Water Quality Effects on Pesticides

Louisiana Agricultural Technology and Management Conference
2009

James L. “Jim” Griffin

Enlightenment?

I am <u>not</u> a Water Quality Chemist or an expert on Pesticides …

Enlightenment?

I am not a Water Quality Chemist or an expert on Pesticides …

But ……

I did stay in a Holiday Inn Express last night ……

Enlightenment?

What qualifies me to make this presentation?

Strictly being asked to do so.

My Goal Today….

- **Discuss water quality factors that can affect stability and efficacy of herbicides, insecticides, and fungicides**
- **Clear up misinformation**
- **Determine when water quality issues are a problem and how to correct the problem**

Every effort should be made to get the most return from your pesticide investment ….

Good Clean Water …..

Water As A Carrier

- Water is the primary carrier for pesticide applications; makes up over 99% of the spray solution
- Water in the spray tank can be:
  - Acidic (pH less than 7)
  - Neutral (pH = 7)
  - Basic/alkaline (pH greater than 7)
- Water in the spray tank can be:
  - Hard or soft water
  - Turbid (contains suspended solids, soil, or organic matter) or not turbid
- Quality of water used in spray tanks can affect pesticide efficacy

Water Quality Effects on Herbicides

Herbicide Activity in Plants

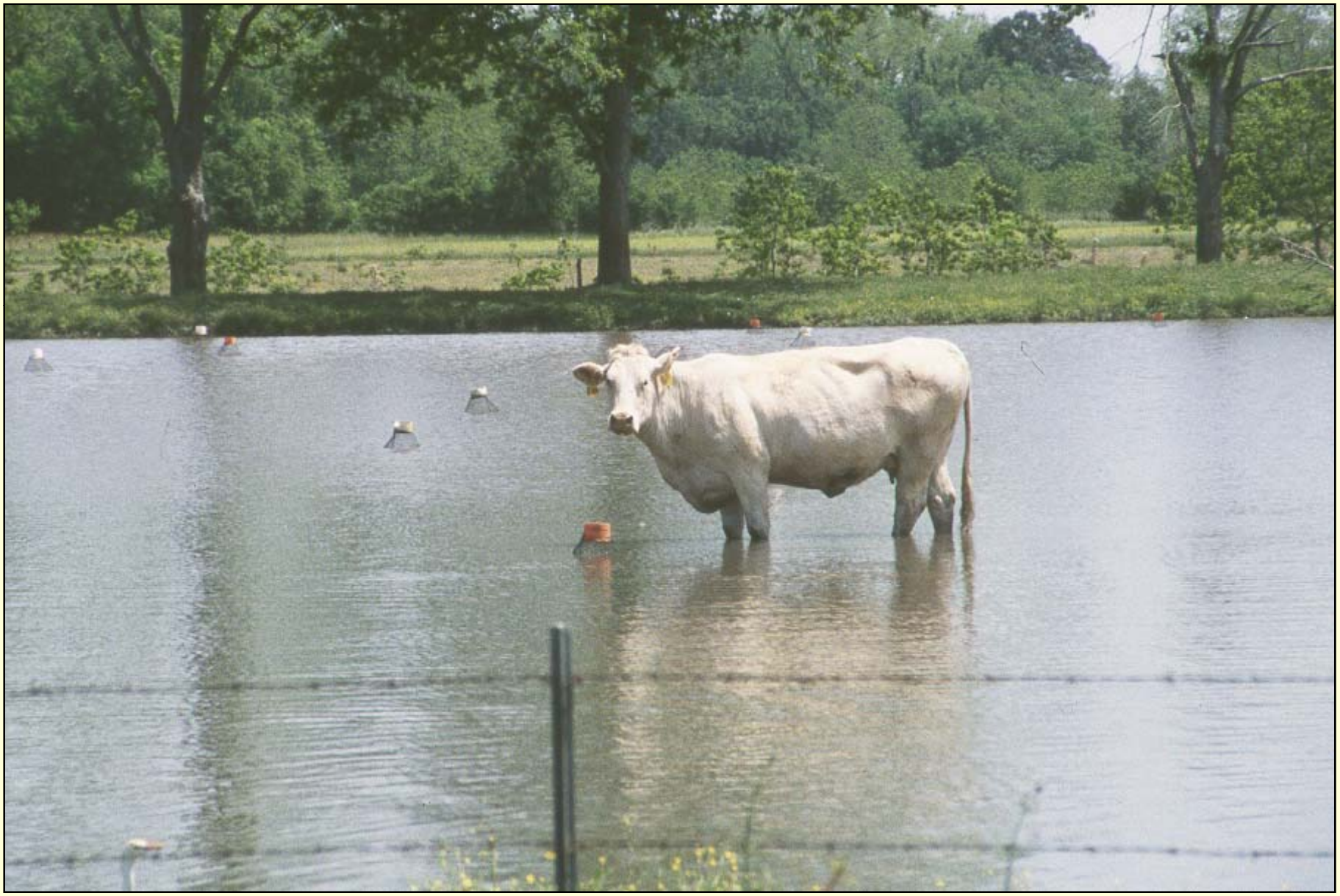
- Whole plant basis vs. cellular basis
- Herbicide is absorbed by the root, shoot, or leaf and moved within the plant to the site of action
- Herbicide enters the cell by moving through the cell wall and cell membrane and interferes with a physiological process

Water Quality Issues

- **pH**
- **Alkalinity**
- **Calcium (Ca), magnesium (Mg), sodium (Na), and iron (Fe) cations (water hardness)**
- **Total suspended solids (turbidity)**

Review:
CEC – cation exchange capacity
Soil (- charge) attracts cations (+ charge)

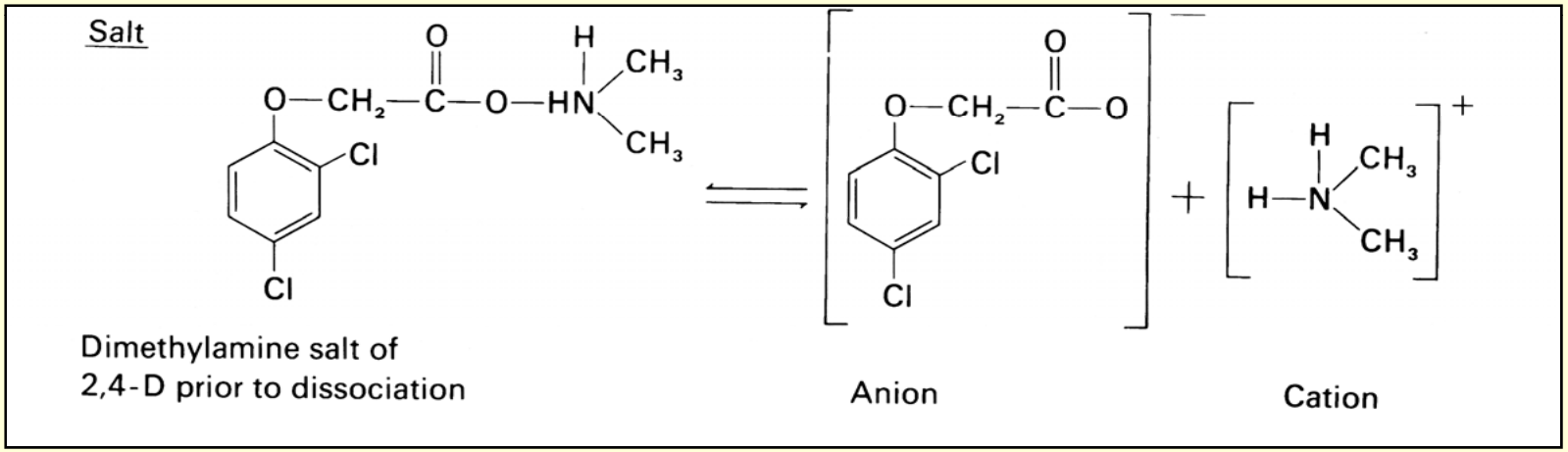
Not Concerned With Water Quality Issues…



Effect of Water pH on Herbicides

- Water in the spray tank can be:
  - Acidic (pH less than 7)
  - Neutral (pH = 7)
  - Basic/alkaline (pH greater than 7)

- Depending on pH of water in the spray tank, a portion of the herbicide molecules will dissociate (split into two pieces); Weak acid herbicides are most sensitive.



- Herbicides not dissociated (the compound remains whole) are more readily absorbed by plant foliage than those that dissociate.

- Ideally, spray water pH should be such that herbicides do <u>not</u> dissociate or dissociate at <u>low</u> levels; pH 6 to 7 ideal.

Weak Acid Herbicides and Dissociation Constants

Herbicide	*pK_a*	*Classification*
Glyphosate	2.6, 5.6, and 10.3	Weak acid
Select	4.1	Weak acid
Fusilade DX	3.0	Weak acid
2,4-D	2.8	Weak acid
Accent	4.3	Weak acid
Pursuit/Newpath	2.1 and 3.9	Weak acid
Beacon	5.1	Weak acid
Basagran	3.3	Weak acid
Asulox	4.82	Weak acid
Permit/Manage	3.5	Weak acid

Water pH Effect on Herbicides

- High pH of water used as a herbicide carrier (pH of 8 or more) can result in the breakdown (degradation) of some herbicides through alkaline hydrolysis.
- The rate of breakdown varies according to the pH and temperature of the water, and the length of time the spray mix sits in the tank.
- Alakaline hydrolysis has been documented for Asulox/Asulam, which is used extensively for johnsongrass control in sugarcane.
- To alleviate this problem, a buffer is added to the spray solution to lower the pH of the spray solution.

Not Concerned With Water pH …

Alkalinity

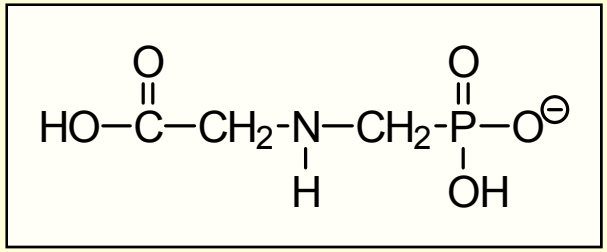
- Alkalinity refers to carbonate (CO_3^{2-}) and bicarbonate (HCO_3^-) levels in water.
- Alkalinity only becomes a problem with some herbicides when levels exceed 300 ppm.
- Alkalinity is an issue but not to the extent of water pH and hardness.

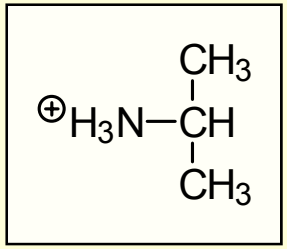
Effect of Hard Water on Glyphosate

- The isopropylamine salt formulation of gyphosate dissociates (split into two pieces) in water and the isopropyl amine groups (cations) are released leaving the glyphosate anion.

- In hard water, Ca, Mg, Na, and Fe cations (positively charged ions) can form a complex with the glyphosate anion so that it is unable to bind to EPSP synthase. If glyphosate cannot bind to the enzyme, it will not provide control.

isopropylamine salt formulation of glyphosate





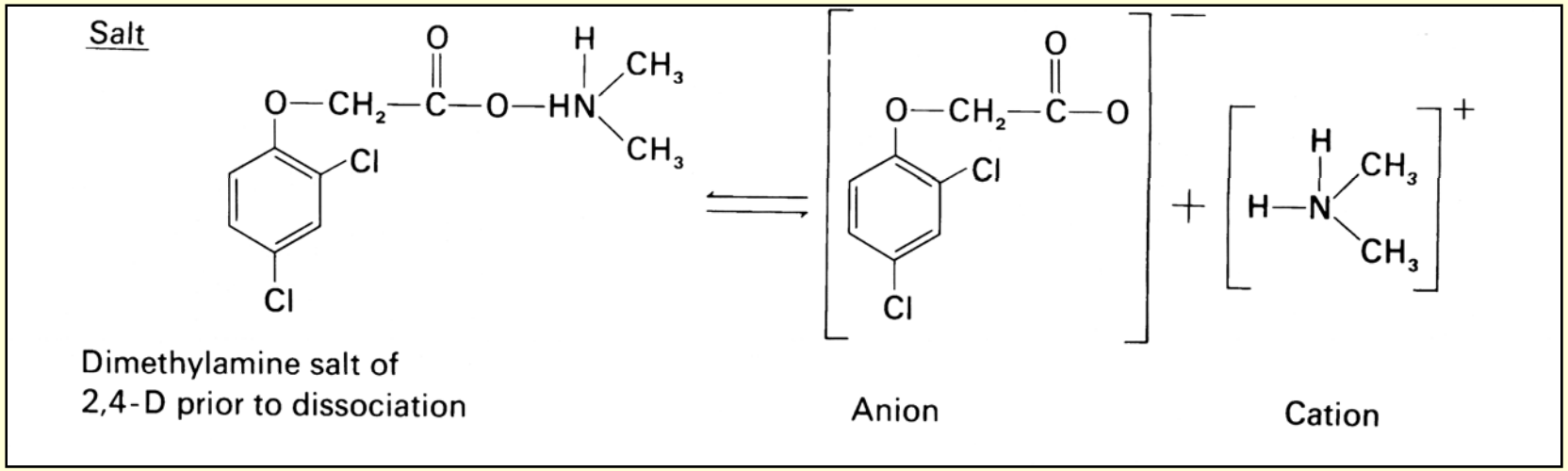
- Adding ammonium sulfate (AMS) to the spray tank overcomes adverse effects of hard water. The ammonium cation preferentially attaches to the glyphosate anion and thus prevents Ca, Mg, Fe, or Na from doing so.

- When ammonium is attached, the molecule binds readily to EPSP synthase and the herbicide functions normally.

Effect of Hard Water on 2,4-D

- 2,4-D dissociates in water and the sodium (Na), potassium (K), lithium (Li), or amine groups (cations) are released leaving the 2,4-D anion.

- Calcium (Ca), magnesium (Mg), sodium (Na), and iron (Fe) cations bind to the 2,4-D anion forming precipitates that can clog filters and nozzles.



- 2,4-D ester has excellent stability in water.

Effect of Hard Water

- Hard water does not negatively affect all herbicides.
- The concentration of Ca, Mg, Na, and Fe in water used for pesticide mixing should be measured.
- If the sum of the concentration (ppm) for all of the cations exceeds 400 ppm, action may be necessary.

Not Concerned With Hard Water …

Effect of Turbidity

- Turbid water, or water containing suspended solids, soil, or organic matter can reduce effectiveness of postemergence herbicides.

- The soil organic carbon sorption coefficient (K_{oc}) is used to describe the binding strength of herbicides to soil. Herbicides with high Koc values bind more tightly to soil particles.

- Glyphosate herbicides (Roundup, and many other brand names) and paraquat (Gramoxone Inteon) have very high K_{oc} values and will bind to soil and organic matter particles suspended in water and will not be available for absorption into weed foliage.

- Be sure water is clear and free of suspended soils or organic matter when using these products. If water is noticeably murky or discolored, find an alternate water source.

Water Quality Effects on Insecticides

Effect of PH on Insecticide Stability and Efficacy

- Insect control failures –
  - Attributed to bad batch of chemical, or poor application, or pest resistance, or …
  - What about the pH of the water prior to mixing the chemical?

- Some insecticide labels contain statements cautioning against mixing with alkaline materials such as lime or lime sulfur because of their effect on water pH.

- High pH of water used as a herbicide carrier (pH of 8 or more) can result in the breakdown (degradation) of many of the organophosphate and carbamate insecticides through <u>alkaline hydrolysis</u>.

- The rate of breakdown varies according to the pH and temperature of the water, and the length of time the spray mix sits in the tank.

- The rate at which insecticides hydrolyze is expressed as “half-life” which is the time it takes for 50% hydrolysis or breakdown to occur.

Half-life of Various Insecticides at Different Water pH

Insecticide	*Optimum pH*	*Half-life of Insecticides at Varying pH's*		
		Alkaline (pH 8-9)	*Neutral (pH 7)*	*Acidic (pH 4-6)*
Ambush*	7.0	Unstable	Stable	Stable
Cygon/Dimethoate*	5.0	48 minutes	12 hours	21 hours
Cymbush	4.0	35 hours	Stable	Stable
Diazinon	7.0	3 weeks	10 weeks	2 weeks
Dibrom*	5.0	48 hours	Stable	Stable
Furadan	5.0	3 days	Stable	Stable
Imidan*	5.0	4 hours	12 hours	13 days
Lorsban	5.0	1.5 days	Stable	Stable
Malathion*	5.0	5 hours	3 days	8 days
Monitor*	5.5	Unstable	Stable	Stable
Orthene	7.0	16 days	46 days	40 days
Pounce	4.0	42 days	Stable	Stable
Provado	7.0	Stable	Stable	Stable
Sevin*	7.0	24 hours	24 days	100 days
Thiodan*	6.5	Unstable	Stable	Stable
Vydate*	5.0	3 hours	8 days	Stable at 4.7
Warrior*	6.0	Unstable	Stable	Stable

Not Concerned With Insecticide Half Life…

How to Prevent Alkaline Hydrolysis

- Consult the LABEL to see if there are any warnings about water pH. Many of the organophosphate and carbamate insecticides are susceptible to alkaline hydrolysis.
- Know the pH of your water source and realize that the pH can change over the growing season.
- Measuring pH of water before mixing can be misleading because the pesticide added may lower or raise the pH of the overall spray solution.
- Purchase a “pocket pH meter” and use it. You can also have water analysis done through Agricultural Chemistry (LSU AgCenter/LDAF).
- If the pH of the spray solution is alkaline, especially if the pH is 8 or greater, and you are using a pesticide that is sensitive to hydrolysis, you should lower the pH of the water in the spray tank.
- A pH in the range 4-6 is recommended for most pesticide sprays. You can adjust your spray solutions to this range by using adjuvants marketed as buffering agents.
- It is always a good practice to spray right after your chemical has been mixed. If a delay occurs, you may want to add a buffering solution to your tank to lower the pH and slow down the rate of alkaline hydrolysis.

Waterproof pH 52 Tester

- Accurate waterproof pH/°C tester has a double junction replaceable pH glass electrode which allows it to be used in heavy-duty applications such as waste water treatment and agriculture.

- The pH52 is housed in an IP67 waterproof case and features automatic temperature compensation and auto shut-off after 8 minutes.

- Operating Environment: -5° - 60°C/100% RH. pH: Range: -2.0 - 16.0 pH. Resolution: 0.1 pH. Accuracy: ±0.1 pH. Calibration: Automatic, 1 or 2 points. Temperature: Range: -5.0° - 60.0°C. Resolution: 0.1°C. Accuracy: ±1°C. Battery: three 1.5V. Battery Life: 200 hours of continuous use.

- Forestry Suppliers $55.95

Water Quality Effects on Fungicides

- In general fungicides are less affected by alkaline water than are insecticides.

- There are a few pesticide materials which should not be acidified under any circumstances. Sprays containing fixed copper fungicides (including Bordeaux mixture, copper oxide, basic copper sulfate, copper hydroxide, etc.) and lime or lime sulfur should not be acidified.

- If the product label tells you to avoid alkaline materials, chances are good that the spray mixture will benefit by adjusting the pH to 6 or slightly lower.

Much Concern …

Bottom Line …

- The water used for pesticide application can in some cases affect stability and efficacy of pesticides.
- Analyze water used for pesticide application for pH and alkalinity.

pH

- If the pH of the spray solution is alkaline, especially if the pH is 8 or greater, and you are using a pesticide that is sensitive to hydrolysis, you should lower the pH of the water in the spray tank.
- A pH in the range 4-6 is recommended for most pesticide sprays. You can adjust your spray solutions to this range by using adjuvants marketed as buffering agents.
- Purchase a “pocket pH meter” and use it. You can also have water analysis done through Agricultural Chemistry (LSU AgCenter/LDAF).

Alkalinity

- Only becomes a problem with some herbicides when levels exceed 300 ppm

Bottom Line …

- Analyze water used for pesticide application for water hardness and turbidity.

  Water Hardness
  - Analyze water source for Ca, Mg, Na, and Fe
  - If the sum of the concentration (ppm) for all of the cations exceeds 400 ppm, it may be necessary to add ammonium sulfate

  Turbidity
  - Analyze water source for total suspended solids.
  - Herbicides with high soil organic carbon sorption coefficients (K_{oc}) will bind more tightly to soil particles and reduce effectiveness
  - If water is noticeably murky or discolored, find an alternate water source.

Every effort should be made to get the most return from your pesticide investment so be aware of the effect that water quality can have on pesticides

Questions?