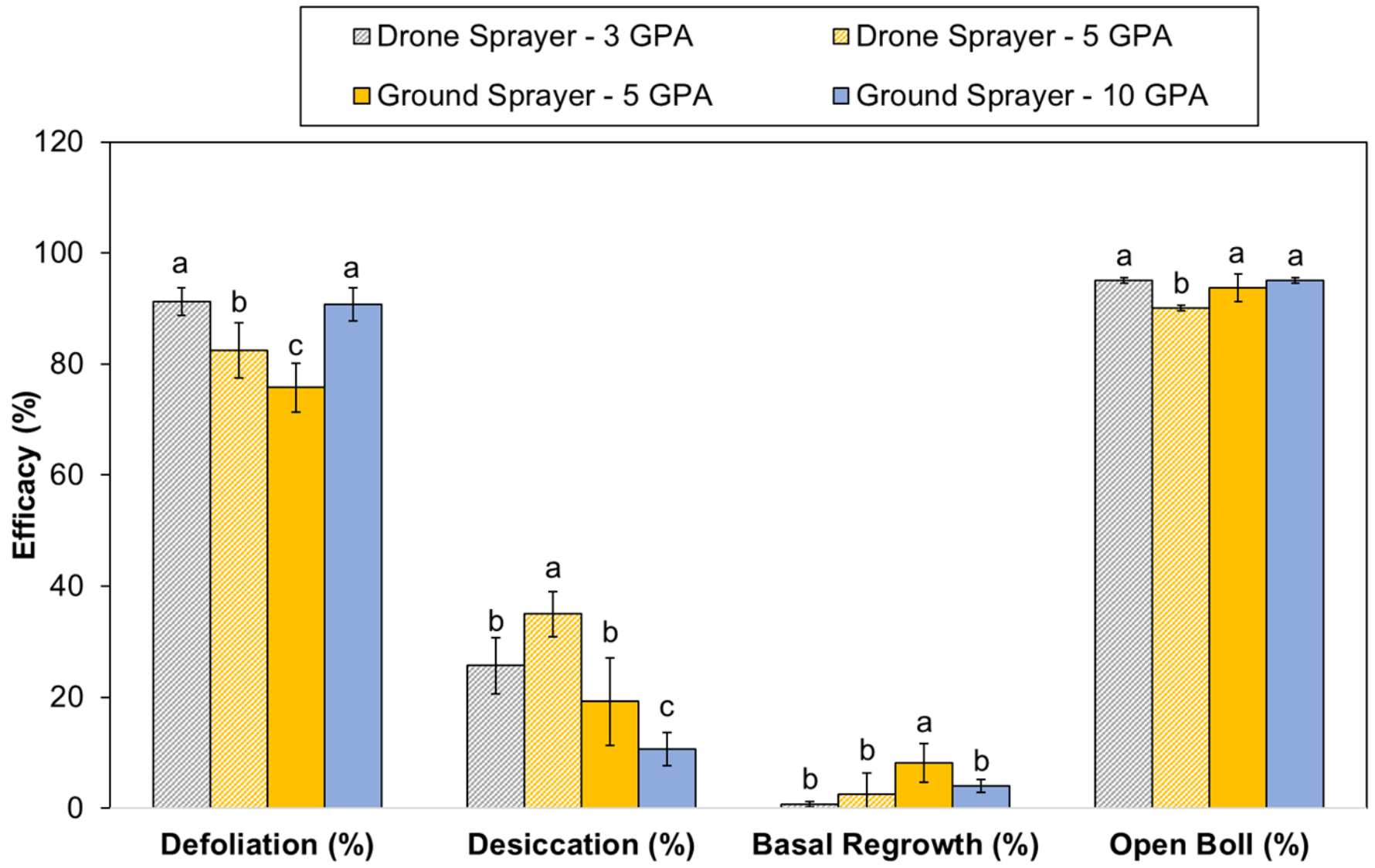
Sprayer	Rate (GPA)	Top		Middle		Bottom	
		Coverage (%)	CV (%)	Coverage (%)	CV (%)	Coverage (%)	CV (%)
Drone	3	2.6 d	63	0.8 c	64	0.3 c	46
	5	4.3 c	51	1.8 c	66	0.7 c	47
Ground	5	6.4 b	31	3.2 b	63	1.4 b	71
	10	12.7 a	19	6.3 a	57	2.7 a	74

Defoliation Efficacy

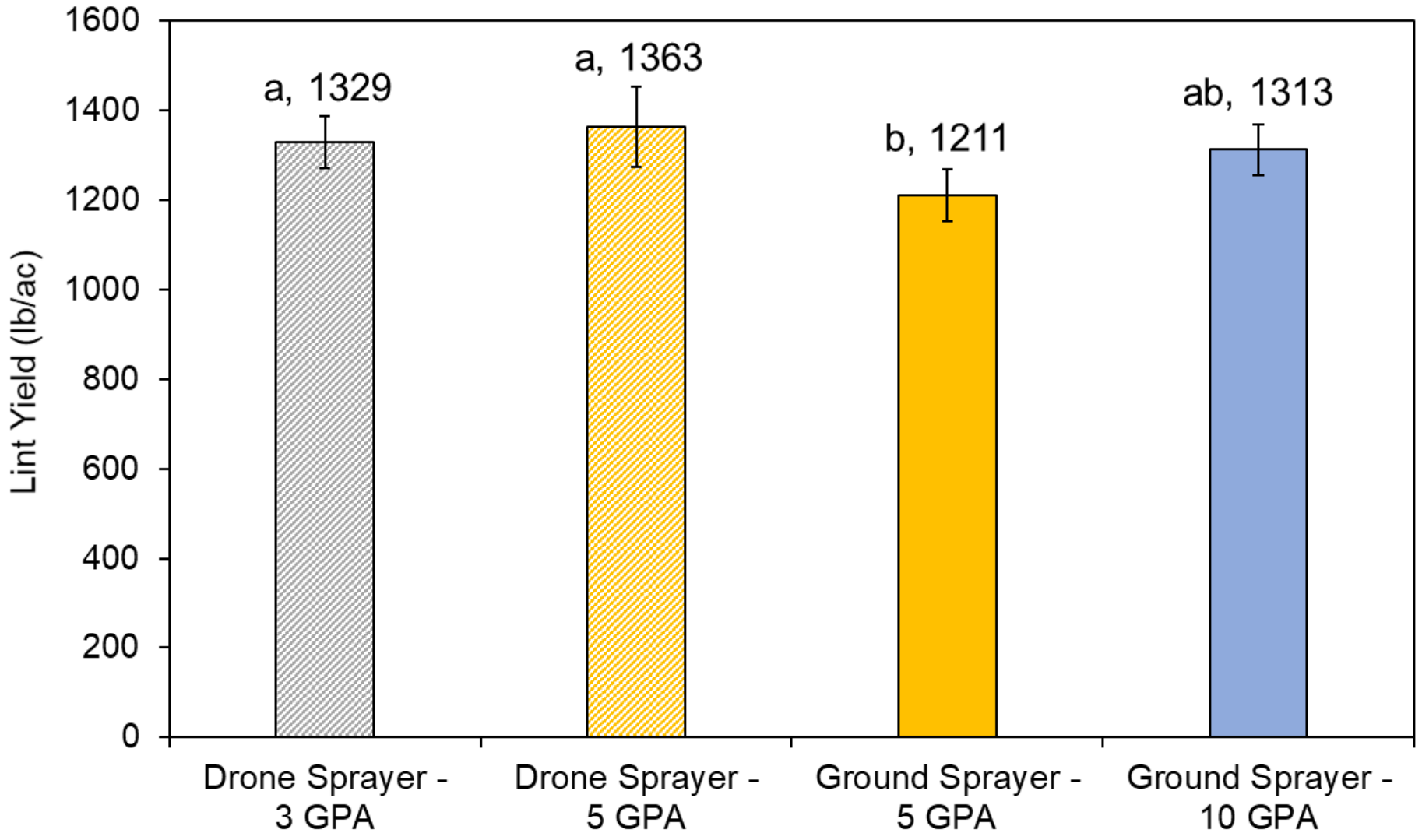
Effect of sprayer and rate on defoliation efficacy (ANOVA results)

Effects	p-value
Defoliation (%)	0.0002
Desiccation (%)	0.0002
Terminal Regrowth (%)	0.4262
Basal Regrowth (%)	0.0107
Open Boll (%)	0.0003

Defoliation Efficacy

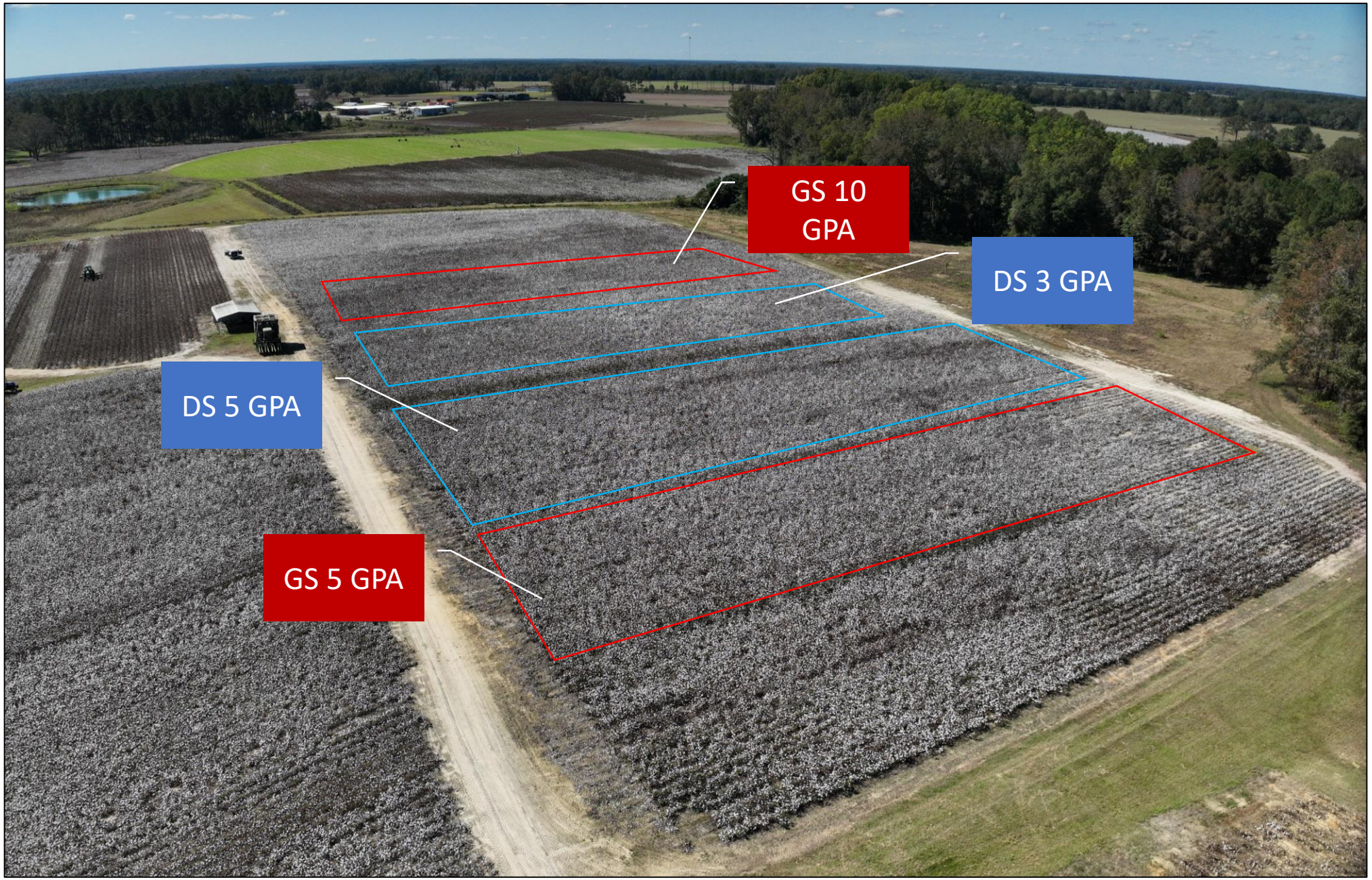


Cotton Yield



Cotton Fiber Quality

Fiber Quality Parameter	Drone Sprayer 3 GPA	Drone Sprayer 5 GPA	Ground Sprayer 5 GPA	Ground Sprayer 10 GPA
Color Grade*	31.0 b	41.0 a	31.0 b	31.0 b
Staple	38.0	38.8	38.0	39.0
Micronaire	4.5	4.3	4.5	4.4
Strength	30.5	30.9	30.2	30.3
Leaf Grade	2.3	1.8	2.0	1.8
Rd	79.1	77.8	79.0	78.9
PlusB	7.3	7.1	7.6	7.5
HVI Trash	0.3	0.2	0.2	0.1
HVI Length	1.19	1.21	1.19	1.23
Uniformity	82.3	82.1	81.6	82.5


GS 10
GPA
DS 3 GPA
DS 5 GPA
GS 5 GPA

Conclusions

❑ Spray Deposition:

- The ground sprayer resulted in higher spray deposition than the drone sprayer at all canopy heights.
- Deposition uniformity decreased with height for the ground sprayer, but improved for the spray drone.

❑ Defoliation Efficacy:

- The drone sprayer showed comparable defoliation to the ground sprayer, however, the ground sprayer had significantly lower regrowth and desiccation.
- Increased application rates for the drone sprayer resulted in lower efficacy.

❑ Cotton Yield and Quality:

- Yield and fiber quality variability between application methods were minimal and likely caused by in-field spatial variability.

Future Research & Practical Implications

- **Future research**
  - Additional on-farm large-scale studies evaluating spray deposition and efficacy of harvest aid applications with drone sprayers, manned aircrafts and ground sprayers
  - Evaluation and optimization of application parameters (height, speed, droplet size, etc.) for spray deposition performance from drone sprayers
- **Implications**
  - The use of spray drones for cotton defoliation is likely to increase each year. Research studies like these helps understand the performance of spray drones compared to other methods
  - Spray performance and efficacy data will help inform best management practices and effective technology utilization

Thanks!

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