ROUNDUP READY PLUS
CROP MANAGEMENT SOLUTIONS

EFFECTS of HARD WATER on HERBICIDE EFFICACY

What You'll Learn...

- Hard water has a high pH due to high levels of calcium, magnesium, and sodium.
- When used as a carrier, hard water can adversely affect the efficacy of weak acid herbicides, such as glyphosate.
- Adding ammonium sulfate (AMS) to the spray tank helps to overcome the adverse effects of hard water.
- A dry spray grade AMS or liquid equivalent should be added to hard water and completely dissolved before adding a weak acid herbicide in the spray tank.

Hard Water and Herbicides

Hard water is caused by high levels of cations (positively charged ions), primarily calcium (Ca), magnesium (Mg), and sodium (Na).

Water hardness is usually expressed as parts per million (ppm) of calcium carbonate ($CaCO_3$) or as grains per U.S. gallon (one grain per gallon = 17.1 ppm). Water with a calcium carbonate concentration of 100 to 200 ppm is considered hard.

Not all herbicides are affected by hard water but weak acid herbicides such as Roundup® agricultural herbicides, Gramoxone® brand herbicides (paraquat), Liberty® (glufosinate), and others can be tied up by hard water cations resulting in less than adequate weed control.

The molecules of the weak acid herbicides partially dissociate (split) and become charged when mixed in hard water. When this happens, absorption of the active ingredient by the plant's leaf cuticle and cell membrane may be reduced, which can reduce herbicide efficacy.

Dissociation of herbicide molecules occurs more in water with a high pH (pH > 7), thus acidic water conditions are more favorable when mixing with weak acid herbicides. If water pH is above 7, it should be lowered prior to mixing with weak acid herbicides.

General AMS Recommendations with Roundup Agricultural Herbicides.

- Should be added to the water in the spray tank prior to the addition of a Roundup brand agricultural herbicide. Ensure that AMS is completely dissolved in before adding herbicides.
- Use 8.5 to 17 pounds (1 to 2 percent by weight) of dry spray grade AMS, or 2.5 to 5.0 gallons of liquid AMS, per 100 gallons of spray solution:
  - Higher rate should be used in spring burndown, tank-mixes with residual herbicides, or when targeting tough-to-manage weeds (such as lambsquarters, velvetleaf, giant ragweed, morningglory, thistle, etc.).
  - Lower rate can be used for in-crop postemergence applications when daytime temperatures exceed 85° F to reduce the potential for cosmetic leaf burn on the crop.
- The spray system should be thoroughly rinsed with clean water after use to reduce corrosion.

Technology Development & Agronomy by MONSANTO

EFFECTS of HARD WATER on HERBICIDE EFFICACY

Additionally, molecules dissociation will result in negative charged acid molecule. This situation will attract the positively charged molecules in hard water to form complexes that are not easily absorbed by the plant, have a lowered activity in the cell, or render the herbicide ineffective. Commercially available test kits can be purchased to measure water hardness and pH.

Ammonium Sulfate (AMS)

Adding AMS to the spray tank can help to mitigate the adverse effects of hard water on weak acid herbicides. When dissolved in water, AMS also dissociates, resulting in positively charged ammonium (NH_4+) and negatively charged sulfate (SO_4-) ions.

The negatively charged SO_4- ions in AMS will bind to the positively charged hard-water cations, thus they are no longer available to bind to the active ingredient of the herbicide.

The positively charged NH_4+ ion in AMS will bind to the active ingredient of the herbicide. This combination actually increases herbicide absorption by plants and its effectiveness on weed management.

In areas where hard water is a concern, AMS is recommended to be used with Roundup agricultural herbicides. However, once approved Roundup Xtend™ and XtendiMax™ herbicides will prohibit or restrict the use of AMS. Currently there are non-AMS water conditioners in the market place with several new products in developmental stages for the 2016 use season.

Always read and follow the labels for the products used as there may be limitations on the amount of fertilizer-based additives to use.

THIS DOCUMENT IS INTENDED TO PROVIDE INFORMATION ABOUT THIS WEED AND GUIDELINES FOR CONTROL. AS A TOUGH-TO-CONTROL WEED, KNOWLEDGE ABOUT THE BIOLOGY AND WEED CONTROL PROGRAMS WILL HELP IN THEIR MANAGEMENT.

Technology Development & Agronomy by MONSANTO