

Water: The Smallest Factor That Makes the Greatest Difference

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Outline

- **Water quality parameters**
 - Suspended solids
 - Dissolved minerals
 - Temperature
 - pH
- **Water testing**



Water

- Water often comprises ninety-five percent (or more) of the spray solution
- Water quality can affect pesticide performance
- Water quality parameters affect pesticide performance:
 - pH
 - Dissolved minerals
 - Suspended solids
 - Temperature
- Poor water quality
 - Reduce solubility
 - Decrease absorption
 - Decrease half-life

Pesticide Degradation

Mix up a load and spray till it's gone, right?

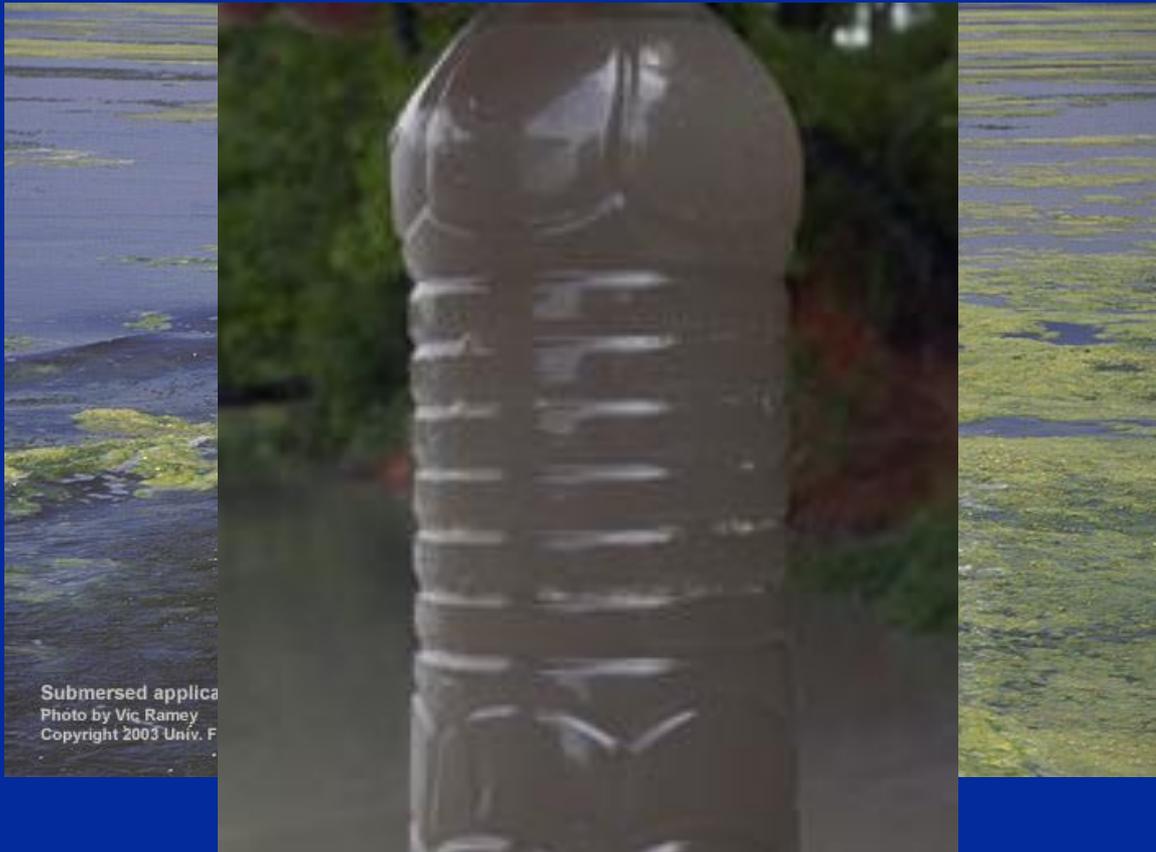


Pesticide Degradation

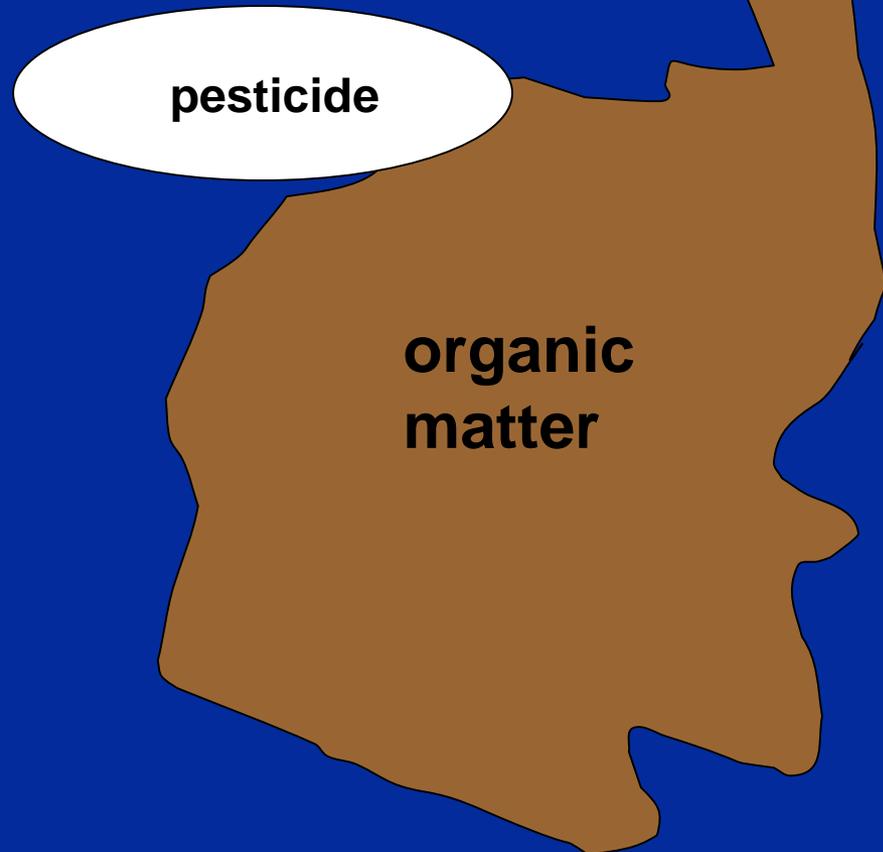
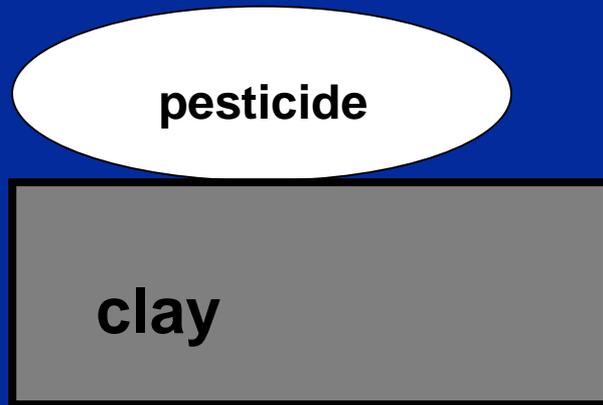
- Pesticides start to break down when they are in water
 - Water (hydrolysis)
 - Light (photodecomposition)
 - Microbes
- These processes can be fast or slow. It depends...

Suspended Solids

Do you draw water from a pond or canal?



Suspended Solids



Suspended Solids

SPECIFIC

7.0 MIXING

Roundup Ultra Label

Reward L
herbicide
ers, bulbs
residential
establishe
Absorption
Landscape
plant tissu
equipment

Clean sprayer parts immediately after using this product by thoroughly flushing with water.

NOTE: REDUCED RESULTS MAY OCCUR IF WATER CONTAINING SOIL IS USED, SUCH AS VISIBLY MUDDY WATER OR WATER FROM PONDS AND DITCHES THAT IS NOT CLEAR.

able plants during application, as injury may result. Application to muddy water may result in reduced control. Minimize creating muddy water during application. Use of dirty or muddy water for Reward Landscape and Aquatic Herbicide dilution may result in reduced herbicidal activity. Avoid applying under conditions of high wind, water flow, or wave action.

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Reward
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Dissolved Minerals

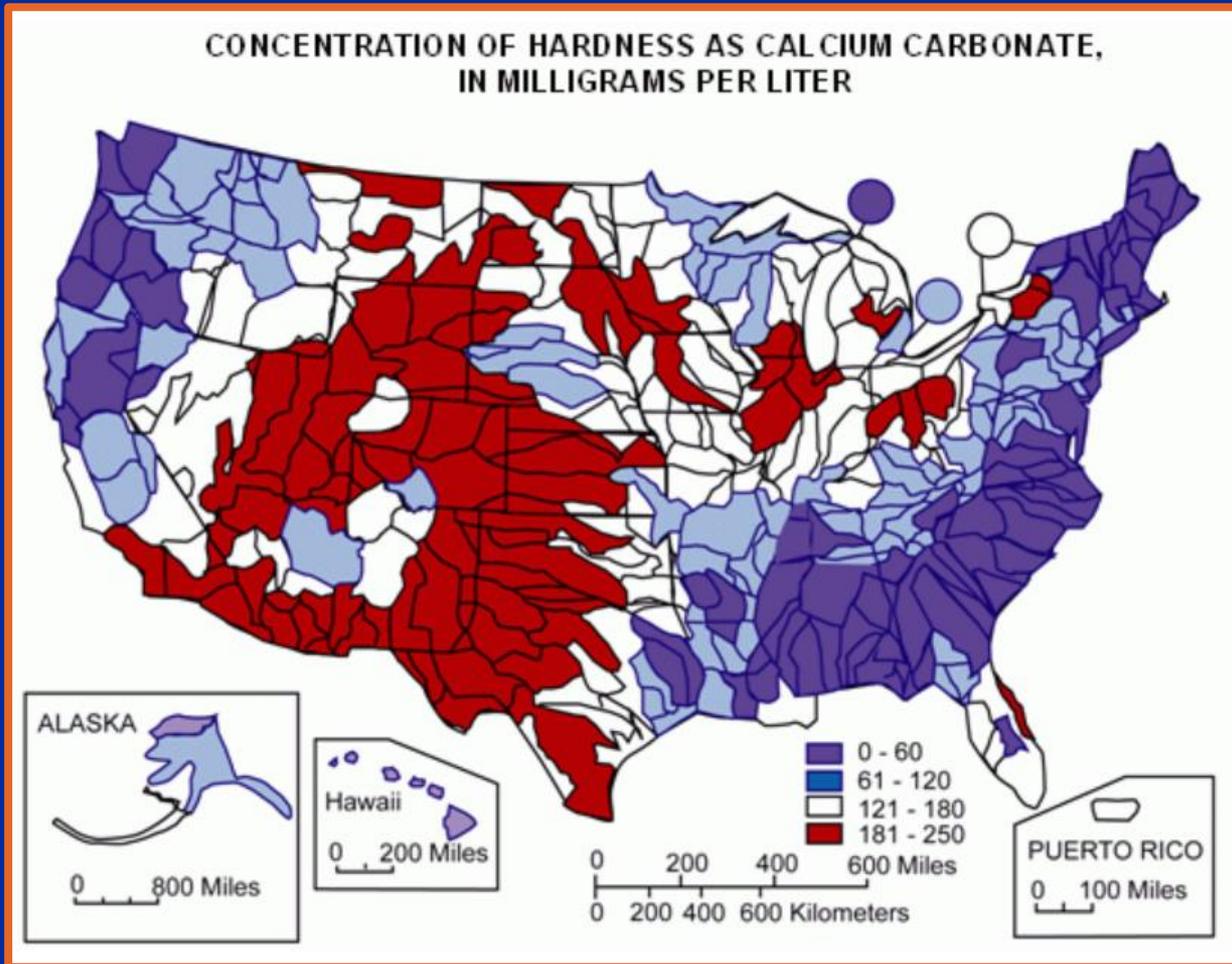
- **Water hardness: a measurement of the total amount of calcium and magnesium ions in water**
- **How hard is hard?**
 - **There are different sets of standards**
 - **World Health Organization**
 - **US Geological Survey**
 - **UF/IFAS Soil and Water Lab**

Dissolved Minerals

UF/IFAS Soil and Water Lab Hardness Scale

Interpretation	Hardness (ppm)	Hardness (grains)
Soft	0 – 17	0 - 1
Relatively soft	17 – 50	1 - 3
Moderately hard	50 – 120	3 – 7
Hard	120 – 170	7 - 10
Very hard	>170	>10

Dissolved Minerals



Dissolved Minerals

- Several herbicides (including 2,4-D, dicamba, and glyphosate) have an overall negative charge
- These herbicides can be influenced by hard water cations
 - Form precipitates
 - Lower probability of passing through plant cuticle

Dissolved Minerals



**Glyphosate +
Distilled water
(Zero hardness)**

**Glyphosate +
hard water**

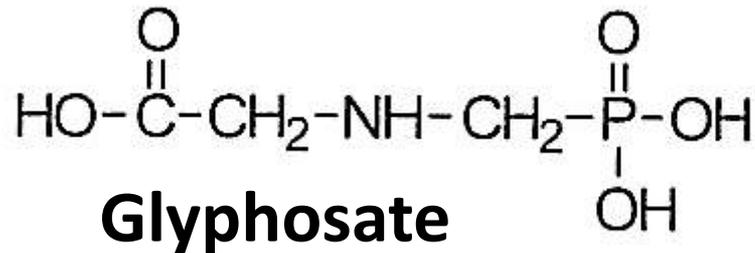
Hard-water Antagonism Study

- Greenhouse study at Michigan State University
- Sunflower used as indicator species
- ^{14}C -glyphosate absorption measured:
 - Alone
 - + Ca
 - + Ca + AMS
- Absorption measured at 0, 4, 24, 48 hours following application

Hard-water Antagonism Study

Glyphosate absorption by sunflower after application (h)				
	0	4	24	48
	-----% absorbed-----			
Glyphosate ^a	1.4	22.6	20.3	32.5
Glyphosate + Ca	1.2	→ 4.9	→ 8.0	→ 6.5
Glyphosate + Ca + AMS	0.8	21.9	28.5	25.3
^a Isopropylamine formulation				

Dissolved Minerals



- Increasing Ca concentration decreases glyphosate activity
- Calcium will bind to the negatively charged glyphosate
- Glyphosate + calcium has no herbicidal activity

Ca(NO₃)₂ – Glyphosate Study

- Greenhouse study at University of Tennessee
- Evaluated 4 specified levels (250, 500, 750, 1,000 ppm) of mix-water hardness using Ca(NO₃)₂ with glyphosate
- Visual % control of 4 weed species evaluated
 - Yellow nutsedge
 - Pitted morningglory
 - Broadleaf signalgrass
 - Palmer amaranth

Ca(NO₃)₂ – Glyphosate Study

Cation	ppm	Y. nutsedge	P. morningglory	B. signalgrass	P. amaranth
		-----% control (21 DAT)-----			
None	0 (soft)	76	77	98	99
Calcium	250	75	76	98	99
	500	64	66	81	89
	750	49	56	75	81
	1,000	40	37	64	78
	LSD	5	6	7	5

Study also compared 3 glyphosate salt formulations: isopropylamine, diammonium, potassium: no differences

Cations and AMS With 2,4-D

- Greenhouse study at Purdue University
- 2,4-D + distilled water and.....
 - + Calcium, Magnesium, Manganese, Zinc
 - Comparisons made with or without addition of AMS
- Visual % control for several weed species.....
 - Horseweed
 - Redroot pigweed
 - Common lambsquarters

Cations and AMS With 2,4-D

Cation solution	Horseweed control (% - visual rating)	Difference (%)
Deionized water + AMS	69	25
Deionized water	44	
Calcium + AMS	73	48
Calcium	25	
Magnesium + AMS	68	47
Magnesium	21	
Manganese + AMS	56	36
Manganese	20	
Zinc + AMS	61	28
Zinc	33	

Cations and AMS With 2,4-D

Cation solution	Redroot pigweed control (% - visual rating)	Difference (%)
Deionized water + AMS	71	33
Deionized water	38	
Calcium + AMS	54	27
Calcium	27	
Magnesium + AMS	56	19
Magnesium	37	
Manganese + AMS	51	11
Manganese	40	
Zinc + AMS	59	21
Zinc	38	

Dissolved Minerals

- The effects of hard water can be reversed with a water conditioner - commonly ammonium sulfate

7.4 Ammonium Sulfate

The addition of 1 to 2 percent dry ammonium sulfate by weight or 8.5 to 17 pounds per 100 gallons of water may increase the performance of this product, particularly under hard water conditions, drought conditions or when tank mixed with certain residual herbicides, on annual and perennial weeds. The equivalent rate of ammonium sulfate in a liquid formulation may also be used. Ensure that dry ammonium sulfate is completely dissolved in the spray tank before adding herbicides. Thoroughly rinse the spray system with clean water after use to reduce corrosion.

Dissolved Minerals



Glyphosate **Glyphosate**
(No conditioner) **(+ conditioner)**

Water Temperature Study

- Greenhouse study conducted at Purdue University
- Objectives:
 - Determine if water temperature in the tank influenced postemergence herbicide applications

Water Temperature Study

- **Postemergence herbicides:**
 - 2,4-D choline
 - Glufosinate
 - Mesotrione
 - Glyphosate + dicamba
- **Mixed postemergence herbicides into cold (41°F), moderate (72°F), warm (102°F), and hot (133°F) water**
- **Evaluated control of giant ragweed, horseweed, Palmer amaranth, and pitted morningglory**

Water Temperature Study

Herbicides	Water Temperature (°F)			
	41	72	102	133
2,4-D choline	X	√	√	X
Glufosinate	X	√	√	X
Mesotrione	X	√	√	X
Glyphosate + dicamba	X	√	√	X

x = herbicide performance was reduced on some weed species

√ = herbicide performance was not reduced at these temperatures

Water Temperature Study

- **Mixing certain herbicides with cold water (about 41°F) or very hot water (about 133°F) can impact performance on specific weeds**
- **Monitor the temperature of water stored in aboveground tanks**

Water pH

- pH
 - Indicator of alkalinity or acidity
 - Scale from 0 to 14
 - Logarithmic concentration scale of:
 - If $H^+ = OH^-$: then pH is 7.0 or neutral
 - If $H^+ > OH^-$: then pH is acidic
 - If $H^+ < OH^-$: then pH is alkaline (basic)

Water pH

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

Water pH

- Scale is logarithmic; so:
 - pH 5.0 is 10x more acidic than pH 6.0
 - pH 4.0 is 100x more acidic than pH 6.0

Water pH

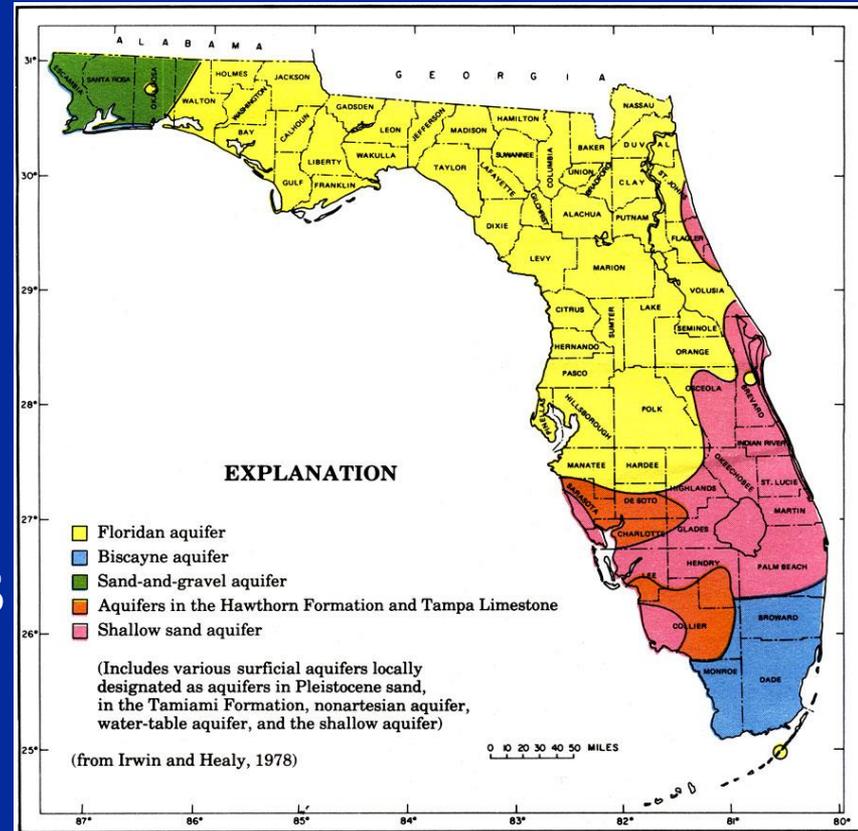
- Some pesticides lose effectiveness when mixed with alkaline water
- pH of 8 to 9 can greatly diminish or cause complete loss of effectiveness
- Most common with some insecticides:
 - Carbamates and organophosphates
- Few fungicides and herbicides susceptible

Water pH

- “General rules:”
 - Herbicides, insecticides, and fungicides perform best in slightly acidic water, pH 4 - 6.5
 - Pesticides such as some sulfonylurea herbicides perform better in water that is slightly alkaline

Water pH

- Most water sources in FL derive from limestone aquifers
- Contain high levels of carbonates – removes H^+ from water, thus increases pH



Water pH

Half-life

<u>Pesticide</u>	<u>pH 6</u>	<u>pH 7</u>	<u>pH 8</u>	<u>pH 9</u>
flumioxazin	---	24 h	---	15 min
captan	---	8 h	10 min	2 min
carbaryl	125 days	27 days	2-3 days	1-3 days
dimethoate	12 h	---	---	1 h
disulfoton	32 h	---	---	7 h
malathion	8 days	3 days	19 h	---
phosmet	---	1 day	4 h (pH 8.3)	1 min (pH 10)
trichlorfon	4 days	6 h	1 h	---

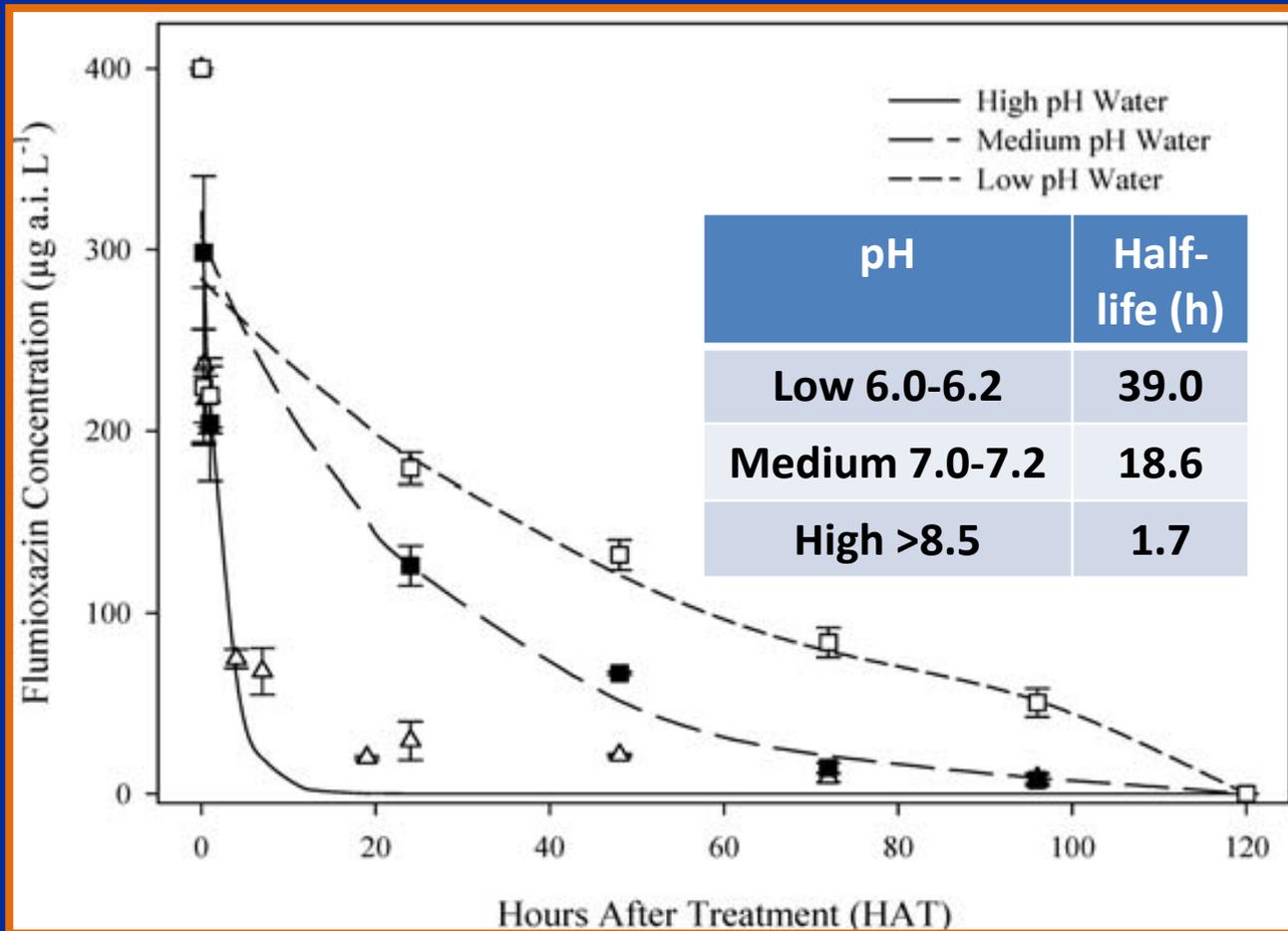
Water pH

Flumioxazin concentration ($\mu\text{g L}^{-1}$)	ET ₅₀ (hours)	
	pH 6	pH 9
100	123	737
200	92	118
400	69	87
800	68	81

ET₅₀ = effective time required to reduce hydrilla photosynthesis by 50%.

Mudge, C.R., et al. 2012. Weed Sci. 60:4-9.

Water pH



Mudge, C.R., et al. 2010. J. Aquat. Plant Manage. 48:25-30.

Water pH

APPLICATION AND SPRAYER INFORMATION

Mixing Instructions

- Mix with water having pH of 5 to 7. If pH is higher than 7, use an appropriate buffer to reduce pH to desirable range.
- Fill clean spray tank 1/2 full of desired level with water and add buffering agent if necessary.
- Add the required amount of *Clipper* Herbicide to the spray tank while agitating.
- Fill spray tank to desired level with water. Ensure that *Clipper* Herbicide is thoroughly mixed before making applications. Agitation should continue until spray solution has been applied.
- Mix only the amount of spray solution that can be applied the day of mixing. Apply *Clipper* Herbicide within 12 hours of mixing.

How long is too long to hold in the tank?

- “General rules:”
 - A pH between 3.5 and 6 is satisfactory for most spraying and short-term (12–24 hours) storage of most mixtures in a spray tank. Not suitable for some sulfonylurea urea herbicides.
 - A pH between 6 and 7 is adequate for immediate spraying for most pesticides. Do not leave the spray mixture in the tank for more than 1 - 2 hours, to prevent loss of effectiveness.
 - Most products mixed in alkaline water should be sprayed immediately.

What is the best adjuvant to use?

- General rules – beware of these:
 - Equal control at reduced herbicide rates
 - Products that “reduce regrowth”
 - Cocktails (spreader + sticker + compatibility + etc).
These are usually more costly and give little benefit.
 - *Anything that sounds too good to be true*

If you use an additive.....

ADDITIVES

When applying *Clipper* Herbicide to the foliage of floating or emerged aquatic weeds, mix with an adjuvant approved for use in aquatic sites. Valent recommends the use of a Chemical Producers and Distributors Association certified adjuvant. Mix *Clipper* Herbicide with a non-ionic surfactant containing at least 80% active ingredient. Follow adjuvant manufacturer's label rates. Mixing compatibility should be verified by a jar test before using.

Council of Producers & Distributors of Agrotechnology

- Voluntary adjuvant certification program
- Certified products meet benchmarks set by the American Society for Testing and Materials
- Provides some assurance of product performance

If a product label includes a recommendation for use in aquatic applications, then an aquatic toxicity study is required

Council of Producers & Distributors of Agrotechnology

INTACT™

Drift Control & Foliar Retention Agent and Deposition Aid

PRINCIPAL FUNCTIONING AGENTS

Polyethylene glycol, choline chloride, guar gum.....	43.18%
Constituents Ineffective as Spray Adjuvants	<u>56.82%</u>
TOTAL.....	100.00%

All ingredients are approved for use under 40 CFR 180
WA Reg. No. 9349-16001

KEEP OUT OF REACH OF CHILDREN



NON-CROPLAND AND RIGHTS-OF-WAY. NOT FOR AQUATIC USE.

USE RATES

0.5% v/v (4 pints) of **Intact** per 100 gallons of spray solution.

MIXING

In the absence of specific mixing instructions found on the pesticide label, fill the spray tank with at least 50% of the desired

Water Testing



<http://soilslab.ifas.ufl.edu>

Water Testing

- **Things to ask the lab concerning your water test:**
 - Do you test for pH and hardness?
 - What will be the cost?
 - How much water will you need to run the suite of tests?
 - Do you have guidelines or special containers for collecting and transporting the water samples?

Water Testing

- Forms, boxes, instructions:
 - Local county extension offices

<http://edis.ifas.ufl.edu/pdf/files/SS/SS18400.pdf>



- Collect 1 pint of water in a plastic bottle (no detergent bottles)

Water Testing

Set: E45005

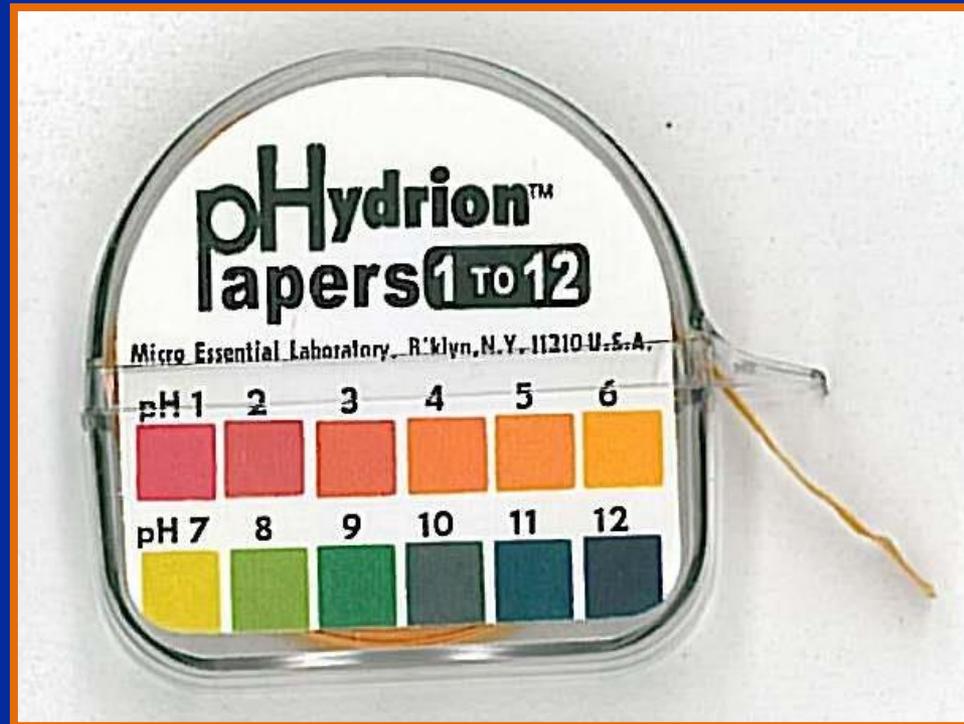
Report Date: 08/24/2017

Lab No	Sample Identification	Parts per million ppm or mg/L								pH	Electrical Conductivity in mmho/cm or dS/m	Total carbonates in meq/liter
		Calcium Ca	Magnesium Mg	Hardness mg/L	Iron Fe	Manganese Mn	Sodium Na	Chloride Cl	Suspended Solids			
E113982	Tap 1	28.85	22.21	163.17	0.00	0.00	11.62	27.46	0.00	8.50	0.36	0.84

- Total hardness = (ppm Ca x 2.5) + (ppm Mg x 4.1)

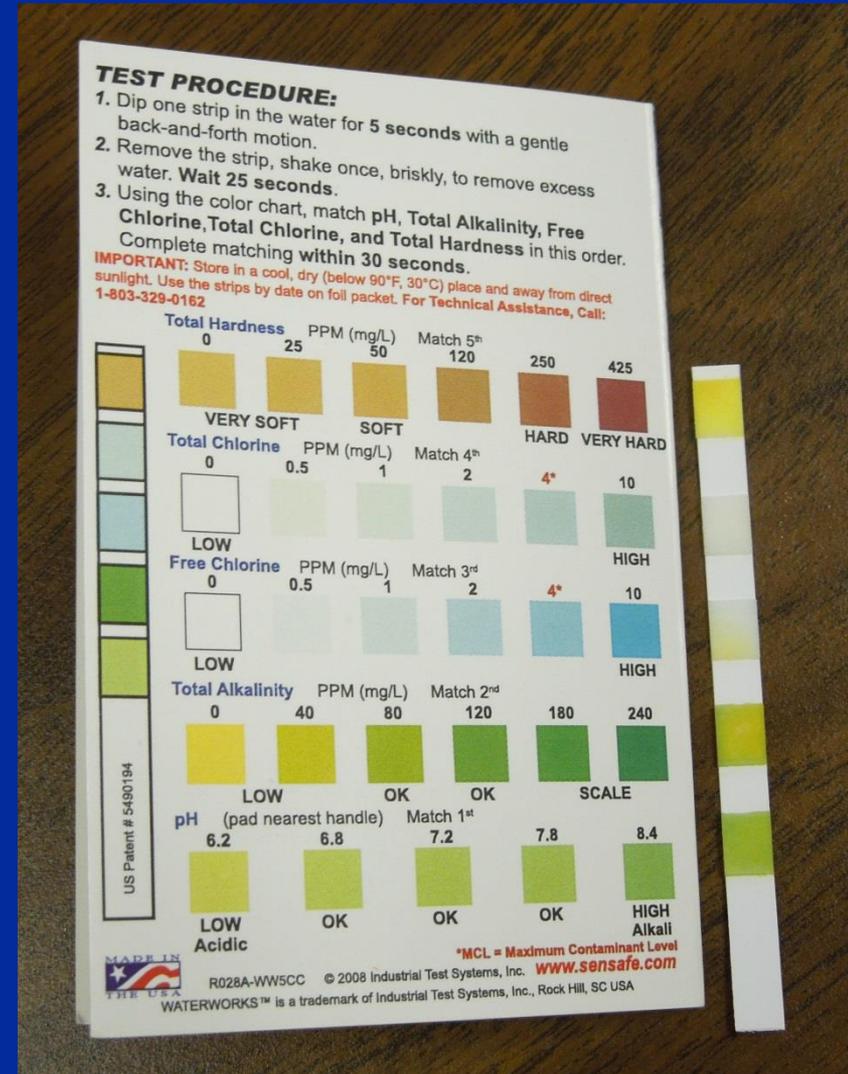
Water Testing

- Litmus paper:
 - Cheap - \$5.00/75 tests
 - Can vary by as much as ± 2.0 points



Water Testing

- Test strips:
 - Cheap - \$6.00/30 tests
 - Can also vary
- More elaborate and expensive instruments are available



Water Testing

- Meters:
 - ExStik
 - ± 0.01 accuracy
 - Digital displays
 - Battery-powered
 - \$99.99



Summary

- **Pesticide performance can be affected by water chemical and physical quality factors:**
 - **Suspended solids**
 - **Dissolved minerals (hardness)**
 - **Extreme water temperatures**
 - **pH**
- **Having your mix water tested is inexpensive compared to the cost of poor pesticide efficacy**

Thank You!