Have you ever used a pesticide, or had someone apply one for you and it did not control the pest? You may have attributed the poor control to weather conditions, the chemical itself, applicator error, pest resistance, or maybe that you bought the wrong material. But have you ever thought to check the pH of the water used to mix the pesticide? The pH of the water that goes into your spray tank makes a difference in how effectively the pesticide works.

**How does pH affect pesticides?**

The characteristics of water used in a spray mix influence the effectiveness of some pesticides. One of the most important is the pH of the water: it’s relative acidity or alkalinity. Water with a pH higher than 7 is alkaline. Many pesticides, particularly commonly used organophosphate and carbamate insecticides, undergo a chemical reaction in the presence of alkaline water that reduces their effectiveness. This reaction is called alkaline hydrolysis. The pesticide is hydrolyzed and rendered ineffective when it is mixed with water with a pH greater than 7. The more alkaline the water, the more rapidly the pesticide breaks down. The severity of the reaction is determined by:

- how susceptible the pesticide is to alkaline hydrolysis,
- the amount of time the pesticide is in contact with the alkaline water,
- the temperature of the diluted pesticide mixture, and
- the level of alkalinity (pH) of the water.

The hydrolysis can be very fast when the pH of the water is greater than 8 or 9. For every unit increase in pH, the rate of hydrolysis increases 10 times. Some pesticides begin to break down as soon as they are combined with alkaline water in the tank, especially when the pH of the water is very high. As a consequence, the active ingredients start to change to inactive ingredients before the pesticide ever leaves the tank! The degree of pest control may be somewhat to greatly decreased or even lost completely. If a spray tank is allowed to stand for several hours or overnight before the contents are used, as much as 50% of the active ingredient may be lost.

**Do I need to worry about the pH of water in Nevada?**

Many water supplies in Nevada have a pH high enough to cause hydrolysis of susceptible pesticides. Water sources may have varying degrees of alkalinity even if they are in the Nevada Department of Agriculture Cooperating
same hydrologic basin. If the pH of your water is higher than 7.5, it is alkaline enough to affect some pesticides. Use a pH meter or pH test kit such as those used for testing swimming pool water to accurately determine the pH of the water. Test papers, like hydron or litmus can be inaccurate and should not be used. Both surface and ground water pH can and do change with time. The pH may fluctuate seasonally. It is a good practice to test the pH of the water just prior to mixing up your spray solution. If your water supply is alkaline, with a pH of 7.5 or greater, you can and should lower the pH, particularly if you are using a pesticide that is sensitive to high pH. A pH of 4 to 7 is recommended for mixing most pesticides. You can adjust your spray solutions to the 4 to 7 pH range with commercially available buffering agents.

What is a buffering agent?

A buffering agent changes the pH of a spray solution to a prescribed level and keeps it there. They are often straight acidifying agents, but many are sold as combination products containing surfactants, trace elements or other fertilizers. Examples of commercially available buffering agents are Buffer-X® (Kalo, Inc.), Buffer® (Ladda Co.), Spray-Aide® (Miller Chemical), and Buffercide® (Custom Chemicals). Buffering agents prevent pesticide hydrolysis during mixing and storage in the tank, until the spray is applied and the water has evaporated away.

How will I know if a product should be buffered?

If the product label tells you to avoid alkaline water or materials, the spray mixture will benefit by adjusting the pH to 6 or slightly lower. In general, insecticides are more susceptible to hydrolysis than fungicides and herbicides. Among insecticides, the organophosphates and carbamates are decomposed by alkaline hydrolysis much more rapidly than others.

Many manufacturers provide information on the rate at which their products hydrolyze. This rate is usually expressed as ‘half-life’ or the time it takes for 50% of the product to breakdown (hydrolyze), Table 1. Dimethoate (Cygon) has a half-life of 1 hour at a pH of 9. This means that if the pH of your spray water is 9, and one hour elapses between the times you mix-up the dimethoate and spray it out, 50% of the active ingredient is already lost! However, if your water has a pH of 6, it is not likely that any significant loss of active ingredient will have occurred in one hour.

Are there any materials that should not be mixed with a buffering agent?

Yes! Under no circumstances should sprays containing fixed copper or lime fungicides, including Bordeaux, copper oxide, basic copper sulfate, copper hydroxide, etc. or lime sulfur be mixed with a buffering agent, or plant damage may occur, Figure 1.

Figure 1. Do not mix buffering agents with lime sulfur or fungicides that contain lime or copper.
Table 1. The Half-life of Selected Pesticides at Different pH Values

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Half-life Time at Different Solution pHs</th>
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<tbody>
<tr>
<td></td>
<td>3</td>
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<tr>
<td>acephate</td>
<td>Acephate Pro 65d</td>
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<tr>
<td>azin-phos methyl</td>
<td>Guthion 17d</td>
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<tr>
<td>bendiocarb</td>
<td>Ficam 4d</td>
</tr>
<tr>
<td>carbaryl</td>
<td>Sevin 125d</td>
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<tr>
<td>carbofuran</td>
<td>Furadan 200d</td>
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<tr>
<td>chlorothalonil</td>
<td>Daconil Stable below pH7 38d</td>
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<tr>
<td>diazinon</td>
<td>Knox-Out 31d</td>
</tr>
<tr>
<td>dimethoate</td>
<td>Cygon 12h</td>
</tr>
<tr>
<td>disulfoton</td>
<td>Di-syston 60h</td>
</tr>
<tr>
<td>malathion</td>
<td>Digon 8d</td>
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<tr>
<td>methomyl</td>
<td>Lannate 54w</td>
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<td>phosmet</td>
<td>Imidan 13d</td>
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<tr>
<td>methylparathion</td>
<td>Declare 690d</td>
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<tr>
<td>trichlorfon</td>
<td>Dylox 4d</td>
</tr>
</tbody>
</table>

1. These figures are generalized estimates and reflect trends, but half-life times vary considerably. Hydrolysis depends on other factors besides the pH of the solution, including temperature, the presence of other pesticides and adjuvants in the spray tank, and the formulation of the pesticide.

2. w = weeks, d = days, h = hours, m = minutes.

How much buffering agent should be used?

To determine how much buffering agent should be used in the spray tank depend on three things: 1) the pH of the water, 2) the volume of the mixture that will be made up for the application and 3) the buffering agent used—its type and effective concentration. Once the pH of the water is determined, read and closely follow the directions on the label of the buffering agent. Follow the directions in Table 2 for help.

Summary

If your water source has a pH above 7, addition of a buffering agent to the spray solution is an easy and economical way to guarantee maximum results from your pesticide application. Know the pH of water that is used with your pesticides and make the appropriate buffering adjustments. Whenever possible, use pesticides that do not hydrolyze in alkaline water. That information is available on the label.
Table 2. Testing and Adjusting the pH of Alkaline Water Used for Mixing Pesticides

Measure pH with an electronic pH meter or swimming pool test kit. Test paper used for pH testing is less reliable and should not be used.

**Water pH Testing Procedures:**
1. Collect a sample of water from the same source that will be used to fill the spray tank. Use a clean container and rinse it several times with the same water.
2. Check the pH of the water using a pH meter or test kit. Follow the manufacturer’s directions.
   - pH 3.5-6.0: Satisfactory for spraying and short-term (12 to 24 hours) storage of most spray mixtures in the spray tank.
   - pH 6.1-7.0: Adequate for spraying most pesticides. Do not leave the spray mixture in the tank more than 1 to 2 hours or the pesticide may lose its effectiveness.
   - Above pH 7.0: Add buffer or acidifier

**pH Adjustment Procedure:**
1. Using a standard eyedropper, add 3 drops of buffer or acidifier to a measured pint of water.
2. Stir well with a clean glass rod or other clean, non-porous utensil.
3. As described above, check the pH and compare the results to the pH ranges given in number two.
4. If further adjustment is needed, repeat steps 1 through 3. Repeat until the pH is satisfactory.
   *Record how many times 3 drops were added to bring the solution to the proper pH!*

**Correct pH in Spray Tank:**
1. Before adding pesticides to the sprayer, fill the tank to the level required for the application.
2. For every 100 gallons of water in the spray tank, *add 2 ounces of buffer for each time 3 drops of buffer were used in the jar test above.* Add buffer or acidifier to water while the agitators are running. If the tank is not equipped with an agitator, stir or mix the solution well by hand.
3. Collect a sample of the water in the sprayer and check the pH to be certain it is correct. Add more buffer if necessary and recheck the pH.
4. Once the pH is correct, add the pesticides to the spray tank.

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1. *From The Safe and Effective Use of Pesticides, University of California Statewide Integrated Pest Management Project.*

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