BY RAYMOND A. CLOYD

# Effects of pH on Pesticides

## Question: *How does water or spray solution pH influence pesticide activity?*

**Answer:** The effectiveness of a pesticide may be impacted by a number of factors, including spray coverage, application frequency or intervals between applications, type of pesticide, rate used, timing of application, age of pesticide, and pH of water or spray solution. The pH is a scale that ranges from 1 to 14. A pH of 7 is neutral, whereas a pH above 7 is alkaline (basic) and below 7 is acidic. It is important to understand that pH is a logarithmic scale and the sensitivity of a pesticide to water pH increases by a factor of 10 for every pH unit. For example, 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.

The pH of the water and/or spray solution can impact how effective pesticides, such as insecticides and/or miticides, will be in suppressing pest populations. A reduction in pesticide effectiveness may be due to hydrolysis, which is a chemical process whereby molecules are cleaved or fractured into smaller compounds by reactions that occur in water. The rate of hydrolysis is dependent on: 1) water and/or spray solution pH, 2) pesticide chemical properties, 3) length of time spray solution is in spray container, and 4) water temperature in spray container.

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Pesticides may undergo **alkaline hydrolysis**, in which a pH greater than 7 causes chemical degradation of certain pesticides in the presence of ions. Alkaline water disassociates or fragments pesticide molecules that results in the release of individual ions (electrically charged atoms), which then reassemble with other ions. These new combinations have no insecticidal or miticidal activity; thus reducing the effectiveness of a pesticide application. However, some pesticides may undergo acid hydrolysis at a pH less than 7.

The rate of alkaline hydrolysis is enhanced as the pH increases. Furthermore, the length of exposure in an alkaline spray solution can influence the effectiveness of a pesticide application. For example, spray emitted from the nozzle during the first portion of a spray application may be more effective than that emitted later in a spray application. In addition, increases in the spray solution temperature may double the decomposition rate.

In general, pesticide manufacturers have data associated with the effect of water pH on the half-life of their pesticides. Half-life is the time required for 50 percent of the active ingredient to hydrolyze or break down, or the length of time that the original strength of a pesticide is reduced by 50 percent. The half-life is based on the technical material and not the formulated product. For example, adjuvants that are used in various formulations may increase the stability of a pesticide in solution. Insecticides, in most cases, are more susceptible to alkaline hydrolysis than either fungicides or plant growth regulators. Insecticide active ingredients in the chemical classes organophosphate (e.g., acephate and chlorpyrifos), carbamate (e.g., methiocarb), and pyrethroid (e.g., bifenthrin, cyfluthrin, and fluvalinate) are most sensitive to alkaline hydrolysis or "high" pH solutions. Some pesticides, however, are not affected by water pH, such as fenbutatin-oxide. Always monitor spray solution pH and make any adjustments accordingly to maximize pesticide effectiveness. The ideal pH range for most insecticides and miticides is between 5.0 and 7.0; however, a number of insecticides perform better at or above a pH of 7. Be sure to read the label to determine the appropriate pH of a given insecticide or miticide.

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Water pH can be adjusted although the process must be performed carefully. The use of pH paper (litmus paper) is not a very accurate means of monitoring the pH within 0.5, although using pH paper may be valid because a water pH between 6.0 and 7.0 is generally acceptable for most insecticides and miticides. Acetic acid (vinegar) is available and can be added to the spray solution in small increments to lower the pH. However, periodically check the pH to avoid adding too much vinegar and maintain the spray solution pH around 6.5. The pH can be increased by adding household ammonia. Always adjust the water pH before adding any pesticides to the spray container.

Water pH is not constant and can be influenced by seasonal variability resulting in changes during the course of the growing season. Therefore, routinely measure or monitor the water pH and make any adjustments using buffers or water-conditioning agents. These are compounds that reduce the potential for alkaline hydrolysis, and subsequently modify the spray solution pH, so that the spray solution pH can be maintained within a range of 5.0 to 7.0. Moreover, buffers or water-conditioning agents are safer to use in lowering the spray solution pH than

compounds such as sulfuric acid. However, always add buffers to the spray tank before adding pesticides because certain pesticides may begin to degrade when they come into contact with an alkaline solution.

Below are ways to avoid or prevent water pH from reducing the effectiveness of a pesticide application:

1. Follow manufacturer label directions regarding the appropriate water pH.
2. Routinely test water pH because the pH of water can change during the growing season. Water samples should be collected in a clean, non-reactive container such as a glass jar. Always collect a water sample that is representative of the spray solution. Allow the water to flow long enough so that water remaining in the spray hose is flushed-out. Then, immediately determine the pH after collection using pH paper.
3. Apply spray solution as soon as possible after mixing. Always use a pesticide spray solution (or mixture) within six hours or less to avoid any potential problems associated with pH.
4. Adjust water pH with buffers or water-conditioning agents, which are compounds designed to sustain buffering capacity and suppress the process of alkaline hydrolysis. These compounds modify the spray solution pH and maintain the pH within a desired range. Both compounds are much easier and safer to use in lowering spray solution pH than sulfuric acid. Acetic acid (vinegar) may also be used to acidify water.

Factors other than resistance may be responsible for insufficient suppression of insect and/or mite pest populations, such as water or spray solution pH. The routine monitoring of water pH is helpful in maintaining the effectiveness of insecticides and miticides used to suppress insect and/or mite pest populations. For more information please consult the following Extension publication:

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