Effective pesticide applications require attention to a multitude of factors. Product selection, following label instructions, calibration of equipment, application timing and operator experience are all factors that impact product performance. One factor that seldom gets much attention is the quality of the water used to spray the product. Water often comprises 95 percent or more of the spray solution. Considering that fact, it should be no surprise that the chemistry of water added to the spray tank greatly impacts herbicide effectiveness.

Dr. Ralph Whitesides, Utah State University Extension Weed Specialist, gave an enlightening presentation on this topic in our recent Cache Crops School. He began by reminding us that water is a simple molecule, composed of two hydrogen (H) atoms attached to one oxygen (O) atom. Water is one of nature’s most remarkable liquids, capable of dissolving or suspending minerals and organic matter.

Whitesides also taught that before any foliar-applied herbicide can perform the desired biological function, it must be transferred from the leaf surface into the plant tissue. The above ground portions of plants are covered by a continuous noncellular, nonliving membrane called cuticle. The cuticle is the first barrier that any herbicide must overcome to be effective. The cuticle is extremely diverse and varies greatly between different species of plants. Surfactants added to the tank mix modify the spreading, wetting, retention, and penetration of the spray solution. The type of surfactant added to the spray tank can enhance the performance of the herbicide and almost always reduces spray runoff.

Acids are compounds that release H+ ions when dissolved in water. Some post-emergence herbicides such as glyphosate (Roundup) and 2,4-D (many products) are weak acids that partially dissociate (split into two charged portions) when mixed in water. Herbicides that do not dissociate (the compound remains whole) do not bind with charged molecules sometimes found in water in the spray tank and are more readily absorbed by plant foliage than those that dissociate. How much of the herbicide dissociates depends primarily on pH of the water in the spray tank.

The pH of water indicates its acidity or alkalinity and is measured on a scale of 1 to 14. A neutral pH is 7. Water above 8 is alkaline and water below 6.5 is acidic. Whitesides shared two lab analyses of northern Utah water with pH readings of 7.2 and 7.7. When water pH exceeds 7, growers should consider adding adjuvants to change pH. Spray water pH can affect the performance of many pesticides, especially insecticides, but usually do not have a direct influence on the activity of herbicides. Dissociated herbicides that are bound to charged ions in the spray tank can be absorbed more slowly across plant cell membranes.

Local farmers also need to be concerned about our hard water. Hard water contains high levels of calcium (Ca), magnesium (Mg), sodium (Na), and iron (Fe). These positively charged ions attach to negatively charged herbicide molecules, often rendering the herbicide ineffective. Weak acid herbicides, many with amine formulations, such as glyphosate, 2,4-D amine, MCPA amine and dicamba are adversely affected by hard water. The solubility of the herbicide is reduced which leads to it being less absorbed by the weeds. Hard water can also plug spray nozzles and cause buildup in spray units.
Adding ammonium sulfate (AMS) to the spray tank overcomes adverse effects of hard water. The ammonium cat ion preferentially attaches to the glyphosate and other weak acid molecules and thus prevents Ca, Mg, Fe, or Na from doing so. When ammonium is attached to glyphosate, the molecule binds readily to ESPS synthase and the herbicide functions normally. Some plants contain high levels of Ca on their epidermis and in their intracellular spaces. Just like hard water in a spray tank, high Ca levels on the plant surface or between plant cells can reduce herbicide effectiveness. AMS in a spray tank alleviates physiologically-induced Ca interference. AMS use rates are often identified on the label of the herbicide being used and often range from 8.5 to 17 pounds of AMS per 100 gallons of water. The added expense of including AMS in the spray mix is relatively minor and the added benefits are often impressive.

I believe every participant in the Crops School left the meeting convinced of the economic and agronomic benefits of using surfactants and AMS agents when spraying herbicides. This article is a reminder to growers to include these products when spraying for weeds. Too often we get busy and hurried and don’t plan as carefully as we should. Serious growers will have their products selected and ready before the moment of spraying actually comes.