Understanding a Water Quality Analysis Report

1. Water pH

Generally, the normal pH range of water used for application has little effect on herbicide efficacy. Carbamate and organophosphate insecticides quickly degrade through alkaline hydrolysis at water pH above 7. Water pH above 7 significantly increases degradation of Cobra, Resource, and Valor, however, these herbicides have very low water solubility and alkaline degradation would affect only the soluble fraction of the herbicide. Increasing water pH to 9 can reduce precipitation and nozzle plugging with the sugarbeet micro-rate treatment. Most sulfonylurea herbicides, POST HPPD herbicides, Select, Status, and Sharpen are more soluble at high pH and efficacy can be greater when applied in water with pH above 7. Some adjuvants marketed for glyphosate reduce water pH. Low pH forces some salt formulated herbicides into the acid state that may not be soluble in the amount of water being sprayed and thus plug nozzles and reduce efficacy. Herbicides need to be in solution for absorption into plant foliage. See #23 on page 93 for additional information.

2. Total Dissolved Solids and Electrical Conductivity

The major mineral constituents in Northern Plains water and their ionic charges are:
Cations (+ charge) = calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), and iron (Fe).
Anions (- charge) = sulfate (SO_4), chloride (Cl), bicarbonate (HCO_3), and nitrate (NO_3).

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) is often used to provide a quick, economical estimate of the TDS in water. If the EC is less than 500 umho/cm, water quality problems for herbicides are unlikely. Water EC values in ND and western U.S. run between 1000 and 2,500. Usually hardness and cation concentration, not TDS, are used to evaluate water quality on herbicide performance.

3. Hardness

Water hardness is caused by potassium, calcium, magnesium, and iron. These minerals can react and antagonize most all POST herbicides registered. Almost all POST herbicides are weak acid herbicides and can ionize (separate into neutral, + and - molecules) in acidic pH. Negative charged molecules can bind with cationic minerals resulting in antagonism. The ester formulations of growth regulator herbicides are oil soluble and do not react directly with the salts in the water. However, these oil type liquid herbicide formulations include an emulsifier to mix with water. Sometimes these emulsifiers when mixed in water with salts cause an oil-like scum or precipitate in the spray water reducing efficacy and plugging nozzles.

Sodium contributes to water hardness but functions to soften water similar to home water softener systems. Hardness levels are reported in mg/L (ppm) of calcium carbonate ($CaCO3$). Hardness values are calculated by adding meq/L of Ca and Mg then multiplying by 50. Hardness of individual cations can be confusing because they can be reported as milliequivalents/L (meq/L), milligrams per liter (mg/L), parts per million (ppm), or grains per U.S. gallon (gpg). The mg/L and ppm are considered equal, and 1 grain per gallon is equal to 17.1 mg/L or ppm.

To convert meq/L to ppm, multiply meq/L x atomic number of the atom: K meq/L x 39.102, Na x 22.991, Mg x 12.156, Ca x 20.04. Water hardness values in MT, ND, and MN run between 0 and 2,500 ppm. There are variations in water hardness classifications but the following scale can be used:

Soft =	<75 ppm
Mod. hard =	75 – 150 ppm
Hard =	150 – 300 ppm
Very hard =	> 300 ppm

The amount of AMS needed to overcome antagonistic ions can be calculated as follows:
Lbs AMS/100 gal = (0.002 X ppm K) + (0.005 X ppm Na) + (0.009 X ppm Ca) + (0.014 X ppm Mg) + (0.042 X ppm Fe).
This does not account for antagonistic minerals on the leaf surface on some species like lambsquarters, sunflower, and velvetleaf which may require additional AMS. Apply AMS at 8.5 lbs/100 gallons of water unless water hardness requires more.

4. Sodium Absorption Ratio

Water high in sodium, when added to clay soils, may have a detrimental effect. Excess sodium will attach to clay particles and displace other ions, namely chloride and sulfide. A high SAR may indicate a limited ability for plants to extract water from the soil. The adjusted SAR has reference to bicarbonates. Some water in the Northern Plains is very high in bicarbonates, which increases the SAR problem. Water quality standards for SAR are as follows:

Excellent =	<3
Good =	3 – 5
Permissible =	5 – 10
Doubtful =	10 – 15
Unsuitable =	>15

5. Residual Sodium Carbonate

Values greater than 0 increase the sodium hazard.

6. Bicarbonates

Since bicarbonate is anionic (-) it is always associated with a cation (+) like sodium or calcium to make sodium or calcium bicarbonate in ground water. The corresponding cation (Ca, Na) may have a greater role in herbicide antagonism than the bicarbonate. High sodium and sodium bicarbonate antagonism of herbicides is usually overcome by ammonia type adjuvants. Small amounts of antagonistic salts do not appear to reduce herbicide efficacy with full use rates. This is because the use rate was established for efficacy using various waters. However in principle to optimize herbicide efficacy, any amount of antagonistic salts will have some negative effect and to optimize efficacy for all conditions always apply AMS to overcome even low amounts of antagonistic salt.

Water with high bicarbonate levels may have low levels of other anions like chloride and sulfate. Calcium chloride is also antagonistic and spray water pH should be below 7. Bicarbonate levels greater than 500 ppm may reduce herbicide efficacy of Achieve, Poast, Select, MCPA amine, and 2,4-D amine. When using water with more than 500 ppm bicarbonates the high rate of these herbicides should be used and applied at the most susceptible weed stage for efficacy. Bicarbonate also increases water pH and high bicarbonate levels may also be associated with high water pH (See #1 above). Water bicarbonate levels in MT, ND, and MN range from 200 to 1,000 ppm.

Analysis of spray water sources can determine water quality effects on herbicide efficacy.

Water samples can be tested at:
USPS: NDSU Dept 7680, Fargo, ND 58108-6050,
UPS and Physical Address: NDSU Soil and Water Laboratory, Waldron Hall 202, 1360 Bolley Dr. NDSU, Fargo, ND 58102.
701 231-7864.