

# Adjuvants – The Rest of the Story

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# Questions:

1. Are adjuvants regulated?
2. How many adjuvant classifications?
3. How many adjuvant modes of action?
4. Is it legal to apply herbicides at reduced rates?
5. Is it legal to apply herbicides at reduced gpa?
6. Does high water volume give good coverage?
7. Is good coverage necessary for optimum activity?
8. Does weed control increase as gpa increases?
9. Should adjuvants be applied at % vol/vol basis or on an area basis (pt/A)?

# Questions:

10. What are basic pH blend adjuvants?
11. What is the difference between COC (petroleum oil) adjuvants and MSO (methylated seed oil) adjuvants?
12. Which salts in water antagonize herbicides?
13. Which herbicides are antagonized by salts?
14. What is the mode of action of AMS (ammonium sulfate)?
15. Do water conditioning/AMS replacement adjuvants work as well with glyphosate as AMS?

# Questions:

1. Are adjuvants regulated?

# Non-regulation of Adjuvants

Active Ingred. / Inerts / Formulants

Not regulated

Not standardized

Those listed (claimed)

Those not listed (proprietary)

Concentration – What is 90% a.i.???

# Questions:

2. How many adjuvant classifications?

# Adjuvant Classification

Components that increase efficacy

1. Surfactants
2. Oils
3. Fertilizer


# Questions:

3. How many adjuvant modes of action?



# Adjuvant Mode of Action

Surfactants / Oils / Fertilizer

1. Retain (Retention)
  2. Deposit (Deposition)
  3. Absorption
  4. Translocation – to site of action
-  You Can Control

# Adjuvant mode of action

1. Retention – NIS
2. Deposition – NIS and oils
3. Absorption – Oils and Fertilizer
4. Translocation – N fertilizer =  
Water quality

# Questions:

4. Is it legal to apply herbicides at reduced rates?

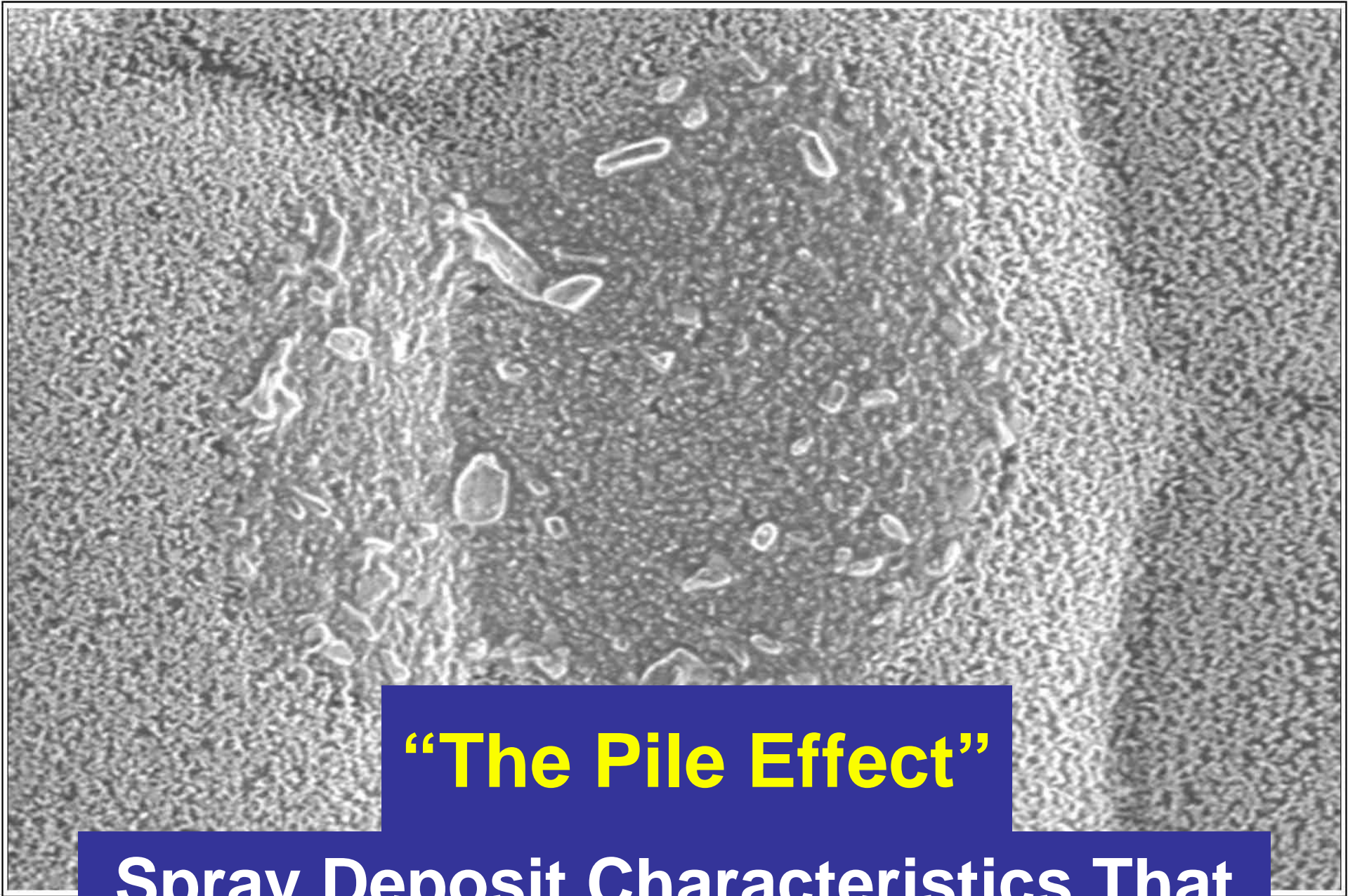
NO!

EPA is concerned with impact of pesticides on the environment. A lower pesticide ai used would result in less impact. There is a provision in FIFRA that allows for legal use is reduced rates.

However – the manufacturer is removed from product liability. The user assumes the liability.

# Questions:

6. Does high water volume give good coverage?
7. Is good coverage necessary for optimum activity?
8. Does weed control increase as gpa increases?



## **“The Pile Effect”**

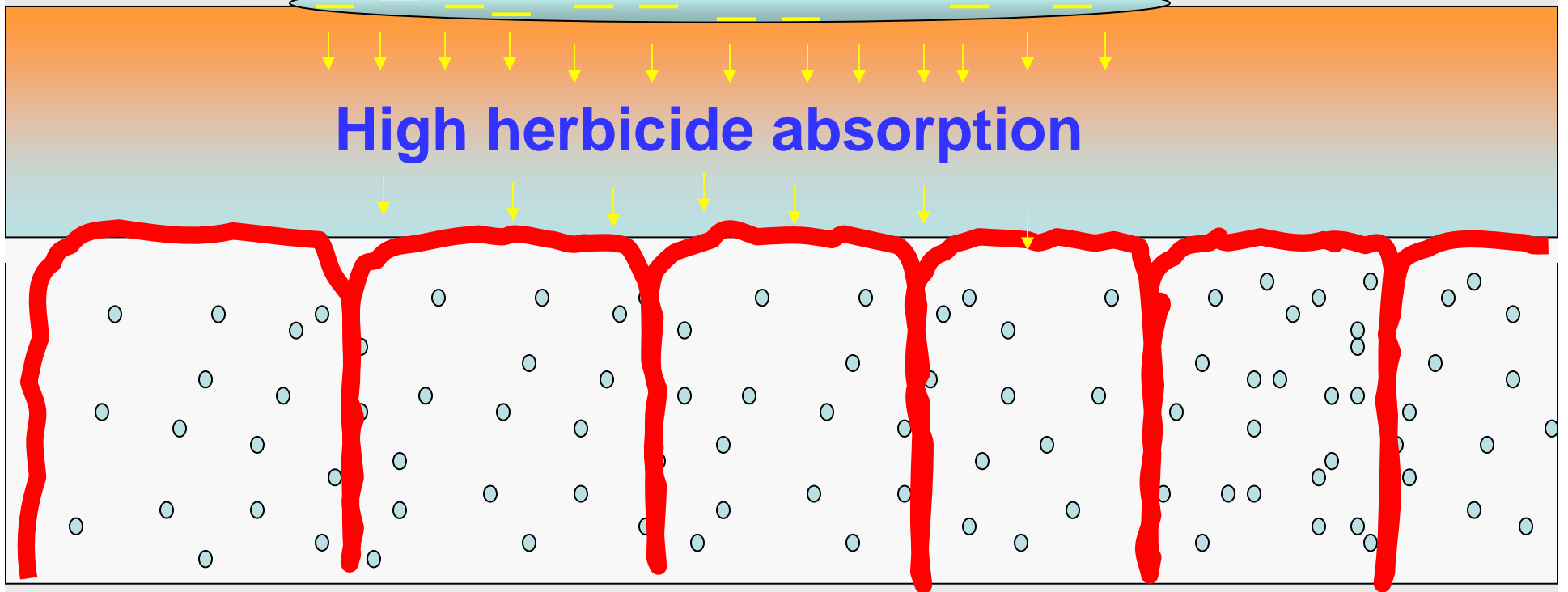
**Spray Deposit Characteristics That  
Influence Herbicide Efficacy**

**Spray deposit remains partially moist**

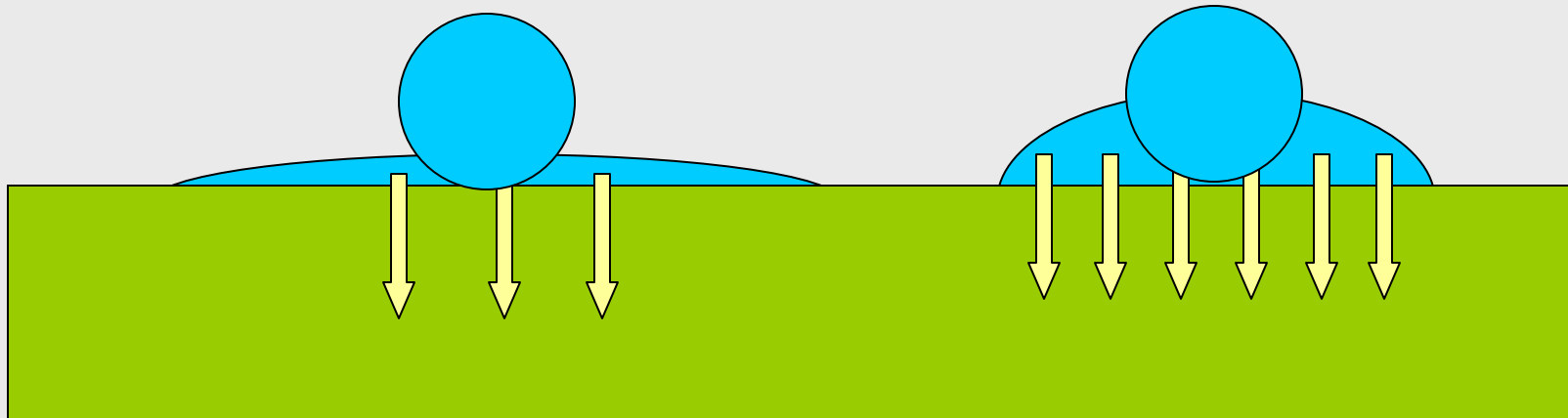
**Herbicide and adjuvant evenly distributed**

**Herbicide remains dissolved in spray deposit**

**High herbicide absorption**



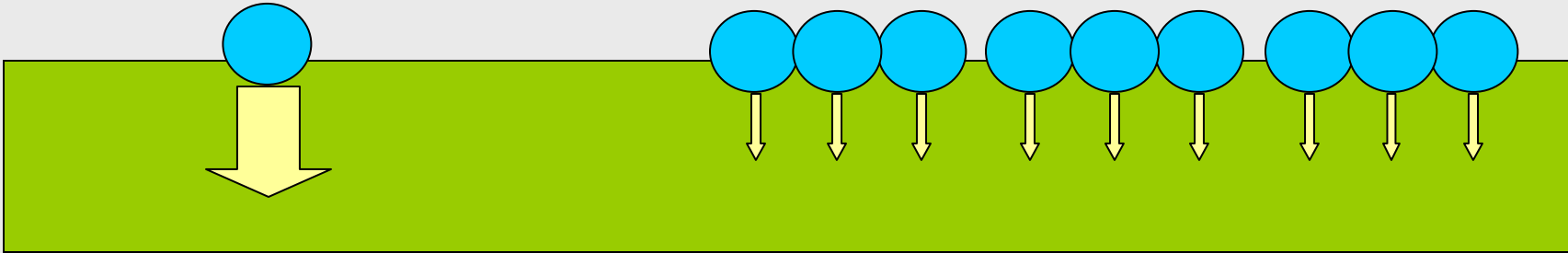
# Thin vs. Thick 'Pile' Deposit - Which absorbs more?



Glyphosate absorption was greater with adjuvants that left a pile deposit

# High herbicide concentration vs. high plant coverage?

Which is better?

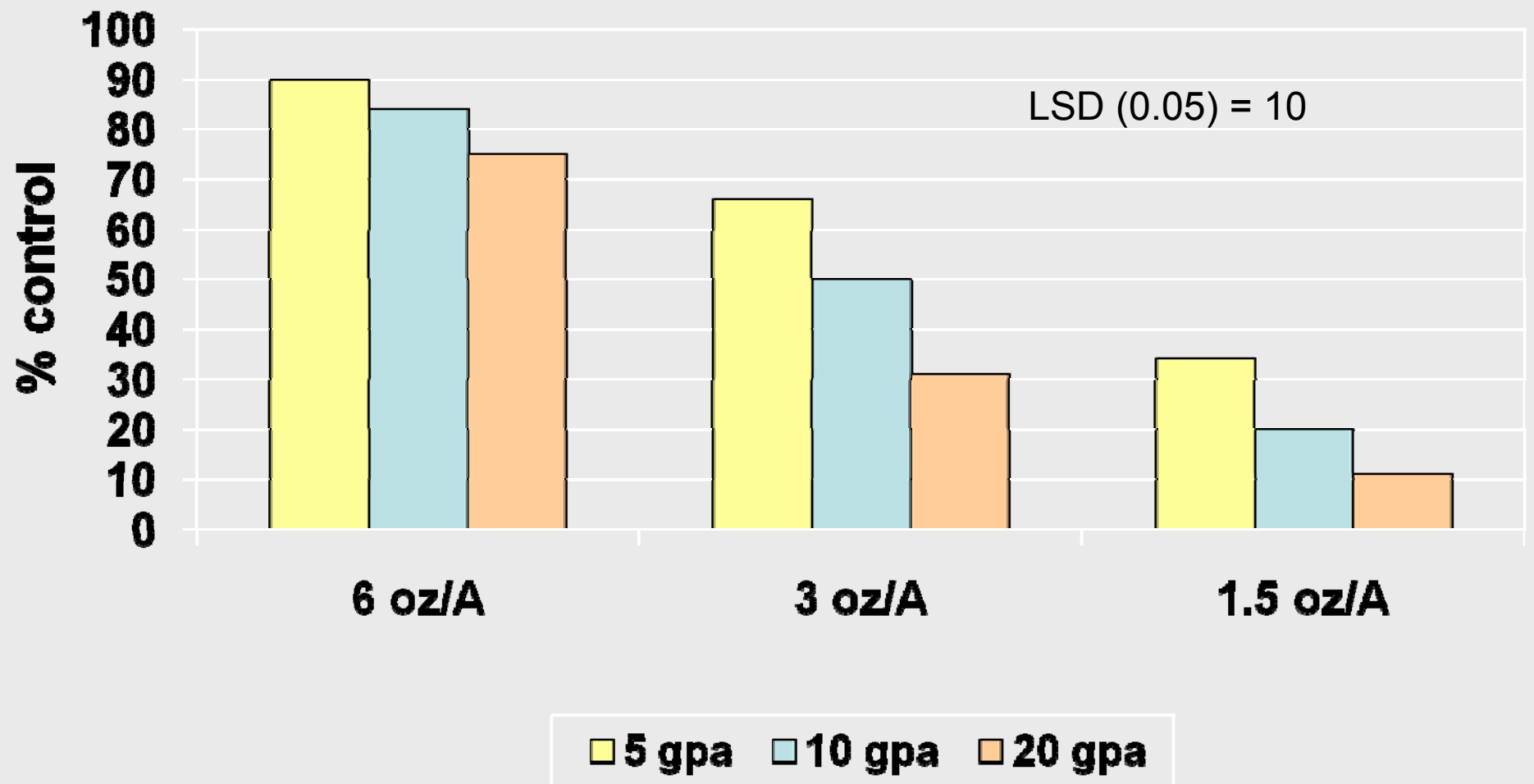


Glyphosate was more phytotoxic when applied in one concentrated drop (pile) than nine dilute drops of equal size



# Spray Volume: Quackgrass

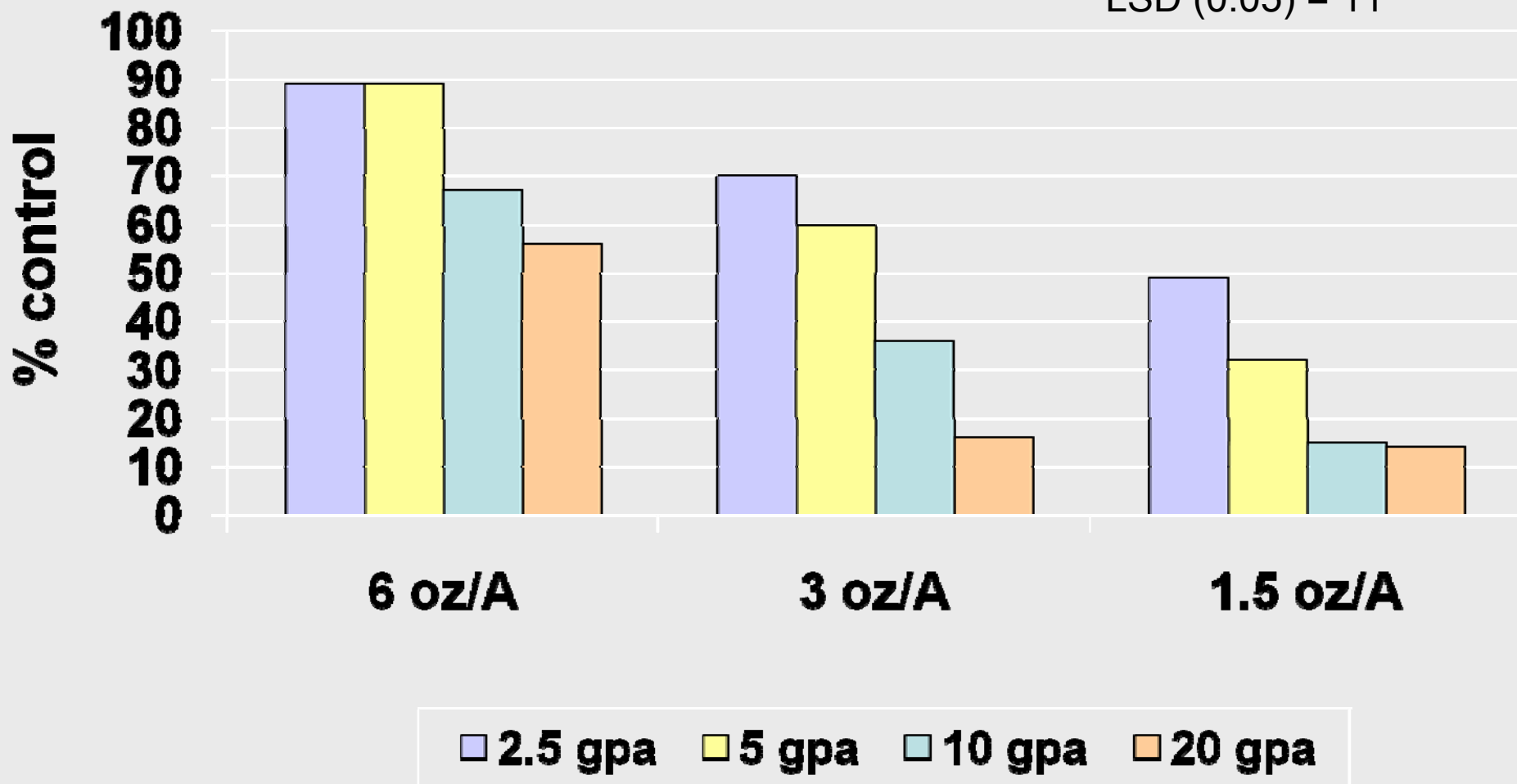
Roundup UltraMAX<sup>®</sup>



# Spray Volume: Roundup Ultra

2001 Fargo

LSD (0.05) = 11

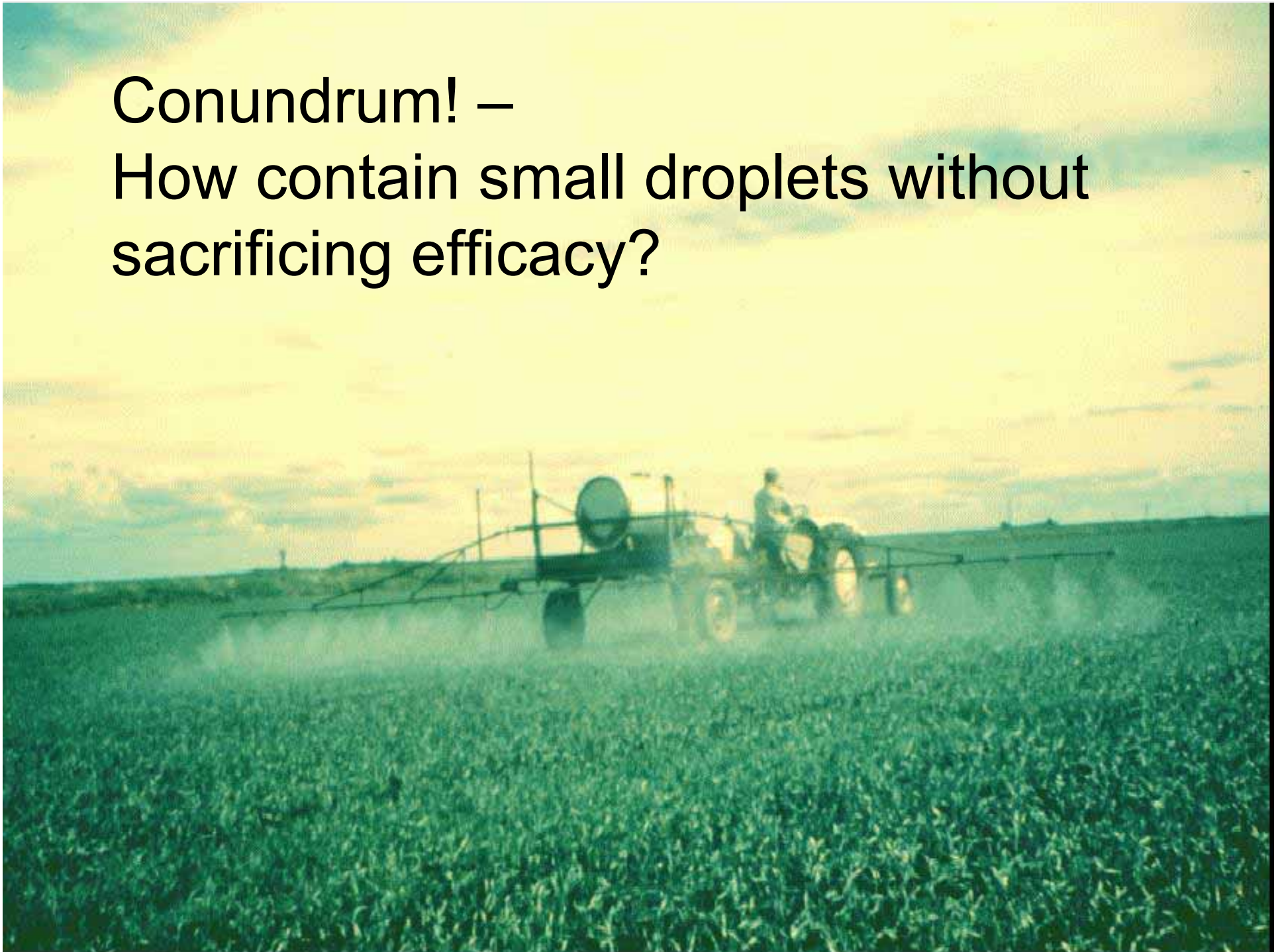


# Spray Volume: What we know

Many herbicides can be effectively applied in low spray volumes (2.5 to 5 gpa)

- Glyphosate
- Pursuit
- Raptor
- Assert
- Accent
- Everest
- Aim
- Select
- Poast
- Achieve
- Assure II
- Puma
- 2,4-D amine

Conundrum! –  
How contain small droplets without  
sacrificing efficacy?





## **XR TeeJet**

**XR 11002**  
**at 40 psi**



## **Turbo TeeJet**

**TT 11002**  
**at 20 psi**



## **AI TeeJet**

**AI 11002**  
**at 60 psi**



## **TurboDrop XL**

**TDXL-110-02**  
**at 60 psi**

# Herbicide efficacy at 5 gpa

Averaged over 3 grass species



# Glyphosate Summary

Glyphosate efficacy increased with AMS regardless of water hardness

AMS at 0.5% w/v (4 lb / 100 gal) was generally sufficient to maximize glyphosate efficacy while AMS at 2% w/v occasionally was antagonistic

Glyphosate rate could be reduced by half when applied in 2.5 or 5 gpa compared to 10 or 20 gpa

Efficacy was generally similar for all glyphosate formulations that do not require additional surfactant

# Questions:

9. Should oil adjuvants be applied at:  
% vol/vol basis = 1% v/v or  
area basis (pt/A)?

Which application type may not contain sufficient oil  
adjuvant concentration?

% v/v or

area (pt/A)



# Question:

Should adjuvants be applied at % v/v or by area?

Poast and Select = 1 qt/A of oil adjuvant

Assure II, Fusidale DX, and Fusion = 1% v/v oil

At 17 gpa - 1% v/v PO = 0.17 gal = 1.4 pt/A

At 8.5 gpa - 1% v/v PO = 0.085 gal = 0.68 pt/A

Apply PO on area basis at 1 qt/A

Apply MSO on area basis at >1.2 pt/A

# Spray Volume: What We Know

Efficacy generally increases as spray volume increases if adjuvant rate is % v/v

- oils and surfactants
- exception: basic blend (Quad 7)

Efficacy at low volume  $\geq$  high volume if adjuvants applied on an area basis  
â oils and surfactants

Some herbicides are more effective in low volumes independent of adjuvant rate  
â glyphosate and Raptor

# Questions:

10. What are basic pH blend adjuvants?

# ▲ pH of spray solution = ▲ solubility

	pKa	Water pH (25 C)			X fold ▲
		5	7	9	
		----- solubility (ppm) -----			
Accent	4.3	360	12,200	39,000	108
Muster	4.6	2	50	410	205
Express	5.0	48	2040	18,300	380
Ally	3.3	550	2,800	213,000	385
UpBeet	4.4	3	110	11,000	3,670
Maverick	--	18	1600	480	--

# Questions:

11. What is the difference between COC (petroleum oil) adjuvants and MSO (methylated seed oil) adjuvants?

# Dissolve green foxtail leaf wax

Adjuvant	0	Exposure time (min)					24 hr
		5	10	20	40		
Distilled water	0	0	0	0	0	0	0
NIS	0	0	0	0	0	0	2
Petro oil(COC)	0	0	0	3	3	3	9
Sunflower oil	0	0	0	0	3	3	6
MSO	3	5	7	9	10	10	10

Manthey, F.A. and J.D. Nalewaja

Evaluation scale: 0 = no solubility, 10 = total wax solubility

# Questions:

12. Which salts in water antagonize herbicides?

# What makes water hard ?

Antagonistic minerals to herbicides:

Calcium –  $\text{Ca}^{++}$

Magnesium –  $\text{Mg}^{++}$

Iron –  $\text{Fe}^{+++}$

} Hard water ions

Sodium –  $\text{Na}^+ =$

Soft water



# Questions:

13. Which herbicides are antagonized by salts in your spray water?

# Questions:

Many herbicides are formulated as salts –  
2,4-D – dma (dimethyl amine)

Curtail – mea (monethanolamine)

Dicamba – dma, dga, Na, K

Basagran – Na

Pursuit, Raptor, Liberty – NH<sub>4</sub>

Tordon – K

Milestone – triisopropylNH<sub>4</sub>

# Questions:

What does “weak acid” mean?

Answer:

Herbicides dissociate from their salt in acid  $\text{pH} = <7$

Herbicides can ionize in acid pH  
(lose or gain (+) or (–) charge)

# Adjuvant quiz

Which herbicides are antagonized by salts in spray water?

A. 2,4-D, MCPA, Dicamba, Curtail

B. Glyphosate, Liberty (glufoninate)

C. Poast, Select, Fusilade, Assure II

D. Basagran, Reflex

# Adjuvant Rule #2

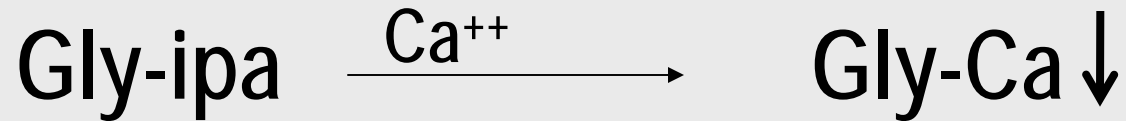
## Kochia control from herbicide formulations

Herbicide	Spray carrier salt		
	None	+CaCl <sub>2</sub>	+CaCl+AMS
	----- % control -----		
2,4-D - ester	45	0	45
2,4-D - amine	0	0	38
Basagran - Na	55	7	61
Banvel - dma	67	17	70
Banvel SGF- Na	34	9	69
Roundup - ipa	94	4	100

# Questions:

14. What is the mode of action of AMS (ammonium sulfate)?

# Glyphosate form in spray residue



Glyt solubility: ipa + Na = 50%, NH<sub>4</sub> = 30%, Ca = 3%

# Adjuvant Rule #2

## Wheat control from Roundup

	Roundup		
	Alone	+NaHCO <sub>3</sub>	+CaCl
	----- % control -----		
Roundup alone +	55	26	0
Ammonium nitrate	62	58	31
Ammonium sulfate	69	76	74

Only use ammonium sulfate



# Questions:

15. Do water conditioning/AMS replacement adjuvants work as well with glyphosate as AMS?

## Alliance (Agriliance)

- AMS + water conditioning, coupling, and antifoam agents

## Choice (Loveland)

- AMS and salts of organic acids + phosphate ester

## Bronc Max (Wilbur-Ellis)

- AMS / ammonium alyl aryl sulfonates, polycarboxylic acid

## Quest (Helena)

- hydroxycarboxylic acids, phosphoric acids, AMS, and polyacrylic acids

## Citron (FarmDirect)

- 91% Citric acid, anhydrous

## N-Tense (West Central/Van Diest)

- AMADS = >50% monocarbamide dihydrogen sulfate or aminomethanamide dihydrogen tetraoxosulfate

## Herbolyte (ProfitPro LLC)

- Hydroxytricarballic acid >2%
- MSDS – ingredients not hazardous – none reported

# Materials and Methods

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<u>Water Cond.</u>	<u>Rate</u>	<u>Rate of AMS</u>
AMS	8.5 lb/100 gal ½ label rate	--
Alliance	1.25% v/v =	4.25 lb/100
Bronc Max	0.5% v/v =	~ 8.5 lb/100
Choice	0.5% v/v =	?
Quest	0.5% v/v =	?
Citron	2.2 lb 100/gal =	0
N-Tense	0.5% v/v =	0
Herbolyte	1% v/v =	0

	<u>Grass</u>		<u>Brdlf</u>	
	93-95	05-06	93-95	05-06
	----- % control -----			
Glyt +	49	68	31	42
R-11	74	90	51	66
APSA 80	74	87	50	62
Wet-Sol 99	--	86	--	61
Preference	67	79	38	58
AMS	--	86	--	68
R-11 + AMS	--	93	--	76
Class Act (NG)	90	94	75	76
Surfate	89	93	75	74
LSD (0.05)	--	6	--	8

	2005-06		
	AMS (lb/100)	Grass ----- % control -----	Brdlf
Glyphosate +		68	42
R-11 + AMS	8.5	93	76
Class Act (NG) @ 2.5 %	8.5	94	76
Bronc Max + R-11	8.5	92	73
Surfate @ 1%	2.8	93	74
Alliance + Pref @ 1.25%	4.25	89	68
AMS	8.5	86	68
Quest (0.5%) +Preference?		87	62
Choice (0.5%) + Liberate ?		81	60
Citron (2.2 lb)+Preference 0		84	66
N-Tense @ 0.5%	0	90	67
Herbolyte @ 0.5%	0	79	55

Data averaged over 68 means (272 observations).

# Herb + AMS Replacement Adj.- Colq / 500 ppm

		Na	Bnvl	Rap	SF	Poast
		----- % control -----				
Herbicide	2 fl oz, 2 fl oz, 0.75 oz, 0.5 pt		5	0	33	0
+ NIS/PO w/ Poast	0.25%		42	8	45	60
+ AMS	8.5 lb		25	0	23	70
+ 28%	2.5%		7	10	22	60
<b>+ NIS + AMS</b>	<b>8.5 lb</b>		<b>53</b>	<b>43</b>	<b>69</b>	<b>95</b>
+ NIS + 28%	2.5%		35	27	64	85
+ Cayuse Plus	0.75%		35	17	61	48
+ Class Act NG	2.5%		52	28	58	60
+ Surfate	1%		43	20	50	40
+ Citron + Preference	2.2 lb		41	43	53	71
+ Alliance + Preference	1.25%		42	30	50	70
+ Choice + Liberate	0.5%		3	10	57	50
+ Quest + Preference	0.5%		42	25	52	70
+ Herbolyte	1%		10	12	42	13
+ N-Tense	0.75%		48	50	42	35
+ Reddy-It	0.25%		35	31	48	33
+ Quad 7 (Basic Blend)	1%		73	57	60	82
+ MSO + AMS	1.5 pt		73	65	62	90
+ Z-64/Renegade (MSO+BB)	1.5 pt		74	67	74	94