Carrier water quality and pesticide stability

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Tank-mixing pesticides and fertilizers is a convenient and cost effective way to apply two or more chemicals at once. When done appropriately, tank-mixing can reduce labor and equipment costs, and save time and energy.

Carrier water is the water you put in the tank to dilute your chemicals and to apply them with. Carrier water makes up about 95 percent of what you are applying. Certain water chemistry can potentially react with, and change the efficacy of, pesticides in both positive and negative ways.

This article examines the origins of water chemistry, and how to take a water sample and determine the water quality. This article also discuss the influence of and the remedies for common problematic water components.

ORIGINS OF WATER CHEMISTRY

The chemical and physical properties of minerals and weathering influence water chemistry. Weathering is the decomposition process of rocks, minerals and soils by physical – for example, degradation by microorganisms and cracking by ice formation– and chemical – such as reactions between water and minerals– processes. Weathering results in different compounds as solutes and or particulates within the water column.

Here is an example of how mineralogy and weathering may influence water chemistry. Along the south eastern coast of the U.S. limestone, composed of mainly calcium carbonate ($CaCO_3$), is the underlying bedrock along coastal South Carolina.

During each rain event, water combines with carbon dioxide in the atmosphere to form a weak acid called carbonic acid. As rain water passes over and through the limestone, the acid combines with the calcium carbonate to form calcium bicarbonate ($Ca(HCO_3)_2$), which is dissolved in the water.

Calcium carbonate and calcium bicarbonate are the two principal causes of hard water. Water chemistry is also influenced by the sources of water. Saline aquifers, tidally influenced streams and rivers and reclaimed stormwater runoff and wastewater all have a considerable amount of salts and other particulates.

TESTING WATER SOURCES

Use opaque plastic containers to collect your water sample. Rinse out the bottle three times with the water you will be sampling before you take the actual water sample. Place your name, location, and date on the sample bottle with a permanent marker. Place the water sample in a cooler or refrigerator until delivering to the laboratory.

Make sure to submit the sample within 24 hours of collection. Regardless of which laboratory you send the sample to, you should receive an interpretation of results as part of your report. Some water components can be determined on site with relatively little expense and will be discussed in the following sections.

COMMON PROBLEMATIC WATER COMPONENTS

pH or Potential of hydrogen is the measure of the concentration of hydrogen ions (H+) and hydroxide ions (OH-) in a solution. It is measured on a logarithmic scale of 1-14 with 1 = acidic (dominated by H+ ion), 7 = neutral, and 14 = alkaline (dominated by OH- ions). Water pH fluctuates diurnally (from photosynthesis and aerobic respiration) and seasonally (from increased rainfall, leaf litter, etc.). Over long periods of time, water pH tends to become more alkaline.

How does pH influence pesticide efficacy?

Certain pesticides undergo chemical breakdown in alkaline water (pH more than 7). The reaction is termed alkaline hydrolysis and the severity and speed in which it occurs is dependent on the pesticide, the alkalinity of the water, the length of time the pesticide is in contact with the water and the water temperature.

Insecticides, particularly organophosphates and carbamates, are susceptible to alkaline hydrolysis than other pesticides. In comparison, sulfonylurea herbicides are more susceptible to acid hydrolysis at pH less than 6.0.

So how do you keep it from becoming a problem?

Since pH is always changing, it is important to check it every time you mix up a pesticide. You can add buffering agents to carrier water whenever necessary.

A pocket pH meter is relatively inexpensive and easy to operate. Test the water pH before adding any chemicals.

Always read the pesticide label and check the pesticide MSDS for the recommended pH range. If correction is needed, add a buffering or acidifying agent *before* adding the pesticide. The acidifying agent may include acid forming nitrogen fertilizers, straight acids and may or may not be used in conjunction with surfactants. Always apply the tank mixture as soon as possible. Buffering agents should not be mixed with fixed copper and lime fungicides; otherwise, plant damage will occur.

SALINITY

Salinity is the concentration of mineral salts – $MgSO_4$, MgCl, CaCl, $NaHCO_3$, NaCl, KCl – dissolved in water. It is measured by electrical conductance (EC) and is commonly reported in either dS/m or mmhos/cm.

So, how does it influence pesticide efficacy?

Salty water is alkaline and more resistant to pH changes, making adjustments with acids more difficult. Salinity of over 0.75 dS/m can stress sensitive

Table 1. Recommendations on the uses of selected fungicides, herbicides and insecticides in carrier water of problematic quality. The effects of water hardness and salinity on fungicides and insecticides are poorly studied; thus, the compatibility should be tested before mixing.

Common Names	Brand Names*	Water Quality				
		Acidic (pH < 6)	Alkaline (pH > 8)	Muddy	Hard	Saline
Fungicides:						
azoxystrobin	Heritage	✓	X	NR		
chlorothalonil	Daconil	✓	✓	Test		
ethazole	Terrazole	✓	✓	Test		
fenarimol	Rubigan	✓	✓	✓		
Fosetyl Al	Aliette	✓	✓	X		
mancozeb	Manzate	NR	NR	Test		
mefenoxam	Subdue Maxx	✓	Test	Test		
PCNB	Terracolr	✓	Test	NR		
propiconazole	Banner Maxx	✓	✓	Test		
thiophanate methyl	Cleary3336	Test	X	Test		
trifloxystrobin	Compass	Test	Test	NR		
Herbicides:						
2,4-D amine	2,4-D amine	Test	NR	✓	X	✓
atrazine	AAtrex	NR	X	Test	✓	X
chlorsulfuron	Corsair	X	✓	✓	✓	✓
clopyralid	Lontrel	Test	X	✓	X	✓
dicamba	Vanquish	✓	NR	✓	NR	✓
diquat (& paraquat)	Reward	✓	✓	X	✓	✓
glyphosate	RoundUp	✓	Test	X	X	✓
halosulfuron methyl	SedgeHammer	X	✓	✓	✓	✓
MCPA	MCPA	Test	NR	✓	X	X
metsulfuron	Manor	NR	X	✓	✓	✓
sethoxydim	Vantage	✓	✓	✓	✓	✓
simazine	Princep	Test	NR	✓	✓	X
Insecticides:						
acephate	Orthene	✓	X	✓		
bifenthrin	Talstar	✓	✓	X		
carbaryl	Sevin	✓	X	NR		
chlorpyrifos	Dursban	✓	X	X		
clothianidin	Arena	✓	✓	✓		
fipronil	TopChoice	✓	✓	NR		
imidacloprid	Merit	✓	Test	✓		
indoxacarb	Provaunt	✓	X	Test		
λ-cyhalothrin	Scimitar	✓	X	X		
spinosad	Conserve	✓	Test	Test		
thiamethoxam	Meridian	✓	Test	✓		
Trichlorfon	Dylox	✓	X	✓		

*Brand names are provided as examples. Mentioning of any products should not be considered as an endorsement.
Key: ✓= OK. X = Do not use. NR = Not recommended but use soon after mixing if there is no alternative. Test = Test for compatibility.

plants and reduce absorption of systemic pesticides through plant roots.

Besides what has been mentioned, not much is known about how salinity influences pesticide efficacy, or if it does at all. However, we are aware of instances in which a pesticide failed and the only water problem possible was salinity. If you have a similar problem, please have your county extension agent contact us immediately.

To keep this from becoming a problem, check the salinity in you carrier water if you use water from reclaimed or tidally influenced sources.

Pocket EC meters are inexpensive and easy to use. Combination Temperature/pH/EC pocket meters are slightly more expensive but still reasonable. Always read the pesticide label and check the pesticide MSDS to see if any precautions should be taken. Sometimes salinity is reported as total dissolved salts (TDS). Most pocket EC meters will give you the option for either an EC or TDS readout.

If a saline water source is used, an alternative water source should be identified for permanent use or for blending with the saline water. Agitators and injection tanks can be installed for water treatment with calcium or sulfur.

Contact your university extension agent or a professional to discuss the best options.

WATER HARDNESS

Hard water contains a high concentration of magnesium (Mg^{2+}), calcium (Ca^{2+}), and Ferric ions (Fe^{3+}). Water hardness is reported in ppm of $CaCO_3$ equivalent. Water <50 ppm is considered "soft", 50-100 ppm is considered "medium hard" and 100 – 2000 ppm is considered "hard".

So how does it influence pesticide efficacy?

The cations in hard water bind with the pesticide molecules (one cation can bind more than two susceptible pesticide molecules) to form insoluble salts and precipitate out of solution. 2,4-D, dicamba, glyphosate and clopyralid are susceptible to binding with minerals in hard water.

Hard water can also reduce the efficacy of some surfactants and agents added to clear turbid water. Precipitates and scales formed in the sprayer can also clog the nozzles and filters resulting in lower pesticide rates applied than expected and or non-uniform spray coverage.

To keep it from becoming a problem you will have to submit a water sample to a laboratory to test for hardness. Always read the pesticide label and check the pesticide MSDS for any precautions. If correction of water hardness is needed, add an agent such as those containing sulfate, organic acids and non-ionic surfactants. Sulfate (SO_4^-) and organic acids are often used to bind with the hard minerals.

Non-ionic surfactants are commonly used to enhance herbicide efficacy but it should be noted that these will not correct the problem, and another agent still needs to be used. The agent should be mixed with the carrier water before adding the pesticide.

Other options are to decrease the volume of carrier water and to use a higher label rate. Spray the tank mixture immediately.

PARTICULATES

Particulates of clay, silt, organic matter and algae that are found within the water column naturally or from agitation.

Large particulates may eventually settle to the bottom but small particulates can suspend in the water column. Collectively, the total amount of particulates is known as turbidity and is commonly reported in Nephelometric Turbidity Units (NTU). The small particles that remain suspended are referred to as *total suspended soilds* and are reported in mg/l.

These particles are both a chemical and physical nuisance and can influence pesticide efficacy. Clay and silt can bind with pesticide molecules. The organic particles not only bind with pesticides but also harbor microbes that naturally degrade pesticides. These particulates can clog filters and nozzles.

To keep it from becoming a problem a water sample will have to be submitted to a laboratory to get an actual value of turbidity. The easiest way to test for a problem is to drop a quarter at the bottom of 5 gallon bucket of the water. If you cannot see the coin, then the water must be treated.

Glyphosate is an example of a herbicide that is degraded by soil. Always read the pesticide label and check the pesticide MSDS for any precautions on using dirty water.

An inline filter can be installed to remove suspended solids. If the pump is within a surface water body, make sure that the location of the intake is in the middle of the water column and not at the very bottom or close to the top of the water column. Locate an alternative water source for permanent use or to blend with turbid/muddy water.

Additionally, agents can be added to help precipitate and clear the water.

IRON

Iron is the sixth most abundant element in the universe and is the fourth most abundant element in the earth's crust, although not commonly found in the free metal form.

Iron is dissolved as water passes through the underlying rocks. The concentration of iron is reported in mg/l.

Iron doesn't directly influence pesticide chemistry. However, in air or aerobic water, iron reacts with oxygen to form rust – oxide and hydroxide forms of iron. It forms faster in the presence of salt, as in certain pesticides or within the carrier water.

The rust can cause reddish-brown staining. Iron also combines with organic materials and bacteria to produce slimes. Rust flakes and slimes can clog nozzles, filters and lines which may result in applying less pesticide than expected.

To keep it from becoming a problem a water sample will have to be submitted to a laboratory to get an actual value of iron concentration.

Stains can appear at concentration as low as 0.3 mg/l.

Treatment for excessive iron depends on the problem that exists (stains, deposits, or slimes). The most common techniques include aeration followed by filtration, the use of a water softener (caution: these usually use sodium), and the use of potassium permanganate and chlorination followed by filtration. Contact your university extension agent or a professional to help decide which is best for you.

TAKE PRECAUTIONS

Always check your pesticide label and MSDS for recommendations and guidance. If you still have a question, contact the company representatives or county extension agents. Table 1 (page 38) summarizes the effect of water quality on the most commonly used and more recent pesticides.

If the irrigation source exhibits one of the above-mentioned water problems, and the pesticide requires water-in after application, the irrigation water should be treated as well. This can be done by installing inline injection tanks. **GCI**

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