AGRI-FACTS
Practical Information for Alberta's Agriculture Industry

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Water Quality for Mixing Herbicides

The importance of using clean, clear water for mixing herbicide solutions has been recognized for many years. Research in Saskatchewan and North Dakota has shown that some of the minerals found in water can have an adverse effect on the performance of some herbicides. This factsheet summarizes the significant water quality parameters and the herbicides that can be affected.

Water chemistry

Six major ions make up the dissolved material in water (Table 1). Small amounts of other ions, such as potassium, iron, and nitrate, may also be present in insignificant amounts.

Table 1. Major mineral constituents in Alberta water

Cations (positively charged)	Anions (negatively charged)
calcium	sulphate
magnesium	chloride
sodium	bicarbonate

Total dissolved solids and electrical conductivity

The sum of all the minerals dissolved in a sample of water is normally referred to as the total dissolved solids (TDS). The higher the TDS, the more electric current water can conduct. Because of this characteristic, a measure of the electrical conductivity (EC), in microsiemens per centimetre, is often used to provide a quick, economical estimate of the total dissolved solids in water. If the EC is less than 500 microsiemens/cm, water quality problems for herbicides are very unlikely. The typical range of EC in well water in Alberta is 1,000 to 2,500 microsiemens/cm.

Suspended solids and organic matter

Suspended solids and organic matter are most simply described as the dirt and color that you see in water. These materials are known to deactivate the following herbicides:

- Diquat (Reglone and Reward)
- Paraquat (Gramoxone)
- Glyphosate (Roundup formulations Rustler, Touchdown formulations, Victor, Glyfos, Maverick, Renegade, Credit, Factor, Eclipse, Vantage, Vantage Plus)

Having clean mixing water is very important when these products are to be used.

Hardness

Water hardness is caused by calcium and magnesium. These minerals can react with some herbicides. The hardness level is expressed in water analysis as an equivalent of calcium carbonate. Test results are sometimes confusing because they can be reported as milligrams per litre (mg/L), parts per million (ppm), or grains per US gallon (gpg). For our purposes, mg/L and ppm are considered equal, and 1 grain per gallon is equal to 17.1 mg/L. The hardness of water in Alberta can range from 0 to 2,000 mg/L.

Water hardness can reduce the effectiveness of the following two herbicides:

Glyphosate

- if hardness is over 350 mg/L (for the low rates used for control of annual grass weeds)
- if hardness is over 700 mg/L (for the high rates used for control of perennial weeds)

Where hard water is a concern with glyphosate, use the maximum recommended rate of herbicide. Reducing the water volume to the minimum required for good coverage will help ensure maximum effectiveness of glyphosate products. Using less than the recommended rate of herbicide will aggravate the efficacy problems. Water should not be harder than 700 mg/L when using 20 litre/acre water volume, or 350 mg/L when using 40 litre/acre water volume.

The effect of hard water can be reduced by:

- adding 2 to 3 kg ammonium sulfate fertilizer (21-0-0-24) per 100 litres of water
- using the spray mix immediately after mixing
- using higher rates of glyphosate

2,4-D amine

At the moment, no definite guidelines can be given for problem levels of water hardness for 2,4-D amine, but a hardness of 600 mg/L can almost totally deactivate this product. Where hard water problems are suspected, the following approaches should be considered, in order of priority:

- use an alternative water source
- use an ester formulation, if practical
- use the maximum recommended rate of amine formulation
- use a non-ionic surfactant (1 L per 1,000 L of water), if the amine formulation is used

Bicarbonate

Bicarbonate, usually found as sodium bicarbonate, is very common in Alberta waters. Bicarbonate levels of 500 to 1,000 mg/L are typical in soft water wells.

Bicarbonate content can affect the performance of some herbicides, particularly those in the tralkoxydim, sethoxydim, and clethodim group of grass killers (Achieve formulations, Poast, Select, FlaxMax Ultra, Pursuit Ultra) as well as 2,4-D amine.

The major effects seem to be from water with elevated bicarbonate levels but low levels of other anions such as chloride and sulfate. Bicarbonate concentrations as low as 500 mg/L have reduced the activity of the above herbicides under some circumstances. Reduced herbicide rate, late application, tolerant weeds, and poor growing conditions combined with high bicarbonate levels have led to problems.

Where bicarbonate occurs in water, the following precautions are suggested:

- avoid using water with more than 500 mg/L bicarbonate when applying Achieve, Select, or Poast
- when more than 500 mg/L bicarbonate is present in the water, use the maximum recommended rate of the above herbicides for the target weed, and apply the herbicide at the optimum growth stage for weed control

Research has demonstrated that the use of liquid ammonium sulfate fertilizer at 1.6 L/ac (0.8 kg 21-0-0-24 dry ammonium sulfate fertilizer/ac) or 0.2 L/ac of 28-0-0 liquid nitrogen fertilizer as an adjuvant will overcome the antagonistic effect of bicarbonate in spray mixing water. Further research is being conducted to confirm these results and refine the fertilizer rates required.

It should be noted that field experience with Achieve, Poast, and Select has not indicated widespread or serious problems due to water quality. When used according to label directions, these products should provide reliable weed control.

If reduced weed control does not appear to be due to common causes such as reduced herbicide rates, late application, wash off by rain, or poor growing conditions, the possibility of bicarbonate antagonism should be investigated.

2,4-D amine activity is also reduced by bicarbonate ions in spray water, especially when low rates (0.34 L/ac) are used. Where water containing more than 500 mg/L bicarbonate is known to occur and where control with the amine formulation of 2,4-D has been less than satisfactory, the following approaches should be considered:

- use an alternative source of water if available
- use an LV ester formulation if practical since the LV esters are not affected by bicarbonate
- use MCPA amine if MCPA is recommended for control of the target weeds. Use the maximum rate of 2,4-D amine
- use a non-ionic surfactant at 0.1 per cent v/v (1 L per 1,000 L of spray mixture) if the amine formulation is used

Iron

The major problem with iron is that it oxidizes to form rust particles that can settle to the bottom of the spray tank and clog nozzles and screens. For this reason, it is best to avoid water with significant levels of iron for all spray applications.

High levels of iron can also reduce the activity of glyphosate.

Alkalinity and pH

High pH and high alkalinity can affect the solubility of Assert. If the pH of the Assert and water solution is too high, the chemical will form a porridge-like sludge in the bottom of the spray tank. A pH reducing acidulate is included with the product. Be sure to add the acidulate before adding Assert to the water.

Water temperature

Water temperature can also affect some herbicides or herbicide formulations. If the water temperature is too low, the herbicides will form a sludge in the bottom of the spray tank. The herbicide Horizon had this problem in its first year; however, formulations and mixing instructions have changed to correct the problem.

If a mixing order is specified for herbicides and surfactants, as it is with Puma and Achieve, follow the prescribed order. The correct order of mixing and agitation will usually prevent sludge formation, even in cold water.

Summary

Evidence to date indicates that only a few herbicides are affected by the minerals in spray mixing water (Table 2). Whether or not a problem arises will depend on a variety of factors, such as weather conditions, stage of growth, and target weed. It can be generally assumed that water quality should not be a problem with herbicides other than those situations mentioned above.

Table 2. Summary of potential water quality problems

Herbicide	Avoid water that has

Roundup formulations, Rustler, Victor, Touchdown formulations, Glyfos, Maverick, Renegade, Credit, Factor, Eclipse, Vantage, Vantage Plus	– high levels of iron
	– hardness
	  – over 350 mg/L when using 40 litre/acre water volume
	  – over 700 mg/L when using 20 litre/acre water volume
	– suspended solids and organic matter

Achieve formulations, Select, FlaxMax, Ultra, Pursuit Ultra, Poast	– bicorbonate levels over 500 mg/L
Assert	– high pH and alkalinity (use pH adjuster)
2,4-D amine	– bicarbonate levels over 500 mg/L – hard water
Reglone, Reward, Gramoxone	– suspended silt and organic matter

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