Effect of pH on Efficacy of Pesticides

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INTRODUCTION

Many factors influence the effectiveness of pesticides. These factors in part include: usage rates, timing, water volume, the specific crop, sprayer types and nozzles, and soil type. Two factors that are often overlooked are the quality and pH of the water used as the carrier. This paper will address the effect of pH on the efficacy of pesticides and what can be done to optimize the performance of pesticides.

Understanding pH. First it is necessary to understand what pH is. The pH is a number that indicates the number of hydrogen (H^+) and hydroxyl (OH^-) ions in solution. This is a measure of the acidity or alkalinity of a solution. The scale is from 0 to 14, where pH 7 contains an equal number of H^+ and OH^- ions. Water at pH 7 is neutral. It is important to realize that each point change in the pH of a spray solution represents a 10× change in the acidity or alkalinity of a solution. In some cases only a minor change in the pH can have a significant impact on the performance of pesticides. For example, a change from pH 7 to pH 5 is a 100× increase in acidity.

Efficacy of Pesticides at Different pH Levels. Significant differences in the efficacy of many pesticides occur at different pH levels. Some pesticides work best at a high pH, others work best at low pH, and some pesticides are unaffected by pH. The magnitude of the problem is less than it was in the past. Currently, label directions for use indicate optimum pH ranges for maximum effectiveness and many formulations contain buffers to help alleviate pH problems. This does not mean that the applicator should assume that everything is OK, particularly if the spray water has a very high or low pH.

Why Bother With the pH of the Spray Water? There are three important reasons for concern about the pH of the pesticide carrier. Firstly, pesticides are expensive and in production situations, cost control is very important in producing a nursery crop that can be sold at a reasonable profit; secondly, obtaining less than optimum performance can result in poor control of the target pest which results in crop losses or a lower quality product; thirdly, optimizing the performance of the product should result in less pesticides being used which in turn results in less pesticides being introduced into the environment.

Water quality and pH vary widely in the U.S. Many water sources contain suspended solids, dissolved minerals such as iron, calcium, sodium, manganese, carbonates, and bicarbonates. They also may have high salt concentrations and vary widely in pH. Most water in the United States is in the pH range of 7 to 9. Recycled nursery irrigation water can contain very high concentrations of substances which affect pesticide performance — hence, its use as spray water is not advised.

The Need for Adjuvants. How big is the problem with water quality and pH? C. L. Foy conducted a survey and presented the results at the 3rd International Symposium on Adjuvants for Agrochemicals in 1992. He reported product labels of 19 agrochemical companies involving approximately 485 formulations of crop

protection chemicals for use in 1992. Of these chemical formulations, 49% recommended the use of adjuvants, 5% specified that no additional adjuvants be added, while the remaining 46% (including granular formulations) did not mention adjuvant use. Adjuvants are recommended with 71% of herbicide formulations (including defoliants), and 14% of the other classes of crop protection chemicals, including plant growth regulators, insecticides, miticides (acaricides), nematicides, fungicides, larvacides, seed treatments, soil fumigants, and repellents. More than 30 types of adjuvants are mentioned on product labels. Based on this survey, it is evident that the performance of many products currently on the market are impacted by water quality and pH.

The Effect of pH on the Half-life of Chemicals. As an indication of the impact that spray water pH may have on the performance of commonly used pesticides, fungicides, and herbicides, I present the following examples:

- Carbaryl, a common insecticide in the ornamental industry is stable at pH 5, has a half-life of 30 days at pH 7 and a half-life of only 24 h at pH 9.
- Acehpate, another commonly used insecticide has a half-life of 45 days at pH 5, 30 days at pH 7, and 16 days at pH 9.
- Cypermethrin has a half-life of 2 h at pH 5 and above. Within 24 h, over 80% of the active ingredient is gone at all pH levels.
- Benomyl which in the past was a very important fungicide in the ornamental market, has a half-life of 30 h at pH 5 and a half-life of only 9 min at pH 9.
- Captan has a half life of 32 h at pH 5 and a half-life of 2 min at pH 9.
- Atrazine is a herbicide with a half-life of 9.5 h at pH 5 and a half-life of 48 min at pH 9. Fluozifop has a half-life of 150 days at pH 5 out at pH 9 the half-life is reduced to 17 days.

Effects of pH on Other Pesticides, Fungicides, and Herbicides are as Follows:

- Diazinon – Stable for 3 days at pH 4.5
- Dimilin – Stable over a wide range of pH
- Dipel – Unstable at pH greater than 9
- Dursban – Stable at pH 5-10
- Kelthane – Lasts 15 min at pH 10
- Malathion – Lasts 2.5 h at pH 10
- Simitar – Label recommends a buffering agent at high pH
- Talstar – Stable at pH 5-9
- Tempo – Stable over a wide range of pH
- Aliettte – Stable at pH 5
- Banner – Stable at pH 5-9
- Chipco 26019 – Stable at pH 5 for 90 days
- Fore – Decomposed at high and low pH
- Subdue – Stable at pH 5-9

How Applicators Can Optimize Pesticide Performance. What can the applicator do to optimize the performance of pesticides? First, know the pH of the spray water. This can be measured with a pH meter, indicator dyes, or litmus paper.

The use of a pH meter is the most accurate, and inexpensive and accurate pH meters and pens are available through nursery/greenhouse supply houses. Indicator dyes can be added to the spray water and are reasonably accurate and easy to use. Litmus paper is the least expensive method for determining pH, but is also the least accurate. If adjustment of the pH of the spray water is needed, there are basically two ways to do it. One is to add an acid such as sulfuric acid to the spray tank. Use of acids are messy, produce erratic results, are difficult to handle, and are corrosive to equipment. The second method to adjust the pH of the spray water is by using commercial buffering agents. They are easy to use, safe, consistent, and stabilize pH at optimal levels. Over 30 products are available to help with water quality and pH problem. Some of the major companies supplying these products are: Brandt, Setre, Riverside, Helena, and Wilbur Ellis.

References and Information on Pesticide Sensitivity to pH. Where can information be found on the sensitivity of pesticides to spray water pH? The first thing one should do is read the product label to determine if there are any label recommendations. Technical bulletins on products often address the pH issue. Another source of information is company 800 numbers that are often listed on the product labels or on other information sheets. Companies that supply buffering agents are also very good sources of information on pesticide stability and products that should be used in specific situations.

CONCLUSION

In summary, here are some hints on how to optimize the performance of pesticides with respect to pH.

- Know the pH of the spray water;
- Know how sensitive the product you are using is to pH;
- Mix the pesticides just before application;
- Mix only the amount that is to be used;
- If necessary, adjust the pH with a buffering agent.