

NOVEL WATER CONDITIONING AGENTS FOR GLYPHOSATE. Donald Penner, Professor, Michigan State University, East Lansing, MI 48824.

Water conditioners are adjuvants that may such as low amounts of fertilizer, like diammonium sulfate, to complex mixtures designed to accomplish several adjuvant functions. Cations such as  $\text{Ca}^{++}$ ,  $\text{Mg}^{++}$ , and  $\text{Fe}^{+++}$ , are commonly found in hard water. At high concentration  $\text{Na}^+$  can also be a problem. These readily exchange in the spray tanks with the positively charged counterion of negatively charged herbicides. At high concentration  $\text{Na}^+$  can also be a problem. The resulting salt from the cations in hard water is generally less soluble and less readily absorbed by plant foliage. Studies with glyphosate applied in hard water have shown that a water conditioner, likely diammonium sulfate, increased control of all weed species tested. However, the magnitude of response differed markedly. The need for water conditioners when applying herbicides in hard water is not limited to glyphosate. Many herbicides that are weak acids benefit from the inclusion of a water conditioner for overcoming hard water problems. Water conditioners act by a) providing a positively charged counterion, like  $\text{NH}_4^+$ , in overwhelming amounts, that form salts with the weakly acidic herbicide that can be readily absorbed by plant foliage, or b) by chelating or sequestering the hard water cations so they are not able to form salts with the weakly acidic herbicide. Products sold as water conditioners are not all equal. Diammonium sulfate (AMS) at 2% in the spray tank has been considered the standard. Other ammonium salts that are effective are diammonium phosphate and ammonium nitrate. Novel materials that have been evaluated for their water conditioning properties include EDTA, citric acid, sulfuric acid, hydrochloric acid, N-formamylsulfamate also called monocarbamide dihydrogensulfate and 1-aminomethanamide dihydrogen tetraoxosulfate (AMADS).