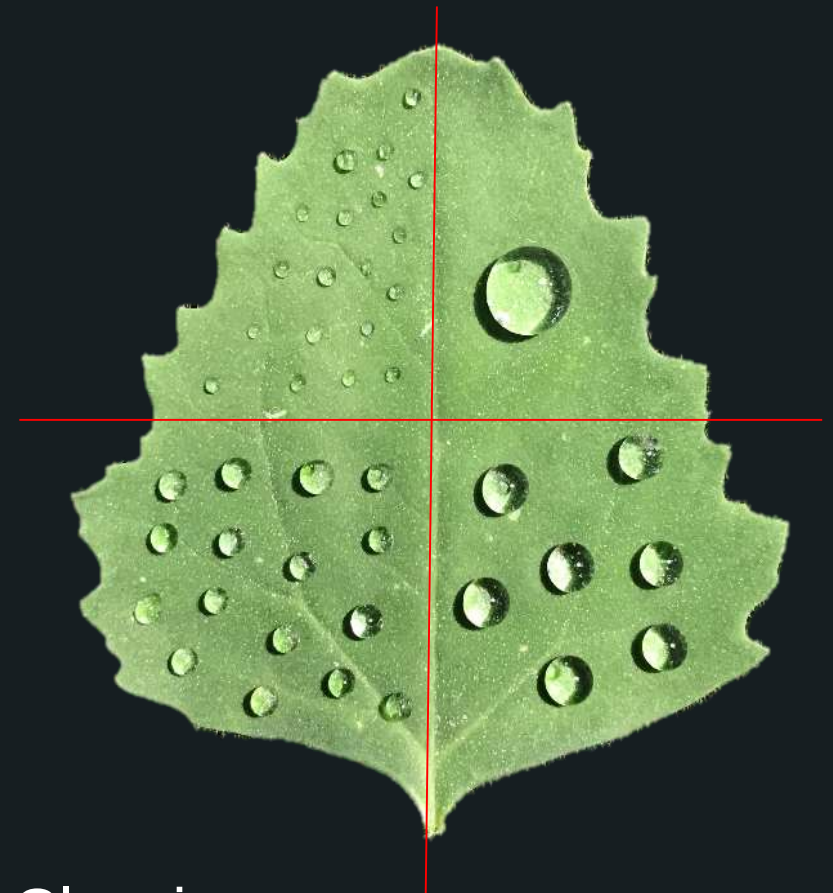


Herbicide Applications: Finding a Balance Between Drift Control and Efficacy



Wisconsin Agribusiness Classic

Madison, WI

Thomas R. Butts, Extension Weed Scientist

Courtesy of: <http://sprayers101.com/drop-arms-improve-spray-coverage-on-field-peppers/>

Courtesy of: Jes Moraes, University of Nebraska-Lincoln

Weed Management History



“The farmer has many problems.”



The farmer has many problems. He confers with specialists on plant disease (top left); hog management (bottom left); soils (top right); and dairy management (bottom right).

Hammonds and Woods 1938. *Today's Agriculture*. 498p.

Herbicide Drift



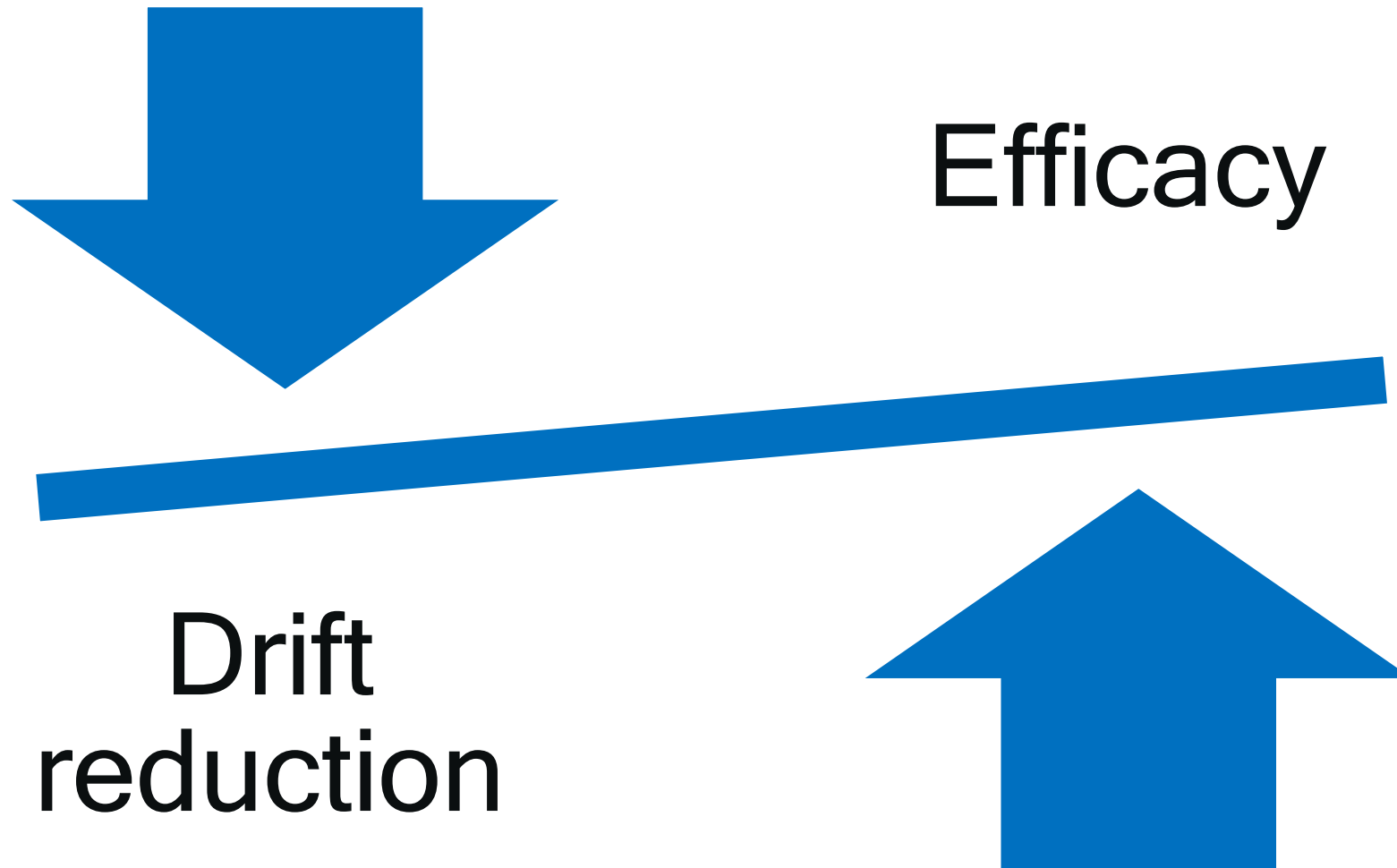
<http://sprayers101.com/drop-arms-improve-spray-coverage-on-field-peppers/>

How far will particles go?

Droplet	Diameter (in μm)	Time to fall 10 ft	Travel distance in 3 mph wind
Fog	5	66 min	15,840 ft
Very fine	20	4.2 min	1,100 ft
Fine	100	10 sec	44 ft
Medium	240	6 sec	28 ft
Coarse	400	2 sec	8.5 ft
Fine rain	1,000	1 sec	< 5 ft

Source: *Herbicide Spray Drift*, NDSU Extension

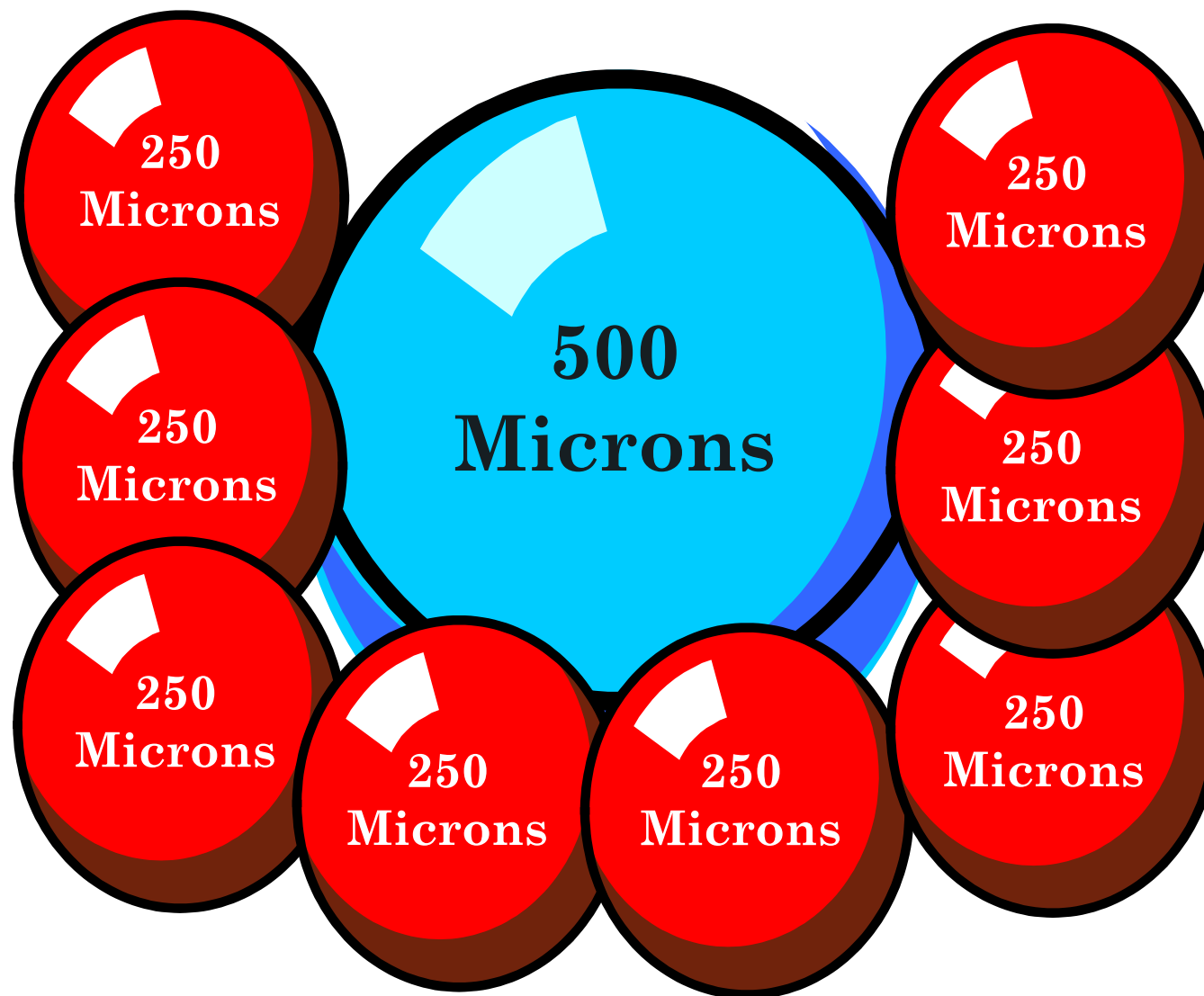
Optimizing Applications



Droplet Size vs. Coverage

Cutting Droplet Size in Half

Results in Eight Times the Number of Droplets



So it's a difficult balancing act...

What can we do?



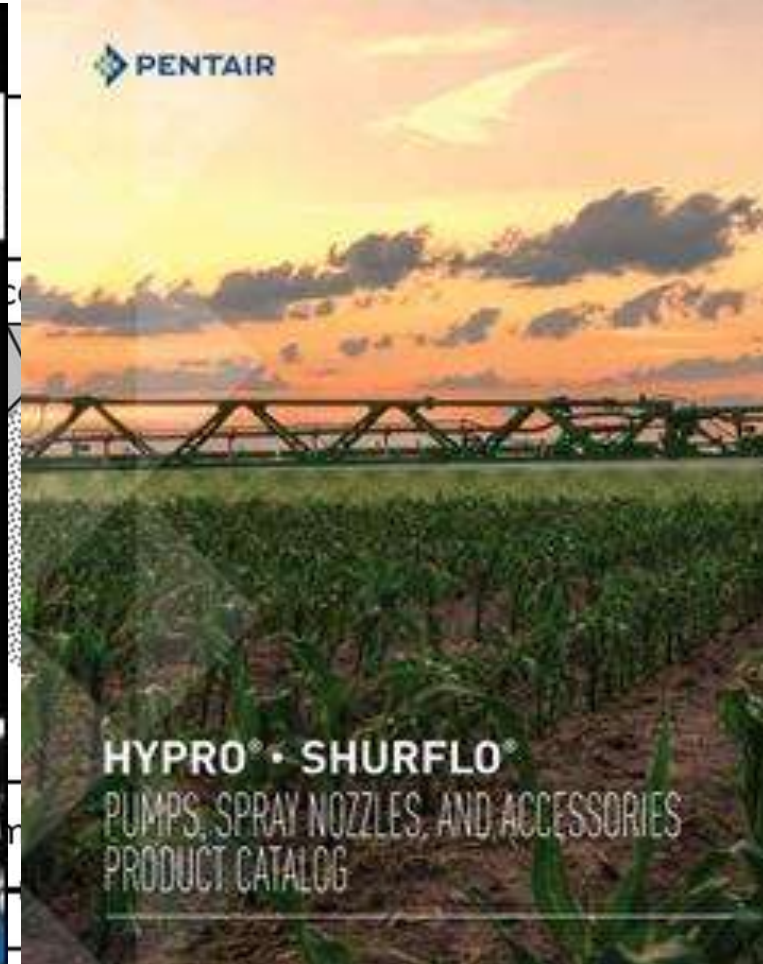
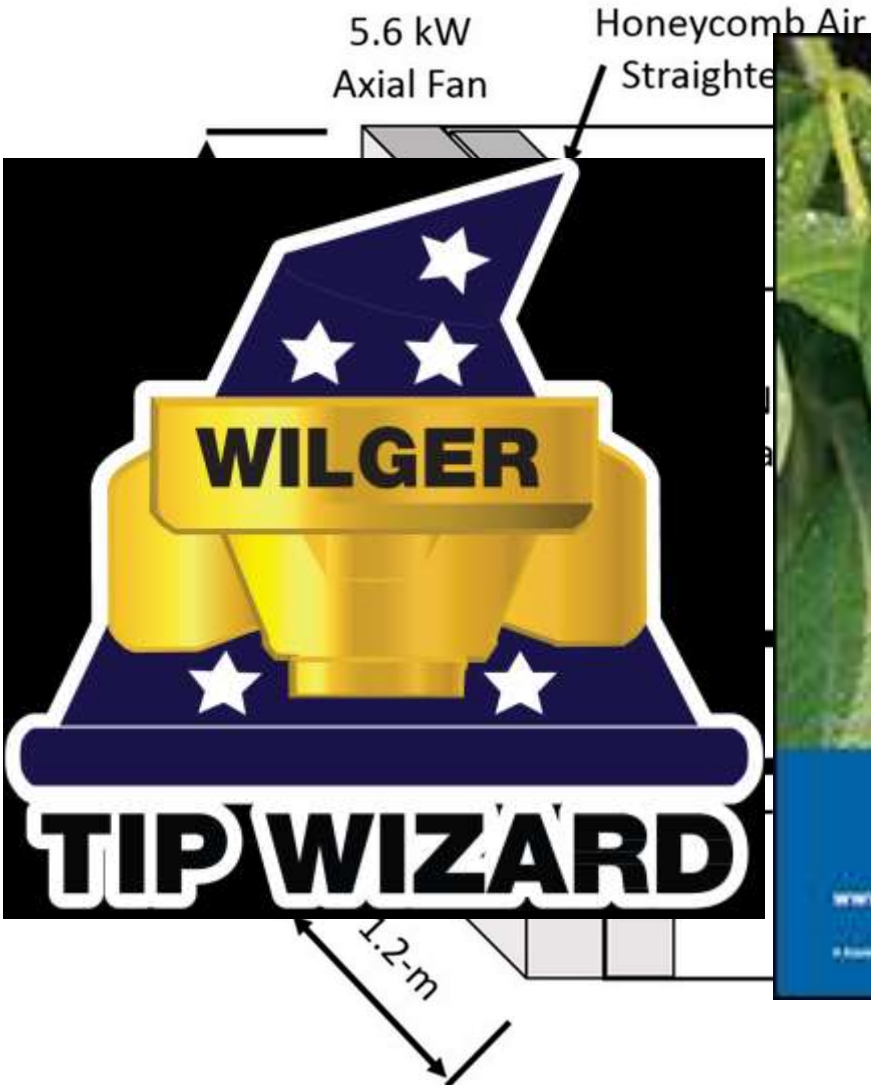
Optimizing Applications

- Pulse-width modulation (PWM) allows for flow to be controlled by the relative proportion of time each electronically actuated solenoid valve is open (duty cycle)¹
- Duty cycle has minimal impact on droplet size²
- PWM system advantages for site-specific management:
 - Individual nozzle control
 - Turn compensation
 - Quick, real-time flow rate changes
 - No pressure-based changes needed



- ¹Giles and Comino, 1989. J. of Commercial Vehicles. SAE Trans. 98:237-249. DOI: 10.4271/891836.
- ²Butts et al., 2019. Biosyst. Eng. 178:52-69. DOI: 10.1016/j.biosystemseng.2018.11.004.

Application Specific Droplet Size



Droplet Size Determination



- Sympatec HELOS-VARIO/KR laser diffraction system
- Identified nozzle*pressure combinations to create **droplet size treatments based on $D_{v0.5}$** (represents the droplet size such that 50% of the spray volume is contained in droplets of equal or lesser values)

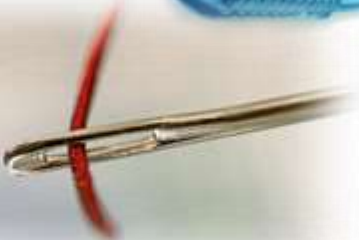


Herbicides and Carrier Volumes Tested

- Glufosinate (Liberty)
 - 5 and 20 GPA
- Dicamba (Clarity)
 - 5 and 20 GPA
- 2,4-D choline plus glyphosate (Enlist Duo)
 - 10 GPA
- Dicamba plus glyphosate (Clarity + Roundup WeatherMax)
 - 10 GPA
- Lactofen (Cobra) plus 1% COC
 - 15 GPA
- Acifluorfen (Ultra Blazer) plus 1% COC
 - 15 GPA



Comparison of Micron Sizes (approximate values)

Pencil lead		2000 μm
Paper clip		850 μm
Staple		420 μm
Toothbrush bristle		300 μm
Sewing thread		150 μm
Human hair		100 μm

Droplet Size Treatments

Herbicide	Carrier volume	Droplet size	Nozzle ^a	Application pressure
	L ha ⁻¹ (GPA)	µm		kPa (PSI)
glufosinate	47 (5)	150	ER 110015	414 (60)
glufosinate	47 (5)	300	SR 11006	296 (40)
glufosinate	47 (5)	450	SR 11004	246 (35)
glufosinate	47 (5)	600	DR 11004	244 (34)
glufosinate	47 (5)	750	DR 11008	246 (35)
glufosinate	47 (5)	900	UR 11006	207 (30)
glufosinate	187 (20)	150	ER 110015	344 (50)
glufosinate	187 (20)	300	SR 11003	207 (30)
glufosinate	187 (20)	450	MR 11004	249 (39)
glufosinate	187 (20)	600	DR 11005	359 (52)
glufosinate	187 (20)	750	DR 11006	268 (38)
glufosinate	187 (20)	900	UR 11006	248 (35)

Dicamba (Clarity[®]) (8 fl.oz./acre) and glufosinate (Liberty[®]) (22 fl.oz./acre)

Droplet Size Treatments

Herbicide	Carrier volume	Droplet size	Nozzle	Application pressure
	L ha ⁻¹ (GPA)	μm		kPa (PSI)
2,4-D choline plus glyphosate	94 (10)	150	ER 110015	551 (80)
	94 (10)	300	SR 11002	276 (40)
	94 (10)	450	MR 11003	207 (30)
	94 (10)	600	DR 11004	207 (30)
	94 (10)	750	DR 11010	413 (65)
	94 (10)	900	UR 11010	324 (47)

0.79 kg ae ha⁻¹ 2,4-D plus 0.84 kg ae ha⁻¹ glyphosate (3.5 pints/acre formulated product)

Droplet Size Treatments

Herbicide	Carrier volume	Droplet Size	Nozzle	Application pressure
	L ha ⁻¹ (GPA)	μm		kPa (PSI)
Dicamba plus glyphosate	94 (10)	150	ER 110015	345 (50)
	94 (10)	300	SR 11004	241 (35)
	94 (10)	450	DR 11003	255 (37)
	94 (10)	600	UR 11004	276 (40)
	94 (10)	750	UR 11006	207 (30)
	94 (10)	900	UR 11010	193 (28)

0.28 kg ae ha⁻¹ (8 fl.oz./acre) dicamba plus 0.87 kg ae ha⁻¹ (22 fl.oz./acre) glyphosate

Droplet Size Treatments

Herbicide	Tips	Pressure kPa (PSI)	Droplet Size (D_{v50})
Lactofen (12.5 fl.oz./acre) + COC (1% v/v)	ER110015	483 (70)	150 μm
	SR11004	379 (55)	300 μm
	MR11006	207 (30)	450 μm
	DR11005	248 (36)	600 μm
	UR11008	379 (55)	750 μm
	UR11010	241 (35)	900 μm
Acifluorfen (24 fl.oz./acre) + COC (1% v/v)	ER110015	414 (60)	150 μm
	SR11004	324 (47)	300 μm
	DR11003	414 (60)	450 μm
	DR11006	331 (48)	600 μm
	UR11006	345 (50)	750 μm
	UR11010	276 (40)	900 μm



Applications



- Applications were made using a Capstan PinPoint® PWM Sprayer (left)
- Only non-venturi, flat fan nozzles were used (below)



Experimental & Treatment Design

- Randomized Complete Block with at least 3 replications

- ≥ 6 inch tall weeds

- Locations (Total = 6 site-years):

- Dundee, MS



- Prosper / Fargo, ND



- Beaver City / Big Springs / North Platte, NE



- Treatments:

- Six droplet sizes (150, 300, 450, 600, 750, and 900 μm)
 - One nontreated control

- Optimum droplet sizes = Maintain 90% of maximum weed control, but will reduce drift potential (due to larger sizes)

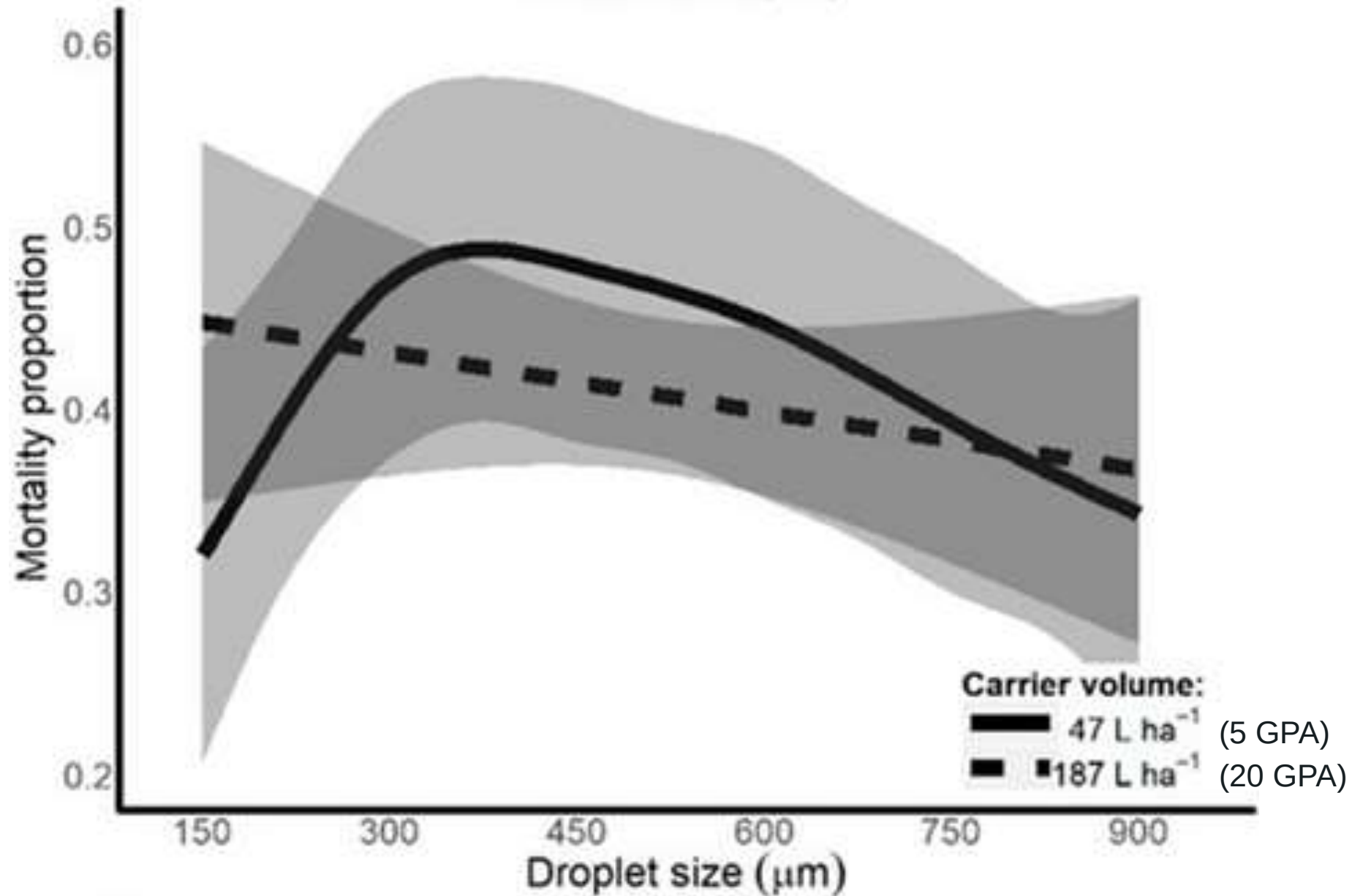


Glufosinate



Glufosinate

6 Site-years



**Glufosinate
(Liberty®)**

**47 L ha⁻¹
(5 GPA)**

14 DAA



Optimum Droplet Size:

47 L ha⁻¹ (5 GPA) = 625 μm (Extremely Coarse)

187 L ha⁻¹ (20 GPA) = 560 μm (Extremely Coarse)



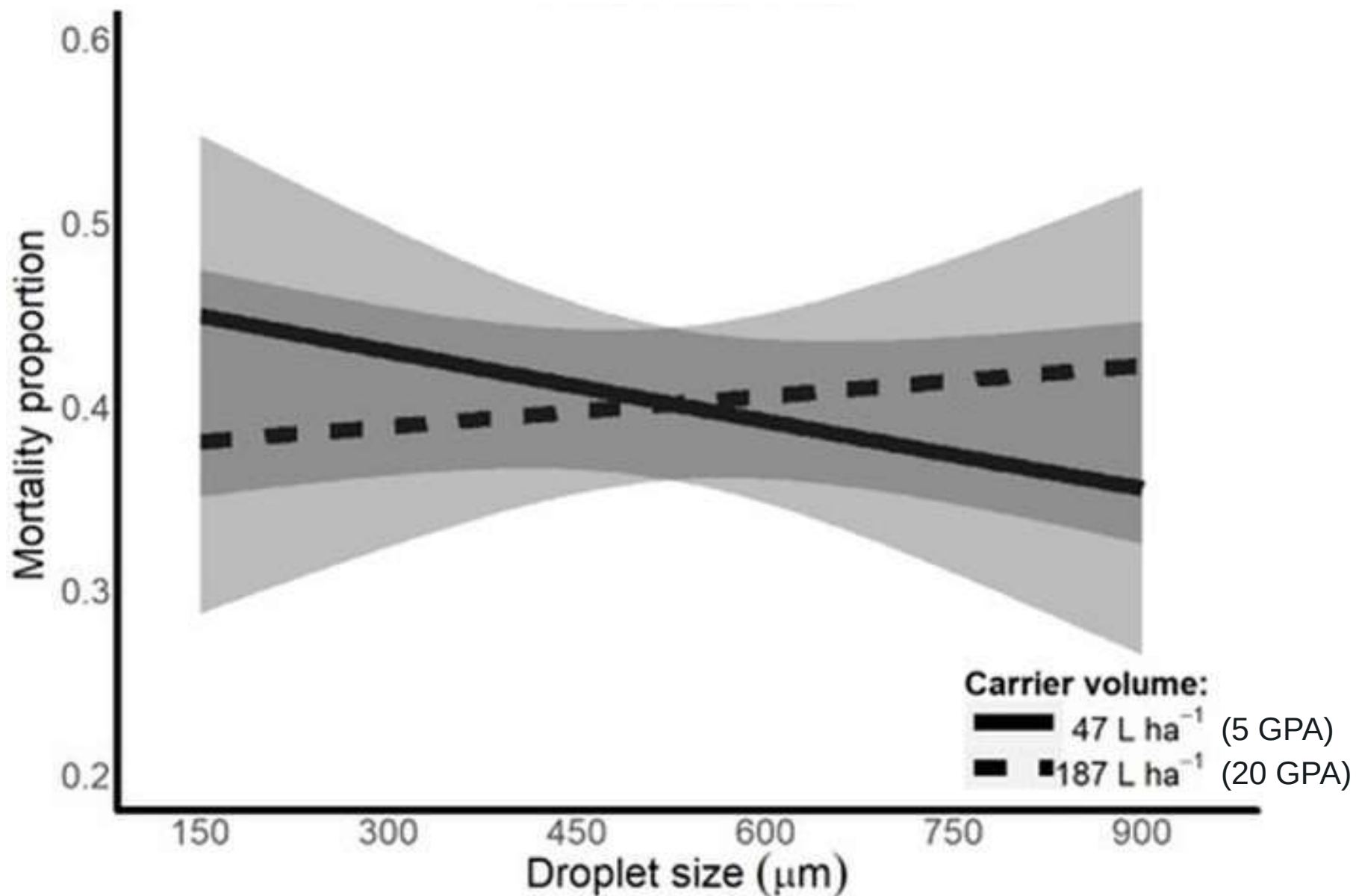
Dicamba

Clarity[®]

Herbicide

Dicamba

6 Site-years



**Dicamba
(Clarity®)**

**47 L ha⁻¹
(5 GPA)**

14 DAA



Optimum Droplet Size:

47 L ha⁻¹ (5 GPA) = 500 μm (Very Coarse)

187 L ha⁻¹ (20 GPA) = 900 μm (Ultra Coarse)

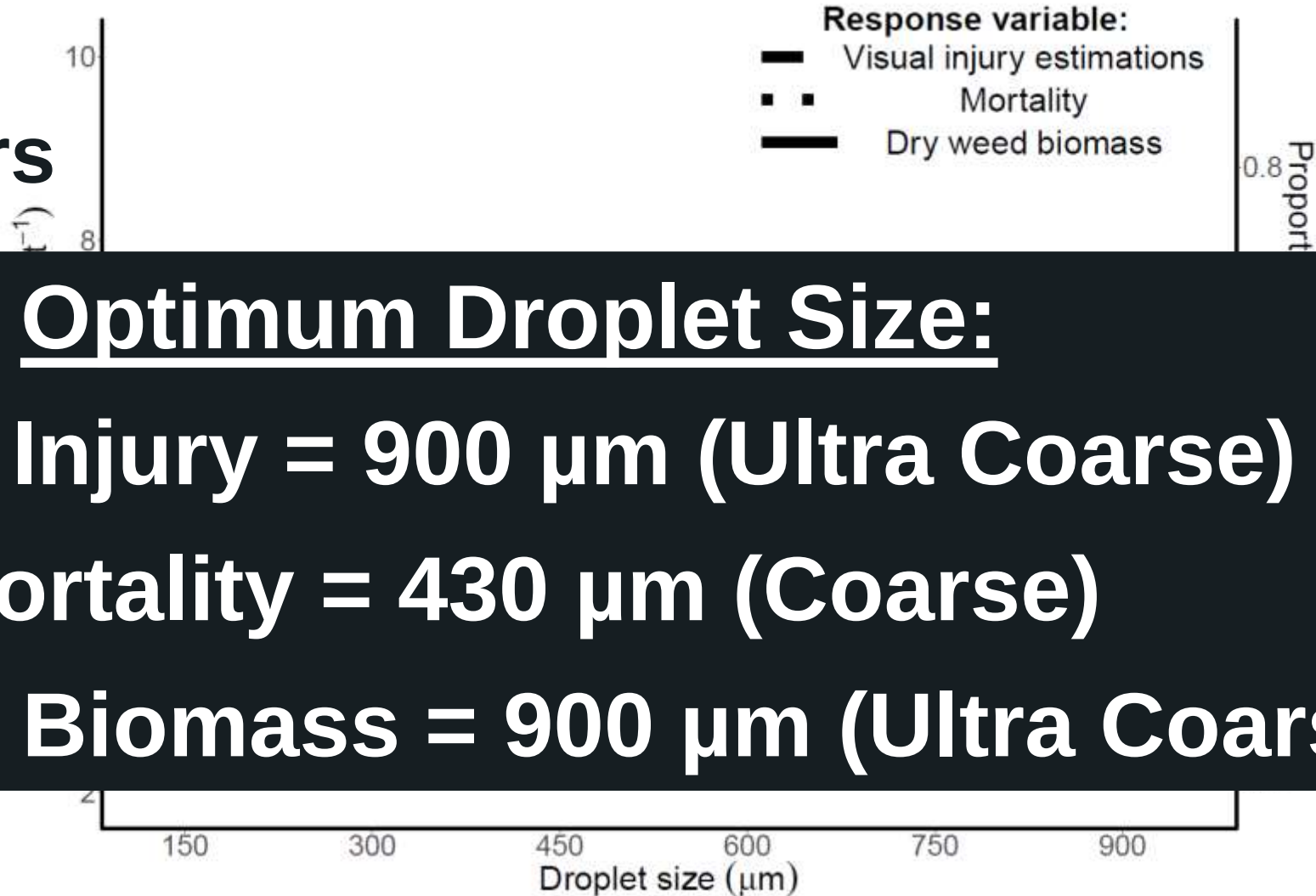


2,4-D Choline + Glyphosate



2,4-D Choline plus Glyphosate

6 Site-years



Dicamba plus Glyphosate

Clarity[®]
herbicide

+



Dicamba plus Glyphosate

6 Site-years
94 L ha⁻¹
(10 GPA)



Optimum Droplet Size:

Visual Injury = 900 μm (Ultra Coarse)

Mortality = 620 μm (Extremely Coarse)

Dry Weed Biomass = 900 μm (Ultra Coarse)



Site-Specific Management

2,4-D Choline plus Glyphosate



Optimum Droplet Size:

**Visual Injury = 675 μm
(Extremely Coarse)**

**Mortality = 690 μm
(Extremely Coarse)**

**Dry Weed Biomass = 565 μm
(Extremely Coarse)**

Dicamba plus Glyphosate



Optimum Droplet Size:

**Visual Injury = 900 μm
(Ultra Coarse)**

**Mortality = 570 μm
(Extremely Coarse)**

**Dry Weed Biomass = 620 μm
(Extremely Coarse)**

Brule, NE 2017

Weed Species

NE

|

ND and MS

Typically, NE required smaller droplet sizes to maintain weed control compared to ND and MS...

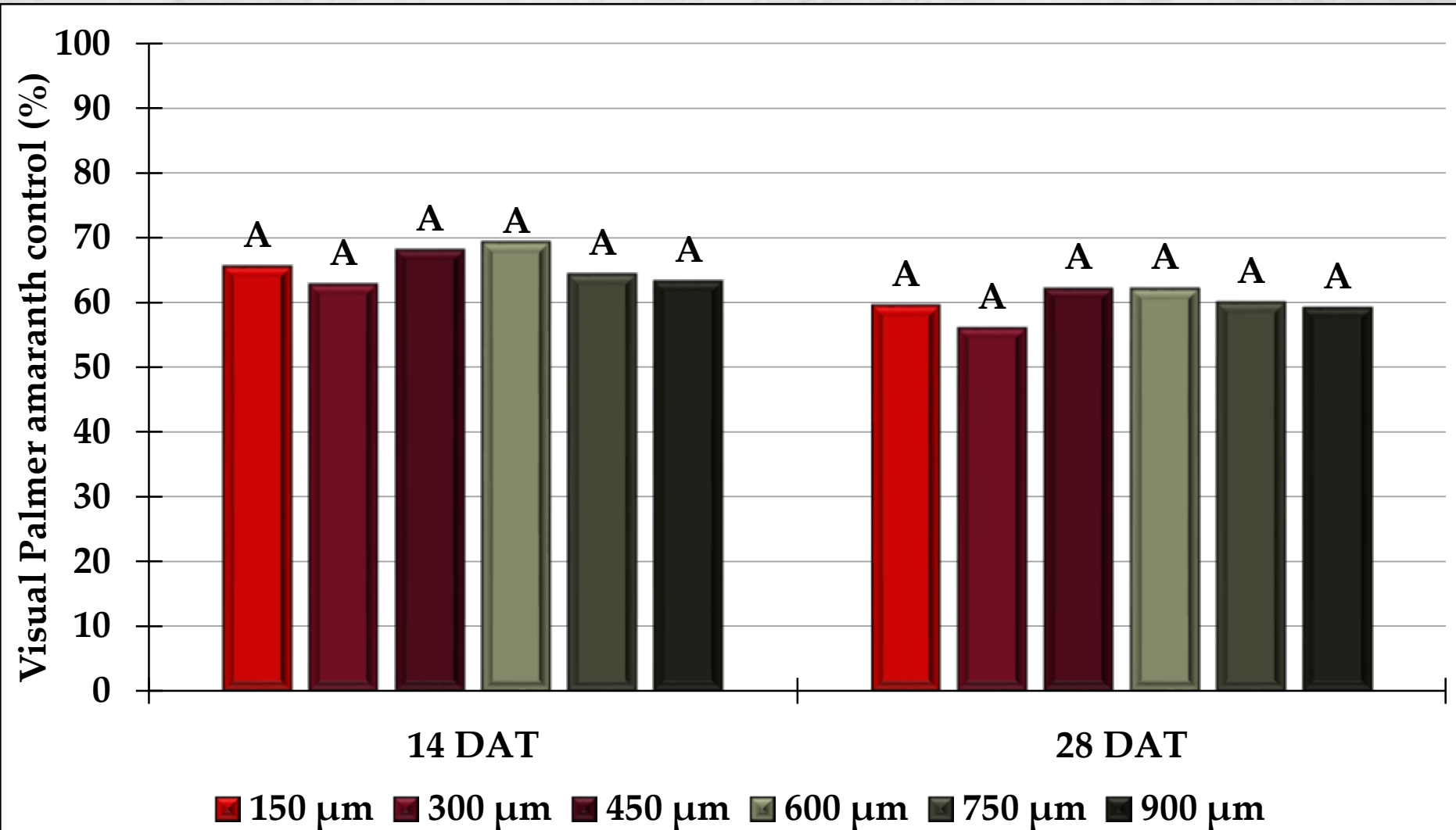
Why?



Lactofen & Acifluorfen



Palmer amaranth Control - Lactofen



*Columns followed by the same letter do not significantly differ according to Fisher Protected LSD ($\alpha=0.05$)



Lactofen – 14 DAT



300 μm

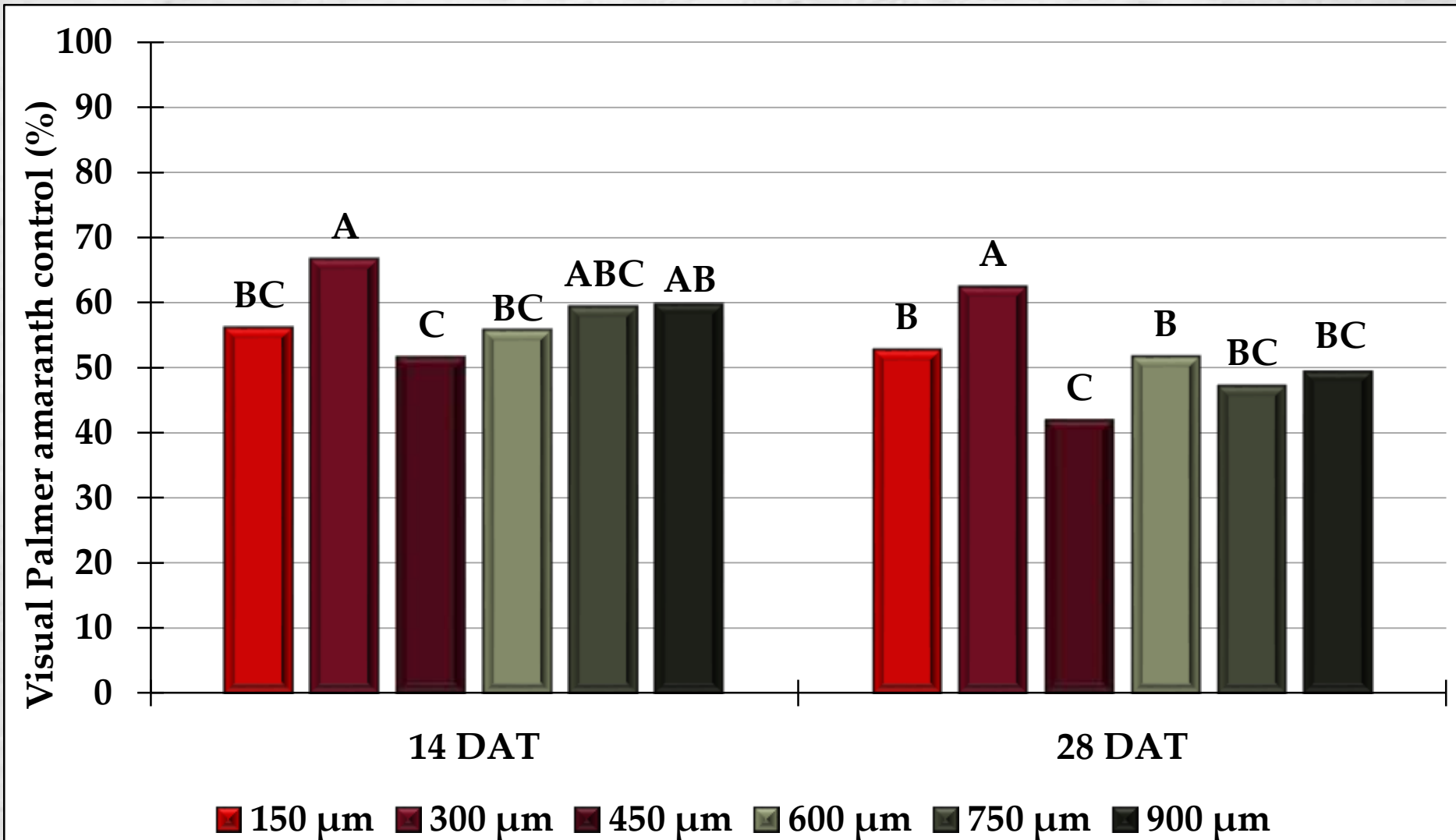


600 μm



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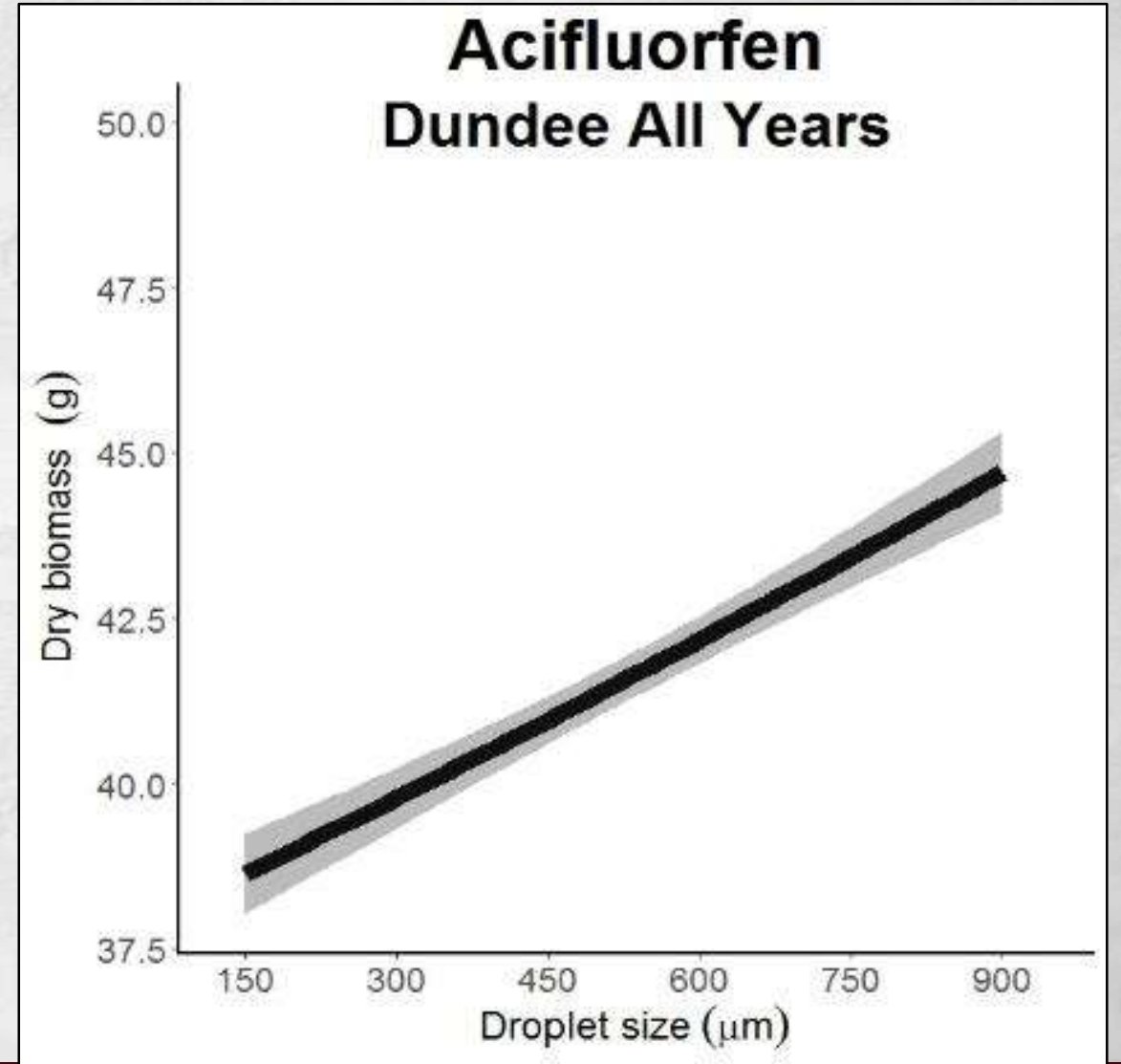
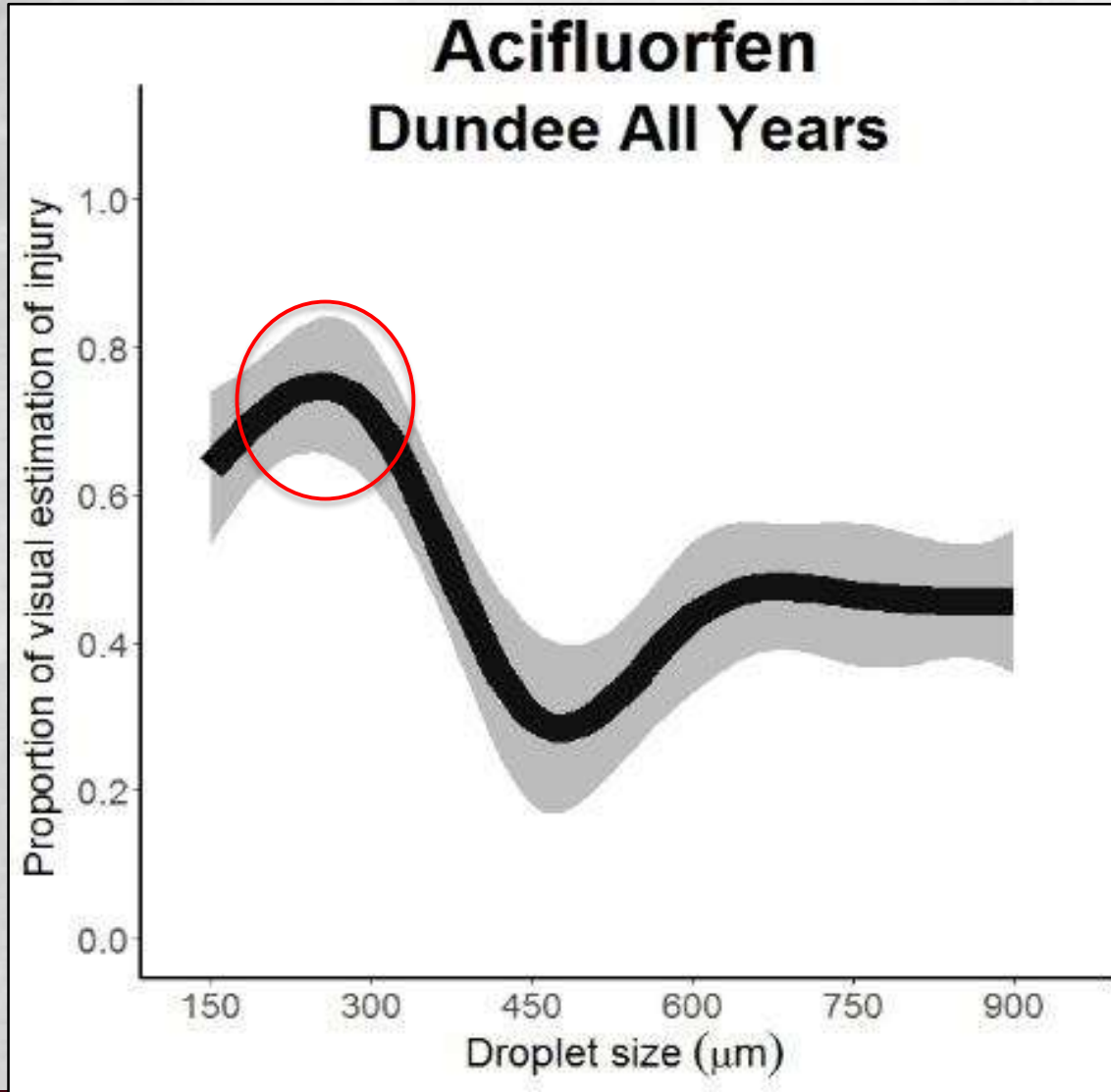
Palmer amaranth Control - Acifluorfen



*Columns followed by the same letter do not significantly differ according to Fisher Protected LSD ($\alpha=0.05$)



GAM Analysis



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Max. weed control: 250 µm
90 % of Max. weed control: 180 – 310 µm

Acifluorfen – 14 DAT



300 µm



600 µm

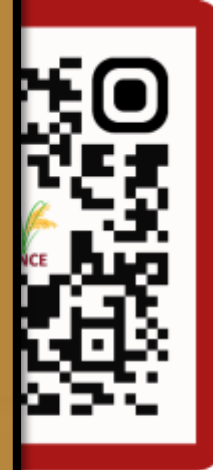
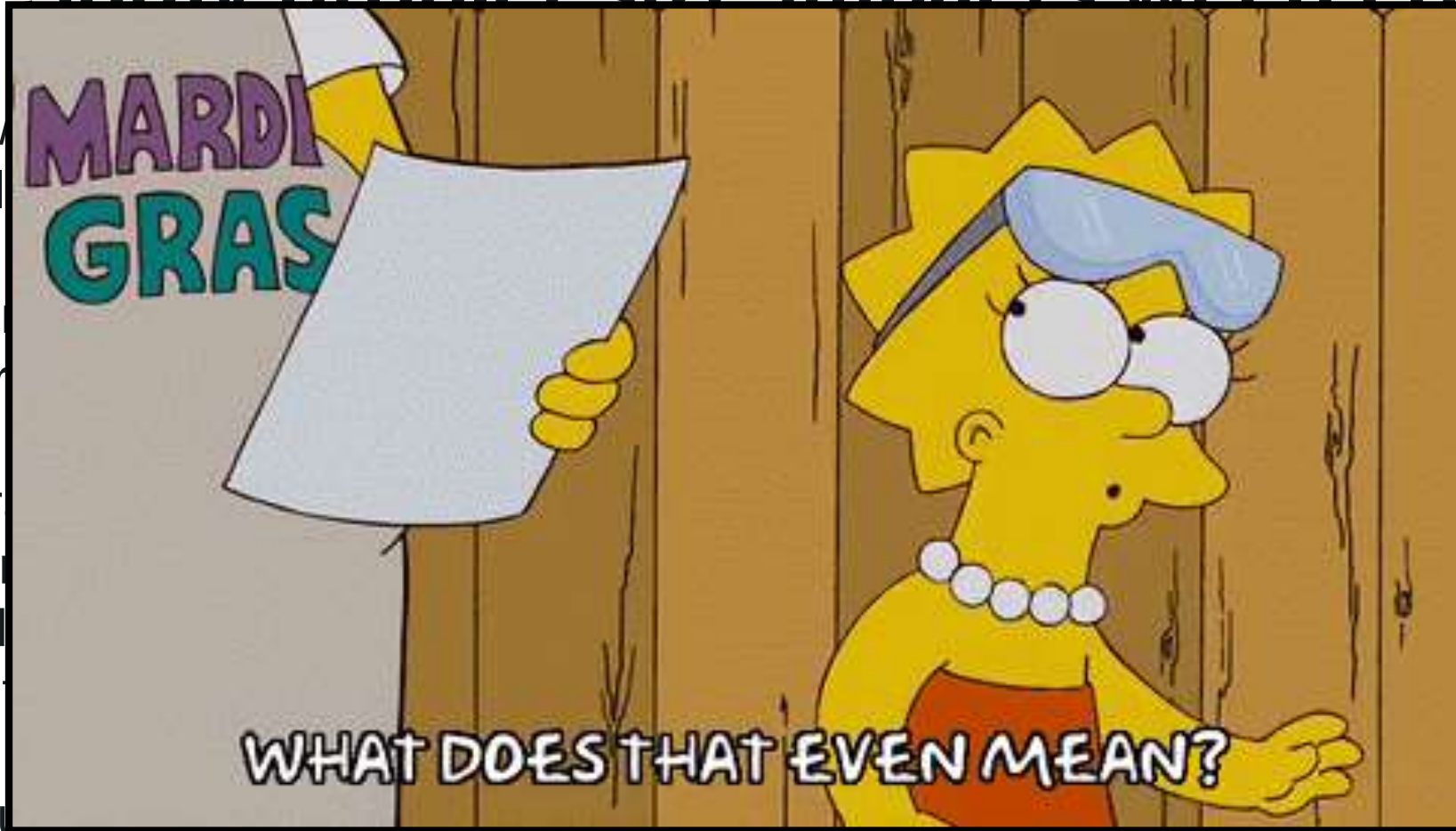


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Summary & Implications

Spray droplet size impacts weed control!

- Even v critical
- ...We drift m
- Geogr environ consid drople
- Optim specific pest management strategies can be effectively applied with PWM sprayers.



me

information
num droplet
sizes for weed control across
other herbicide solutions
please scan the QR code.

Questions?

Thank-you!

