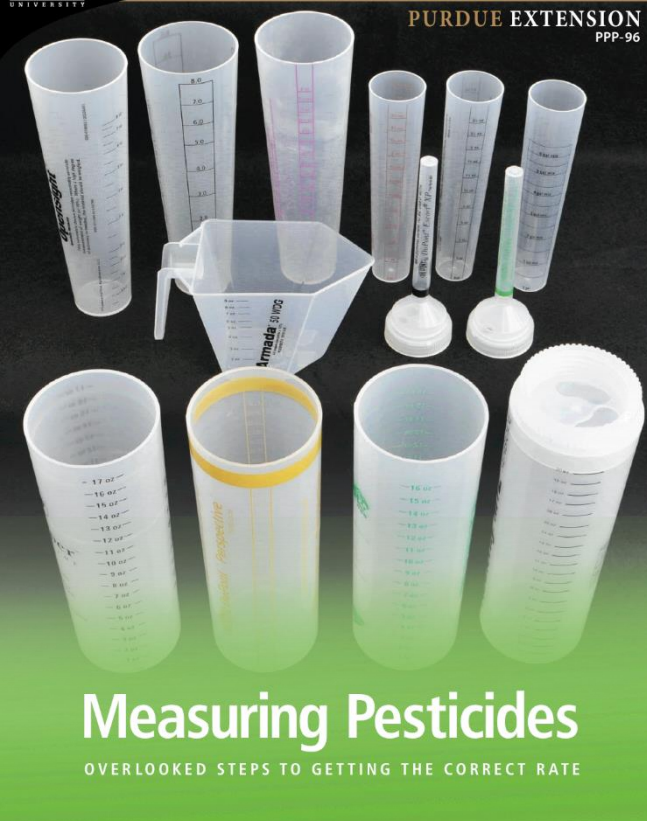


# Adjuvants and the Water Droplet

## Squeezing More Efficiency Out of the Spray Application

Sherm Takatori, ISDA





## Adjuvants and the Power of the Spray Droplet




Improving the Performance of Pesticide Applications



Thanks to Fred Whitford of Purdue University in Indiana

[www.ppp.purdue.edu](http://www.ppp.purdue.edu)



- 
- **Is there science behind adjuvants?**
  - **Do they work?**
  - **Are they worth the money?**





# The Spray Water Droplet







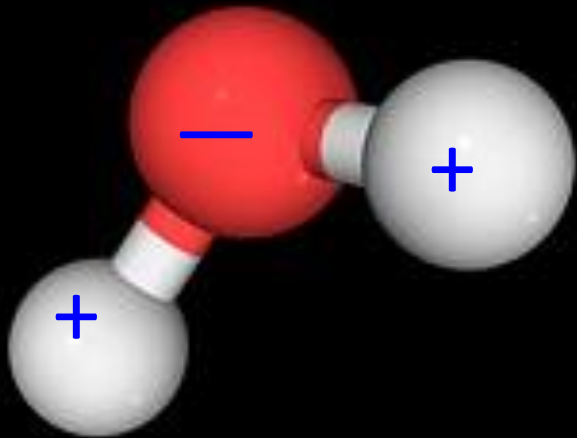




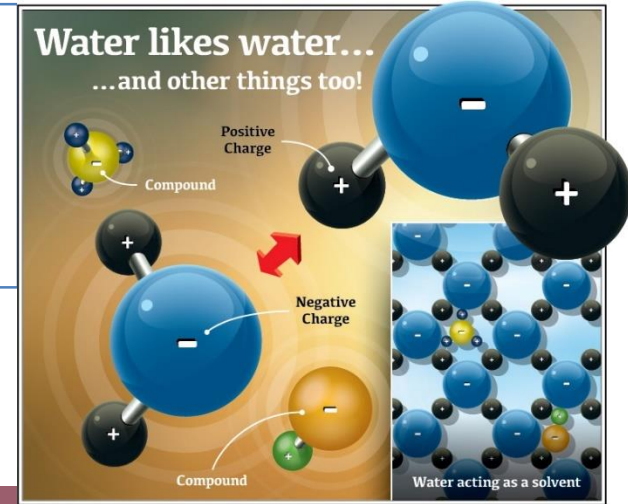
# Unlocking the Mysteries of the Water Droplet is Important Because It Forms Most of the Spray Mixture

- Water is not 'just' the carrier
- Water is not pure
- A very complex molecule

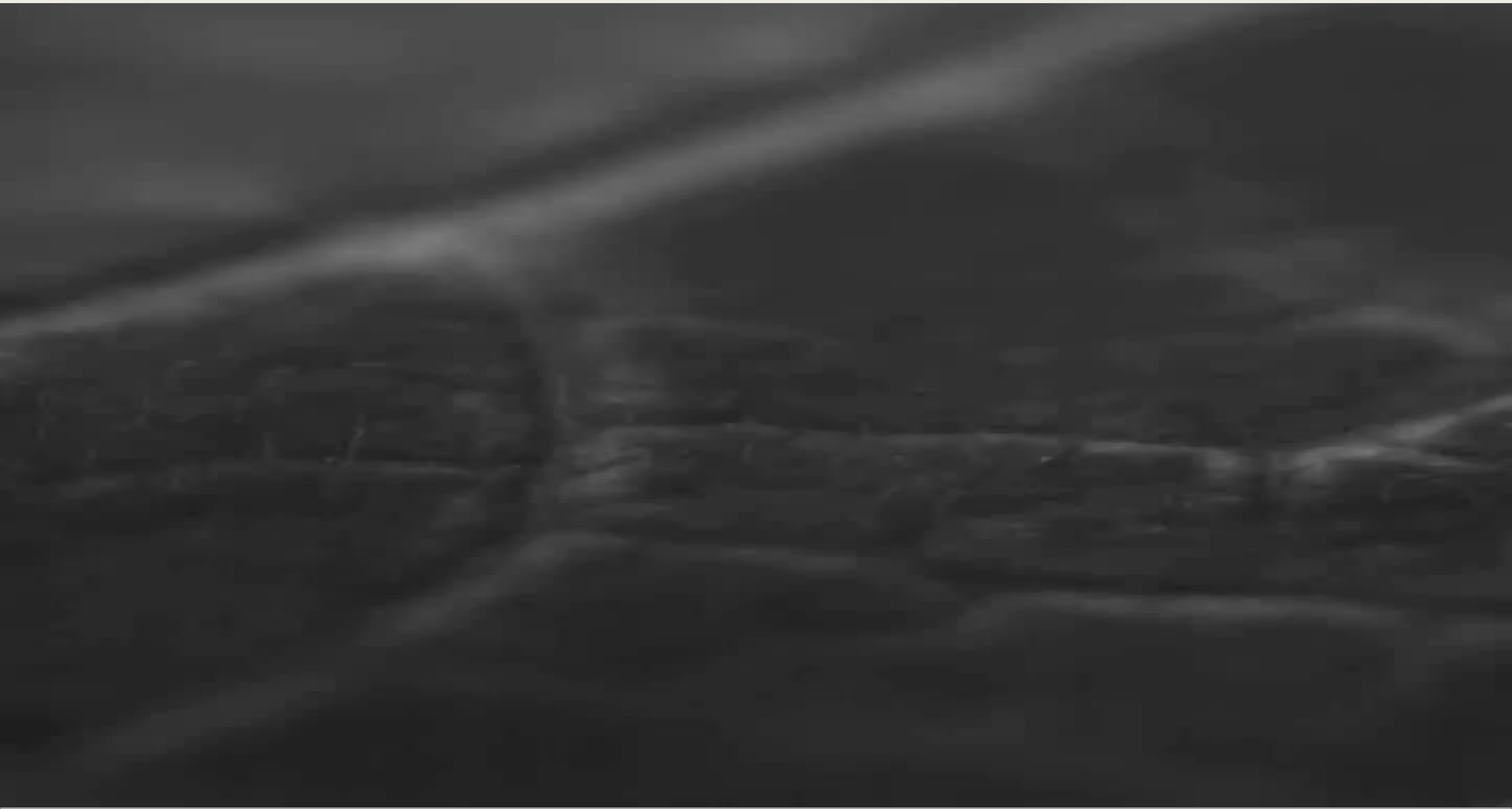




# Water is a polar compound



# Water droplets bounce, break, runoff, stick together







# No surfactant, hairy leaf

By Dr. Heping Zhu, USDA-ARS-ATRU



# When water dries herbicide salt remains



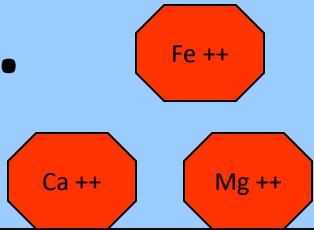
# Water repelled by waxes on surface





# Water may contain minerals bind to the pesticide

1.

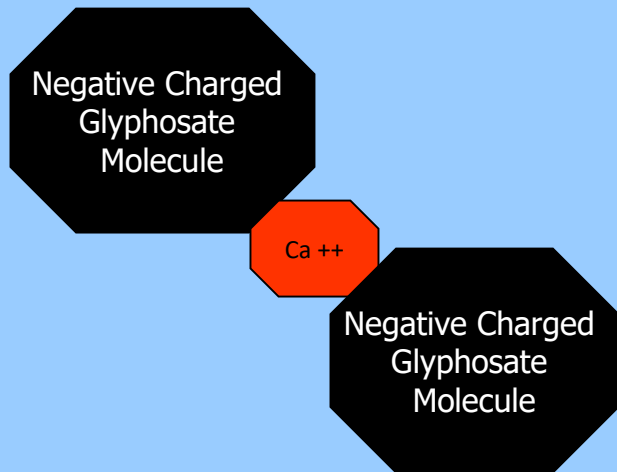


2.

Negative Charged  
Glyphosate Molecule

3.

Glyphosate Salt Complex



(as Calcium Carbonate)

Part Number: 481108

Contains 30 Test Strips

### TEST PROCEDURE:

1. Dip one test strip into a water sample for **3 seconds**.
2. Remove the strip and immediately match to the color chart below. Complete color matching within **1 minute**.



### Understanding Your Results:

Hardness greater than 80 PPM - Detergents with softening agents are not completely effective in cleaning

Hardness greater than 120 PPM - Some scaling will occur in pipes and appliances.

Hardness greater than 250 PPM - Dishwasher impossible to use without producing film on dishes.



For Technical Assistance, Call: 1-803-329-0100  
[www.sensafe.com](http://www.sensafe.com)

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University of Idaho  
Extension

# Pesticide in the Droplet: pH breaks down the pesticide

pH Value	Substance
14.0	sodium hydroxide
12.6	bleach
11.5	ammonia
10.2	milk of magnesia
9.3	borax
8.4	baking soda
8.0	sea water
7.4	human blood
7.0	distilled water
6.8	tea
6.7	milk
6.0	atmospheric water
5.0	pickle juice
4.5	tomatoes
4.2	orange juice
4.0	wine and beer
2.8	vinegar
2.2	lemon juice
2.0	stomach acid
1.0	battery acid
0.0	hydrochloric acid



	Product Half-Life		
	pH 9	pH 7	pH 5
Brand X Herbicide	10 minutes	17 hours	16 days
Brand X Fungicide	2 minutes	3 hours	10 hours
Brand X Insecticide	24 hours	10 days	stable







WINFIELD™

## Effect of Water on Pesticide Efficacy

Red = rapid degradation of pesticide, Yellow = moderate degradation of pesticide, Green=slow degradation of pesticide

Active Ingredient	Optimum pH	Alkaline (pH 8-9)	Neutral (pH 7)	Acidic (pH 4-6)
Abamectin	6.5			
Acephate	7			
Acetamiprid	7			
Ancymidol	6			
Azadirachtin	6			
Azin-phos methyl	6			
Azoxystrobin	6			
Bendiocarb	7			
Bentazone	8			
Beta-cyfluthrin	7			
Bifenthrin	6			
Boscalid	7			
Captan	6.5			
Carbaryl	7			
Carbofuran	5			
Chlorantraniliprole	7			
Chlorfenapyr	6			
Chlorothalonil	7			
Chlorothalonil, Thiophante-methyl	6.5			
Chlorpyrifos	7			
Chlorsulfuron	7			
Chormequat	6			
Clethodim	6			

Active Ingredient	Optimum pH	Alkaline (pH 8-9)	Neutral (pH 7)	Acidic (pH 4-6)
Glyphosate	5			
Hexythiazox	7			
Hydrogen Dioxide	6			
Imazaquin	7			
Imidacloprid	7			
Indoxacarb	7			
Iprodione	7			
Isoxabin	7			
Kresoxim Methyl	6.5			
Lambda-cyhalothrin	7			
Malathion	5			
Mancozeb	7			
Mefenoxam	7			
Mefluidide	6.5			
Methamidophos	5.5			
Methomyl	7			
Methyl parathion	7			
Metolachlor	7			
Myclobutanil	7			
Naled	5			
Oryzalin	6			
Oxadiazon	7			
Oxamyl	5			
Oxyfluorfen	6.5			



Clethodim	6			
Clopyralid	7			
Clothianidin	7			
Copper	6			
Copper Hydroxide	7			
Copper Sulfate	6.5			
Cyfluthrin	7			
Cypermethrin	4			
Cyromazine	6.5			
Daminozide	7			
Deltamethrin	7			
Diazinon	7			
Dicamba	5.5			
Difenazate	7			
Dimethoate	4			
Dimethoate	5			
Dimethomorph	6			
Dimethyl	5.5			
Diquat	7			
Disulfoton	5			
Dithiopyr	7			
Edosulfan	6.5			
Esfenvalerate	7			
Ethephon	5			
Etridiazole	7			
Fenarimol	6			
enhexamid	6			
Fenoxaprop	7			
Fenpropathrin	6			
Fenpyroximate	7			
Fluaizifop-p-butyl	7			
Fludioxonil	7.5			
Fluprimsidol	7			
Foramsulfuron	7			
Fosetyl AI	6			
Gamma-cyhalothrin	7			
Gibberellic Acid	6			

Oxyfluorfen	6.5			
Paclobutrazol	7			
PCNB	7			
Pelargonic Acids	7			
Pendimethalin	6			
Permethrin	4			
Phenylmethyl, Gibberellins	6			
Phorate	6			
Phosmet	5			
Piperalin	6			
Potassium Bicarbonate	8			
Potassium Salts	7			
Prodiamine	7			
Pronamide	7			
Propamocarb	7			
Propiconazole	7			
Pymetrozine	6			
Pyraclostrobin	7			
Pyriproxyfen	6			
Sethoxydim	7			
Spinosad	7			
Thiamethoxam	7			
Thiophanate-methyl	6.5			
Triadimefon	7			
Trichlorfon	5			
Trichoderma harzianum	6			
Trifloxy Sulfuron- sodium	7			
Trifloxystrobin	6			
Triflumizole	7			
Trinexapac-ethyl	7			
Uniconazole	6			
Zeta-cypermethrin	7			

\*ALWAYS READ AND FOLLOW LABEL DIRECTIONS. © Winfield Solutions, LLC





pH = 5.0



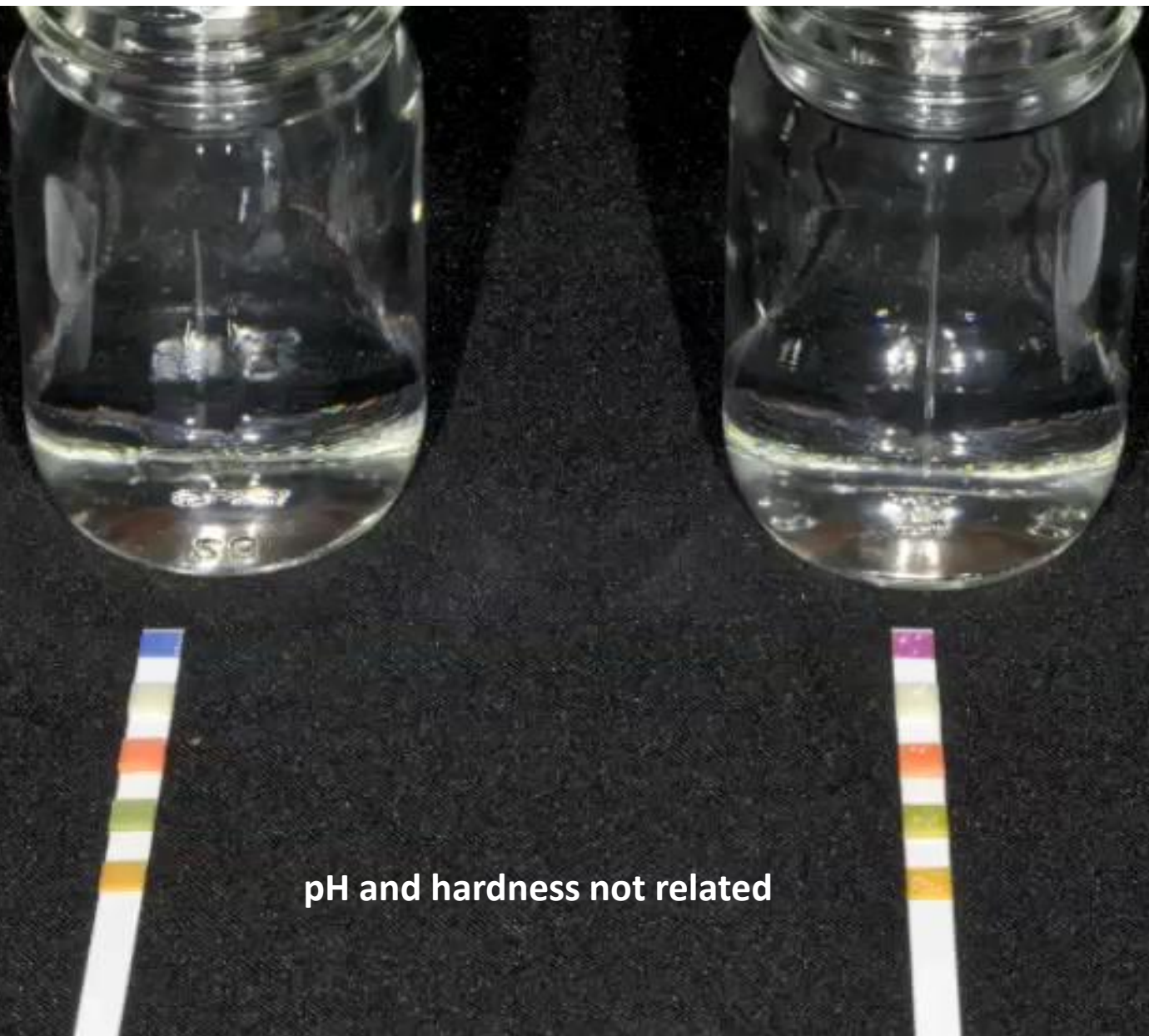
pH = 7.0



pH = 9.0







**pH and hardness not related**



# The Spray Droplet Is The Delivery System



## Adjuvants Added to Alter Water Chemistry and Droplet



## All of These Are Adjuvants

- Antifoam
- pH adjusters
- Buffering agents
- Water conditioning agents
- Surfactants/ “wetters”
- Stickers
- Oil concentrates
- Humectants
- Drift control/deposition

**Adjuvants are  
added to  
enhance the  
spray water  
droplet**

**Laundry  
detergent**

**Tank Cleaner**





# Antifoam



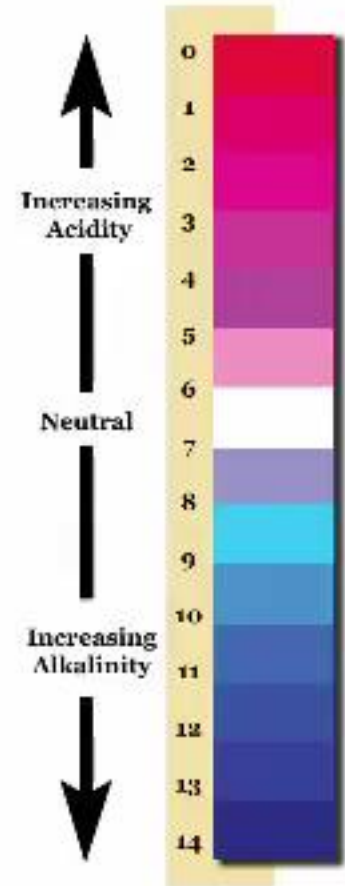
**FOAM CONTROL FOR TANK MIXES**



**ADJUVANT  
ANSWER LAB**



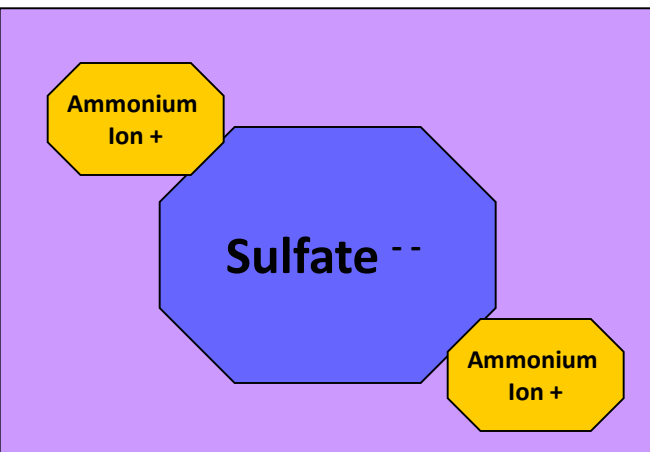
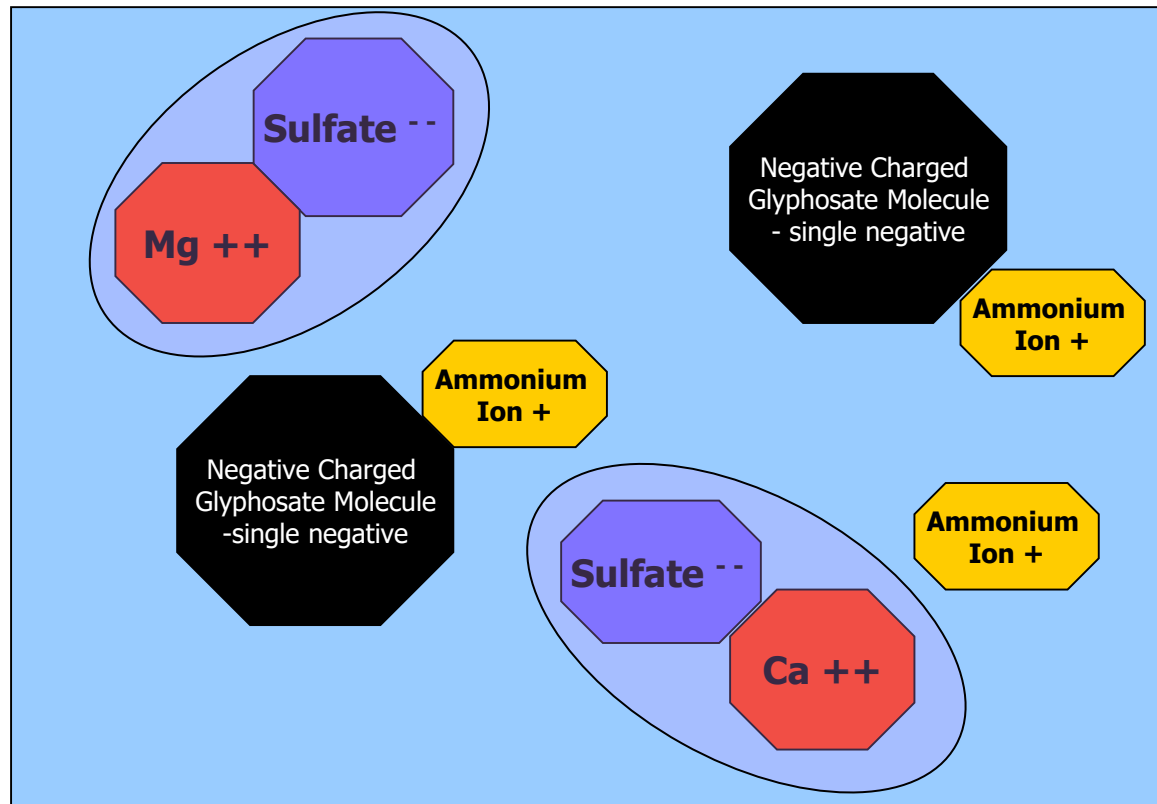
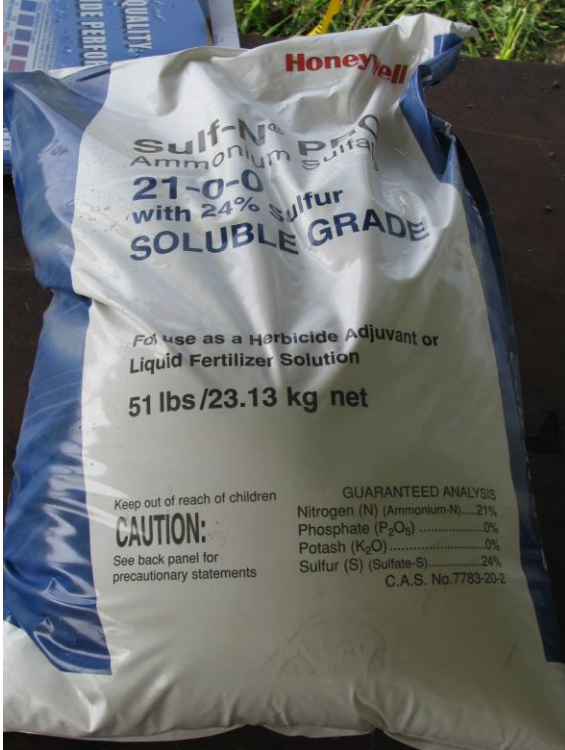
# pH adjusters and Buffering agents



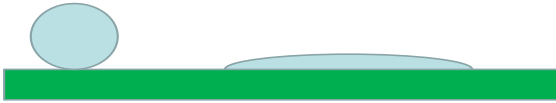
# Water conditioning agents (hardness/ph)







Reduction of Droplet  
Surface Tension



**Surfactants (“wetters”)**  
—surface active agent or spreader—

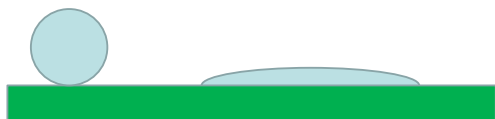
No surfactant, waxy leaf



By Dr. Heping Zhu, USDA-ARS-ATRU



Reduction of Droplet  
Surface Tension




**Surfactants (“wetters”)**  
—surface active agent or spreader—





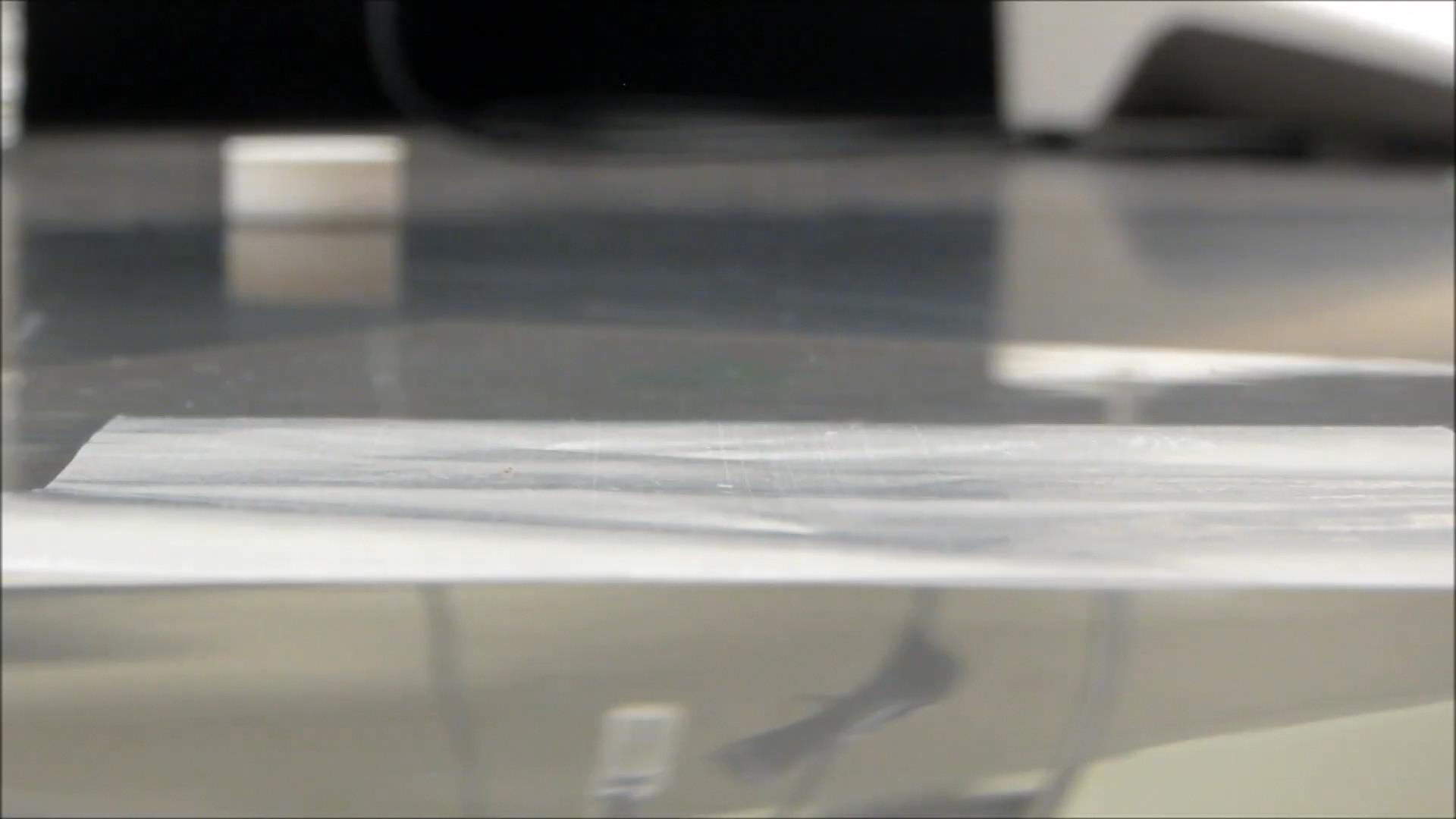
# Surfactants (“wetters”) —surface active agent or spreader—



**SPRAY DROPLET SURFACE TENSION**

**ADJUVANT  
ANSWER LAB**













# No surfactant, hairy leaf

By Dr. Heping Zhu, USDA-ARS-ATRU



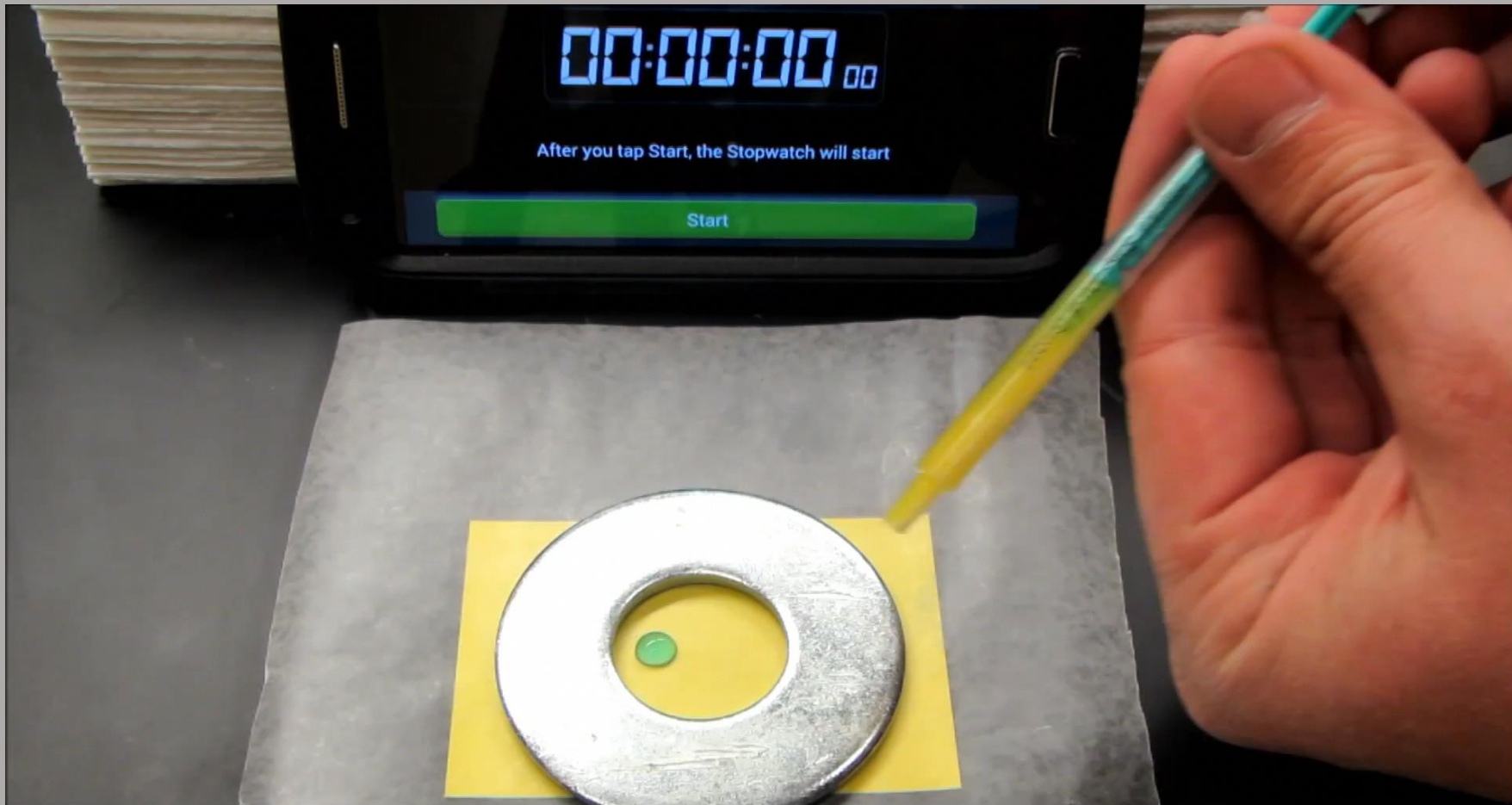
# With surfactant, hairy leaf



By Dr. Heping Zhu, USDA-ARS--ATRU



# Oil concentrates







**Without Adjuvant**



**With Adjuvant**



# Drift Control Adjuvants

- Significantly reduce fines or driftable particles.
- Increase the ratio of desirable droplet sizes (250-400 $\mu$ )



# Drift Control Adjuvants

- Synthetic Polymers
  - Modified polyacrylamides
  - Good solubility, pump shear stability, increased leaf retention, lower costs
- Natural Polymers
  - Hydro Propyl Gar (HPG) and xanthan gum
  - Poor solubility, good pump shear stability, increased leaf retention, higher costs



# Drift Control Adjuvants

- Oil Emulsion Based
  - Newer Technology
  - Doesn't negatively affect the spray pattern



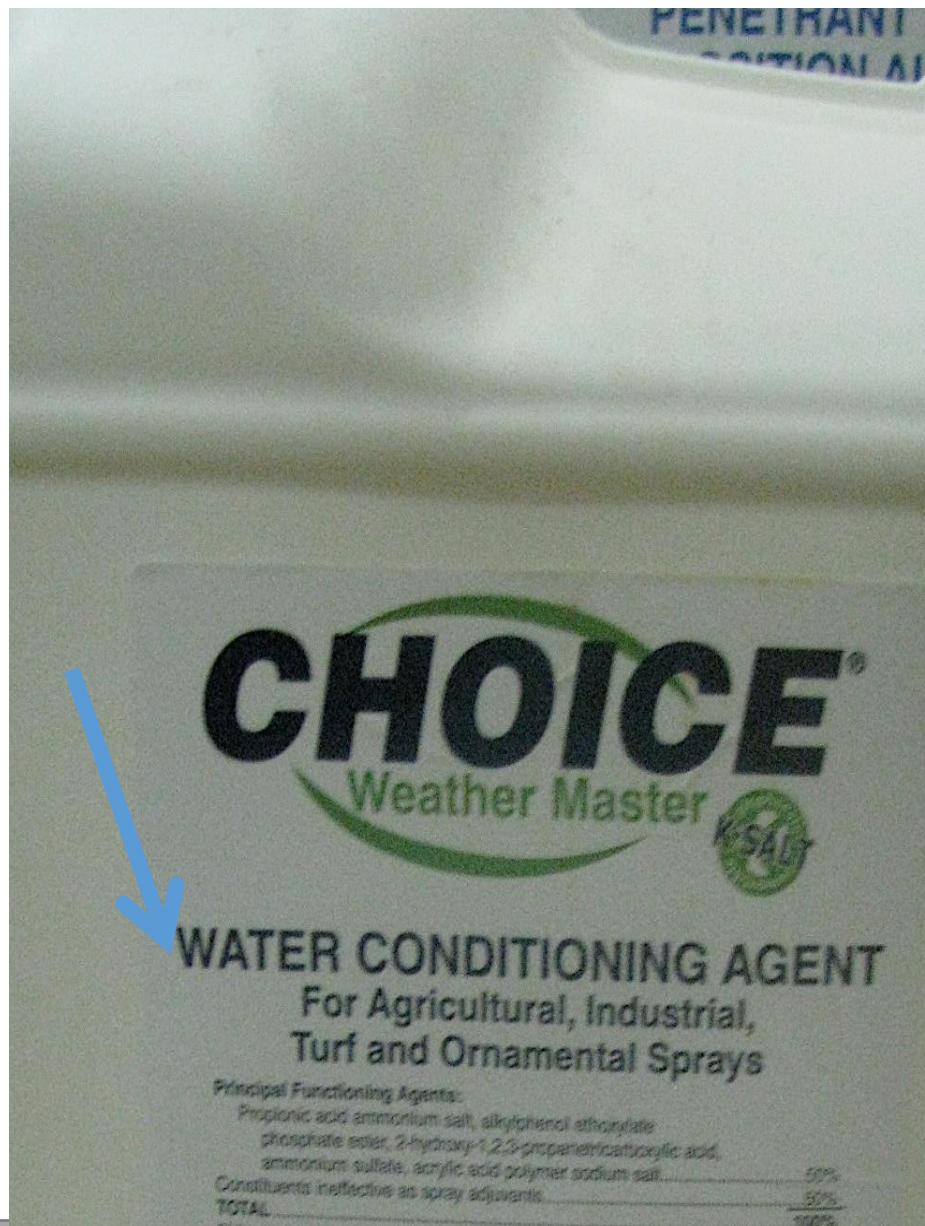


**Water Droplet Chemistry**  
**Adjuvant Used to Alter Water Droplet**

# **Testing Your Knowledge On Adjuvants**









**DSM**

BRIGHT SCIENCE. BRIGHTER LIVING.

**SPRAY GRADE  
AMMONIUM  
SULFATE**

**51 Lb. Net Wt.**

MANUFACTURED BY  
DSM Chemicals North America, Inc.  
#1 Columbia Nitrogen Road  
Augusta, GA 30901







# INDUCE

## A Nonionic Low Foam Wetter/Spreader Adjuvant

### \*ACTIVE INGREDIENTS:

Amyl Acyl Polycrylate ethers, alkanolamides, dimethyl siloxane, and Free Fatty Acids . . . . . 90.0%

Components ineffective as adjuvant . . . . . 10.0%

TOTAL . . . . . 100.0%

Surfactant Content: . . . . . 70.0%

\*All ingredients are accepted for use under CFR 40, 180.

### KEEP OUT OF REACH OF CHILDREN WARNING

See Inside Panel for Additional Precautionary Statements

DA-07-12-1112

Manufactured For

**HELENA CHEMICAL COMPANY**

225 SCHILLING BOULEVARD, SUITE 300 • COLLIERVILLE, TENNESSEE 38017

OPM #110238

PEEL BACK BOOK HERE AND RESEAL AFTER OPENING ➤

NET CONTENTS:

2.5 GAL LOT DI4D0541



# Glypnosate 41%+ Surfactant

Shuttle 265 Gal.

6258-0296

**11.99\***

30 Gal.

6258-0238

**12.99\***

15 Gal.

1146-4020

**13.99\***

Generic  
Equivalent to



**\*Prices Per  
Gallon**



# Water Droplet Chemistry

## Adjuvant Use to Alter Water

### Testing Your Knowledge On Adjuvants

# Pesticide and Adjuvant

# Labels





## PRINCIPAL FUNCTIONING AGENTS:

Proprietary blend of hydroxy carboxylic acid,	
phosphoric acids and ammonium sulfate .....	52%
Components ineffective as water conditioners .....	48%
TOTAL .....	100%

All ingredients are accepted for use under CFR 40, 180.

## KEEP OUT OF REACH OF CHILDREN CAUTION

Harmful if swallowed, inhaled, or absorbed through skin. Avoid contact with eyes and skin, may cause irritation. Avoid breathing spray mist. Do not take internally. Wear chemical resistant eyewear, gloves, long sleeve shirt and pants and shoes and socks. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, or using tobacco. In addition, follow precautionary statements on all products used with this material.

## FIRST AID

**Call a poison control center or doctor immediately for treatment advice.**

Have the product container with you when calling a poison control center or doctor, or going for treatment.

**If Swallowed:** Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give anything by mouth to an unconscious person.

**If on Skin or Clothing:** Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes.

**If Inhaled:** Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth to mouth if possible.

**If in Eyes:** Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses if present, after the first 5 minutes, then continue rinsing eye.

## GENERAL INFORMATION

**FOR USE WITH PRODUCTS REGISTERED FOR: AGRICULTURAL, AQUATIC, FORESTRY INDUSTRIAL, MUNICIPAL, NON-CROPLAND, ORNAMENTAL, RIGHTS-OF-WAY, TURF AND OTHER USES.**

**IMPERIAL** is a water conditioning agent which promotes herbicide performance by modifying elements such as pH and hardness of the spray water. To aid in herbicide uptake, a blend of ammonium sulfate and ammoniacal nitrogen have been added along with buffers, sequestrants and chelating agents to condition the spray water.

Hard water and high pH can minimize the efficiency of certain pesticides. Ammoniacal nitrogen is known to be an effective uptake enhancer for herbicides by several plant species and by conditioning the spray water and providing a source of ammoniacal nitrogen, **IMPERIAL** positively affects herbicide spray applications.

Do not use **IMPERIAL** with herbicides that are not compatible in acidic conditions or low pH.

**Do not use with sulfonfyl urea herbicides.**

Do not use with tank mixes utilizing fixed copper fungicides such as cupric hydroxide, basic copper, COPPER COUNT N or copper oxychloride.

Do not apply this product in such a manner as to directly or through drift, expose workers or other persons.

Always jar test **IMPERIAL** with tank mix herbicides prior to mixing. Applicator must have experience with this product or conduct a phytotoxicity trial or use the directions from the products used in the tank mix.

## DIRECTIONS FOR USE

### READ AND FOLLOW DIRECTIONS FOR USE ON HERBICIDE LABELS.

It is recommended to use test areas when applying during high humidity, high temperatures or other possible situations where field practice is restricted.

1. Fill spray tank half full of water and begin agitation.
2. Add desired rate of **IMPERIAL** to water before adding pesticides.
3. Add pesticides, as directed by label, while maintaining agitation.

**NOTE:** If pesticide label recommends the addition of a surfactant follow instructions accordingly. **IMPERIAL** is not a replacement for a surfactant.

## RECOMMENDED USE RATES

**Ground:** Apply at the rate of 1-4 pints per acre in 100 gallons of spray (0.125 - 0.50% v/v).

**Aerial:** Use 2-4 pints per 100 gallons of spray (0.25 - 0.50% v/v).

**Water Conditioning:** Use 1 to 5 pints per 100 gallons of water as a general use water conditioning agent for pH reduction and hard water sequestering.

## STORAGE

Store in cool, dry place. Store in original container. For best results, store above freezing. Keep tightly closed and do not allow other chemicals to be introduced into the container. Do not contaminate water sources by runoff from cleaning of equipment, disposal of equipment washwaters or spray waste.

## DISPOSAL

Triple rinse or equivalent and add rinsate to spray tank, then offer for recycling or reconditioning or puncture and dispose of according to state and local authorities. Recycling decontaminated containers is the best option of container disposal. The Agricultural Container Recycling Council (ACRC) operates the national recycling program. To contact your state and local ACRC recycler visit the ACRC web page at [www.acrcycle.org](http://www.acrcycle.org). If burned, stay out of smoke.

## WARRANTY

Seller warrants that this product conforms to its chemical description and is reasonably fit for the purpose stated on the label when used in accordance with directions under normal conditions of use, but neither this warranty nor any other warranty of merchantability or fitness for a particular purpose, expressed or implied, extends to the use of this product contrary to the label instruction, or any abnormal conditions, or under conditions not reasonably foreseeable to the seller, and buyer assumes the risk of any such use.

## Tech Matrix

Virgin Ingredients	100%
Active Ingredients	52%
Sequestering	<input checked="" type="checkbox"/>
Buffering	<input checked="" type="checkbox"/>
Chelating	<input checked="" type="checkbox"/>



7545 Haygood Road Shreveport, LA 71107





**It's all about the spray droplet!**





- **Is there science behind adjuvants?**
- **Do they work?**
- **Are they worth the money?**





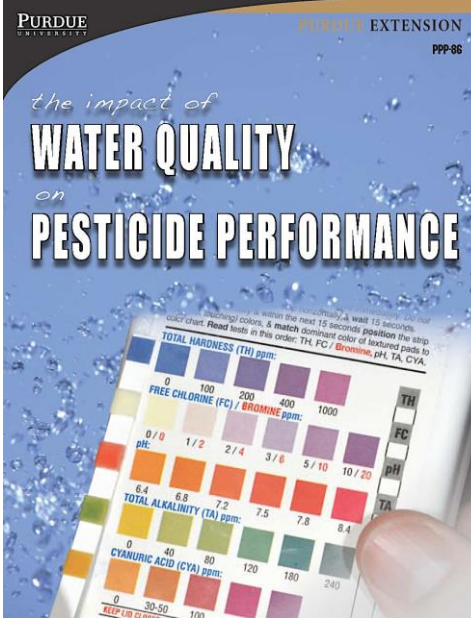
# Are they worth the money?

- For sure if the pesticide label requires it.
- Recommendations supported by data and experience









# Adjuvants and the Power of the Spray Droplet



Improving the Performance of Pesticide Applications

