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How to Interpret a Water Analysis

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Analyzing the quality of your source water is the first step in developing a nutrition program – this is our starting point and sets our baseline for selecting appropriate water-soluble fertilizer formulas. A detailed analysis of your water provides information on starting pH, alkalinity, electrical conductivity (EC), nutrient profile, and whether any harmful ions may be present. All of this information is critical in building a successful nutrition program.

This guide provides a brief overview of how to interpret a water analysis and select a water-soluble fertilizer formula(s) to match the water quality.

pH AND ALKALINITY

pH

pH measures the acidity or basicity of a solution on a scale of 0-14, where pH 7.0 is neutral. pH values below 7.0 are considered acidic while pH values above 7.0 are considered basic. The pH is determined by the concentration of hydronium ions in the solution, which is measured on a logarithm scale.

Hydroponic and soilless container growers should target a nutrient solution pH in the range of 5.8-6.2 (5-5-6.5 is acceptable). Outside of the pH range 5.5-6.5, nutrient disorders may arise due to nutrient availability.

Links: Plants by pH

ALKALINITY

Alkalinity is a measure of a particular solution's capacity for neutralizing acids and is dependent on the presence of carbonates, bicarbonates, and hydroxides. Alkalinity can be thought of as the buffering capacity of a solution and has a strong impact on substrate pH. In fact, alkalinity may be more influential on substrate pH than the actual pH of water. **Put simply, high alkalinity water requires more acid to lower pH to the desired range AND has a greater tendency to raise substrate pH compared to water with low alkalinity.**

Table 1. Recommended alkalinity ranges for different container sizes.

TABLE 1. JR PETERS LABORATORY ALKALINITY GUIDELINES

CONTAINER SIZE	RECOMMENDED RANGE		LEVEL OF CONCERN[1]	
	ppm=mg $CaCO_3$/L	Milliequivalents[2] $CaCO_3$	ppm=mg $CaCO_3$/L	Milliequivalents $CaCO_3$
Plugs	60-100	1.2-2.0	<40, >120	<0.8, >2.4
Small pots/Shallow flats	80-120	1.6-2.4	<40, >140	<0.8, >2.8
4" to 5" pots/deep flats	100-140	2.0-2.8	<40, >160	<0.8, >3.2
Pots ≥ 6"/long term crops	120-180	1.6-3.6	<60, >200	<1.2, >4.0

[1] Alkalinity levels are intended as guidelines only and are dependent on the plant and media type, pot diameter/size, acidity of the feed program and watering practices.
[2] Milliequivalents=ppm total alkalinity expressed as mg $CaCO_3$/liter divided by 50.

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FERTILIZER SOURCES AFFECT ON pH

CALCIUM CARBONATE EQUIVALENT

Each fertilizer formula will affect solution and substrate pH differently. The effect each fertilizer formula has on a solution and substrate pH is dependent upon the raw materials used in the formulation. This information is documented on the fertilizer label as potential acidity or basicity in terms of calcium carbonate equivalent (CCE) per ton (Figure 1). This value refers to the effect the formula will have on substrate pH over time. **It is important to remember that this is the "potential" acidity or basicity, meaning that water quality, substrate, etc. also impacts the extent to which fertilizer will affect pH.**

NITROGEN FORM

Another indication of the effect that particular formulas will have on pH is the form of nitrogen that is used in the formula (Fig.1). A general rule of thumb is that ammonium nitrogen-based fertilizers are acidic and will lower pH while nitrate-nitrogen **uptake** will raise pH.

guaranteed analysis

Total Nitrogen (N)	5.0%
5.0% Nitrate Nitrogen	
Available Phosphate (P_2O_5)	12.0%
Soluble Potash (K_2O)	26.0%
Magnesium (Mg)	6%
6% water soluble magnesium (Mg)	
Sulfur (S)	8.5%
8.5% combined sulfur (S)	
Boron (B)	0.05%
Copper (Cu)	0.015%
0.015% chelated copper (Cu)	
Iron (Fe)	0.30%
0.30% chelated iron (Fe)	
Manganese (Mn)	0.05%
0.05% chelated manganese (Mn)	
Molybdenum (Mo)	0.019%
Zinc (Zn)	0.015%
0.015% chelated zinc (Zn)	

Derived from: Potassium nitrate, magnesium sulfate, monopotassium phosphate, iron DTPA, iron EDTA, iron EDDHA, copper EDTA, manganese EDTA, zinc EDTA, boric acid, ammonium molybdate.

Potential Basic: 170 lbs. of calcium carbonate equivalent (CCE) per ton. Information regarding the contents and levels of metals in this product is available on the internet at: http://www.aapfco.org/metals.html

Limit of Solubility = 1 lb. per gallon

ATTENTION: The application of fertilizer material containing Molybdenum (Mo) may result in forage crops containing levels of Molybdenum (Mo) which are toxic to ruminant animals.

WARNING: This fertilizer carries added Boron and is intended for use only on vegetative crops. Its use on any other crops or under conditions other than those recommended may result in serious injury to the crops.

Information regarding the contents and levels of metals in this product is available on the internet at: **http://www.aapfco.org/metals.htm**

Figure 1. Guaranteed Analysis. The potential basicity of this formula is 170 lbs. of calcium carbonate equivalent per ton, and is 100% nitrate-based – these characteristics make this formula (when paired with 15-0-0 Part B) an excellent complete balanced nutrient source for crops grown in pure water sources.

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ADJUSTING pH

As stated above, fertilizer can certainly impact pH, but what if our pH is still not on target after mixing our fertilizer?

LOWERING pH AND ALKALINITY:

If pH is above 6.5 after mixing your fertilizer, pH should be lowered and maintained at ~6.0 through the addition of acid. The addition of acid lowers both pH and alkalinity. Common acid sources in the horticultural industry include sulfuric, phosphoric, nitric, and citric acid. Sulfuric acid is most common as it is cheap and unlikely to create nutrient imbalance issues.

A water softener should not be used to lower alkalinity in crop production as this will add unwanted sodium to your water!

RAISING pH AND ALKALINITY:

Although most water sources will require acid to lower pH, in some cases it may be beneficial to increase alkalinity – and pH if it becomes too low!

Pure water sources (RO, rainwater, etc) contain little to no alkalinity and thus, lack buffering capacity to aid in maintaining a stable pH. For this reason, pH swings can be more common when growing with pure water sources.

For example, it is common for growers using pure water sources to experience a drop in pH when using Jack's 10-30-20 Bloom. This is due to the nature of the raw materials used in this formula. For growers using Jack's 10-30-20 Bloom with pure water sources, the addition of Jack's Potassium Bicarbonate and/or Jack's 15-0-0 Part B (calcium nitrate) should be considered to aid in pH management.

Jack's Potassium Bicarbonate will effectively add alkalinity to water which can help reduce pH swings that may be observed when growing with pure water sources. However, given that this product will also raise pH, if your pH is already above the target, adding alkalinity to the water may not be practical. In these cases, selecting fertilizers that will aid in pH management is a more suitable option **(e.g. nitrate-based fertilizers aid in raising pH).**

Potassium Bicarbonate Technical Data Sheet
Jack's Calcium Nitrate Technical Data Sheet (15-0-0 Part B)

PUTTING IT ALL TOGETHER

Information on the CCE and nitrogen form in the formulation – along with our source water alkalinity value can help in selecting a formula to aid in pH management. Source waters high in alkalinity (above 150 ppm $CaCO_3$) may be better suited for fertilizers that are potentially acidic and have a higher ammonium nitrogen percentage. Alternatively, source waters with lower alkalinity (below 150 ppm $CaCO_3$) are likely better suited for potentially basic and nitrate-based formulas. Most soilless media and hydroponic fertilizer formulas are primarily nitrate-based as excessive ammonium can cause pH to crash and ammonium toxicity. In mosts cases, acid/base may be required to maintain proper pH.

The take-home message here is that we want to adjust the pH of our nutrient solution to ~6.0 before feeding. pH should be monitored, measured, and adjusted regularly to avoid pH-induced nutrient disorders.

Links:

- Getting Technical - Alkalinity, Fertilizer Sources, and your pH
- Alkalinity and Fertilizer Source Handout

DOES ANYTHING PRESENT A CONCERN?

ELECTRICAL CONDUCTIVITY (EC) – SOLUBLE SALTS

Electrical conductivity is used to measure the soluble salts of a solution. This measurement indicates a solution's fertility levels and if any salinity problems may exist. Electrical conductivity (and nutrient concentration) of water can vary greatly depending on the source, location, etc.

Water sources with a starting EC above 0.75 mS/cm may lead to salt accumulation in grow media and/or recycled solution, which can inhibit plant growth. **However, when analyzing source water EC, it is necessary to consider which ions are contributing to the EC**. Ions carry a negative or positive charge that will contribute to the overall EC value. Some ions, such as calcium, magnesium, and sulfur, sodium, and chloride may occur naturally in some water sources but most other plant nutrients do not naturally occur in water. Some of these ions, such as calcium, magnesium, and sulfur are nutrients that are available for uptake by the plant. On the other hand, some water sources may contain undesirable ions, such as sodium and chloride which can lead to salt accumulation in grow media and/or recycled nutrient solution and inhibited plant growth.

The tolerable concentration of Na and Cl varies between species and fertigation system (closed vs. open system), but as a general rule thumb, water sources containing over 50 ppm Na and 70 ppm Cl are more problematic and difficult to manage, and may not be suitable for closed recirculating systems. Sodium and chloride accumulation is particularly an issue in closed recirculating systems as these ions tend to accumulate over time.

Water sources with an excessively high EC (>0.75 mS/cm) or concentration of sodium (>50 ppm Na) and chloride (>70 ppm Cl), can be managed by blending with pure sources such as RO, leaching when irrigating, and replacing or diluting recycled solution as needed. Consult with a water treatment specialist to determine the source of unwanted elements and treatment options.

Learn more about managing media EC

NUTRIENT PROFILE

Most water sources will contain an insignificant concentration of nitrogen, phosphorous, potassium, and micronutrients. Nitrogen, phosphorous, and potassium concentrations greater than 10 ppm could indicate runoff or water contamination but will cause no negative effect on plant growth.

Micronutrient concentration (Fe, Zn, Mn, Mo, Cu, B) of the water source should be analyzed to ensure an excessive concentration of these elements is not present. The table below can be used as a reference. Consult with a water treatment specialist to determine the source of unwanted elements and treatment options.

Table 2. Source water micronutrient ranges.

	PARAMETERS	NORMAL RANGE	LOW	HIGH
T	Manganese (Mn)	---	---	>1.50
R	Iron (Fe)	---	---	>2.00
A	Copper (Cu)	---	---	>0.20
C	Boron (B)*	---	---	>0.50
E	Zinc (Zn)	---	---	>0.40
S	Molybdenum (Mo)	---	---	>0.20

CALCIUM (Ca)

Some water sources may contain enough calcium that it does not need to be provided through fertilizer. On the other hand, pure water sources will lack calcium. When water sources lack calcium, it is critical to ensure that a calcium-containing fertilizer is being used. Due to solubility issues when calcium is mixed with phosphates and sulfates at high concentrations (>50x), many formulas may lack calcium or require a “Part B Calcium Nitrate” formula to be used in conjunction with the main “Part A – NPK” formula.

Jack’s has a catalog of calcium-containing and non-calcium-containing formulas to account for differences between water sources.

DETERMINING HOW MUCH Ca (IF ANY) NEEDS TO BE PROVIDED BY FERTILIZER

Most hydroponic and container-grown crops grow best with a minimum of 70 ppm of calcium. Knowing this, if our source water contains less than 70 ppm Ca, the use or rotation of calcium-containing fertilizers is recommended for most crops (strawberry is an exception to this as most strawberry recipes target ~40 ppm calcium).

SOURCE WATER CONTAINS LITTLE TO NO CALCIUM (<40 PPM Ca)

Purer water sources with less than 40 ppm Ca and lower alkalinity (<150 ppm CaCO3) will be better suited for Jack's 5-12-26 Part A and 15-0-0 Part B (Jack's 3-2-1) or Jack's 12-4-16. These formulas will provide elevated levels of necessary calcium.

The main difference between Jack's 3-2-1 and Jack's 12-4-16 is the 12-4-16 utilizes a one-bag base formula with slightly less potassium and phosphorus whereas the 3-2-1 (Part A and Part B) is a two-bag system with slightly higher potassium and phosphorus. Some people prefer the simplicity of the one-bag system, while others prefer the flexibility that the two-bag system offers. However, both of these formulas meet the targeted nutrition demand of controlled environment crops grown in pure water sources.

Jack's 3-2-1 and Jack's 12-4-16 Nutrition Program.

SOURCE WATER CONTAINS A MODERATE CONCENTRATION OF CALCIUM (40-70 PPM Ca)

Water sources containing 40-70 ppm Ca and high alkalinity (>150 ppm CaCO3) are a great fit for Jack's 15-5-20 formula. This formula will provide an additional 40 ppm Ca when feeding at 200 ppm nitrogen.

Jack's 15-5-20 Nutrition Program.

SOURCE WATER CONTAINS ELEVATED LEVELS OF CALCIUM (>100 PPM Ca)

Water sources containing 100 ppm Ca or more will typically be associated with high alkalinity. For these water sources, an acidic fertilizer without calcium will be most suitable. This is where Jack's 18-8-23 formula comes in! Don't let the "Outdoor" in the name fool you! This formula is more than suitable for controlled environment producers using high calcium and alkalinity water.

Jack's 18-8-23 Nutrition Program.

MAGNESIUM (Mg)

If source water contains less than 30 ppm Mg, a fertilizer formula containing magnesium or Epsom salts (magnesium sulfate) should be used.

For most hydroponic and container-grown crops, the magnesium concentration of the nutrient solution is typically targeted at half the concentration of calcium. However, anecdotal evidence from JR Peters laboratory has shown most cannabis cultivars perform well with a Ca: Mg that is closer to 1:1.

EPSOM SALT MIXING TIPS

1 dry oz of Epsom salt (9.7% Mg) per 100 gallons of water will provide 7.3 ppm of magnesium

Mixing rate to achieve 1 ppm magnesium:

	Per 100 gallons or per 1 gallon of stock concentrate with injector set at 1:100
Grams	3.90
Dry oz.	0.14

SULFUR (S)

High levels of sulfur are generally not a problem unless excessively high (>120 ppm S) where it can contribute to increased EC. **If the water source contains more than 120 ppm S, acid sources that do not provide sulfur should be considered.**

NITROGEN (N), PHOSPHORUS (P), POTASSIUM (K)

Most water sources contain low concentrations (< 10 ppm) of nitrogen, phosphorus, and potassium. Water sources that contain these nutrients do not cause nutritional problems for plant growth but may need to be accounted for when developing a nutrition program if high concentrations are present (> 25 ppm).

BORON (B)

Boron is a plant micronutrient and is usually applied 0.10-0.50 ppm B in the nutrient solution. Water sources containing more than this level may cause phytotoxicity. Poinsettias are a **B** sensitive crop. A level equal to or greater than 0.25 ppm **in source water** may be considered high and could cause toxicity.

COPPER (Cu)

Copper is a plant micronutrient and is usually applied 0.05-0.75 ppm Cu in the nutrient solution. Water sources containing more than this level may cause phytotoxicity.

IRON (Fe)

Iron is a plant micronutrient and is usually applied 1.0-3.0 ppm Fe in the nutrient solution. Water sources containing more than this level may cause phytotoxicity.

MANGANESE (Mn)

Manganese is a plant micronutrient and is usually applied around 0.20-1.0 ppm Mn in the nutrient solution. Water sources containing more than this level may cause phytotoxicity.

MOLYBDENUM (Mo)

Molybdenum is a plant micronutrient and is usually applied around 0.04-0.20 ppm Mo in the nutrient solution. Water sources containing more than this level may cause phytotoxicity.

ZINC (Zn)

Zinc is a plant micronutrient and is usually applied around 0.20-0.75 ppm Zn in the nutrient solution. Water sources containing more than this level may cause phytotoxicity.