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 (CaCO₃) 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 become 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.

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If water pH is above 7, it should be lowered prior to mixing with weak acid herbicides. Additionally, herbicide molecule dissociation results in negatively charged acid molecules. This situation attracts 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)**

In areas where hard water is a concern, AMS is recommended to be used with Roundup® brand glyphosate-only agricultural herbicides. 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 (NH₄⁺) and negatively charged sulfate (SO₄²⁻) ions.

The negatively charged SO₄²⁻ 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 NH₄⁺ ions in AMS will bind to the active ingredient of the herbicide. This combination increases herbicide absorption by plants and its effectiveness on weed management.

The use of AMS and ammonium-based additives is prohibited in applications that include XtendiMax® herbicide with VaporGrip® Technology. For a list of approved adjuvants that may include non-AMS water conditioners that may help mitigate the effects of hard water, please visit [www.xtendimaxapplicationrequirements.com](http://www.xtendimaxapplicationrequirements.com)

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