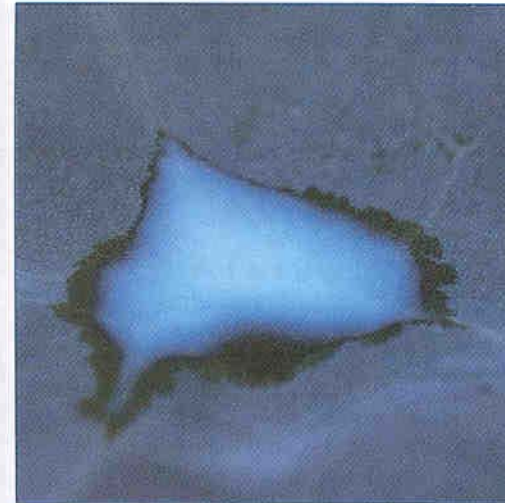


WORKING THROUGH THE CONFUSION OF ADJUVANTS

BY BARBARA GRONDIN

Below is a follow-up to the author's article in the January issue of *Agrichemical Age* titled "Industry Regulation Causes Uncertainty." That article looked at the confusion rampant in the agrichemical industry over the legalities of using adjuvants. Here, Ms. Grondin defines adjuvants and asks an expert to critique their different uses.



R. K. Zollinger
North Dakota State University

Map of the U.S. as seen by a North Dakotan





ANN HYDROUS

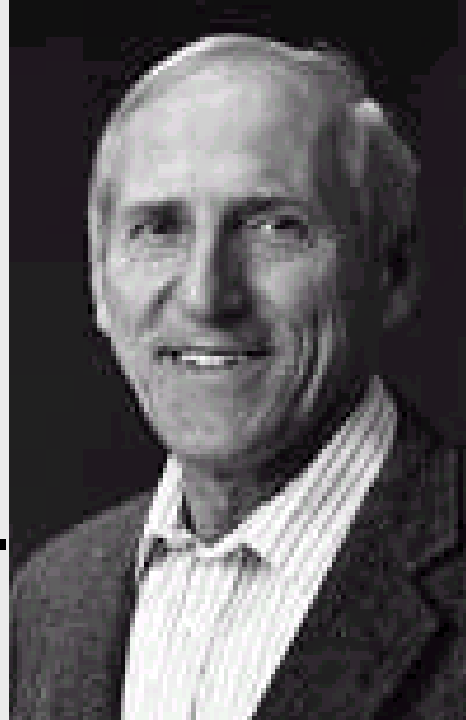
JMI

745-4558





Dr. John Nalewaja
Professor Emeritus
Weed Science
North Dakota St. Univ.



Contributions to science:

Methylated Seed Oil (MSO)
Basic pH Blend
Hard water herbicide antagonism



Questions:

Einstein final exam

Questions:

Is it legal to apply herbicides at reduced rates?

Is it legal to apply herbicides at reduced gpa?

Are adjuvants regulated?

How are adjuvants classified?

What are the modes of action of adjuvants?

Are adjuvants created equal?

Herbicide Spray Adjuvant Choices

ND Weed Control Guide

2003 = 96 Choices

2010 = 165 Choices

**60% Increase in
Choices**



Information Overload

Questions:

Is it legal to apply herbicides at reduced rates?

Is it legal to apply herbicides at reduced gpa?

Are adjuvants regulated?

How are adjuvants classified?

What are the modes of action of adjuvants?

Are adjuvants created equal?

Herbicide Spray Adjuvants – ND Weed Guide

Nonionic surfactants (60 – 90% NIS)

NIS with Organosilicone (OS)

NIS + Fertilizer

Water Conditioning Agents (WCA)

NIS + WCA

Oil Based NIS

Basic pH Blend

Petroleum Oil Concentrates (COC)

High Surfactant Oil Concentrates

Methylated Seed Oils (MSO)

MSO Basic pH Blend

MSO + WCA

MSO + OS

Fertilizer (AMS / UAN / 28% / 32%)

AMS + Drift Retardant or Defoamer

AMS + Deposition + Defoamer

AMS + Deposition + Retention + Defoamer

AMS + NIS + Dep. + Retention + Defoamer

WCA + Deposition + Defoamer

WCA + Deposition + Defoamer + NIS

Deposition – Drift Retardants

Deposition + Drift Retardants + NIS

Drift Retardants + Defoamer

Acidifying Agents

Compatibility Agents

Spray Tank Cleaners

Herbicide Spray Adjuvants – ND Weed Guide

Nonionic surfactants (60 – 90% NIS)

NIS with Organosilicone (OS)

NIS + Fertilizer

Water Conditioning Agents (WCA)

NIS + WCA

Oil Based NIS

Basic pH Blend

Petroleum Oil Concentrates (POC)

High Solubility Concentrates

Methylated Soluble Oils (MSO)

MSO Basic pH Blend

MSO + WCA

MSO + OS

Fertilizer (AMS / UAN / 28% / 32%)

AMS + Drift Retardant + Defoamer

AMS + Deposition

AMS + Deposition + Retention + Defoamer

AMS + Deposition + Retention + Defoamer

AMS + Deposition + Defoamer

WCA + Deposition + Defoamer + NIS

Deposition – Drift Retardants

Deposition + Drift Retardants + NIS

Drift Retardants + Defoamer

Acidifying Agents

Compatibility Agents

Spray Tank Cleaners

28 Adjuvant Categories

Simplify

- Active adjuvant components

- 1.

- 2.

- 3.

Simplify

- Active adjuvant components
 1. Surfactants
 2. Oils
 3. Fertilizer

Questions:

Is it legal to apply herbicides at reduced rates?

Is it legal to apply herbicides at reduced gpa?

Are adjuvants regulated?

How are adjuvants classified?

What are the modes of action of adjuvants?

Are adjuvants created equal?

Herbicide Groups

How many herbicide modes of action?



Adjuvant Groups

➤ Herbicide Modes of Action

How many = 28

How many adjuvant modes of action?

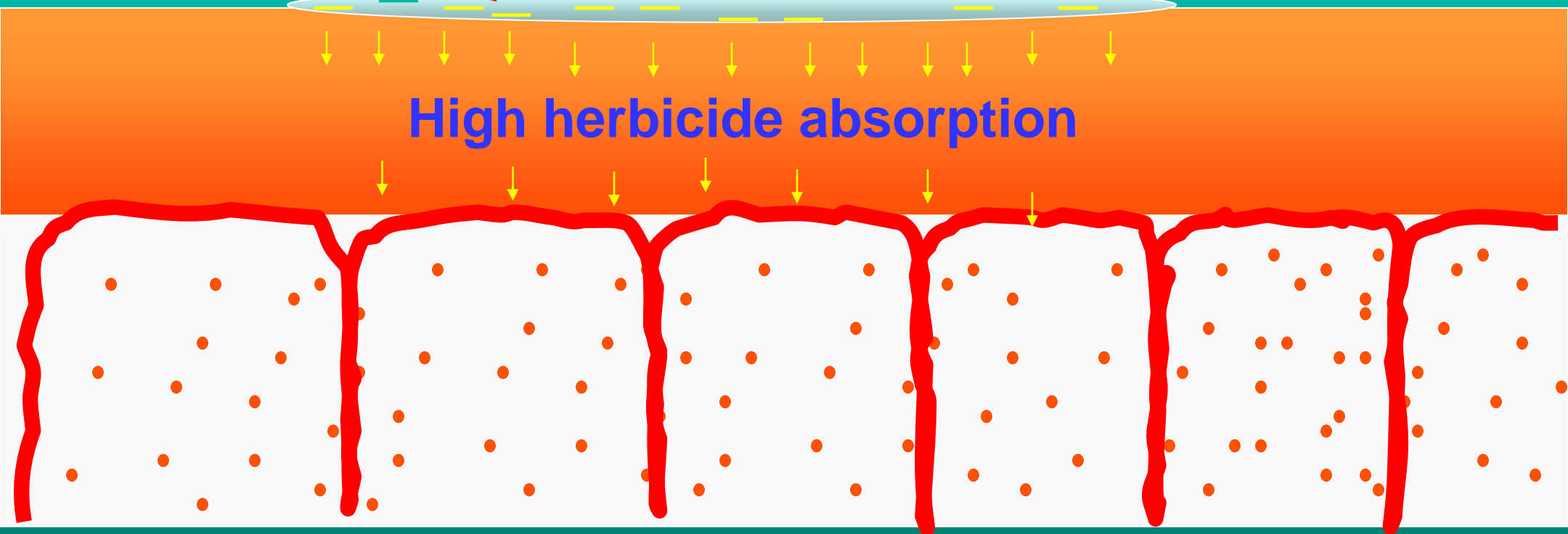
???

Spray deposit remains partially moist

**Herbicide and
adjuvant evenly
distributed**

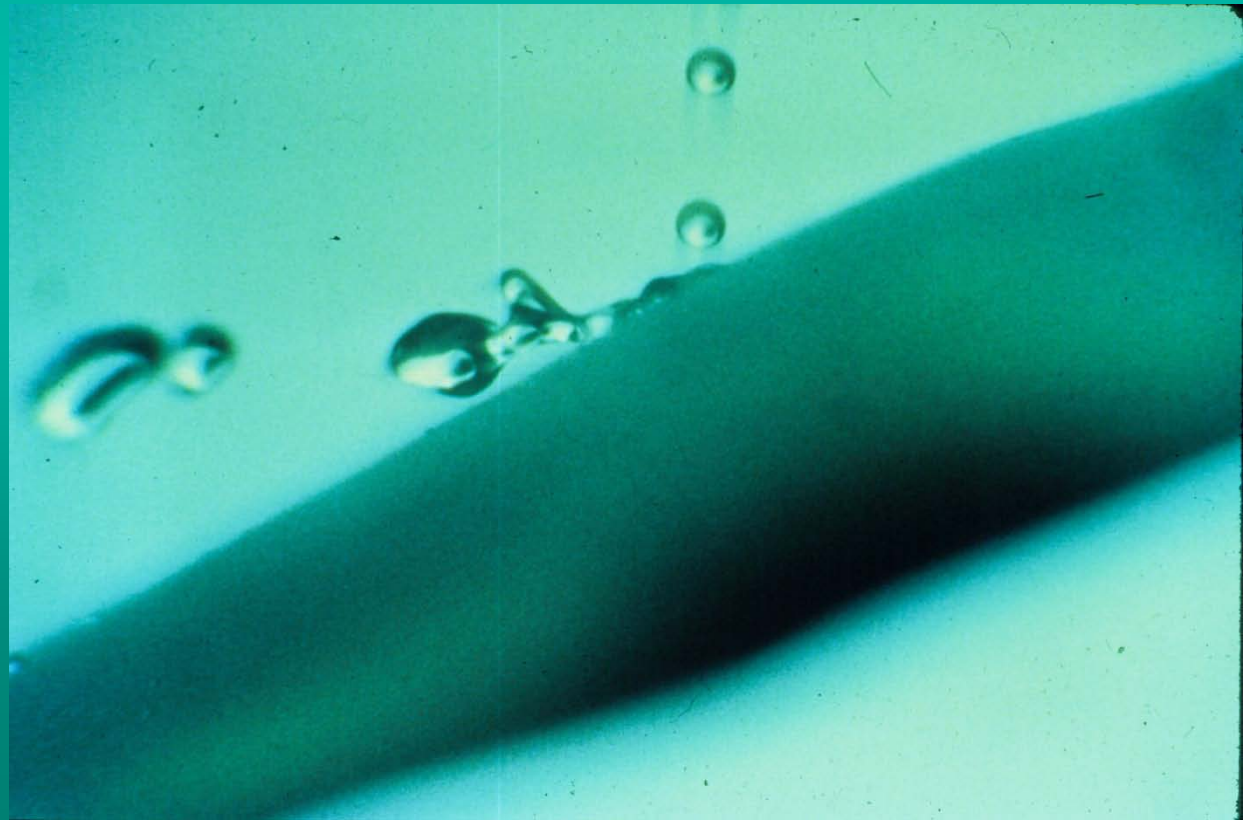
**Herbicide remains
dissolved in spray
deposit**

High herbicide absorption



Simplify

- Adjuvant (NIS, Oil, fertilizer) mode of action
 1. Retention
 2. Deposition
 3. Absorption
 4. Translocation



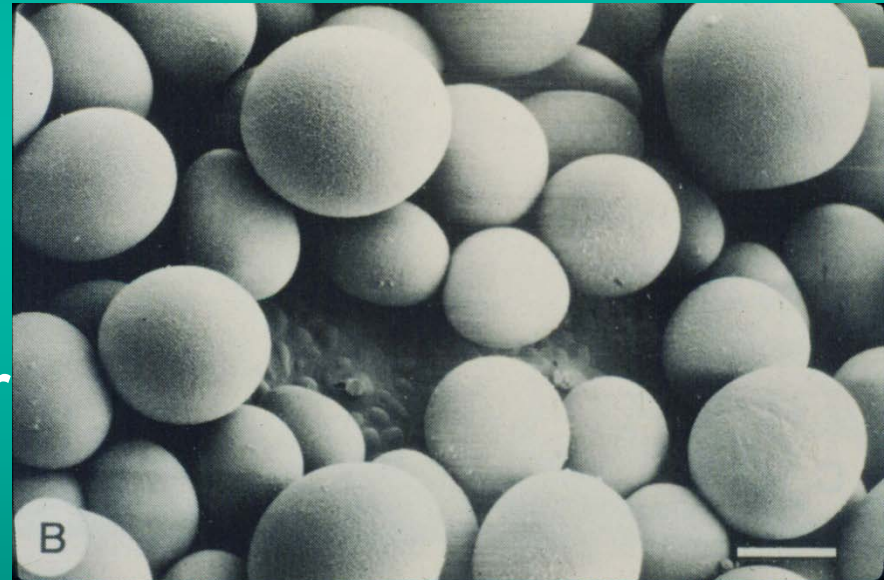
Simplify

➤ Adjuvant mode of action

1. Retention – NIS



2. Deposition – NIS and oils



3. Absorption – oils and fertilizer

4. Translocating agents - fertilizer

Dissolve green foxtail leaf wax

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

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

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

➤ Why are MSOs not used more?

1. NIS = \$20/gal – 0.25% v/v @ 10GPA
= \$0.50/A

2. MSO = \$16.00 gal
- 1.5 pt/A = \$3/A



Questions:

Adjuvant R history

Is it legal to apply herbicides at reduced rates?

Is it legal to apply herbicides at reduced gpa?

Are surfactants adjuvants or are adjuvants surfactants
– terminology

How are adjuvants classified?

What are the modes of action of adjuvants?

Are adjuvants created equal? - regulation

Adjuvant Rule #1

Not all adjuvants are created equal!!



Adjuvant Rule #1

Adjuvant enhancement of Roundup (Williston)

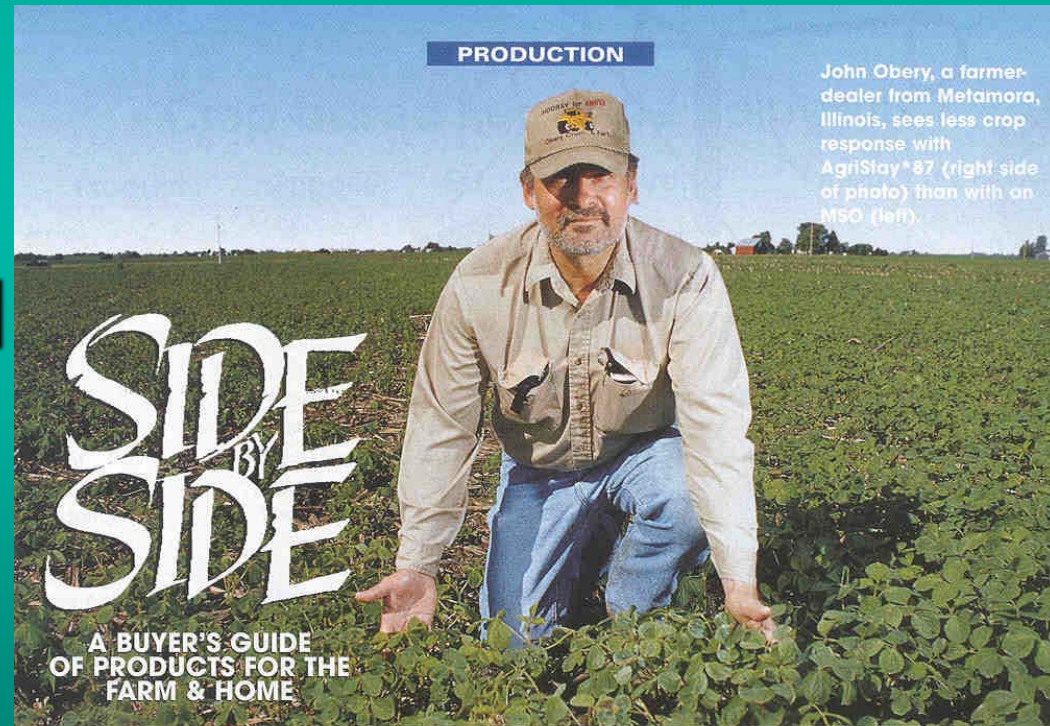
Surfactant (0.5%)	Oat	Rrpw
	----- % control -----	
None	21	26
APSA-80	75	60
R-11	66	51
X-77	50	43
Spray Booster S	42	48
LI-700	31	22
Silwet L-77 (0.25%)	16	56



Adjuvants are like a lot of things
some work and some don't

Do not fall for every snake oil, perfume, or mouse milk

1. Use chemical company rec – DuPont, Bayer
2. Use proven brands
3. Use major brands
4. Use unbiased tested



Crop-based adjuvants

More new herbicide adjuvants are based on products you grow

Questions:

Which is the “best” adjuvant to use?

Does weed control increase as GPA increases?

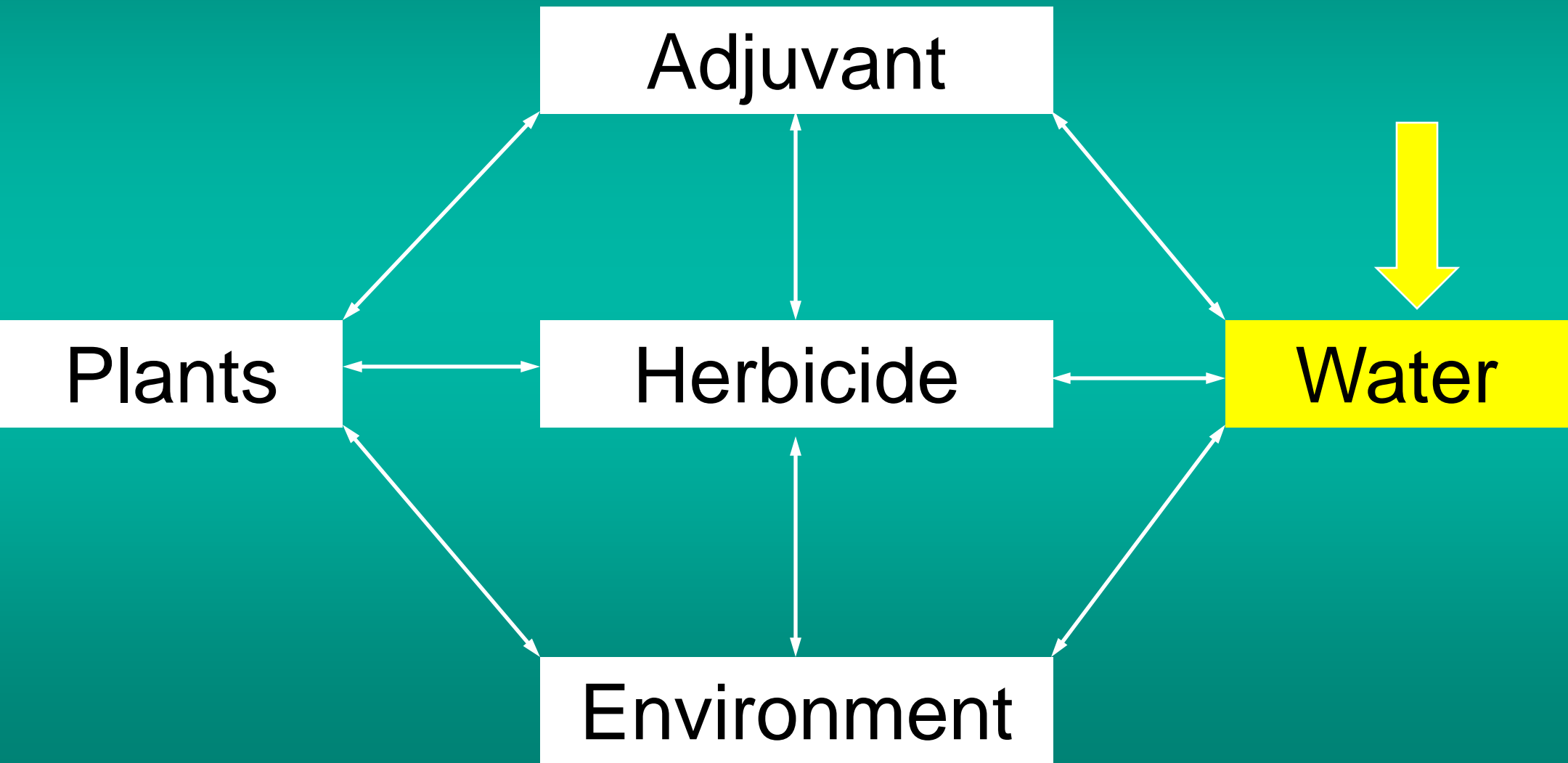
Is there a difference in NIS + UAN, COC or MSO?

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

What are basic pH blend adjuvants?

Is there a difference in glyphosate formulations?

The Weed Control Complex





LOOKS LIKE A DUCK. WALKS LIKE A DUCK.

— Must be *glyphosate*. —



The exact same pre-harvest power.

- The same reliable weed control.
- The same approved label claims.
- The same fast plant absorption, premium weed control and one-hour rainfastness through enhanced surfactant technology.
- Consistently high level of weed control for pre-harvest, post-harvest, *glyphosate*-tolerant canola, burndown and chemfallow.
- The new alternative *glyphosate* product for control of

The point is, a duck is a duck. And *glyphosate* is *glyphosate*. Period.

Pre-harvest glyphosate's pre-harvest glyphosate.

Vantage Plus, from Dow AgroSciences, is a new choice of premium *glyphosate* for pre-harvest and all other applications. You get the exact same power and the same consistent



LOOKS LIKE A DUCK. WALKS LIKE A DUCK.

— Must be *glyphosate*. —

Glyphosate

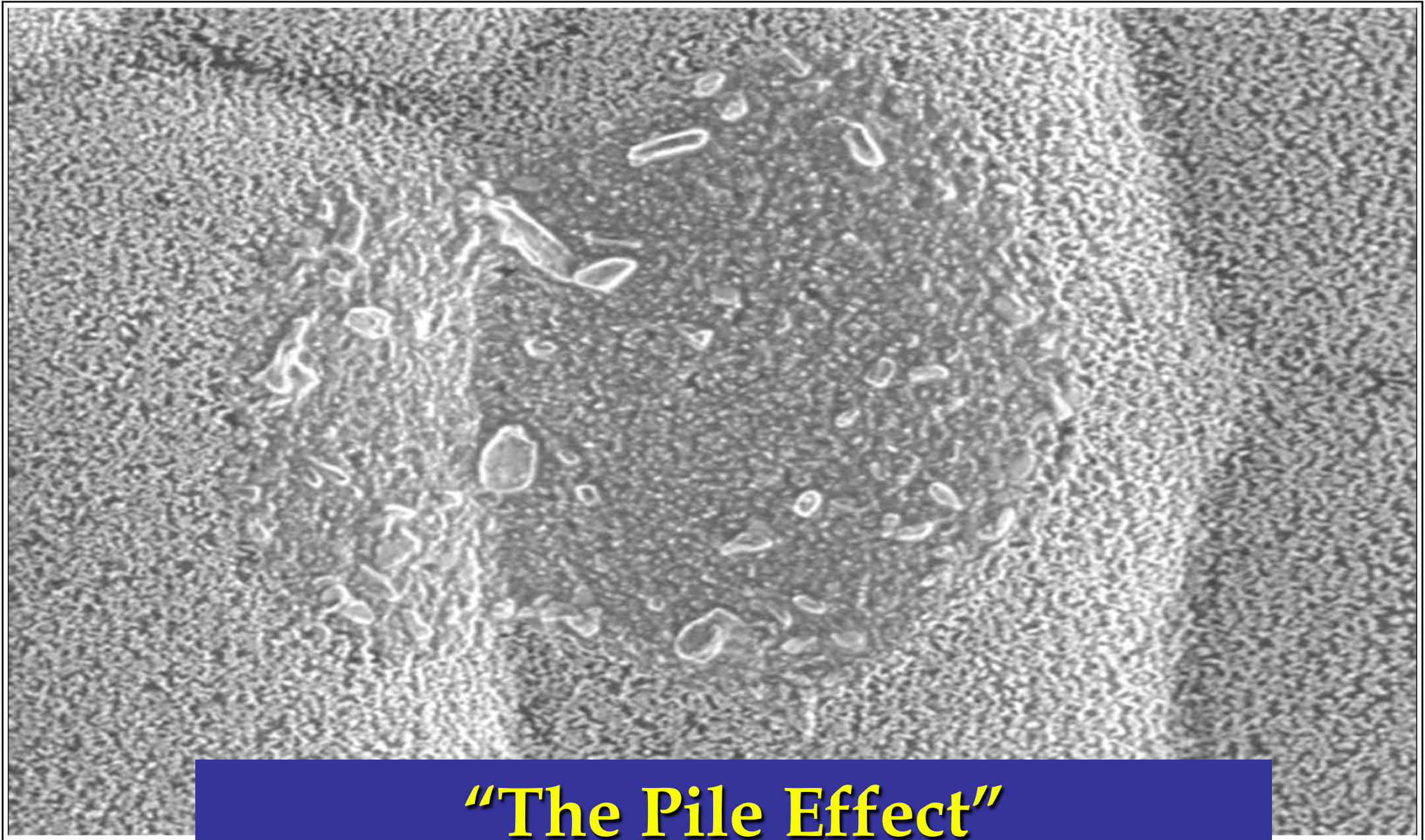
Is glyphosate more active at
10 gpa or 20 gpa?

Glyphosate

Is glyphosate more active at
10 gpa or 20 gpa?

Lowest spray volume allowed!

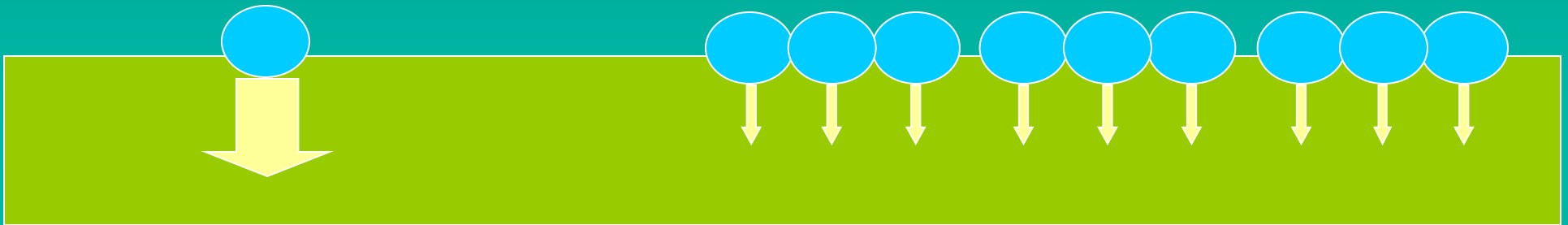
Why?



“The Pile Effect”
Dr. John Nalewaja

High herbicide concentration vs. high plant coverage?

Which is better?



Glyphosate = more phytotoxic when
applied in 1 concentrated drop (big pile)
than 9 dilute drops of equal size

Spray Volume: What we know

Many herbicides can be effectively applied in low spray volumes (5 to 10 gpa)

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

So if droplets with thicker piles
(high herbicide concentration)
give greater weed control

then....

what adjustments do I make to
my sprayer?

If I reduce my water volume

then....

what happens to my droplet size?

If small droplets increase risk of
drift

then....

how do I minimize drift?

Use drift retardants or DR nozzles



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

Adjuvant quiz

Some herbicide labels recommend oil adjuvants at % volume while others on an area basis (pt/A).

Which method may not have sufficient adjuvant concentration in low gpa?

- A. % volume
- B. Area

2000 ND Pesticide Use Survey

What % of herbicide applications in ND are made at < 10 gpa?

2000 ND Pesticide Use Survey

What % of applications are made at =
or < 10 gpa?

88%

What affect does this have on
adjuvant rate?

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 oil adjuvants on an area basis – pt/A

Gr. Foxtail control from Accent (1/2 rate) (Roehl, NDSU)

Spray vol.	<u>MSO, pt/A</u>	
	0.5	1
(gpa)	----- % control -----	
8.5	64 (1%)	89 (2%)
17	60 (0.5%)	84 (1%)
<u>LSD (5%)</u>	----- 4 -----	

Oat control from Accent (1/2 rate)

Spray vol. (gpa)	NIS	MSO	
		1% v/v	1.6 pt/A
	-----	% control	-----
5	61	70	96
10	67	73	93
20	78	78	87

5 gpa = 8001 nozzle

10 gpa = 8004 nozzle

20 gpa = 8004 nozzle

C. cocklebur control with Express

	1% v/v (0.68 pt/A)	2% v/v (1.4 pt/A)	1.5 pt/A
	----- % control -----		
Express (0.5 oz/A)			
+ Basic Blend	42	69	--
+ MSO	35	44	57
+ MSO + BB	42	64	74
LSD 0.05	----- 7 -----		
GPA = 8.5			

General rule:

Apply oil adjuvants at 1% v/v but not less than 1.25 pt/A.

Glyphosate

Glyphosate is VERY water soluble?

NIS or oil adjuvant?

Humid or dry environment?

Dry leaf surface or dew on leaf?

Oil adjuvants

Glyphosate = hydrophilic

Other POST herbicides = Lipophilic

What can happen when tank-mixed?

Oil adjuvant antagonism of glyphosate

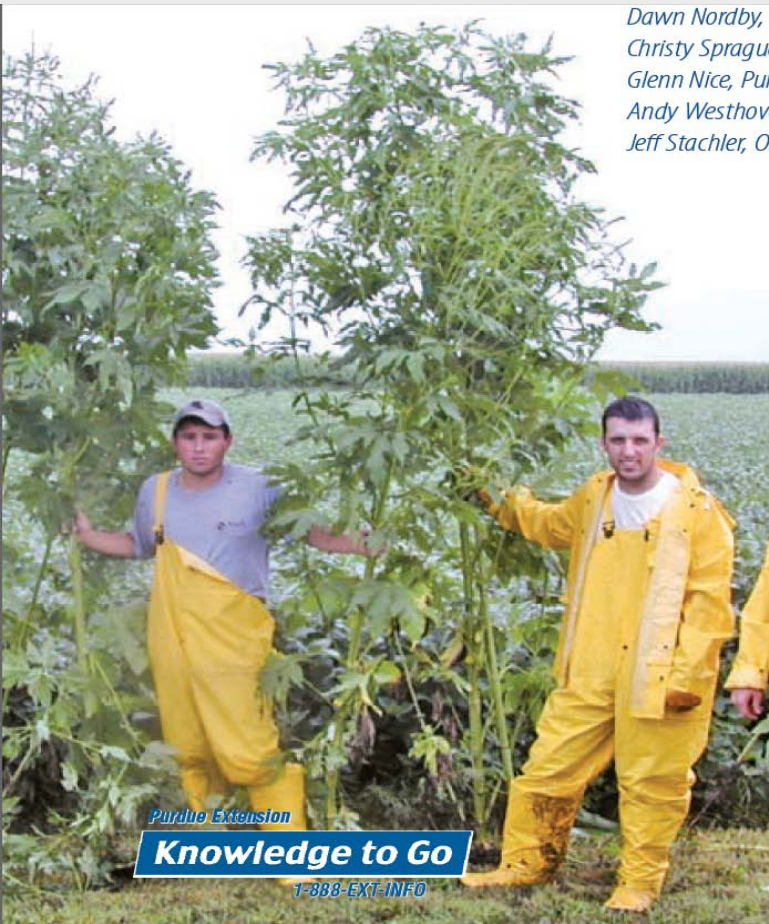
NDSU, 2008, 28 DAT

Herbicide*	RR soy	Flax	Grass**
	----- % control -----		
Glyt+Laudis +	18	18	31
NIS	28	23	56
NIS + AMS	37	62	87
COC	67	13	59
COC + AMS	88	28	71
LSD (5%)	7	6	8

* Glyt = 0.28 lb ae/A, Temb = 1 fl oz/A

** Grass = averaged over oat, foxtail millet, and foxtail barley

Conundrum!



*Dawn Nordby,
Christy Sprague,
Glenn Nice, Pur
Andy Westhov
Jeff Stachler, O*



How overcome the antagonism from oil soluble herbicides or oil adjuvants?

ND Weed Control Guide

High Surfactant Oil Concentrate

Between (PO)	United Suppl.	\$15.00 gal	1 to 2 pt/A
Destiny HC (MSO)	Winfield	\$34.00 gal	1 to 2 pt/A
Diplomat (PO)	Rosens	\$11.50 gal	1 to 2 pt/A
Exchange (PO)	Precision Labs	\$22.00 gal	1 to 2 pt/A
Hi-Load (PO)	Simplot	\$ - gal	1 to 2 pt/A
High Load (PO)	Wilbur-Ellis	\$24.00 gal	1 to 2 pt/A
Superb HC (PO)	Winfield	\$17.00 gal	1 to 2 pt/A

Oil Based Surfactant

Trophy Gold	West Central	\$32.00 gal	0.5 pt/A
-------------	--------------	-------------	----------

ASTM Adjuvant Definitions

Crop oil concentrate (PO) =

emulsifiable petroleum oil-based products containing 15-20% surfactant and remainder phytoabland oil.

High surfactant oil conc. (HSOC) =

emulsifiable oil (PO or MSO) based products containing 20-50% surfactant and a minimum of 50% oil.

High Surfactant Oil Concentrate

Between (PO)	United Suppl.	\$15.00 gal	1 to 2 pt/A
Destiny HC (MSO)	Winfield	\$34.00 gal	1 to 2 pt/A
Diplomat (PO)	Rosens	\$11.50 gal	1 to 2 pt/A
Exchange (PO)	Precision Labs	\$22.00 gal	1 to 2 pt/A
Hi-Load (PO)	Simplot	\$ - gal	1 to 2 pt/A
High Load (PO)	Wilbur-Ellis	\$24.00 gal	1 to 2 pt/A
Superb HC (PO)	Winfield	\$17.00 gal	1 to 2 pt/A

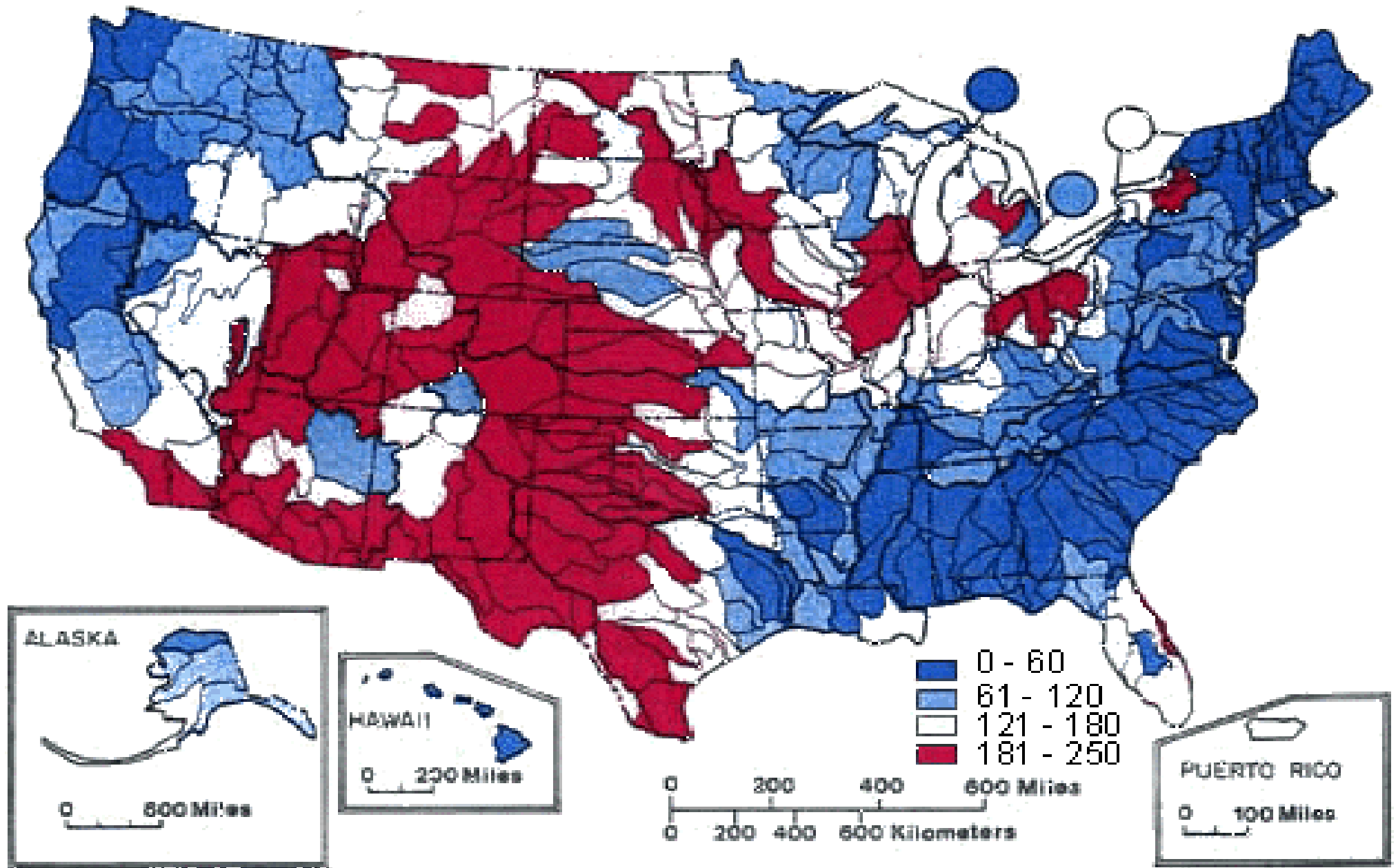
Oil Based Surfactant

Trophy Gold	West Central	\$32.00 gal	0.5 pt/A
-------------	--------------	-------------	----------

Adjuvant Rule #2

What makes water hard ?

CONCENTRATION OF HARDNESS AS CALCIUM CARBONATE, IN MILLIGRAMS PER LITER



Mean hardness as calcium carbonate at USGS NASQAN stations during 1975 water year.

Water quality test

<u>Water hardness</u>	<u>ppm</u>	<u>AMS needed</u>
Soft	75	0.67 lb
Mod hard	150	1.5 lb
Hard	300	3 lb
Very hard	400	3.6 lb
	500	4.5 lb
	600	5.4 lb
	700	6.3 lb
	800	7.2 lb
	950	8.5 lb

Adjuvant Rule #2

What makes water hard ?

Antagonistic minerals to herbicides:

Calcium – Ca^{++}

Magnesium – Mg^{++}

Iron – Fe^{+++}

} Hard water ions

Sodium – $\text{Na}^+ =$

Soft water

How overcome mineral
antagonism?

How much AMS do I need?

Is 17 lb/100 gal of water needed?

How much AMS is needed?

Monsanto label:

2% w/v = 17 lbs/100 gal water

1% w/v = 8.5 lbs/100 gal water

0.5% w/v = ~4.25 lb/100 gal water

How many of you have had your water
tested for antagonistic minerals?

Formula for amount of AMS:

AMS (lbs/100 gal water) =

0.002 x ppm K +

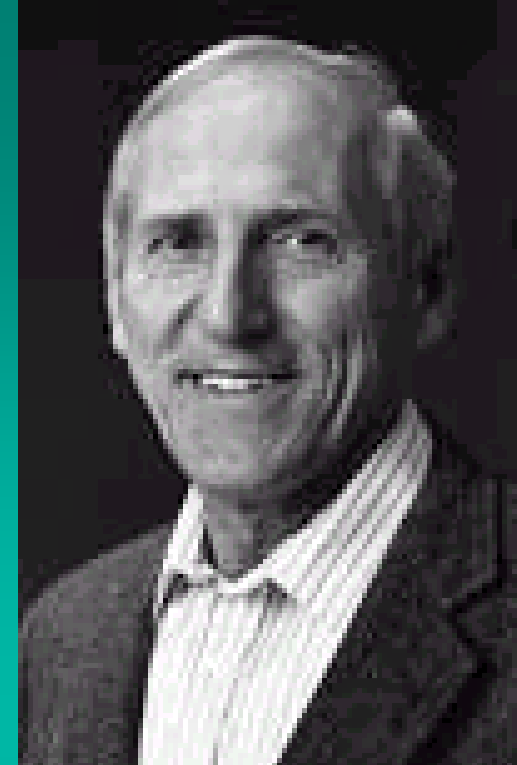
0.005 x ppm Na +

0.009 x ppm Ca⁺⁺

0.012 x ppm Mg⁺⁺

0.042 x ppm Fe⁺⁺

K, Na, Ca, Mg, Fe values from
water analysis



Agrilance now Winfield Solutions

- Tested 1,000's of water samples in U.S.

- Conclusion:

- 4 lbs AMS is enough for >90% of water samples in NC region

- Know your water quality

➤ Adjuvant mode of action

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

Lets summarize:

Adjuvant Rule #1

Not all adjuvants are created equal!



