Auxin Herbicides: What Should I Know?

2019 Indiana CCA Conference – *Bryan Young*

Auxin Herbicide Use Prior to Adoption of Xtend and Enlist Soybean

Herbicide	Corn	Soybean
	% of area	
2,4-D	??%	??%
Dicamba	??%	??%

Data: NASS, Corn-2016, Soybean 2015

Auxin Herbicide Use Prior to Adoption of Xtend and Enlist Soybean

Herbicide	Corn	Soybean
	% of area	
2,4-D	12%	17%
Dicamba	15%	0%

Data: NASS, Corn-2016, Soybean 2015

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Auxin Herbicide Use Prior to Adoption of Xtend and Enlist Soybean

Herbicide	Corn	Soybean
	% of area	
2,4-D	12%	17%
Dicamba	15%	0%
Glufosinate	1%	5%

Data: NASS, Corn-2016, Soybean 2015

Outline

Xtend Soybeans

- ***The great divide***

Enlist Soybeans

- ***2,4-D reinvented?***

Weed Management Strategies

“Dicamba Fatigue”

Leo Reed
Office of the Indiana State Chemist
President-elect of the Association of American Pesticide Control Officials (AAPCO)

- Three years of killing weeds, paranoia, and anxiety
- 2019 AAPCO survey: Nearly 1,400 OTM complaints (724 IL; 178 IN)
- Bayer (Monsanto) complaints received
  - 2017 - 3,071 OTM complaints
  - 2019 - 463 OTM complaints (as of 9-25-19)

- “They're tired of reporting and not getting any results.”

  Ryan Williams, Oklahoma Dept. of Agriculture, Food & Forestry

- Dicamba approval through 2020
  - June 20, 2020 cutoff date for Indiana
    - Based on historical frequency of dicamba complaints

Dicamba – The Great Divide

AP

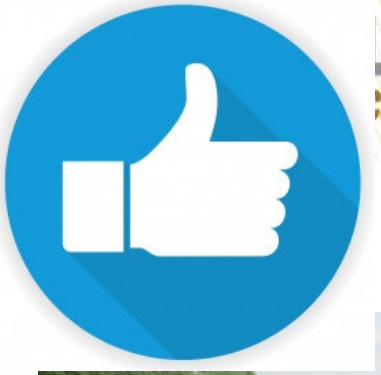
Some dispute dicamba damage sources

Dec 5, 2019

University of Illinois weed scientist Aaron Hager is convinced that, despite some claims to the contrary, much of the damage is due to volatilization. He is skeptical about company claims that some of the soybean damage is from application of ammonium sulfate.

"Everybody wants to talk about symptoms. I want to talk about yield," said Kruger, who was involved in one of several Midwestern field trials in the development of Monsanto's Xtend soybeans, which are genetically modified to be resistant to dicamba. "If I'm a soybean grower, the problem is yield."

He added that in one field, affected soybean plants actually exhibited yield increases of 10 to 20%.



LOCAL FACES
COUNTLESS CONNECTIONS

Dicamba proc
soybeans app

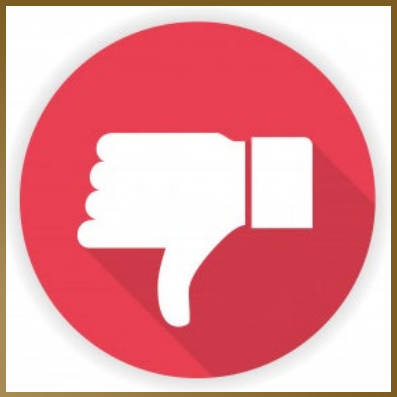
Accepted for publication 13 August 2010. Published 20 September 2010.

Weed Control in Dicamba-Resistant Soybeans

Johnson, B., Young, B., Matthews, J., Marquardt, P., Slack, C., Bradley, K., York, A., Culpepper, S., Hager, A., Al-Khatib, K., Steckel, L., Moechnig, M., Loux, M., Bernards, M., and Smeda, R. 2010. Weed control in dicamba-resistant soybeans. Online. Crop Management doi:10.1094/CM-2010-0920-01-RS.

Abstract

Field experiments were conducted in 11 states to evaluate broadleaf weed management programs in dicamba-resistant soybeans which involved the use of preemergence and postemergence dicamba. Preemergence (PRE) dicamba at 0.25 lb ae/acre provided less than 60% control of smooth pigweed, giant ragweed, velvetleaf, palmer amaranth, waterhemp, and morningglory spp., but 97% control of common lambsquarters and horseweed at 3 weeks after treatment (WAT). Preemergence flumioxazin plus chlorimuron or sulfentrazone plus cloransulam provided 66 to 100% control of these weeds. Use of dicamba postemergence (POST) improved uniformity of control of velvetleaf, smooth pigweed, morningglory, and glyphosate-susceptible waterhemp. However, combining dicamba at 0.25 lb/acre with glyphosate resulted in 30% to 65% greater control of glyphosate-resistant palmer amaranth, glyphosate-resistant common waterhemp, glyphosate-resistant horseweed, and glyphosate-resistant giant ragweed compared to sequentially applied glyphosate.



As of September 25, we've also received 934 inquiries about weed performance (compared to 693 weed performance inquiries received in 2018) and 5 inquiries about crop response. This season growers faced a number of unique challenges, including extreme weather conditions, that resulted in late planting and increased weed pressures as timely execution of effective weed and pest management plans across many geographies were delayed. Through our field visits, we've seen several themes emerging related to weed performance, such as:

- We recommend that weeds receive herbicide applications when they are 4" or less. This season, post-planting applications were delayed, resulting in many weeds being taller than 4" by the time growers were able to make over-the-top dicamba applications. This meant those weeds were less likely to have the same response to labeled rates as weeds at a more optimum height.
- With the delays growers faced, many weren't able to apply the necessary pre-emergence residuals that are key to controlling weeds early. As a result, growers saw thick weed canopies that were more difficult to control and threatened yield potential.
- We observed instances where the spray volume was less than the minimum 15 gallons of spray solution per acre required on the XtendiMax label, and in some cases, spray tanks contained multiple DRAs, which impacted spray coverage and effected strong weed control.

Bayer, Email Update 10/15/19

Dicamba Efficacy Concerns

- **Grass escapes**
  - Barnyardgrass
  - Fall Panicum
  - Goosegrass
  - Annual bluegrass
  - Result of dicamba antagonism of glyphosate?

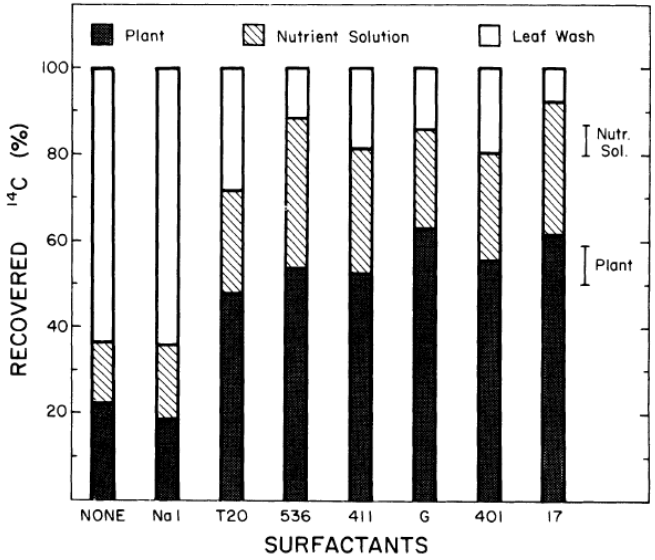
In 2019, Bayer (Monsanto) received 934 complaints on weed control.

- **Broadleaf escapes**
  - Waterhemp and Palmer amaranth
  - Velvetleaf

- **Possible causes**
  - Dicamba antagonism of glyphosate on grass species?
  - Lack of spray coverage due to Extremely Coarse and Ultra Coarse droplets?
  - Weed size larger than 4”?
  - Resistance evolution?

Adjuvants & Water Quality

- Drift reduction agents
  - Proven to reduce physical drift
  - Can alter herbicide uptake (Petersen et. al. 1985)



- Suspended soil in the carrier water
  - Can reduce herbicide efficacy
  - Negative binding site interaction with herbicide molecules (Oschwald 1972)

Drift Reduction Agents

	Dicamba formulatio		
Drift reduction agent	Clarity[a]	Xtendimax	Engenia
	---------- ng m^{-3} ----------		
None	4590 a[b]	1696 ab	2301 a
Polyacrylamide + APG	2569 a	879 b	798 b
Hydroxypropyl guar	3309 a	1974 a	1456 ab
Polyvinyl polymer	3946 a	2071 a	1765 a

[a]Dicamba vapor collected over a 48-h sampling period from treated soybean plants.
[b]Treatment means within a herbicide followed by the same letter are not statistically different according to Tukey's HSD test (P≤0.05).

Water Quality

Spray Solution pH and Spray Solution Ions

- Spray solution pH
  - Low pH (< 5) can increase risk of volatilization
  - Influenced by tank-mix partners and initial pH of carrier water (Mueller and Steckel 2019)
- Spray solution ions
  - Hard water cations can reduce dicamba efficacy
  - Ammonium sulfate known to increase volatilization

Suspended Soil in Carrier Wate

		Dicamba formul		
Soil type	Soil concentration	Clarity[a]	Xtendimax	Engenia
		---------- ng m^{-3} ----------		
None	-	4217 a[b]	2860 a	5362 ab
High OM	high	5170 a	3209 a	7052 a
	low	5140 a	3080 a	5744 ab
High clay	high	4523 a	2798 a	4251 b
	low	4890 a	3714 a	7001 ab

[a]Dicamba vapor collected over a 48-h sampling period from treated soybean plants
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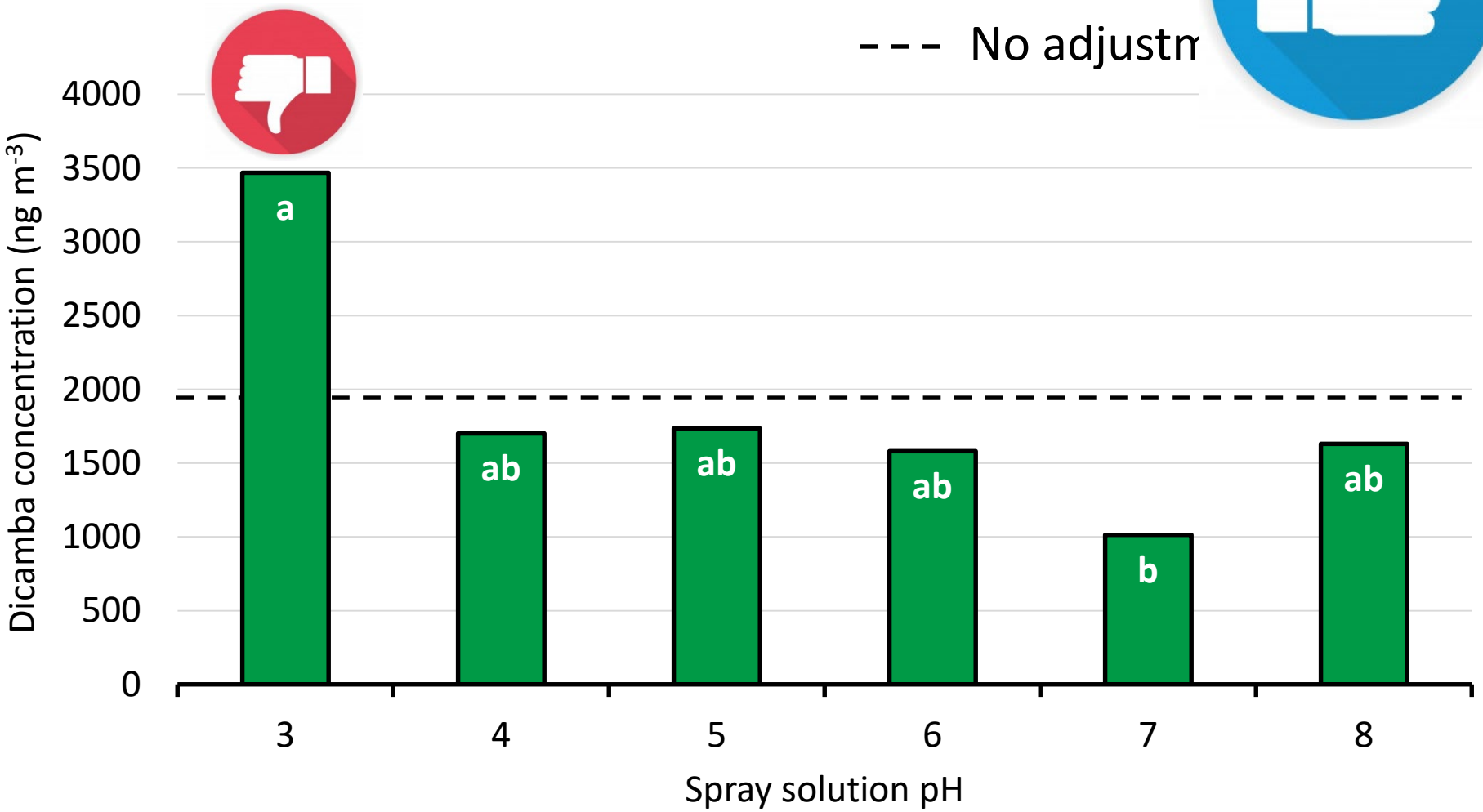
pH – Clarity



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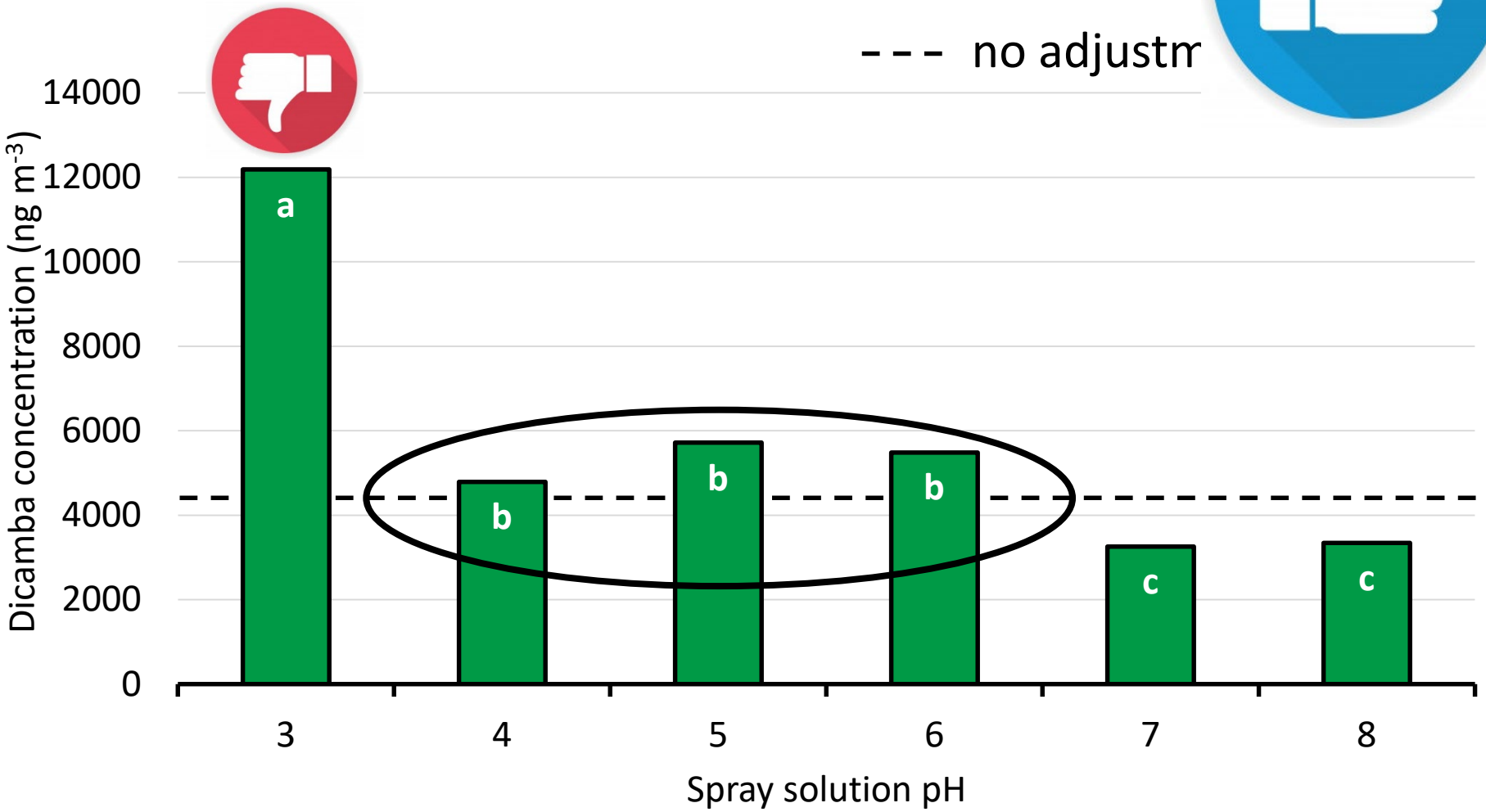
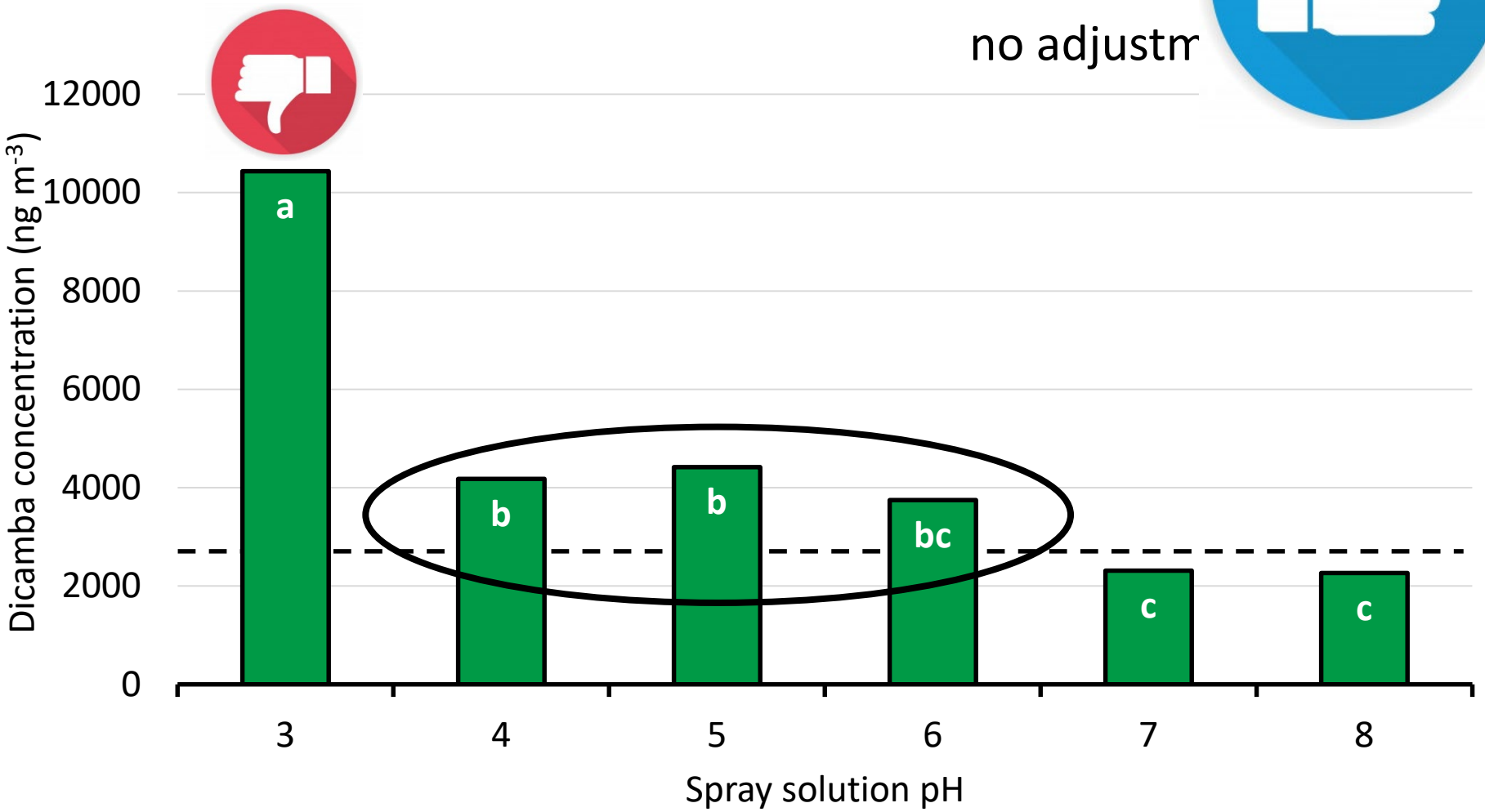
Dicamba vapor collected over a 48-h sampling period from treated soybean plants.

pH – Xtendimax



Dicamba vapor collected over a 48-h sampling period from treated soybean plants.

pH – Engenia



Dicamba vapor collected over a 48-h sampling period from treated soybean plants.

Spray Solution Ions

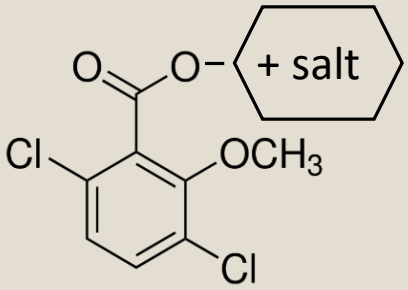
Spray solution ion	Salt concentration cation / anion	Dicamba formul					
		Clarity[a]		Xtendimax		Engenia	
	[M]	---------- ng m^{-3} ----------					
None	-	2006	b[b]	4887	c	4212	b
Ferrous sulfate	0.02 / 0.02	32034	a	44055	a	47363	a
Ammonium sulfate	0.02 / 0.01	27963	a	25841	b	48180	a
Calcium sulfate	0.02 / 0.02	2447	b	4581	c	3613	b
Magnesium sulfate	0.02 / 0.02	1556	b	3849	cd	3880	b
Calcium chloride	0.02 / 0.04	1062	b	3319	d	3555	b

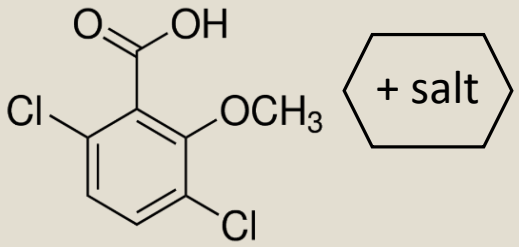
[a]Dicamba vapor collected over a 48-h sampling period from treated soybean plants.
[b]Treatment means within a herbicide followed by the same letter are not statistically different according to Tukey's HSD test (P≤0.05).

Off-Target Dicamba Movement

- Causes of off-target dicamba movement
  - Spray tank contamination
  - Particle drift
  - Volatilization
- Dicamba volatilization
  - Weak acid herbicide with a relatively high vapor pressure
  - Formulated as a salt
  - Dissociation between dicamba acid and the salt

https://www.dtnpf.com/agriculture/web/ag/crops/article/2017/02/17/skimp-tank-cleanout-new-dicamba-3
https://www.agriculture.com/crops/soybeans/growing-soybeans-101





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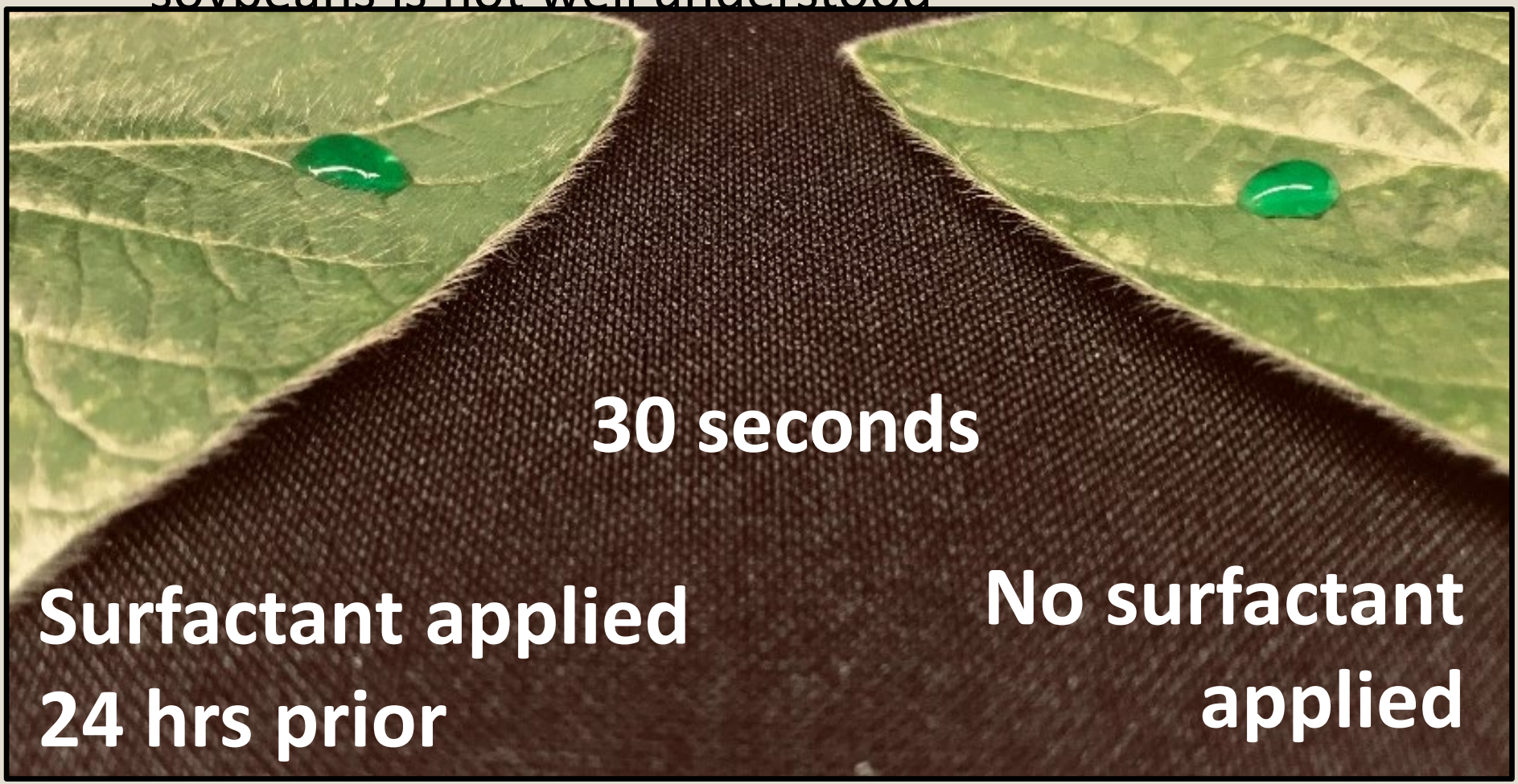
Dicamba Absorption

NCWSS
North Central Weed Science Society

- How volatilized dicamba acid enters sensitive soybeans is not well understood



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Soybean Injury – 28 DAT

NCWSS
North Central Weed Science Society

Soybean Injury (%)

32
30
28
26
24
22
20

a
a
b

21.3

Water
Roundup PMax
Liberty

Herbicide

dashed line indicates dicamba applied alone

* Data pooled over application timing

Soybean Injury

Water
0.5 hrs Prior

Glyphosate
0.5 hrs Prior

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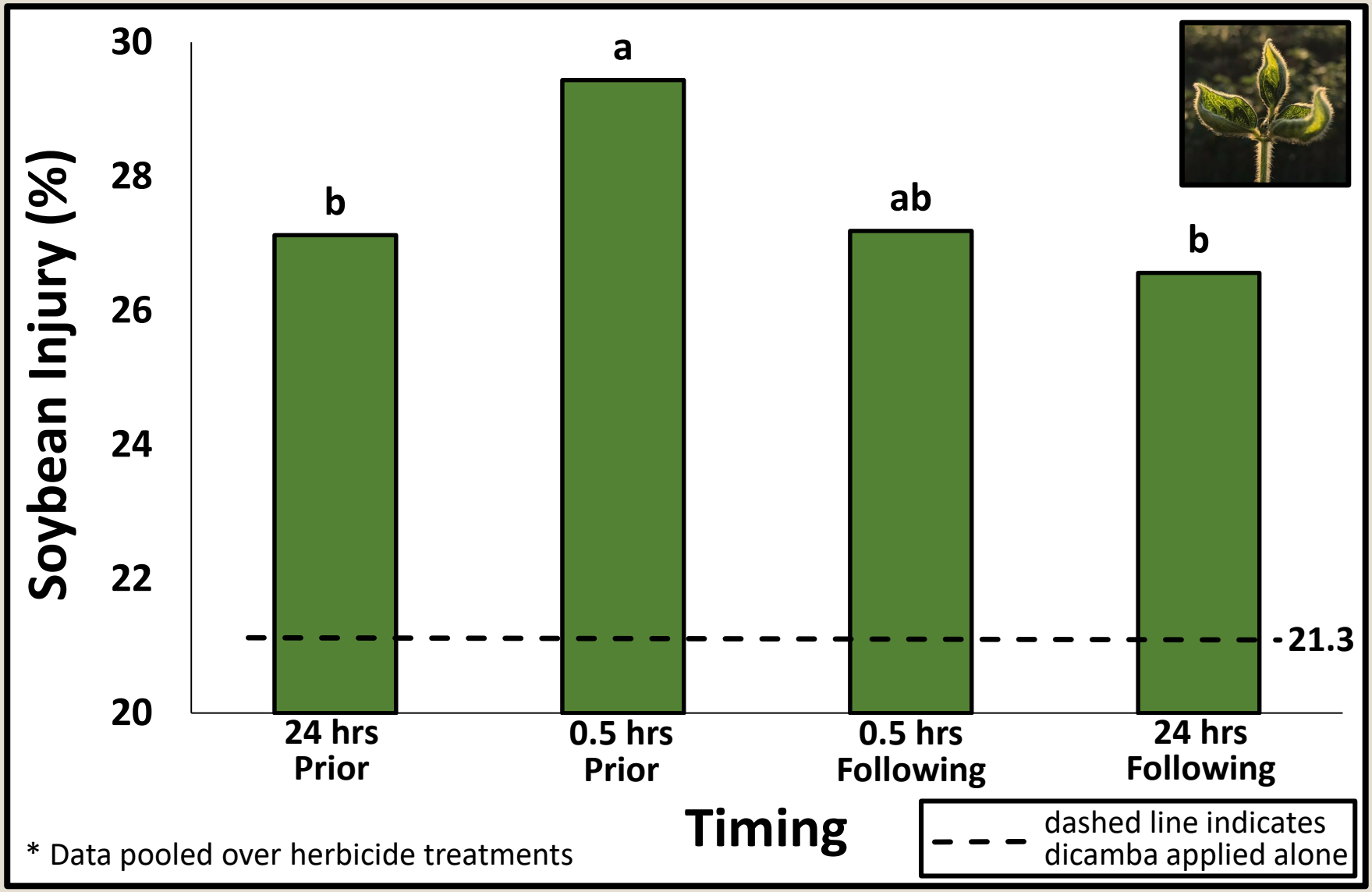
Soybean Injury – 28 DAT

NCWSS
North Central Weed Science Society



Soybean Injury

Glyphosate
0.5 hrs Prior

Glyphosate
24 hrs Following

So how is dew involved with dicamba volatility?

Table 1. A trial summary outlining the treatment breakdown and procedure.

Trt.	Source Dew	Sensitive Dew	Treatment Procedure
1	No	No	No dew applied
2	Yes	No	Source soybeans were extracted, dew applied, and slid back into the tent (Photo 1 & 2)
3	No	Yes	Source soybeans extracted, dew applied to sensitive soybeans, and source soybeans slid back into the tent (Photo 3)
4	Yes	Yes	Both the source plants and sensitive plants received a dew application.

- Tent structures were dissembled at the end of the third day

Photo 1. Sliding mechanism used to extract and re-insert trays from the tent

Photo 2. Single nozzle misting system utilized to apply simulated dew to source soybeans

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Volatility and Dew

Soybean Response at Center of the Tunnel

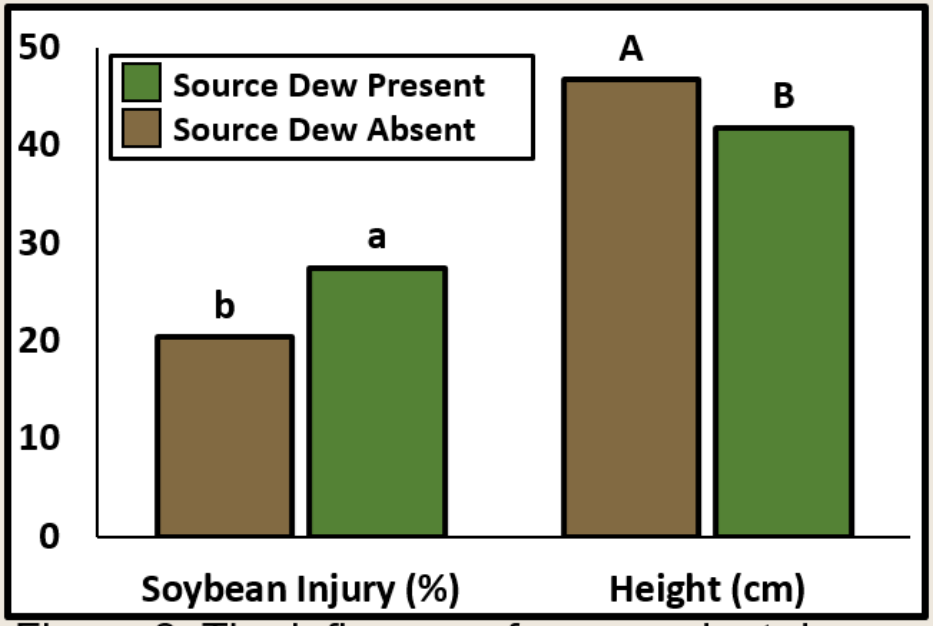

Figure 2. The influence of source plant dew on sensitive soybean injury and height 28 DAT

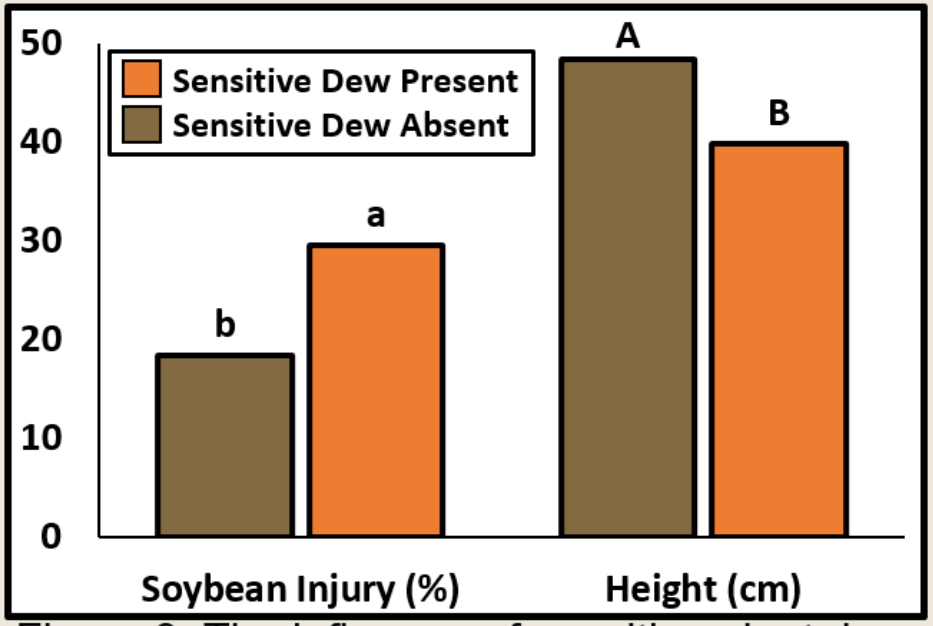

Figure 3. The influence of sensitive plant dew on soybean injury and height 28 DAT

The presence of dew:

- ❑ Increased dicamba volatility from treated soybean
- ❑ Increased injury response of sensitive soybean

Outline

Xtend Soybeans

- ***The great divide***

Enlist Soybeans

- ***2,4-D reinvented?***

Weed Management Strategies

Enlist E3 Soybean

Enlist™ Weed Control System

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Enlist E3 Herbicides

- Enlist Duo
  - Glufosinate: Mixtures with Enlist Duo not labeled (EPA holdup)
  - Caution on large broadleaves that are Gly-Res (aka waterhemp)

- Enlist One
  - Expected to be most common 2,4-D choline formulation sold
  - Mixtures with glyphosate and glufosinate are allowed
    - Caution on large broadleaves that are Gly-Res (aka waterhemp)
  - Compatibility problems with K-salt glyphosate when mixing with too little water
    - Mix each component thoroughly before adding other
    - Continuous circulation recommended
  - Glufosinate + Enlist One @ 15 GPA more consistent than Glufosinate alone @ 20 GPA

Enlist E3 Herbicides

- Glufosinate
  - Marketing focus on Liberty brand, others are labeled
- Glyphosate
  - Only Enlist Duo and Durango is labeled for use on GlyTol trait in Enlist soybean.
- ACCase (SOA #1) herbicides for volunteer corn
  - More antagonism when applied with 2,4-D than dicamba
  - Increase ACCase herbicide rates and use oil-based adjuvants

Glyphosate + Glufosinate?

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Soybean Traits for Weed Management

Soybean Technology	Traits	Herbicides Enabled	Benefit	Risk	Comments
Non-GMO		ALS / PPO	Seed premiums	Resistance	Includes STS and Bolt
RR2Y	RR2Y	Glyphosate	Grass and numerous BL weeds	Most problematic weeds have resistance	
Liberty Link	LL	Glufosinate	No resistance in Midwest….yet	Weak on grass / Requires good weather	
RR2Y Xtend	RR2Y Xtend	Glyphosate Dicamba	Keep glyphosate as an option	Application requirements	
LL/GT/27	LL HPPD GlyTol	Glufosinate Isoxaflutole Glyphosate	Keep glyphosate as an option	HPPD has more value in corn	Less sensitivity to mesotrione
Enlist E3	2,4-D LL GlyTol	2,4-D choline Glufosinate Glyphosate	2,4-D and Glufosinate both effective on HRWs	Application requirements	
XtendFlex	RR2Y Xtend LL	Glyphosate Dicamba Glufosinate	Dicamba and Glufosinate both effective on HRWs	Application requirements	Not commercial yet

What strategy or application methods should be used?

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Spray Like You Mean It!

Application Factor	Roundup (glyphosate)	Xtendimax (dicamba)	Enlist One (2,4-D)	Liberty (glufosinate)
Optimal GPA	5-15	15-20	10-15	15-20
Droplet Size	C, VC, XC*	XC, UC	VC, XC, UC	M, C, VC*
Sensitive Area Buffers	No	Yes	Yes	No
Soybean Growth Stage	Through R2	Prior to R1	Through R2	Prior to R1
Ammonium Sulfate	Yes	No	Yes	Yes

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*Indicates presenter's bias

Outline

Xtend Soybeans

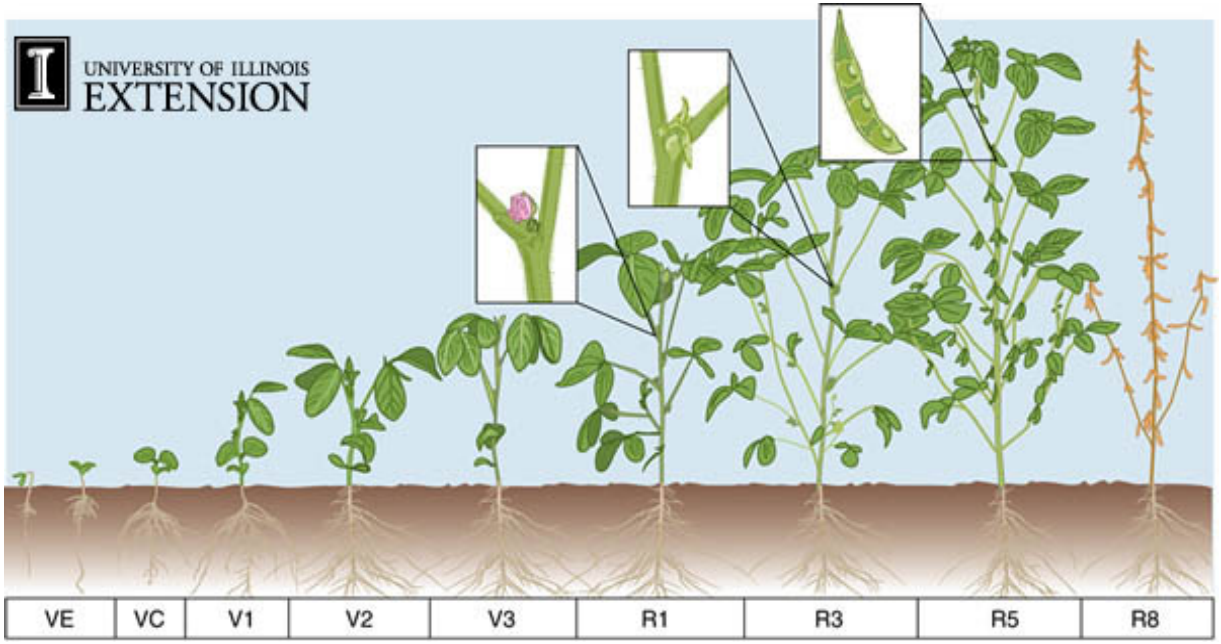
- ***The great divide***

Enlist Soybeans

- ***2,4-D reinvented?***

Weed Management Strategies

Application Strategies



Preplant

Post Harvest

Prior to R1 — Dicamba

Thru R2 — 2,4-D choline

Prior to R1 — Glufosinate

2,4-D to V?

Glufosinate ← *V1 to Prior to R1*

Dicamba to V2

Residuals to V5

Auxin Summary

- Still don't know all the mechanisms responsible for "Ultra Low" concentrations of dicamba physical or volatile drift
  - Spray pH mostly an issue if the droplets don't hit any target
  - High temps, low wind, topography
- Don't be OVERconfident on the drift potential of 2,4-D choline
- Application methods not always optimal for some possible herbicide combinations.

Weed Management Strategies

- Residual herbicides provide the greatest value to weed management.

- Apply herbicides in a manner that optimizes efficacy, even in the presence of resistant weeds.
  - Use full use rates – PRE or POST
  - Apply POST to small weeds ------- Auxins early!
    - **Better to spray a second time for another flush of weeds than a rescue treatment for weeds that didn't die in the first pass!**

- Soybean traits enable effective herbicides and strategies.
  - Flexibility comes with stacked traits.
  - Strength of soybean traits NOT limited to single POST herbicides!
  - Effective weed control is not 'automatic'.

- What non-chemical methods for weed control are best for you?

Technologies for Battling Weeds

LIBERTYLINK
GT27

ALL CURRENT/FUTURE TECHNOLOGIES WILL REQUIRE AN INTEGRATED PROGRAM APPROACH

NEW ***BioDirect*** **TECHNOLOGY** — **WEED-CONTROL RESEARCH**

MONSANTO RESEARCH LAB TRIALS

GLYPHOSATE-RESISTANT WEEDS SPRAYED WITH GLYPHOSATE ALONE

GLYPHOSATE-RESISTANT WEEDS SPRAYED WITH *BioDirect* + GLYPHOSATE

Example: Glyphosate-Resistant Weed Control

Early testing indicates that ***BioDirect*** technology can be used with Glyphosate to target resistant weeds and provide more effective spectrum of control of problem weeds

Questions?

Thank you Purdue Weed Science staff and students