

Soils & Analytical Methods

January 2022

*“These boxed pine trees don’t even know it’s summer (120 deg. F in the shade),
their hydrated and still pushing”*

“They realized a 20% increase in nut yield”

“They realized 400 lbs per acre more nut yield”

“Their grapefruit production doubled year 1”

“Their citrus production increased 50% the initial year”

*“The leaves were exceptional vitality and size yet the sodium and chloride of 1,000 ppm each,
had no adverse effects. What is the mode of action? Is it proprietary?”*

INTRODUCTION

We look at water analyses, then soil analyses – available nutrition and exchangeable, but what does it all really mean? If the available is low, just add more? I can assure you that may be hurting the vegetation versus helping it. If you have the elements in the soil as exchangeable, but deficient in available, that means what’s in the soil is locked up! Too much locked up is consuming pore space and infiltration, including the flushing potential. And what if we scientifically showed you the amount of exchangeable were significantly greater than what you’re seeing on the report, so much more your soil may be re-classified as drywall or an iron source in itself?

Soils are the host to vegetations productivity potential through the addition and maintenance of available hydration and nutrition as a minimum. Growers are spending more and producing less - spending more trying to provide hydration, make available nutrition, detoxify chloride, sodium and bio toxins, getting water down, force feeding calcium and lowering pH, and with meager impact on the results. We’ll explain what’s going on and what you can do to the reverse the deteriorating conditions into sustainable and profitable gain.

ABOUT YOUR ANALYTICAL DATA

Water Quality – Available Nutrition – Exchangeables – What are we really seeing here?



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Standards Council of Canada
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California Department of
Food and Agriculture



Water Quality: We add calcium and maintain magnesium ratios, add P and K, yet we call hard water problematic. High TDS and high EC are the sum of elements in the water and when they are collectively beneficial minerals and metals, not sodium, if they REMAIN AVAILABLE throughout the soils and plant uptake, they become nutrition.

The actuality is, these elements, the minerals and metals, evaporate to dryness before being consumed, and become complexed, unavailable. An easy demonstration; evaporate your water to dryness in a glass beaker and try to re-hydrate the minerals. You can add acid, but then when you evaporate that to dryness, the acid will no longer dissolve the scale.

If you have been on a site for three or more years and used sulfurous acid, you've seen the soils become more challenging to get water down. This is the negative effects of sulfurous acid and gypsum – more relevantly put – drywall. And drywall competes for moisture, it is a desiccant. [University Data: Item No. 3 – Page 19](#)



UC DAVIS

Sulfurous Acids
Sulfuric, N-pHuric, UN32

Why Sulfuric has a Short Range Benefit

Salts of weak acids are soluble in strong acids

The solubility of a sparingly soluble salt of a weak acid or base will depend on the pH of the solution. To understand the reason for this, consider a hypothetical salt MA which dissolves to form a cation M⁺ and an anion A⁻ which is also the conjugate base of a weak acid HA. The fact that the acid is weak means that hydrogen ions (always present in aqueous solutions) and M⁺ cations will both be competing for the A⁻:

$$\text{MA(s)} \xrightarrow{1} \text{M}^+ + \text{A}^- \quad \text{H}^+ \xrightarrow{2} \text{HA}$$

The weaker the acid HA, the more readily will reaction 2 take place, thus gobbling up A⁻ ions. If an excess of H⁺ is made available by addition of a strong acid, even more A⁻ ions will be consumed, eventually reversing reaction 1, causing the solid to dissolve.

... but strong acids will *not* dissolve salts of strong acids

Neither will RO, DI or Rain Water

$$\text{CaSO}_4\text{(s)} \xrightarrow{1} \text{Ca}^{2+} + \text{SO}_4^{2-} \quad \text{H}^+ \xrightarrow{2} \text{HCl}$$

But that's not all, this situation also causes many more issues.

And perhaps you think better water will fix the problem, or more water will fix the problem. The realities are;

1. Better water will flush salts "if the soils are not already compromised". However, if the soils are already compromised, flushing Na may occur, but flushing the mineral and metal complexes does not. Also, eventually even the good water can and likely will accumulate insoluble matter in the soil pores

eventually hindering the waters infiltration rate and flushing of even sodium, one of the most soluble elements, does not occur.

What's missing about water analyses is the impact that bacteria can have. With Bacteria in water, transferred into the soil, we have the potential, with elements in the water and soil, to create biologically induced problems; specifically iron bacteria and its associated slime that is impervious to acid, and sulfate reducing bacteria whose primary mode of action is gassing our vegetation to death with hydrogen sulfide gas (rotten egg odor, also observed as black layer, fungi and sometimes organic matter).

Whether the elements are in the water or in the soil, they have characteristics;

Cementous:

Calcium, Magnesium, Potassium, Phosphate, Iron

Unavailable essential nutrients

Bio-toxicity:

Bacteria + Sulfur, Sulfate, Iron and/or Manganese

Slime and deathly gas

Toxicity:

Chloride and Sodium

Cell damage

Vegetation Uptake: If you look at the solubility of each element, the ease to which they are hydrated / hydratable / re-hydratable, whether in water or soil, you'll find them in this order. The first five you might relate to what you observe after a rain – the push of growth, followed a few days later by the stress.

Oxygen

Water

Nitrogen

Chloride

Sodium

Zinc

The least being Calcium aluminum the iron.

Available Nutrition: Here we found concerns with the existing methods, namely the amount of water being used, and the quality of the water being used, much less the locations of the soil samples taken. These testes are typically a soil sample at or nearby the root zone, at different depths, where the soil is mixed with lab water at a 1:1 ratio, the liquid is extracted and the elements measured.

How relevant is this data to real world conditions when/if you can't get water down, your water is better or worse than the lab water, the ratio of water to soil in the field is less than 1:1 or more, 2:1, 4:1, 10:1? How many spoonfuls of sugar can you put in 1 glass of water, versus 1 gallon of water before it begins to settle on the bottom? And in the same scenario, why can you put a lot more sodium in the water before it settles, yet less calcium or iron?

The purpose of "Available" is to give us an indication of what is available to our root zones when we water. In many cases agronomists will use the actual treated water to make these determinations, as well as using soils that are in the hydrated root zone of the vegetation. HCT prescribes these same recommendations but we also include a 3:1 water to soil ratio along with a chemical retention time of 72 hours minimum. By using the actual water we're also introducing whatever bacteria may be present and its' role over a short period of time.

The actuality; the Available Nutritional Analysis – using the actual water, treated water, with a 3:1 water to soil ratio, with 72 hours soak time, on soils that are actually receiving the treated water, is a more realistic representation of what your vegetation "has the ability to make available" for actual nutritional uptake.

Exchangeables – An industry changing discovery.

We see this column on our analytical results next to Available - Exchangeables, and where most labs do not specify the Method used, yet some do – most recently Texas Tech University. The known methods are two; the Ammonium Acetate (minerals) and DTPA (metals) extracts which is very commonly used throughout the west. Then there is the Mehlich III Method that uses an array of acids and chemical extracts which are much more aggressive and would naturally show more of the minerals and the metals within a soil. This is exactly our point! The stronger chemicals used between the two Methods show the more "Exchangeables".

Let's think about this a bit. The ammonium acetate resembles the acids exuded from root hairs to form more soluble salts for uptake. Surely the nitrate and the sodium need very little chemical conversion. However, the more insoluble salts need a lot – the calcium, iron, even the bonds with chloride need to be liberated – calcium, iron, zinc, sodium, boron. So, this method is only showing us what the Ammonium Acetate and the DTPA can liberate at the labs precise concentration of the extracts in a given water. Does that resemble what's occurring in the real soils?

If we take that same soil, and same ratio of water, yet run it through the Mehlich Method, due to the chemicals used, we'll surely see more of the elements liberated from the soil sample. You can see in the table below Mehlich is using Acetic Acid, Ammonium Nitrate, Ammonium Fluoride, Nitric Acid and also EDTA. Is it at all possible for our plants to exude such chemicals to form soluble salts for uptake? Not likely.

Total Digestion – The eye opener.

When you take the same soil and have it analyzed by Total Digestion, you see all the elements in the soil. What's shocking, in most cases, not just agriculture, but landscape, turf, even golf course greens that are treated and flushed religiously, massive amounts of namely Calcium, Iron and Aluminum, that nobody knew was there.

What that means to us, the soils are becoming cementous, and metal like, a soil that has become like a "dirty air filter", that is harboring nutrition in the form of crystals/bricks, contributing to confining layers which in turn can harbor toxic sodium and chloride, perpetuate stagnant water and problematic bacteria, of which our vegetation is drinking from, of which if not fixed, gradually becomes somewhat septic.

Should we till, add organic matter, lower pH, overwater to flush, or might we chemically treat the soil to liberate, sequester and make available the saturations of nutrients, while managing the bacteria, oxygen and detoxifying the sodium and chloride?

TIME TO MAKE A CHANGE, MAKE A DIFFERENCE

1. Water analyses are good! Get the transient indicators (pH, TDS, Ec, etc.), and be sure to get "all" the mineral and metals as well as the bicarbonate and chloride.
 - a. **Add Total Bacteria!** – If your lab doesn't do it, we can! [It's a simple dip slide test.](#)
2. Soil analyses – **significant room for improvement**
 - a. **Available Nutrition** – What your plant is supposed to get when you water.
 - i. Like many, use actual treated water! Do not allow the use of lab water.
 - ii. Specify that you want a 3:1 water to soil ratio and a minimum 72 hours soak time. This slows down the labs processes and procedures but you get more accurate data of what your water liberates for nutrition along with the impacts from watering, soak time and water chemistry, including the biological aspects.
 - b. Exchangeables – I would convert to Total Digestible.
 - i. Hypothetically conventional methods report what is in the soils that can be converted to Available Nutrition, if exposed to ammonium acetate or other acids as are noted in the table below.
 - c. **Total Digestion** - The same analytical methods used for quantifying manure and compost. You'll be shocked to find "massive" amounts of calcium and iron compromising your soils. Excessive nutrition is referenced in the NCRS/USDA as nutritional toxification, in one paragraph!

Why these matter – Soil Physics – we have to have pore space, infiltration, transportation and retention within the soil of water, “available” nutrition and nutritional reserves - while relieving the bonds of bicarbonates, chlorides and valence – attacking bio-films and bio-matter (H2S as well), while detoxifying sodium and chloride.

It’s pretty much a nationwide chronic issue in agronomy as a whole, and now you can do something about it.

Plants optimize growth, likely beyond what you’ve experienced, through

Available Hydration

Available Nutrition

Detoxification of Chloride and Sodium

Maintaining an aerobic soil profile

Mitigating the negative effects of bacteria – namely slime and H2S

Saturated Minerals & Metals
With WaterSOLV™
250,000 TDS – pH 8.2

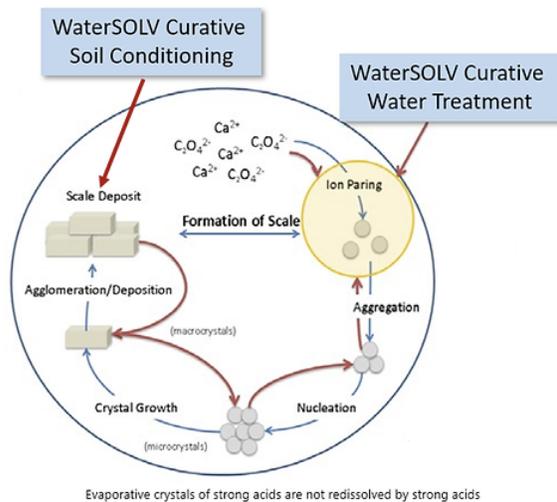


The Formation of Scale

One cycle of tap water evaporated to dryness



Untreated, evaporated, rehydrated
Treated, evaporated, rehydrated



Sample Report Template

Summary Tables for Analyses of:

Client ID: _____
 Client Name: _____
 Water ID: _____

Sample Date: _____

Soil ID: _____
 Slope: _____
 Condition: _____
 Depth, in.: _____
 Moisture: _____

 Zone: _____

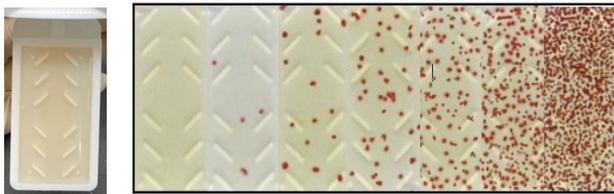


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Item	Symbol	Measurement	Lab no.	Lab no.	Lab no.	Lab no.	Lab no.	Lab no.	Notes
			Water	Available	Exchangeable		Digestible		
				Legacy Method	AA/DTPA	Mehlich III	Legacy Method	Dig. Ratio to Water	
Electrical	conductivity	umho/cm							
Sodium	Na	%							
SAR		ratio							
SAR	Adjusted	ratio							
pH		Units							
pHc		Units							
Hydroxide	OH	ppm							
Ttl. Alk	as CaCO3	ppm							
Carbonate	CO3	ppm							
Total Hardness	As CaCO3	ppm							
Nitrate	NO3-N	ppm							
Bicarbonate	HCO3	ppm							
Calcium	Ca	ppm							#REF!
Magnesium	Mg	ppm							#REF!
Phosphorus	P	ppm							#REF!
Potassium	K	ppm							#REF!
Iron	Fe	ppm							#REF!
Aluminum	Al	ppm							#REF!
Total Bacteria	CFU/mL	Exponents (1-7)							
Sulfur	S	ppm							
Sulfate	SO4	ppm							
Iron	Fe	ppm							#REF!
Manganese	Mn	ppm							#REF!
Chloride	Cl	ppm							
Sodium	Na	ppm							#REF!
Calcium	Ca	ppm							#REF!
Iron	Fe	ppm							#REF!
Zinc	Zn	ppm							#REF!
Boron	B	ppm							#REF!
Copper	Cu	ppm							#REF!



<100	10 ²	10 ³	10 ⁴	10 ⁵	10 ⁶	10 ⁷	Exponents cfu/ml
10	100	1,000	10,000	100,000	1,000,000	10,000,000	cfu's/ml

Legacy Testing Methods developed in collaboration with Dr. York of Tournament Turf Laboratories, Inc., Robert Oppold of ISTRC, and HCT, LLC