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the impact of WATER QUALITY on PESTICIDE PERFORMANCE

The Impact of Water Quality *on* Pesticide Performance

The Little Factor that Makes a Big Difference

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The Little Factor that Makes a Big Difference

Effective pesticide applications require attention to factors that influence product performance: product selection, label instructions, equipment calibration, and application timing. Applicators also learn about product performance from trial and error and from industry and university recommendations. Experience and education allow applicators to see what happens to control programs when rates are changed, products are compared, and various application techniques are attempted.

However, one factor that doesn't get much attention is the quality of the water used to spray the product. Water often comprises ninety-five percent (or more) of the spray solution. What affect might it have on product performance? Research clearly shows that the quality of water used for spraying can affect how pesticides perform. Its effect on product efficacy is reflected in the success of your spray operation.

So why is it that we seldom notice something as obvious as the quality of water used in the spray tank? For the most part, water is viewed as a relatively clean input; if it runs clear, we don't give much thought to its purity. Concise, easy-to-read information on how water quality affects pesticide performance is scarce.

Understanding the quality of the water used to mix products is an important component of the entire operation.

What kinds of problems can poor water quality cause? Water quality parameters such as acidity and dissolved minerals can interact with the active and/or additive ingredients of the pesticide product. Poor water quality can adversely influence the pesticide by reducing solubility and decreasing absorption by the target pest, resulting in inferior performance and the need for re-treatment.

Reduced product performance may not be obvious. In some cases, the influence of water on the pesticide reduces its effectiveness only slightly, yet enough that tolerant or tough-to-control weeds, insects, and diseases are not well controlled. An applicator might blame the pesticide, add another product to the tank mix, blame other factors for lack of performance (e.g., weather, resistance), or increase the application rate, thereby masking the effect of the water on the product's performance.

Checking water quality is important. Time spent addressing the quality of water used in the spray tank can pay big dividends. This publication provides an overview of water quality and related factors known to affect pesticide performance; testing methods and options to improve the quality of the water used are discussed.

This applicator is all ready to go to the field. However, what if the water in the tank is less than ideal, leading to a less than perfect application?

Sensitive paper strips allow you to evaluate the water that will be used in your spray tanks.

Basic Terms Used to Describe Water Quality

Water is a simple molecule composed of two hydrogen atoms attached to one oxygen atom. It's one of nature's most remarkable liquids, capable of dissolving or suspending minerals and organic matter.

The chemical characteristics of water may change slightly (significantly in some cases) as it moves through the atmosphere, through the soil profile, or over the soil surface. For example, rainwater falling to earth turns slightly acidic as it interacts with atmospheric gases. The slightly acidic water may turn alkaline as the calcium in the limestone layers on the ground solubilizes in the water as it percolates downward. Understanding what is in the water can help determine its quality and whether it is suitable for pesticide application.

Debris. This includes material floating or suspended in water, such as leaves, sticks, seeds, and other solid waste materials. Debris generally is found only in water obtained from lakes, ponds, rivers, or ditches. Appropriate filters can remove debris from water and prevent the plugging of spray tips.

Suspended Solids. Materials such as silt, clay, and organic matter can be suspended in water but will settle to the bottom of a tank if the water is left undisturbed. "Turbid" is the term for water in which suspended solids can be seen floating in the water.

Pesticides have indexes called the soil sorption coefficient (Kd) and the soil organic carbon sorption coefficient (Koc). Both coefficients reflect how strongly the pesticide binds (adsorbs, or sticks) to soil particles and particles suspended in water; the process is called "adsorption." Herbicides with high Kd or Koc values bind tightly to soil as well as sediment and organic matter in water. So, the more sediment and organic matter in the water, the less herbicide remains available to bind to the soil or be taken up by plant tissue. The Kd or Koc values can be obtained by asking the manufacturer for product-specific information about the chemical and physical properties of the pesticide.

Dissolved Minerals. All water sources in nature contain dissolved minerals such as calcium, magnesium, and iron. Unlike suspended solids, these minerals do not settle. We all have heard, "My water tastes great, just like the water I grew up with." It is the minerals dissolved in water that give it a "good" taste. Distilled water, from which the minerals have been physically or mechanically removed, tastes flat.

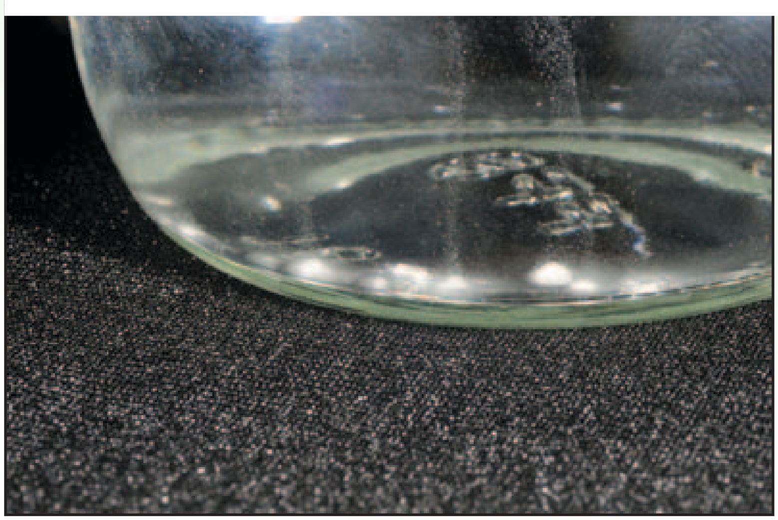
The concentration of minerals such as calcium, magnesium, and iron in water is important in describing water quality. Technically, water hardness is a measurement of the total amount of calcium and magnesium ions in water: the greater the concentration of these and similar minerals, the harder the water. Conversely, water becomes "soft" as dissolved calcium and magnesium ions are replaced with sodium or potassium ions.

Total hardness is measured in parts per million or in grains of calcium and magnesium per gallon of water. One grain (65 milligrams) is approximately 17.1 ppm. Example: A water sample could contain 20 grains per gallon. A common aspirin is about five grains in weight, so 20 grains would have the equivalency of 4 aspirin tablets dissolved in each gallon of water, or 342 ppm.

Water hardness concentrations also are categorized as follows:

Parts Per Million (ppm)	World Health Organization Water Classification
0–114	Soft
114–342	Moderately Hard
342–800	Hard
> 800	Extremely Hard

Sodium and calcium chlorides also affect some pesticides but often are overlooked; their presence results in water described as saline. Saline water is common in arid regions, especially where crops are irrigated, in areas of salt-rich soils, and along seacoasts. Saline water is not detected using standard tests for hard water.

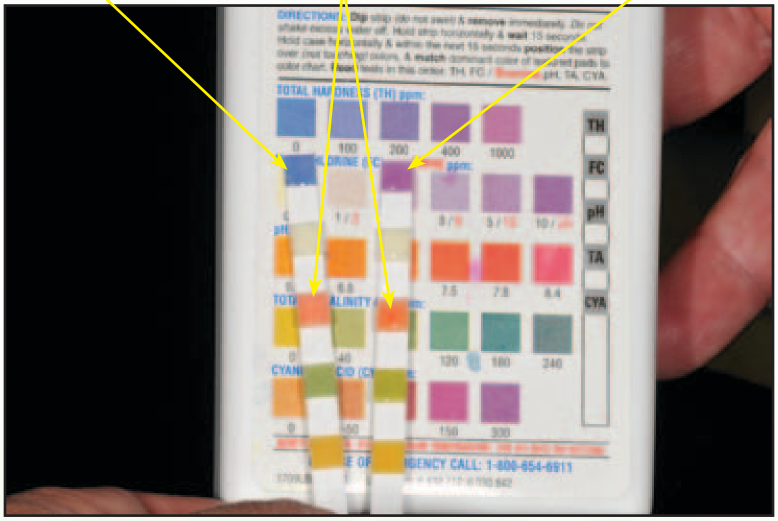


Page 12, top: Two bottles of distilled water with the minerals removed.

Page 12, middle: Adding calcium carbonate to the bottle on the right.

Page 12, bottom: Calcium carbonate dissolved in the water.

Below: Using a test strip to measure hardness. The hardness of the distilled water is 0 ppm (blue) while that of the water with the dissolved calcium is between 200 and 400 ppm (purple). Notice that the pH (orange) did not change.



Acidic or Alkaline? The pH value describes the acidity (concentration of hydrogen ions) or alkalinity of any solution. The scale ranges from 0 to 14:

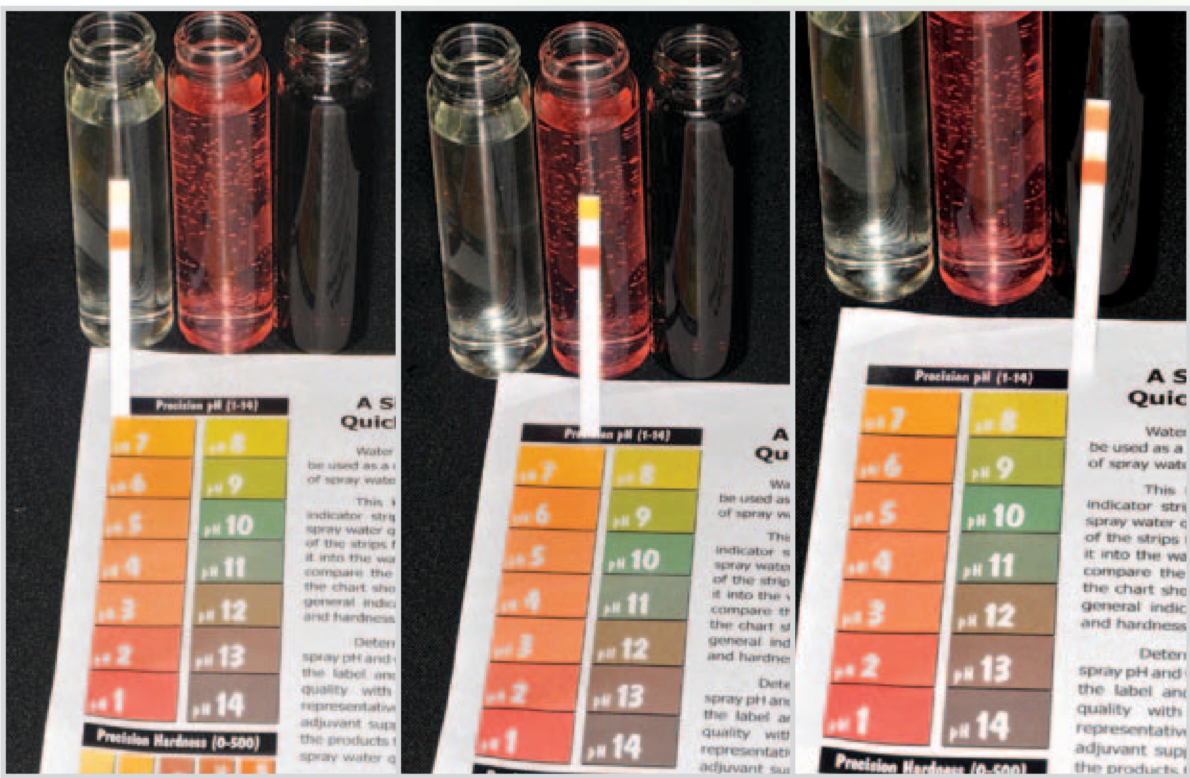
pH < 7.....considered acid (low pH)
pH = 7.....considered neutral
pH > 7.....considered alkaline (high pH)

It is important to remember that small changes in the pH scale represent large changes in acidity. For example, a pH of 5 is ten times more acidic (i.e., contains 10 times more hydrogen ions) than pH 6 and 100 times more acidic than pH 7. This 10x relationship between the values is the same whether going up or down the pH scale (e.g., a pH of 9 is 100 times more alkaline than a water solution measured at pH 7).

Examples of pH Values for Common Substances

pH Value	Substance
14.0	sodium hydroxide
12.6	bleach
11.5	ammonia
10.2	milk of magnesia
9.3	borax
8.4	baking soda
8.0	sea water
7.4	human blood
7.0	distilled water
6.8	tea
6.7	milk
6.0	atmospheric water
5.0	pickle juice
4.5	tomatoes
4.2	orange juice
4.0	wine and beer
2.8	vinegar
2.2	lemon juice
2.0	stomach acid
1.0	battery acid
0.0	hydrochloric acid

In each photograph below, the first bottle contains distilled water, the middle bottle contains a soft drink, and the third bottle contains coffee. The pH indicator is the second little square from the top of the paper strip, showing pH values of common products.



Water Chemistry Impacts Pesticide Performance

Since water normally is used to deliver the chemical to the target pest, it should be considered the foundation for the application process. Whether the water is from a well or from a lake, stream, or pond, it may be the deciding factor between ineffective and optimum product performance.

Turbidity. Suspended, positively-charged organic pesticides are attracted to and bind with negatively-charged particles found in the water. Some products (e.g., glyphosate) bind to suspended sediments, rendering them unavailable for plant uptake. One label states, "Product performance may be significantly reduced if water containing soil sediment is used as a carrier. Do not mix this product with water from ponds or ditches that is visibly muddy or murky."

Water Hardness. Water hardness can affect some pesticides negatively. As in magnets, opposite charges attract: negatively-charged pesticide molecules attach to the positively charged iron, calcium, and magnesium molecules (cations) in hard water. The binding of pesticides with these minerals creates molecules which cannot enter the target pest, or which enter at a much slower rate, or which precipitate out of solution.

The following cations, if present in water, can cause problems and may contribute to water hardness. They are listed in the order of greatest potential to bind to pesticides:

- aluminum ($A1^{+++}$)
- iron (Fe^{+++}, Fe^{++})
- magnesium (Mg^{++})
- calcium (Ca^{++})
- sodium (Na^{+})

The chemical characteristics of the pesticide change once the pesticide recombines with the positively-charged ions such as calcium or magnesium. The label for one herbicide indicates that a water conditioner "…may increase the performance of this product on annual and perennial weeds, particularly under hard water conditions."

In one sense, the more the pesticide is bound to minerals, the more "diluted" the product becomes in the tank. In some cases, the chemically-altered molecule may be unable to dissolve in water, penetrate the leaf tissue, attach to the site of activity in the pest to disrupt biological functions, or perform as a pesticide.

These effects are not limited to the spray tank environment but extend to the spray solution on the leaf surface, which can affect product uptake.

Water pH. Pesticides normally are formulated as weak acids or neutral to weakly-alkaline products. As a general rule, herbicides, insecticides, and fungicides perform best in slightly acidic water, pH 4–6.5. Pesticides such as the sulfonylurea herbicides perform better in water that is slightly alkaline (above pH 7). When water pH falls outside of the preferred upper or lower boundaries, product performance can be compromised. In some cases, the pesticide can fall out of solution.

The bottle on the left (in each photo) contains distilled water with zero hardness; the bottle on the right contains hard water. A material that mimics glyphosate is added to both bottles of water. Notice that the water on the left remains clear, indicating the added product is in solution. The water on the right is cloudy, indicating that the calcium has bound to the glyphosate mimic.

The pH of the solution also can influence how long a pesticide molecule remains intact. A higher or lower than optimal pH causes some pesticides to begin degrading or "hydrolyzing." When a weakly acidic pesticide is placed in water that is slightly acidic, it stays largely intact. Certain insecticides and fungicides have been shown to break down in alkaline water, and the effect of pH usually proceeds faster as the temperature of the water increases.

Many products have a weak electrical charge. The pH also can change the chemical charge of a pesticide molecule, limiting its ability to penetrate the leaf cuticle and reach the site of action, thus reducing its efficacy.

What Do Pesticide Labels Indicate about Spray Application Water?

The pesticide label may or may not specify the need for water conditioners, additives, or adjuvants. Following are some pesticide label statements addressing water quality.

Protecting a home against termites is a long-term proposition. Checking the label for any water quality issues is critical.

Example regarding suspended solids and turbidity:

> Reduced results may occur if water containing soil is used, such as visibly muddy water or water from ponds and ditches that is not clear.

Examples regarding water hardness:

- The addition of 1–2 percent dry ammonium sulfate, by weight, or 8.5–17 pounds per 100 gallons of water, may increase performance of product….

- Recommended nitrogen-based fertilizers include liquid fertilizers (such as 28% N, 32% N or 10-34-0) and may be applied at the rate of 1.25–2.5 percent per 100 gallons of spray solution. Spray grade ammonium sulfate may be used at 12–15 pounds per 100 gallons of spray solution.

Examples regarding water pH:

- Do not add pH adjusting agents.
- Do not use nonionic surfactants or other additives that alter the pH of the spray solution below pH 5; spray solutions of pH 6.0–8.0 are optimum.
- Do not use with a liquid fertilizer solution less than pH 3.
- Do not use spray additives that reduce pH of the spray solution to below 3.0.
- Do not use with spray additives that alter the pH of the spray solution below pH 5 or above 9.0, as rapid degradation can occur.
- Do not use tank additives that alter the pH of the spray solution below pH 5 or above pH 8. Buffer the spray solution to alter the pH range as appropriate.
- The spray mixture pH should be 4 to 7 for good efficacy.
- Product is hydrolytically sensitive to degradation of active ingredient by strong acids, strong bases, and certain heavy metal oxides and salt of certain fungicides.
- Best results obtained at spray solution pH of 6.0–8.0.
- Product is unstable under highly alkaline conditions. Do not use this product in water with pH values above 8.0 unless a buffer is added. If necessary, water should be buffered to neutral (pH = 7.0) before adding this product to the spray tank. [In this example, buffering means lowering the pH and holding it there, initially; it may return to the original pH, after time, because of the water chemistry.]
- Product should not be applied in a spray solution having a pH of less than 6.5 as phytotoxicity may occur.

In some situations, a pesticide label may prohibit the use of water conditioners or other additives. One example from a label states, "Do not apply tank mixes that contain ammonium sulfate (AMS) or crop oil concentrate to any food/feed crop listed on this label. For food/feed crop uses, do not use liquid fertilizers that contain ammonium sulfate (AMS) as a source of nitrogen, as commodities derived from the crop may contain residues that exceed established tolerances." Another example: "Do not add buffering agent or pH adjusting agent to the spray solution when this herbicide is the only pesticide used."

Applicators could assume that you don't have to worry about the mix water and product performance if the manufacturer has not addressed this issue on the label. But it is important to look at the half-life (fate) of the product in the spray solution under different conditions. For instance, one product might have a half-life of two minutes at pH 9 compared to ten hours at an acidic pH of 5 (see page 36). This is why it is important to consider water quality even when the label does not address the issue.

Testing the Water

Determining water quality and choosing a specific water conditioner and amount to use requires knowledge of the water to be used for the specific application. Testing the water is the key to ensuring the best performance of the spray application.

Temperature: Thermometers can provide temperature information quickly. If formulation stability can be affected by temperature extremes, alternate water sources may be required. Another approach is to store the water in the sprayer or tank, indoors or outdoors, until the water reaches the desired temperature.

Below and page 20: An example showing herbicide in a pond. Notice the cloudy water, which is an indication of pesticides tied up by hard water or sediment. This ultimately reduces the effectiveness of the pesticide product on weeds in the pond. The product label states, "The harder the water or the greater the algae concentration, the higher the required dose of this product."

Suspended Solids. Whether the water is from a well or a surface source, solids can settle in the tank and cause equipment problems. Sedimentation and filtration can be used to remove suspended solids for some applications; otherwise, finding an alternative water source may be necessary. Glass jar tests of standing water can indicate the likelihood of a problem with suspended solids.

Would you expect that water from a creek would be different than water from ground water?

Top: Taking water quality measurements from a cave.

Right: Filling spray tank from a creek.

Dissolved Minerals: The composition of water (e.g., hardness, pH, and iron) can vary widely among wells in close proximity to each other. What is dissolved in water depends on the composition of the soil profile and the underlying bedrock. The depth of the well and type of aquifer also influence water quality. Each well is unique in terms of its water chemistry and turbidity.

Water in creeks, ponds, and reservoirs can differ greatly. The dissolved minerals and suspended sediments from all sources flowing into a reservoir or pond are mixed together, giving the water a unique chemistry profile. Filtration is recommended whenever surface water is used.

Water quality can be checked anytime. Addressing water quality a few weeks prior to the pesticide application season will give you time to purchase kits, ask questions, and evaluate whether the water needs to be improved for the pesticide chemistries that you will be using. Water also may be tested quarterly. After a few years of testing, you will probably notice that the water quality doesn't change much. Surface water is much more variable than underground sources; thus, underground sources often are easier to manage.

Water Testing Approaches

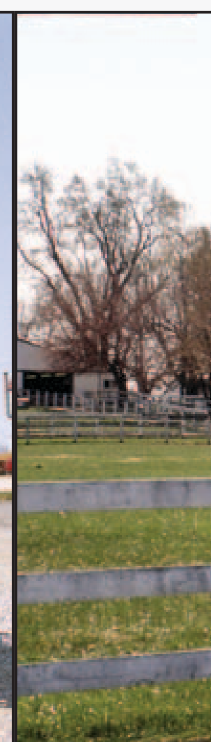
Two options for testing the water are hiring a commercial vendor and purchasing do-it-yourself water testing kits.

Take the water sample to a professional. Farmers and businesses such as nurseries, greenhouses, and lawn care and pest control companies often use the same water source throughout the season. If you use the same water source consistently, you can plan ahead by having the water tested by a professional in your community that manages water, water quality, and water testing. Examples include local companies whose primary business is to condition water for industrial, research, and residential customers (e.g., drinking water and swimming pools).







CO-OP


“Good enough” no longer is acceptable when it comes to controlling weeds, insects, and diseases; and the quality of water used in the spray tank with pest control products can make or break the application.

Eradication of weeds along railroad tracks and around stop signs (top left and right) makes it easier for drivers to see oncoming trains and vehicles.

Diseases and insects can damage apples severely, but the right pesticide, applied with the right water (middle left), can protect the crop.

Turf diseases can decimate a golf course; but pesticides — mixed with the right water — can prevent the damage.

Agricultural pest control applications (bottom left) increase yields by killing weeds that would otherwise compete with the crop for moisture and nutrition.

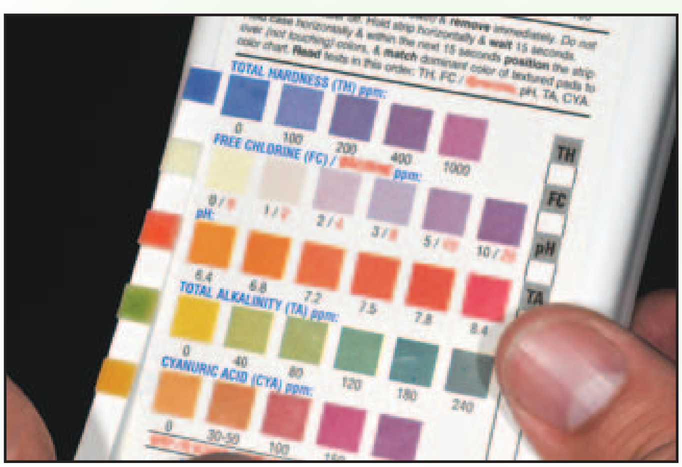
Pesticides are used to control poisonous weeds in pastures. Consumption of certain weeds can cause horses (bottom right) to die or abort.

These companies routinely conduct tests for iron, pH, and water hardness; they can provide a complete analysis of your water. If you choose this route, be sure to ask the vendor the following:

- Can you test for iron, pH, and hardness?
- What will be the cost?
- How much water will you need to run the suite of tests?
- Do you have guidelines or special containers for collecting and transporting the water samples?

Do-it-yourself test kits and meters. Industries such as right-of-way, aerial, and forestry pest management use multiple water sources as they travel over wide geographical areas to apply pesticides. They generally don't have enough advance notice to arrange testing of each water source since they often don't know where their next source of water will be.

Numerous water-testing kits are commercially available for both spontaneous and scheduled testing. The kits are readily available, reasonably priced, easy to use and interpret, and reliable. The majority of the test kits use color-changing, sensitive paper to document water hardness, pH, and iron levels. Surface water should be filtered and stored in a bulk tank before testing,

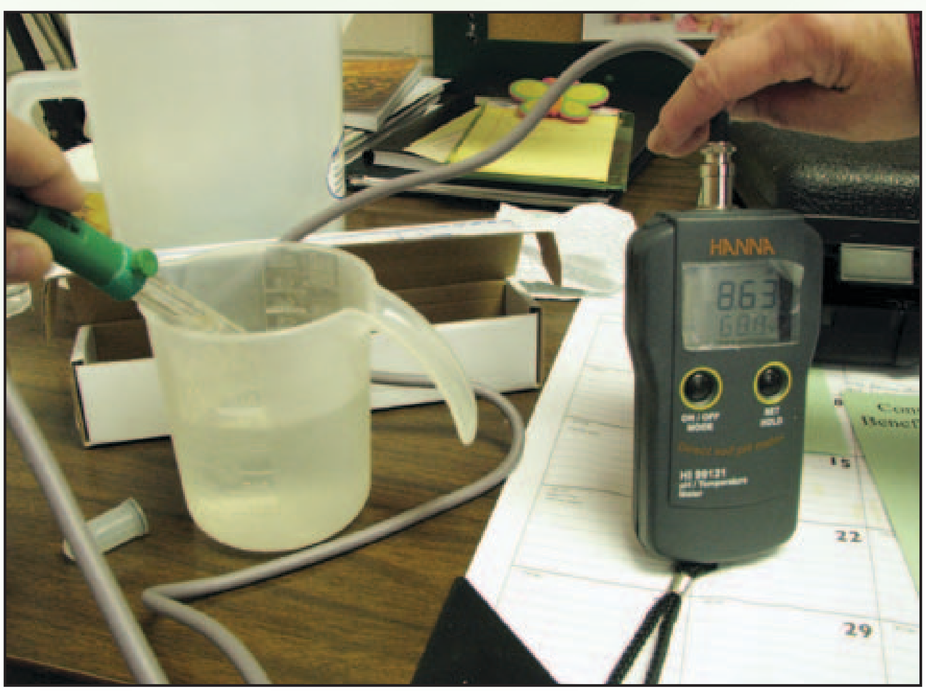


whereas collecting a water sample from a faucet or a well is rather straightforward. Let the water run for a brief time; then, with the water running, rinse a clean pint or quart glass container. Fill the container with water.

Sensitive paper provides pH readings that are less precise than those of more sophisticated meters. A meter might indicate a water pH of 8.4, while the same water shows pH of 8 when colors are matched using the sensitive paper method. Some color charts use whole numbers for pH and broad concentration categories for iron and water hardness (e.g., 50–150 ppm), but the results are adequate for analyzing pesticide spray water.

There are meters available that provide quick and accurate readings without having to carry multiple kits; these may be useful if you fill tanks from multiple sources. Whether it is a pH meter or something more elaborate that also tests for iron and hardness, one of these instruments offers a simple, efficient, and effective method of examining water sources at a reasonable cost.

The pH of this municipality-treated water used in a greenhouse is 8.6.



Solving Water Quality Problems

Herbicide labels recommend rates that perform across a wide spectrum of conditions: small weeds, large weeds; good water, bad water; high temperatures, low temperatures. Higher rates overcome variation in performance associated with products over wide geographical areas. When using lower product rates, the quality of water can play a more important role in effective weed, insect, and disease control.

Test results from each water source form the basis for your decision whether or not to condition your spray water. The purpose of conditioning water is to maximize the effectiveness of the pesticide. Broadly defined, water conditioners are added to the spray solution or tank-mix to eliminate problems associated with water hardness. A pH buffer is used to raise or lower the pH, depending on the desired range needed for optimum performance.

Some pesticide formulations contain water conditioners that make them compatible within a wide range of water conditions. Other products, however, perform better when adjuvants are added to overcome water quality issues.

Correcting the pH or solving hardness problems depends on the particular pesticide label restrictions or requirements as well as the target species. The use of water conditioners is advised under the following conditions:

- It is recommended on the pesticide label.
- The pesticide label specifies the quality of the water, e.g., the water pH range, to be mixed with the pesticide.
- A pH between 4 and 7 is needed for insecticides, fungicides, and most herbicides.

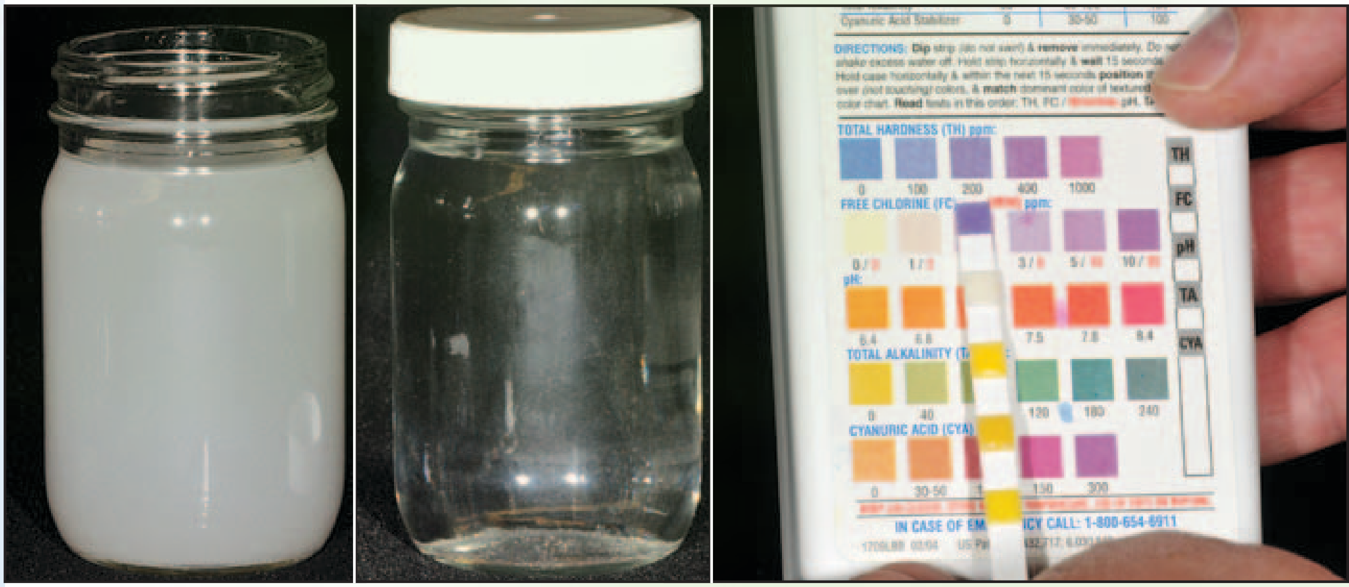
- Herbicides in the sulfonylurea family, such as Steadfast, Classic, and Harmony, perform best when water with a pH of 7–8 is used.
- A weak acid herbicide is used and the water hardness exceeds 150 ppm.
- Iron levels exceed 25 ppm and hardness plus iron exceed 400 when herbicides are used.
- A weak acid herbicide (e.g., glyphosate, glufosinate) is used and the target weeds include velvetleaf and common lambsquarters (regardless of water hardness, as these and other weed species have sufficient Ca^{++} in and on the leaves to reduce activity of these herbicides).
- Make sure that water is perfectly clear when the Koc of the pesticide's product exceeds 800. This value is for glyphosate, in which turbidity reduces efficacy.

Above: Checking water quality with a pH meter.

There are numerous commercial water conditioners available, but some have not been proven effective. The pesticide label may be very specific as to the water conditioner and application rate to be used. Some manufacturers of weak acid herbicides do not recommend adding a water conditioner; instead, they may promote applying the highest rate of product indicated on the label.

The user should check the efficacy of the water conditioners in the same manner that seed variety, pesticide products, and fertilizer rates are tested. The money spent for any product — including water conditioners — should return a value to the purchaser. Ask the vendor for data showing that the water conditioner works. If none are available, consider applying the pesticide, with and without adding a water conditioner, to the targeted pest within a small test area and evaluate the differences in control as well as crop injury.

The bottle on the left has the glyphosate mimic tied up with calcium ion. A water conditioner has been added in the middle photo, and the product is back in solution. However, the hardness value did not change (right).



Are there any special concerns about conditioning water? Concerns about using water conditioners may include the order of introduction into the spray tank and their action as tank cleaners.

Does the introduction of the water conditioner first or last make any difference? Few products have been evaluated to determine how — or if — the order of introduction into the tank impacts their performance. However, you can't go wrong by conditioning the water first, especially under the following conditions:

- Products have a low use rate.
- Multiple products will be tank mixed.
- Rates selected are among the lowest listed on a label.
- Problems have been observed in the past.

Do some pH modifiers act as tank cleaners? Products that condition pH levels generally acidify the water (most herbicides are weak acids). There are a few products that raise the pH level for use with pesticides that perform best in combination with water that is alkaline; but be careful using these products because they might also "clean" the tank. Ammonia-based products increase the pH of the spray tank solution to between 10 and 12, depending on the rate used. These highly alkaline solutions tend to pull out of the tank and solubilize into the mix any residues left from previous contents. Make sure to thoroughly clean the tank, prior to raising the pH level, even when using water conditioners.

The Importance of Compatibility and Mixing Order

The ability of water to dissolve or suspend materials is influenced by the order of introduction of pesticide products into the spray tank. Mixing products out of order or combining products meant to be applied at different rates or pressures can lead to significant problems. Chemicals may not mix properly, causing poor product performance, clogged nozzles, product separation, adverse changes in pH, reduced solubility, and negative spray pattern effects.

Pesticide products work best when all components of the spray mixture are compatible and when they are added to the tank in the proper sequence. Always consult product labels for the preferred order of introduction into the tank. Generally, you should run water into a clean tank, then add pesticides in the following order:

- Wettable powders and dry flowables (agitate these before proceeding)
- Liquids and flowables
- Emulsifiable concentrates
- Microencapsulates
- Surfactants

When in doubt, use the "jar" method to make sure the products are compatible. Many labels offer specific advice on how to do jar tests.

Be careful when mixing products for which water requirements are radically different. The label is the only source of this information. One pesticide product might need a pH above 7 to maximize its solubility and performance, yet another might require a more acidic environment (pH less than 7). This difference cannot be accommodated because conditioning for one would diminish the performance of the other, and adjusting the water to accommodate both products would reduce the performance of both.

As a general rule, do not combine products that have contradictory pH requirements. A second, less preferable option for mixing opposing products is to use water suited for the product that you are most dependent upon; and, if the label allows, use a higher rate of the second product to overcome poor water quality.

Leaving Pesticides in the Tank: How Long is Too Long?

Even when water characteristics are ideal, most pesticides break down in water, over time, through a chemical process called hydrolysis. Some break down slowly, while others become inactive within a few hours. The pH of the tank water often has a dramatic effect on the breakdown process.

What we need to know is how long products can stay in the tank before undergoing changes that can impact efficacy. Manufacturers formulate their products to stay in slightly acidic water for twenty-four hours with little appreciable reduction in effectiveness. But this general statement does not hold up for all products.

We express how quickly a pesticide product loses its effectiveness as its half-life; that is, the number of days it takes for half of the active ingredient to break down in water. It is understood that, at that point, the product would not provide the desired efficacy.

If we were to assume that treated municipal water is the perfect mixer because it is safe to drink, we would be wrong. Municipalities create safe drinking water by adding products such as chlorine that disinfect by killing harmful bacteria, and these treatments often shift pH levels into the alkaline range, typically pH 7.8–8.5.

Let’s assume we are using municipal water with a pH of 8.2. Consider how the pesticide products in the chart on page 36 react to changes in the pH.

	Product Half-Life		
	pH 9	pH 7	pH 5
Brand X Herbicide	10 minutes	17 hours	16 days
Brand X Fungicide	2 minutes	3 hours	10 hours
Brand X Insecticide	24 hours	10 days	stable

Assume that you mixed a pesticide product, but weather conditions caused a five-day job delay. Realize that, depending on the water pH, the product in the tank may have broken down and become ineffective.

Some labels bear statements that provide information on stability under specific pH levels. Here are some examples:

- Spray preparations are stable if they are pH neutral or alkaline and stored at or below 100°F.
- Do not let spray mixtures stand overnight.
- Apply the spray the same day it is prepared, while maintaining continuous agitation.

The University of California at Davis has come up with the following guidelines based on water pH:

- A pH between 3.5 and 6 is satisfactory for most spraying and short-term (12–24 hours) storage of most mixtures in a spray tank. Not suitable for sulfonylurea urea herbicides.
- A pH between 6 and 7 is adequate for immediate spraying for most pesticides. Do not leave the spray mixture in the tank for more than 1–2 hours, to prevent loss of effectiveness.
- Most products mixed in alkaline water should be sprayed immediately.

The use of water for application is nearly universal for all pesticide products. The tank is filled with water (top left); pesticide product is metered into the tank (top right); a spreader/sticker adjuvant is added to the mixture (bottom left); and a water conditioner is added to improve the quality of the water (bottom right).

Conclusion

Pesticide application processes require due diligence in keeping up-to-date with today's trends, tools, and technologies. The process of managing pests takes considerable money for salaries, products, equipment, and fuel. The paybacks are better results and value from your pesticide applications.

Water quality needs to be understood and managed, first. Once you manage the quality, then you can follow label directions to provide the best results possible. Conversely, starting off with

water that has quality issues can mean reduced pesticide performance even if the rig is calibrated and the application is perfect. It has been proven that poor water quality can have a negative effect on certain families of pesticides. Water quality also affects the uniformity of the mix in the tank. With so much at stake, the quality of the water used in your spray solution should be evaluated and considered just as you evaluate the purchase of spray equipment and the selection of pesticide products. A small amount of effort to test or to have your water tested is rather cheap insurance to ensure that products perform as promised and deliver the expected results.

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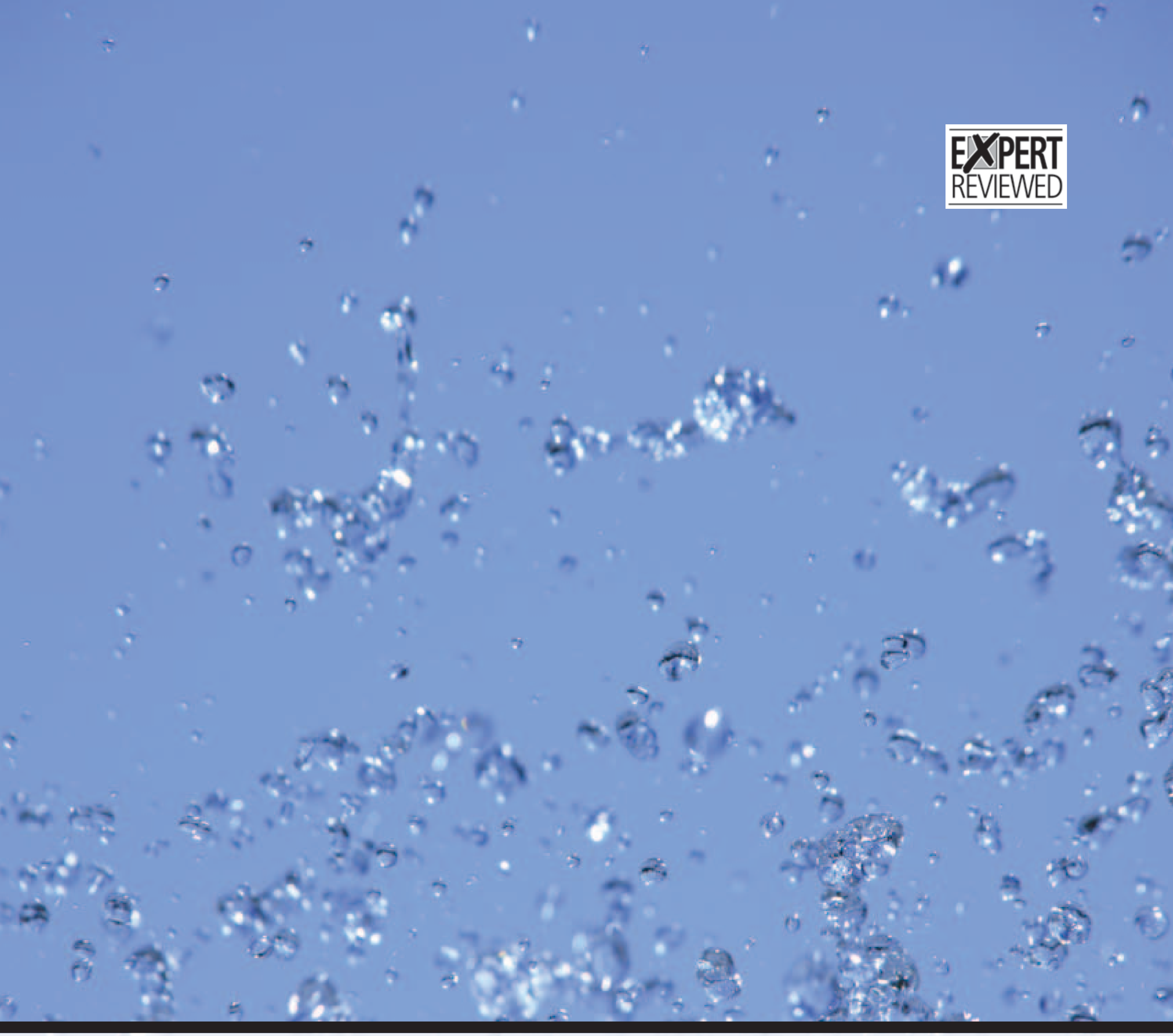

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