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PI-156

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# Water pH and the Effectiveness of Pesticides[1]

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## Introduction

Some pesticides lose their effectiveness when mixed with alkaline (high pH) water. This document discusses the effects of alkalinity and presents some methods for preventing this reaction in pesticide mixes.

## Water pH and Pesticides

### What is pH?

The term pH, potential of hydrogen, refers to a measure of the concentration of hydrogen ion (H+) and hydroxide ion (OH-) in a solution. If hydrogen predominates, the solution is acidic; if hydroxide predominates, the solution is basic, or alkaline. A logarithmic scale of 0 to 14 is used to measure pH. A pH value of 7 indicates neutrality. Values below 7 indicate acidic conditions; pH values above 7 indicate alkaline conditions. Because a logarithmic scale is used in measuring pH, a pH of 6 is 10 times more acidic than a pH of 7, and a pH of 5 is 100 times more acidic than a pH of 7.

### How does pH affect pesticides?

Some pesticides, particularly carbamate and organophosphate insecticides, undergo a chemical reaction in the presence of alkaline water (water that has a pH value greater than 7). The reaction is known as alkaline hydrolysis, and it reduces the effectiveness of the pesticide's active ingredient. The speed with which the breakdown occurs depends on the specific chemical properties of the pesticide, the pH of the mix water and the length of time the pesticide is in contact with the water. Spray-mix water with a pH value between 8 and 9 can cause rapid hydrolysis to the point that the degree of pest control is greatly diminished or lost.

Chemical breakdown of a pesticide is commonly referred to in terms of its half-life. A half-life is the period of time it takes for one-half (50% hydrolysis) of the amount of pesticide in the water to degrade. The half-lives of some commonly-used insecticides/miticides are presented in Table 1.

There are water sources in Florida that have pH values between 7 and 9, (from neutral to alkaline). This is the case wherever water comes from a

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limestone aquifer, such as the Floridan (majority of groundwater withdrawal in Florida) or Biscayne (south Florida), or from lakes or canals that cut into limestone. There is some variability in these values even if they are within the same hydrologic region of the state. Both surface and ground water pH values fluctuate over time and even seasonally. One factor that influences the pH of open water is the amount of resident plant life.  In these systems, there are high concentrations of carbonate in the water. The pH of the water may rise in poorly buffered systems because carbonate leads to increases of pH. Therefore, in some Florida water bodies with high levels of healthy aquatic plants, it is possible for pH to reach a measurement of 9 or 10.

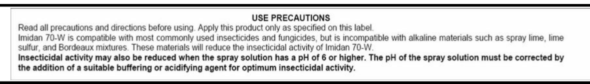
### How can I determine the pH of the water I use to mix with pesticides?

A water test is the surest means of determining whether a pH problem exists. The IFAS Extension Soil Testing Laboratory in Gainesville offers a water test to the public for $10.00 per sample. The form and instructions are available through all county Extension offices or can be printed directly from the ESTL website (http://soilslab.ifas.ufl.edu). A faster and cheaper way to determine the pH level of water is to use test paper. However, paper test strips can vary by as much as 2 pH points. A pH meter will also provide fast results, but more reliable and consistent readings. Meters that measure pH within 0.2 points of accuracy are available commercially for as little as $50 . More expensive models have greater precision and may have the ability to conduct additional measurements such as electrical conductivity.

### When should a pesticide solution be acidified in the spray tank?

If you know that your mix water has a pH of 7.5 or greater, consider lowering the pH, especially if you are applying a pesticide that is sensitive to high pH. A pH of 4 to 7 is recommended for mixing most pesticides; a value of 5.5 to 6.5 is ideal. If your spray rig will be left to stand for several hours before the contents are applied, consider adding an acidifying agent to prevent alkaline hydrolysis.

Some product labels will direct you to avoid mixing the pesticide with alkaline water or other specific alkaline materials such as lime, lime sulfur, or Bordeaux mixtures (Figure 1). You may also see statements that the activity of the pesticide will be reduced under alkaline conditions. The directions will state that a buffering or acidifying agent should be added to the spray tank. There are a few pesticidal materials that should not be acidified under any circumstances: sprays containing fixed copper fungicides (Bordeaux mixture, copper oxide, basic copper sulfate, copper hydroxide, etc.) and lime and lime sulfur. Their labels will contain specific statements.


USE PRECAUTIONS

Read all precautions and directions before using. Apply this product only as specified on this label.

Imidan 70-W is compatible with most commonly used insecticides and fungicides, but is incompatible with alkaline materials such as spray lime, lime sulfur, and Bordeaux mixtures. These materials will reduce the insecticidal activity of Imidan 70-W.

**Insecticidal activity may also be reduced when the spray solution has a pH of 6 or higher. The pH of the spray solution must be corrected by the addition of a suitable buffering or acidifying agent for optimum insecticidal activity.**

**Figure 1.** Label precautionary statement regarding solution pH concerns.

### Acidifiers and Buffering Agents

Acidifiers and buffering agents are a type of pesticide spray mix adjuvant. All adjuvant materials are added to the chemical formulation or spray tank to make the application more effective, safer, or easier for the applicator. Various commercially available acidifying agents will lower the pH of spray solution. Buffers are capable of changing the pH of a water solution to a level which will be maintained even if the pH of the solution changes. Like pesticides, their labels should be read and followed closely. The amount to add will depend upon the initial pH, the volume of water, and the desired final results.

## Flumioxazin – An Herbicide Case Study in Florida

Flumioxazin is an herbicide registered for use in a wide range of agricultural commodities under the trade names Chateau®, Payload®, SureGuard®, Valor® and Broadstar™. Flumioxazin has been shown to provide consistent control of several broadleaf weed species, but this molecule is susceptible to alkaline hydrolysis. At pH 5, flumioxazin is very stable and will persist in water for several days. However, as pH increases to 7 the half-life decreases to approximately 24 hours, and at pH 9 the half-life is a mere 15 minutes. Hence, mixing flumioxazin with high pH water can cause this herbicide to  degrade and completely lose its herbicidal activity before it can be

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applied. When using Flumioxazin, it is important to know whether the available water should be acidified to enhance herbicidal activity. Otherwise, it is possible to lose herbicidal efficacy simply because high pH water was used to fill the sprayer.

## Summary

Determining the pH of the spray mix water and adding an acidifier, if necessary, is inexpensive compared to the cost of losing a pesticide's effectiveness. There are water sources in Florida that are alkaline by nature, and the addition of an acidifying agent to the spray mix is an easy and economical way to guarantee maximum results from your pesticide applications.

## Additional Information

Ferrell, J.A., G.E. MacDonald, and J.T. Ducar. 2006. Adjuvants. UF/IFAS EDIS Document SS-AGR-109. http://edis.ifas.ufl.edu/WG050

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**Table 1.**

| **Active ingredient** | **pH 6** | **pH 7** | **pH 8** | **pH 9** |
|---|---|---|---|---|
| Azinphos-methyl | | 10 days | | 12 hours |
| Captan | | 8 hours | 10 minutes | 2 minutes |
| Carbaryl | 100-150 days | 24-30 days | 2-3 days | 1-3 days |
| Carbofuran | 200 | 40 days | 5 days | 3 days |
| Chlorpyrifos | | 35 days | 22 days | |
| Diazinon | | 70 days | | 29 days |
| Dimethoate | 12 hours | | | 1 hour |
| Disulfoton | 32 hours | | | 7 hours |
| Malathion | 8 days | 3 days | 19 hours | |
| Methomyl | 54 weeks | 38 weeks | 20 weeks | |
| Phosmet | | 1 day | 4 hours (pH 8.3) | 1 minute (pH 10) |
| Propargite | 331 days | | | 1 day |
| Trichlorfon | 4 days | 6 hours | 1 hour | |