Does Water Quality Make A Difference in the Performance of A Pesticide?

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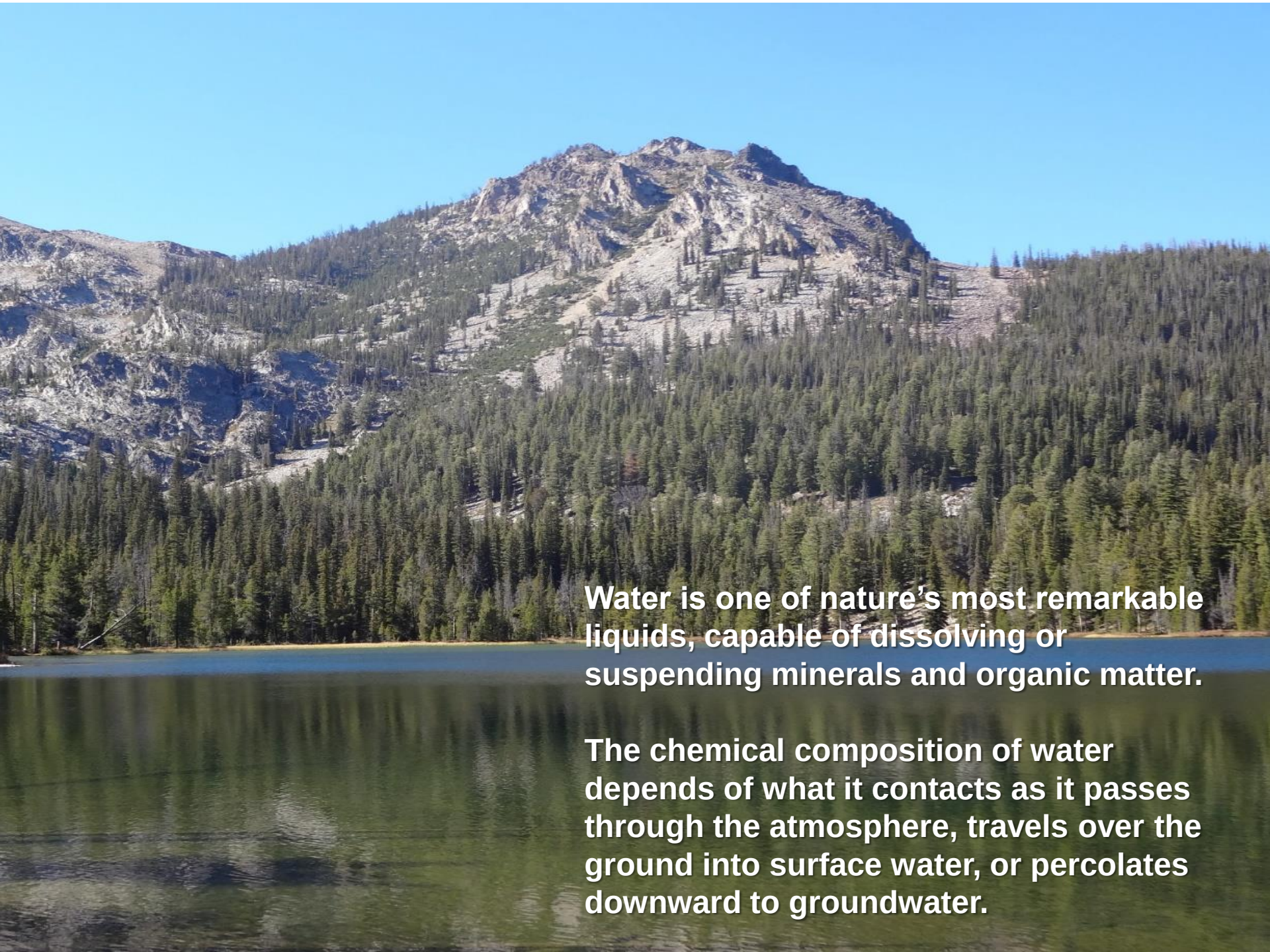
Importance of Water Quality on Pesticide Performance

Why is water quality important?

Water is the primary diluent.

For example: Spray equipment calibrated at 30 GPA will deliver 99% water solution if delivering a pesticide product at the rate 1 pint per acre.

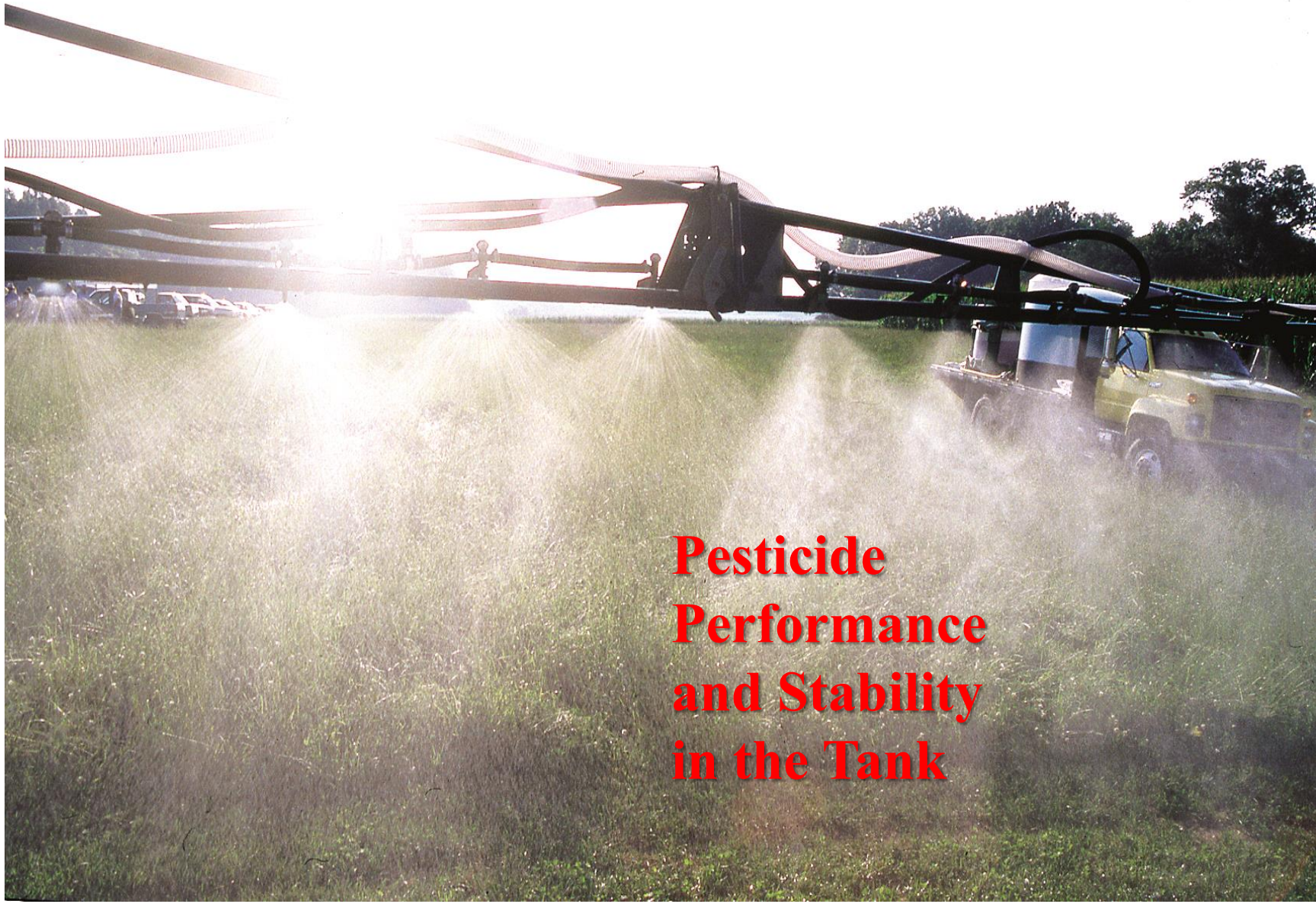


Water is one of nature's most remarkable liquids, capable of dissolving or suspending minerals and organic matter.

The chemical composition of water depends of what it contacts as it passes through the atmosphere, travels over the ground into surface water, or percolates downward to groundwater.

Clean Water?

- Not always obvious if the water quality is poor
- Clear water not “clean” water
- Reduced pesticide product performance may not be obvious
- Poor performance may be blamed on something else—not water quality
- CHECK YOUR WATER—it can pay off!



Pesticide Performance and Stability in the Tank

Common Complaints Indicating a Water Quality Issue

The pesticide doesn't have any residual. I need to re-apply every week.

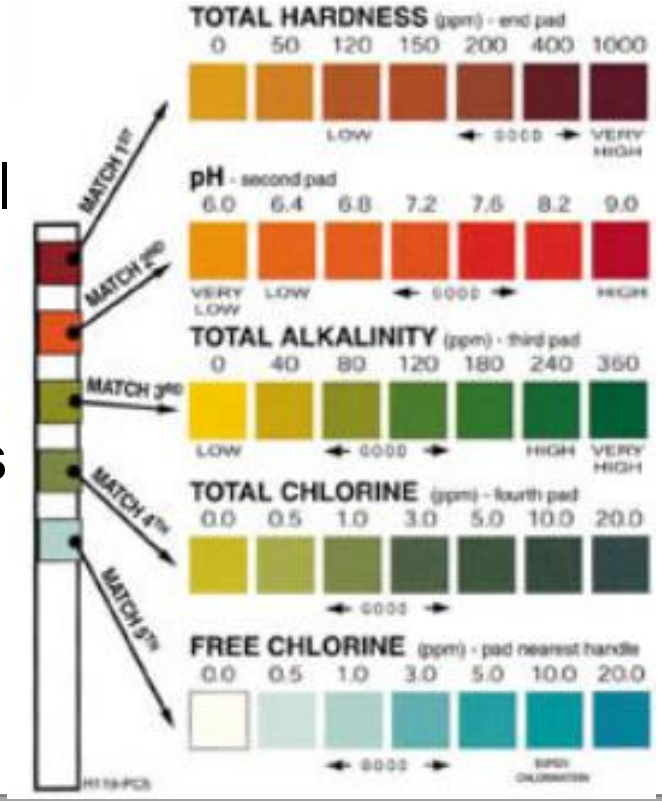
The pesticide doesn't work at the labeled rates. I need to double or triple the rates!

The pests are resistant to this pesticide.

The pesticide doesn't work!

Qualities Which Affect Pesticide Performance

1. pH
2. Dissolved Mineral Hardness
3. Suspended Solids Turbidity

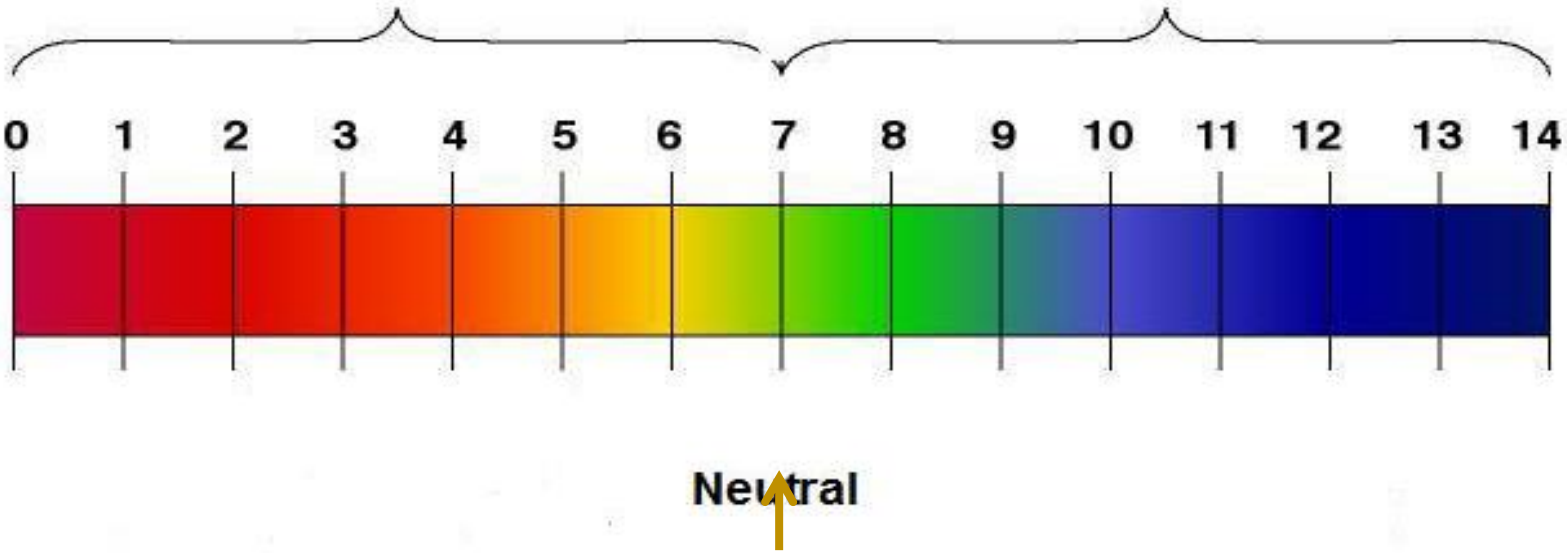


What is pH?

- A measure of the hydrogen ion (H+) concentration
- Acidic, neutral, or basic

Acidic pH <7 Neutral pH = 7 Basic pH >7

The pH Scale



pH of Common Solutions

pH	Type	Solution
1	Acidic	Battery acid
2	Acidic	Lemon juice
3	Acidic	Orange juice
4	Acidic	Tomato juice
5	Acidic	Pickle juice
6	Acidic	Rain water
7	Neutral	Distilled water

pH of Common Solutions

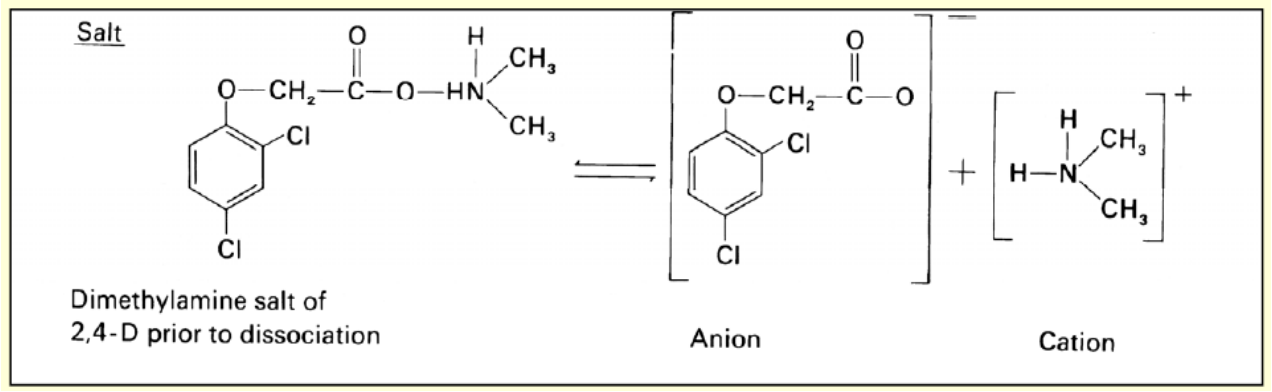
pH	Type	Solution
8	Alkaline	Sea water
9	Alkaline	Baking soda
10	Alkaline	Milk of Magnesia
11	Alkaline	Household ammonia
12	Alkaline	Soapy water
13	Alkaline	Bleach
14	Alkaline	Liquid drain cleaner

Pesticide Dissociation

Dissociation is the break down of a complex molecule into simpler units.

Efficacy is often reduced when molecules are broken into subunits. Plants often won't absorb the chemical as well.

pH 4 – 7 is ideal for most pesticides.



pH and Pesticides

- Most pesticides are weakly acidic or neutral
- Most work best at pH of 4 to 6.5
- When put in alkaline water, they may degrade
  - Break down into simpler units, so the pesticide:
    - May not be absorbed by pest
    - May be rendered inert and not affect the pest

	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

- **Spray preparations are stable if they are pH neutral or alkaline and stored at or below 100 degrees.**

- **Do not let spray mixtures stand overnight.**

- **Apply the spray the same day it is prepared….**

Examples of Weak Acid Herbicides

2,4-D amine

Atrazine

Bentazone (Basagran)

Clethodim (Select)

Clopyralid (Stinger)

Dicamba (Banvel)

Glyphosate (Roundup)

Imazamox (Raptor)

MCPA

Picloram (Tordon)

The Half-life of Selected Herbicides at Different pH Values (Deer & Beard 2001; McKie et al. 2002)

PESTICIDE		½ life[1] at different pH solutions				
Common Name	Trade Name[2]	5	6	7	8	9
dicamba	Banvel	Stable	Stable	Unstable	Unstable	Unstable
paraquat	Gramoxone	Stable	Stable	Stable	Unstable	Unstable
trifluralin	Treflan	Stable	Stable	Stable	Stable	-
2,4-D amine	Weedar 64	Stable	Stable	Unstable	Unstable	Unstable

[1]These are estimates that reflect trends. Half- life depends on other factors besides pH of the solution including temperature, contaminants in spray tank, formulations, etc…

[2]This represents only 1 pesticide product which may be available on the market. Discrimination or endorsement is not intended with the listing of commercial products by Montana State University Extension.

Municipal Water Supplies

Municipal water supplies create safe drinking water by adding chlorine as a disinfectant

Typically this can increase pH levels between 7.8 – 8.5

Weak Alkalines

- Degrade when mixed with slightly acidic water
  - pH is slightly less than 7
- Sulfonyl-urea herbicides
- Ally, Escort, Amber, Harmony, Extra, Express, Accent
  - May want neutral to slightly basic water
    - pH 7 or slightly greater

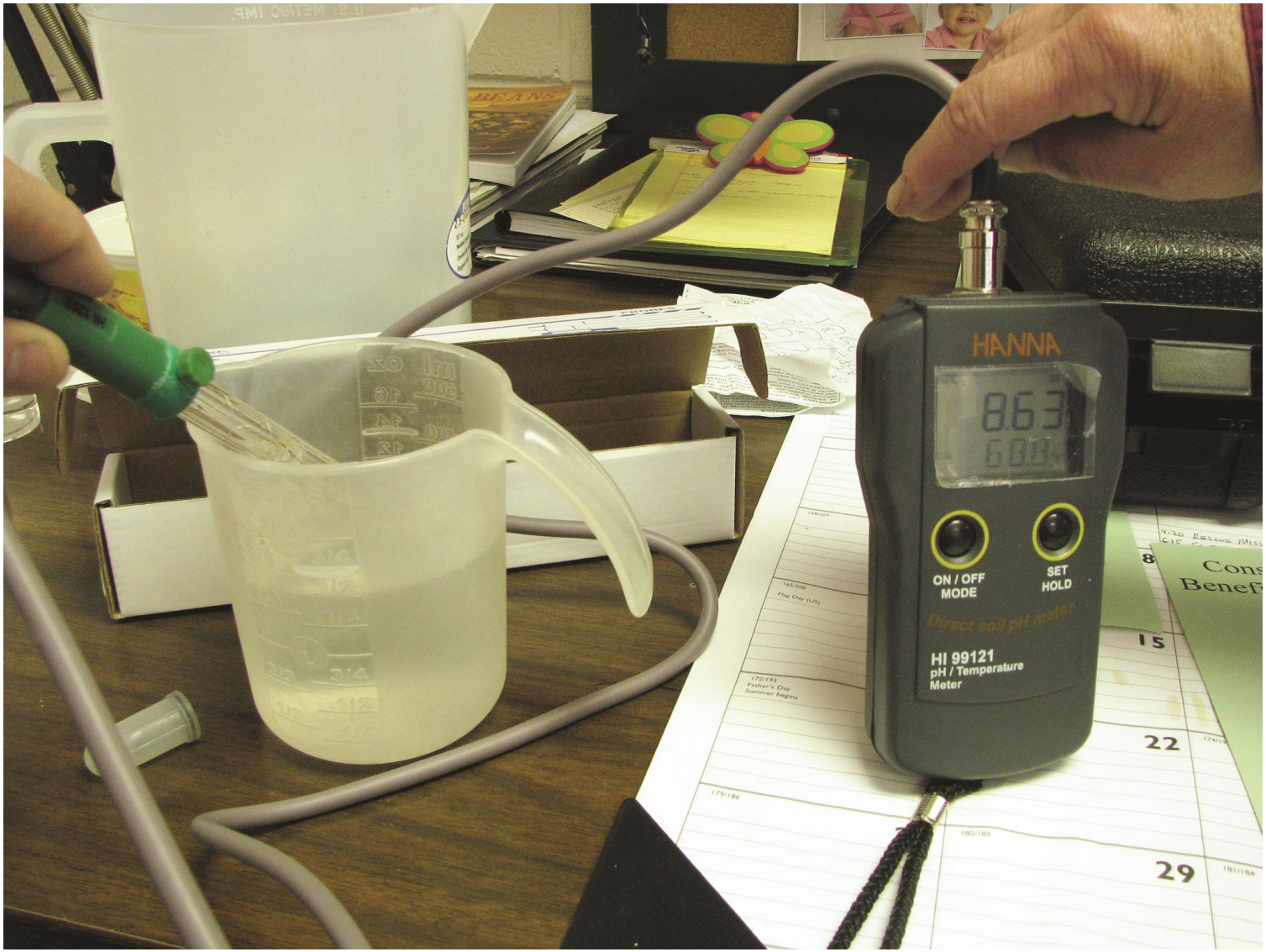
Testing Water

Check the water pH

If greater than 7.0 consider adding buffering agents or find an alternative water source

- **If using organophosphates, carbamates, many fungicides or a weak acid herbicide**

If pH < 7.0 use buffering agent to raise pH if using sulfonylurea herbicides



Review

pH is the measure of hydrogen ions (H+) and hydroxide ions (OH-)

Acid solutions are <7

Alkaline solutions are >7

Weak acid herbicides breakdown within high pH solutions (>7)

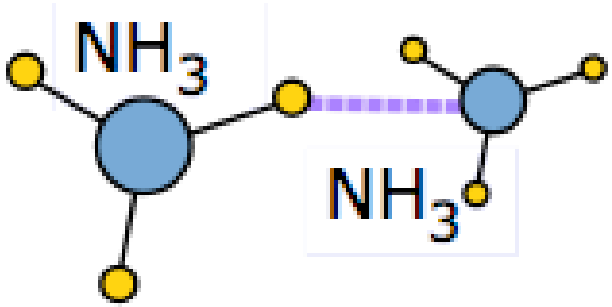
Sulfonylurea herbicides are insoluble in a low pH solution (<7)

Adjuvants

- Acidifiers
  - Lower pH of water
  - Don’t necessarily maintain a constant pH level
- Buffers
  - Stabilize pH at a relatively constant level

Be Aware: Alkalizing Agents May Act as Tank Cleaners

Ammonia-based products can increase the pH of the spray tank solution between 10 and 12 depending on the usage rate



Solutions within this pH range may pull previous pesticide residues out of the tank prior to contaminating tank solutions

Always clean the tank prior to raising the pH level

pH

- Some pesticides should not be acidified
  - sulfonylurea herbicides
  - fixed copper fungicides
- Some pesticides should have the pH of mix water adjusted
- Read the label

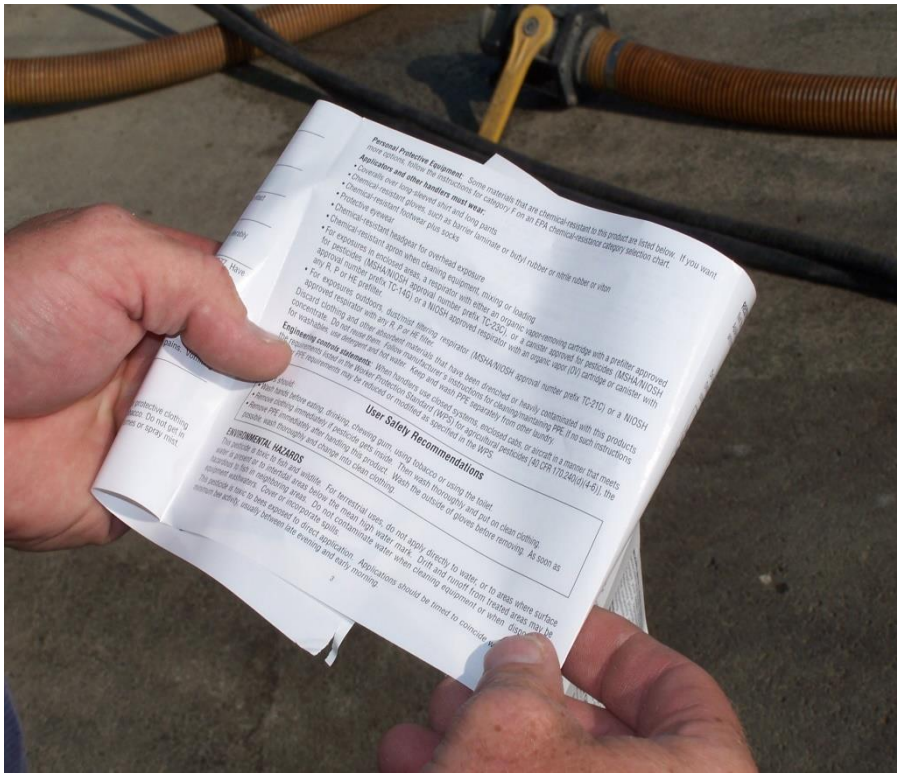
Label Examples

"Do not use with spray additives that alter the pH of the spray solution below pH 5 or above 9.0, as rapid degradation can occur"

"Do not use with a liquid fertilizer solution less than pH 3"

Do not use nonionic surfactants or other additives that alter the pH of the spray solution below pH 5; spray solutions of pH 6.0-8.0 are optimum"

"The spray mixture pH should be 4 to 7 for good efficacy"



REMEMBER

- **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 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 spray water should be sprayed immediately.**

Total Dissolve Solids (TDS) and hardness

TDS is defined as the total dissolved solids (minerals) in water.

Is determined by either:

- **evaporating water to dryness and weighing minerals that remain (mg/L; ppm)**
- **measuring the specific conductance**

Gives water it's taste

Positive Charge (Cations)	Negative Charge (Anions)
Calcium (Ca++)	Sulphate (SO_4-)
Magnesium (MG++)	Chloride (Cl-)
Sodium (Na+)	Bicarbonate (HCO_3-)

TDS is the Sum of Minerals in Water

Calcium	500 ppm
Sulphate	250 ppm
Magnesium	150 ppm
Chloride	50 ppm
Sodium	100 ppm
Bicarbonate	400 ppm
Total	1,450 ppm

Types of Water and TDS

Hardness of Solution

Hardness is the measure of + charged (cation) minerals

Measured in ppm

Cat-ionic minerals bind with negatively charged pesticide molecules

Most hardness kits measure Ca^{2+} and Mg^{2+}

Positively Charged Cations
Aluminum (Al^{3+})
Iron (Fe^{2+}, Fe^{3+})
Magnesium (Mg^{2+})
Calcium (Ca^{2+})
Sodium (Na^{1+})

Hardness Ranges

Parts Per Million (ppm)	World Health Organization Classification
0 – 114	Soft
114 – 342	Moderately Hard
342 – 800	Hard
> 800	Extremely Hard

Hard Water

- Can reduce the effectiveness of weak acid pesticides, especially if the pH of the water is above the ideal range.
  - Pesticide breaks down into + and – ions
  - Ions attach to water molecules and the pesticide
    - can't be absorbed by the target pest, or
    - is absorbed at a slower rate, or
    - forms insoluble salts

The problem with water hardness

- Ties up pesticides—will reduce the effectiveness
- Reduces effectiveness of some surfactants
- May get scale buildup in nozzles, plug sprayer

Hard Water

- Minerals dissolved in water reduce the activity of the following salt-formulated herbicides
  - 2,4-D
  - Glyphosate
  - Poast
  - Pursuit
  - Liberty

Hardness Problems Due to Ca, Mg

- 2,4-D
  - Hardness of 500 ppm completely deactivates
- Glyphosate
  - Effects are noticeable at 150 ppm
  - At low application rates, effectiveness lost for hardness over 350 ppm
  - At high application rates, effectiveness lost for hardness over 500 ppm

To Reduce Hardness

- Add dry ammonium sulfate (AMS)
  8.5 to 17.5 lbs per 100 gal water ***OR***
- Liquid fertilizers (28%N, 32% N or 10-34-0) at 1.25 to 2.5% per 100 gallons
- Check the pesticide label!

Sample Buffer Label

- “The recommended use rate is 2 to 4 quarts per 100 gallons of spray solution. The 3-quart rate is recommended in most situations. If water hardness is greater than 500 ppm, the higher rate should be used or additional water conditioning agents, such as Bronc®Max, should be added.”

Review

TDS is the measure of dissolved minerals in water (measured in mg/l or ppm)

Hardness is the measure of positively charged minerals in water (Fe++, Ca++, Mg++, Na+)--cations

Hardness may be a concern if > 150 ppm

pH and hardness often work hand in hand to reduce efficacy of pesticide products

Non-ionic surfactants and ammonium sulfate may be added to tanks to alleviate bicarbonate and hard water problems

Turbidity

Turbidity is defined as total suspended solids (TSS) in the water

Suspended solids refers to suspended soil and/or organic matter in water

<u>Reduces effectiveness of many herbicides</u>

When is turbidity a problem?

Pesticides may be rendered inert after binding to soil particulates in spray tank

Pesticides with a high KOC (soil adsorption coefficient) are vulnerable

- **Glyphosate (24,000 KOC)**
- **Paraquat (1,000,000 KOC)**
- **Diquat (1,000,000 KOC)**

Monitoring Turbidity

Digital turbidity instruments

- **Precise**
- **Expensive ($600 - $2,000)**

KATS enterprises

Cole Parmer

Monitoring and Mitigation of Turbidity

Drop a quarter to the bottom of a 5 gallon bucket

If you can't see the quarter then the water must be treated or not used.

If dirty then:

Use select pesticides with a low KOC (adsorption potential)

Locate an alternative water source

Install inline filters

Review

Turbidity is the total suspended solids (TSS) in water.

Suspended solids refers to suspended solids, soil, and/or organic matter

Many pesticides bind to soil particulates (high soil sorption potential; KOC)

Pesticides such as glyphosate, diquat, paraquat, bifenthrin and permethrin bind readily in turbid water.

Perform the bucket test using a quarter to determine if water is too turbid for pesticide use.

If water is murky then use an alternative water source; or use only select pesticides with low KOC's and install additional inline filters.

Review – Testing Water

Test the hardness of your water

- **If over 150 ppm and > 7 pH then mitigate especially if using organophosphates, carbamates, many fungicides and weak acid herbicides**

Test your bicarbonate levels

- **Bicarbonate levels over 400 ppm will cause a reduction in performance of many grass herbicides**

Test the turbidity of your water

- **If water is murky consider an alternative water source**

When to test Water Quality

Addressing water quality well before a pesticide application will give you time to purchase test kits and evaluate mitigation strategies

Water also should be retested periodically due to natural fluctuations in water quality throughout the season

After a few years of testing, you will probably notice that the water quality follows certain cycles or remains consistent

Mitigation Strategies - Adjuvants

Adjusting pH

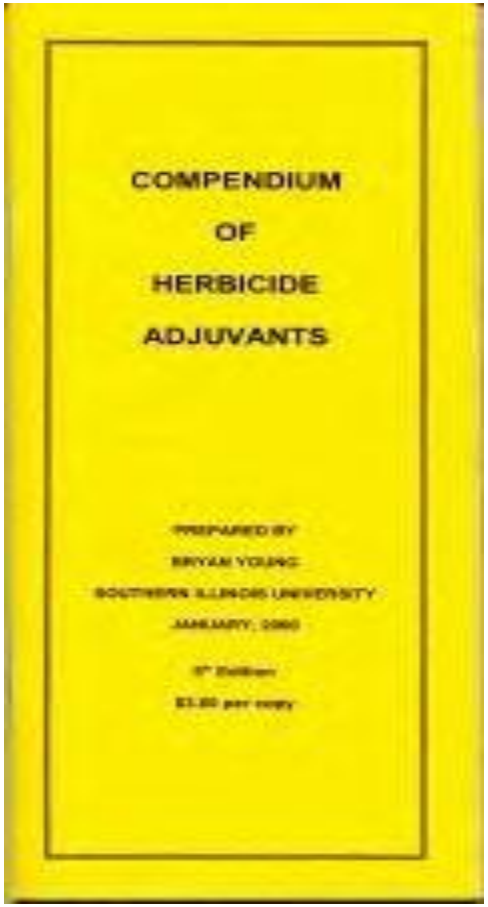
- Add acidifiers
- pH buffers

Decreasing Hardness & bicarbonates

- Non-ionic surfactants
- Ammonium sulfate

For more information:

- Navigate to www.herbicide-adjuvants.com
- Contact a product sales representative.



Mitigation Strategies - Adjuvants

Some commercial water conditioners have not been proven effective. Follow these steps when selecting the proper water conditioner:

Read the pesticide label as it may be very specific as to the water conditioners to be used. Some product labels do not recommend adding a water conditioner

Contact your pesticide manufacturer or sales representative for more information regarding the proper water conditioners to be used

Mitigation Strategies

Sometimes it's easier to locate an alternative water source

- **If hardness, pH or bicarbonates are extreme**
- **Turbidity issues**

Summary

- Water quality affects pesticide performance
- Pesticide may degrade and become ineffective
- Poor water quality results in lost money due to wasted time, product, and a lower quality or lower yielding crop

THANK YOU

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