Water Quality – Herbicides and Micro Nutrients

There are 3 key water factors that are addressed in this article and as such need consideration before beginning a spray program.

1. Water pH – Acid or Alkaline
2. Water Hardness
3. Turbidity

When you consider that water makes up greater than 99% of the material in spray tanks it is little wonder that its quality will affect the efficacy of whatever it is that is applied.

There is a similarity in acid soils and in acidifying water. We know that many micronutrients become available to plants in the pH range of approx 4.5 – 6 so it should come as no surprise that the same occurs when feeding through the leaf tissue. As soil becomes more acidic what is happening is that there are more H+ ions being released; Weak acids (buffers) similarly release H+ ions, but just slightly. Leaf tissue has a pH associated with it (usually about 6pH) so logically it will be more likely to absorb solution that is acidic.

Chemical Companies are continually bringing "new" products into the market. Often they have differing names but the same active constituents. The following list is typical of some of the products used in our cropping programs:

CHEMICAL	**COMMENTS**
Atrazine	Rapidly hydrolysed at pH > 9
Benomyl	pH 5.6 - half life > 30 hrs, pH 7 - half life 1 hr
Captan	pH 4 - half life 4 hrs, pH 10 - half life 2 min
Chlorpyrifos	Rapidly hydrolysed at pH > 8
Cypermethrin	Stable at pH 4, hydrolysed in alkaline conditions
Dicamba	Affected by hard water
Dimethoate	pH 6 - half life 12 hrs, pH 9 - half life 48 min
Diquat	Unstable at pH > 9
Dithane	Optimum pH 5-6
Diuron	Affected by saline water
Fusilade	Rapidly hydrolysed at pH > 7
Glyphosate	Optimum pH 3.5, hydrolysed in alkaline conditions, affected by hard water
Malathion	Rapidly hydrolysed at pH > 7
Mataven	hydrolysed at pH > 7
MCPA Amine/2,4-D	Hydrolysed in alkaline conditions, affected by hard water
Paraquat	Oxidised under alkaline conditions
Rovral	12 min half life at high pH
Simazine	Hydrolysed in alkaline conditions, affected by saline water
Trichlorfon	pH 6 - half life 4 days, pH 8 - half life 6 min

The following examples are used to highlight what does or can actually happen when the water used in spray tanks is affected by alkalinity, hardness or turbidity.

Glyphosate (Roundup)

Glyphosate is the active ingredient in Roundup and numerous other products. Different formulations of these products utilise different surfactants and additives, but in every case glyphosate is the active ingredient. Glyphosate kills plants by binding to an enzyme called EPSP synthase. When bound to EPSP synthase, the enzyme cannot function and the plant cannot produce three critical amino acids. Hence, the plant dies.

Glyphosate has a high Koc value (24,000 mL/g) and therefore rapidly and tightly adsorbed to soil particles and organic matter.

Hard water also affects glyphosate. Ca, Mg, Fe, or Na can form a complex with the glyphosate molecule so that it is unable to bind to EPSP synthase. If glyphosate cannot bind to the enzyme, it will not provide control.

Adding ammonium sulfate (AMS) to the spray tank overcomes adverse effects of hard water. The ammonium cation preferentially attaches to the glyphosate molecule and thus prevents Ca, Mg, Fe, or Na from doing so. When ammonium is attached, the molecule binds readily to EPSP synthase and the herbicide functions normally.

Some plants contain high levels of Ca in their intracellular spaces. Just like hard water in a spray tank, high Ca levels between plant cells can reduce Roundup effectiveness. AMS in the spray tank also alleviates physiologically-induced Ca interference.

Adding AMS (assuming water is not hard) only improves effectiveness against plants that have elevated Ca levels described above.

2,4-D

Herbicides containing 2,4-D are available in two broad categories, ester and amine formulations. Many growers prefer the amine formulation because it is less volatile and less prone to drift off target and injure valuable ornamental crops. However, amine formulations are more sensitive to poor water quality than esters.

Amines of 2,4-D can be sensitive to hard water. Accurate guidelines are currently not available. If water hardness is greater than 600ppm or alkalinity greater than 500 mg/L, $CaCO_3$ can reduce 2,4-D effectiveness. If water analyses indicate the water supply is approaching these levels, consider finding a more pure water source or switching to an ester formulation of 2,4-D.

Herbicides are less prone to dissociate under acid conditions where H^+ ion concentration is high. As much of the water used in broad acre farming in Australia tends to be on the alkaline side (pH above 7), it is critical that the pH

is changed so that whatever it is being applied has the best chance of producing the desired result.

Sulfonylurea (SU) herbicides are different. Some common active constituents used in these products are:

- Bensulfuron-methyl
- Chlorimuron-ethyl
- Chlorsulfuron
- Metsulfuron-methyl
- Nicosulfuron
- Rimsulfuron
- Sulfometuron-methyl
- Triflusulfuron-methyl
- Tribenuron-methyl

It is not recommended that the pH be lowered when using these as they may cause the herbicide to affect the crop as well as their desired target.

Alkalinity

Alkalinity refers to carbonate (CO32-) and bicarbonate (HCO3-) levels in water. Alkalinity only becomes a problem with some herbicides when levels exceed pH 7, however to get the best results water should be buffered well below this due to the tendency for disassociations to occur.

ALKALINE HYDROLYSIS: High concentrations of hydroxyl ions (OH^-) in alkaline water (> pH 7) that cause a breakdown in the structure of a chemical, resulting in reduced efficacy. The most susceptible chemicals are organophosphates and carbamates.

Hard Water

Hard water contains high levels of calcium (Ca), magnesium (Mg), sodium (Na), or iron (Fe). Other cations can cause hard water, but these are the usual suspects.

Ca, Mg, Na, and Fe cations (positively charged ions) attach to negatively charged herbicide molecules. Often, the association between herbicides and these cations renders the herbicide ineffective.

High pH and hard water act together to reduce herbicide effectiveness. High pH causes more of the herbicide to dissociate while high concentrations of cations bind with the dissociated herbicide to reduce its effectiveness. When labels permit, additions of ammonium sulfate to the spray tank overcome many interactions with herbicides and cations (see note below).

Note: Measure the concentration of Ca, Mg, Na, and Fe in water used for pesticide mixing. If the sum of the concentration (ppm) for all of the cations exceeds 400ppm, action may be necessary.

Turbidity

Turbid water, or water containing suspended solids, soil, or organic matter can reduce effectiveness of post emergence herbicides. Water should be clean and clear for all pesticide applications, however, some pesticides are not as sensitive to turbidity as others.

Pesticides are measured for their ability to bind to soil particles. This information is typically used to assess their potential for off-site movement or leaching through the soil profile. The soil organic carbon sorption coefficient (Koc) is used to describe the binding strength of herbicides to soil. It represents the ratio of herbicide that is bound to soil particles when the herbicide is mixed with a slurry of water and soil. Herbicides with high Koc values bind more tightly to soil particles.

The herbicides glyphosate (Roundup, and many other brand names) and paraquat (Gramoxone) have very high Koc values. Because of their high Koc, these herbicides will bind to soil and organic matter particles suspended in water and will not be available for absorption into weed foliage.

Comparatively, Dicamba (Banvel) has a low Koc and is less likely to be adversely affected.

Glyphosate and Paraquat are commonly used in crop production. Be sure water is clear and free of suspended soils or organic matter when using these products. If water is noticeably murky or discolored, find an alternate water source.

Summary

Analyze water used in filling spray tanks for pH, alkalinity, Ca, Mg, Na, and total suspended solids (turbidity). Take corrective action if any parameter exceeds values discussed in this article.

A vast majority of the herbicide is added water, therefore, water quality can greatly affect herbicide performance.

Clean water, free of suspended solids is essential for spraying Glyphosate or Paraquat.

Disclaimer: This article is for educational purposes only. Mention of a specific product should not be interpreted as an endorsement, nor should failure to

mention a product be considered a criticism. Always read the product label prior to using any herbicide.

Literature Cited

Hall, G.J., C.A. Hart, and C.A. Jones. 1999. Twenty-five years of increasing glyphosate use: the opportunities ahead. February Pest-Management-Science. 56: 351-358.

Nalewaja, J.D., R. Matysiak, and E. Szelenzniak. 1994. Weed Technology. 8:591-597.

Byerlee, B., The Effect of Water pH and Quality On Chemical Efficiency.