WATER QUALITY AND Inadequate Pesticide Performance

There are 5500 pesticide applicators in Montana, who adjust to a range of soils and varying water quality to achieve their work. It is not uncommon for an applicator to experience a pesticide performing poorly. When sleuthing this issue an applicator should not assume it is the pesticide product, as many factors contribute to low pesticide performance. If equipment is calibrated properly, an applicator may benefit from testing water quality.

Testing water quality prior to mixing pesticides is recommended.

It is not uncommon for Montana applicators to use water sources with a pH greater than 8.0 and / or hardness rating greater than 150 parts per million (ppm). Regions where poor water quality can affect pesticide product performance include large stretches of the Madison Valley, many areas along the Hi-Line of northern Montana and many regions of southeastern Montana. Because pesticide tank mixes often consist of over 95 percent water, a slight variation in water quality can have a severe impact on pesticide performance. This may be due to water pH or hardness of the water.

Water pH

The pH describes the concentration of hydrogen (H+) and hydroxide (OH-) ions in a solution (Table 1). Minerals in the solution affect the pH which is measured on a logarithmic scale ranging from 0 – 14:

- pH = 7....neutral (H+ equals OH-)
- pH > 7....alkaline (> concentration of OH-)
- pH < 7....acidic (> concentration of H+)

Most insecticides, fungicides and herbicides are weakly acidic or neutral and can be used in pH solutions from 4 – 7 with little antagonism. When these pesticides are placed into an alkaline (pH > 7) water source they undergo alkaline hydrolysis. Hydrolysis is the breakdown of larger pesticide molecules into simpler units that are not easily absorbed by the pest; thereby reducing pesticide performance. Some common pesticides that are extremely susceptible to alkaline hydrolysis are 2,4-D amine, glyphosate, glufosinate ammonium, ammonium salt of imazethapyr, and a wide range of carbamate and organophosphate insecticides (Table 1). Weak alkaline pesticides such as the sulfonyl urea herbicides are susceptible to acid (pH < 7) hydrolysis. Sulfonyl urea herbicides including such products as "Ally, Escort, Amber, Harmony, Accent" can be identified by the active ingredient which includes "uron."

Applicators should test their water source prior to a spray application using a pH meter or pH litmus strips. A pH meter is the most accurate method of determining pH of water; while litmus strips are inexpensive and deliver coarse readings. If the water source is alkaline an applicator can easily adjust the pH using adjuvants, or substance added to improve performance, known as acidifiers. Acidifiers can lower the pH of the spray solution from alkaline to an ideal 6.0 for most weak acid pesticides. Applicators may contact their local agricultural pesticide dealers, pesticide manufacturer or see the adjuvant compendium at herbicide-adjuvants.com for obtaining proper adjuvants. If an acidifier isn't

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used to adjust the pH to an ideal range, applicators should remember to use the spray mixture as soon as possible.

Hard Water

The term water 'hardness' refers to presence of metals with a multivalent cationic charge (++) such as calcium (Ca++), magnesium (Mg++), and iron (Fe++). Total hardness is measured in parts per million or in grains per gallon. One grain (per gallon) equals 17.1 ppm. These cations can further reduce the effectiveness of weak acid pesticides, especially if the pH of the water is above the ideal range. The effect happens because of the pesticide dissociating into positively and negatively charged components and the cations in the water binding with the negatively charged subunits of the pesticide. Hardness ranges from 0 to over 800 ppm, and can be measured using litmus strips available at most hardware stores. Weak acid pesticides such as clopyralid, 2,4-D amine, glyphosate and dicamba may lose efficacy if hardness exceeds 150 ppm, especially if pH > 7.0. Formulations such as 2,4-D amine can be totally deactivated if hardness > 600 ppm, and many other herbicides will lose efficacy if hardness > 400 ppm. Negative effects from hardness can be reduced with addition of dry ammonium sulfate $(NH_4)_2SO_4$ at 8.5 to 17.5 lb per 100 gallons of water, or liquid fertilizers (such as 28 percent N, 32 percent N, or 10-34-0) at a rate of 1.25 to 2.5 percent per 100 gallons.

General Rules to Follow

Prior to any spray application test your water source and assess suitability by reading and following any water quality warnings on the pesticide product label. Applicators may wish to select pesticides that are least affected by water quality. If using a susceptible formulation an applicator may:

- use non-ionic surfactants, buffers, or acidifiers to correct any water quality problem.
- use ammonium sulphate fertilizer (21-0-0-24) at a rate of 8.5 to 17 lb per 100 gallons of water for hard water (many weak acid herbicides lose efficacy if hardness > 150 ppm).

For weak acid pesticides which are vulnerable to high pH, if the pH is between 3.5 and 6.0 applicators can store for 12 to 24 hours; if pH is between 6.1 and 7.0 applicators may spray within 2 hours; if pH > 7.0 add a buffer or acidifier.

For More Information

For additional information applicators may view the MontGuide *Pesticide Performance and Water Quality* by navigating to pesticides.montana.edu and select "Reference Material" then "MontGuide." ■

TABLE 1. The half-life of selected pesticides at different pH values [1]

PESTICIDE		half-life[1] at different pH solutions				
Common Name	Trade Name[2]	pH 5	pH 6	pH 7	pH 8	pH 9
acephate	Orthene	40 days	-	46 days	-	16 days
carbaryl	Sevin	-	125 days	24 days	2.5 days	1 day
diazinon	Knox-Out	31 days	-	185 days	-	136 days
dicamba	Banvel	Stable[3]	Stable	Unstable	Unstable	Unstable
dimethoate	Cygon	-	12 hours	-	-	48 minutes
malathion	Digon	-	8 days	3 days	19 hours	-
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 one 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.
3. Stable/unstable listings do not have qualitative values and are provided as general reference.