NEWS FROM
VERDE-CAL®
Products of **AQUA-AID, INC.**

Third Quarter
2012

Miller's Miscellaneous

I was at a Boy Scout event last week and one Troop performed a "news" skit as a take-off from the Saturday Night Live show. When it came to the weather portion of the skit… the scout got up as if in front of a camera (only in front of all of us) and yelled really loud "ITS HOT"! And it was hot, in fact sweating in your tent all night hot. Much like the rest of the country right now, it is HOT!

In this summer issue of VERDE-CAL News I am highlighting the USGA's information on gypsum that just came out on the web. It is great information, and much of it you have heard during our talks or newsletters. VERDE-CAL G can answer many of your customers tough soil issues and fits in very well with the USGA's key points.

The same USGA article highlights creating soluble calcium from the calcium already present in the soil. Everyone who has soil on their golf course qualifies to read this article on our AcidipHy product which does exactly what the USGA states! Creating release of what you already have in the soil. And what does that do in turn to benefit your turf and plants? Read on.

Lastly, I am including some leaf tissue data for your future reference to use when interpreting your tissue tests.

And, for those of you who are avid Turfnet users, you may have noticed the Turgrass Zealot making mention of upcoming water issue information. He actually made reference to a chart I used in a recent article published in the Florida Turf Digest. There is a link to the Zealot's site and my article included here. It is great reference material for those of you dealing with tough water sources to use.

Once again… ITS HOT! So stay cool and enjoy this newsletter.

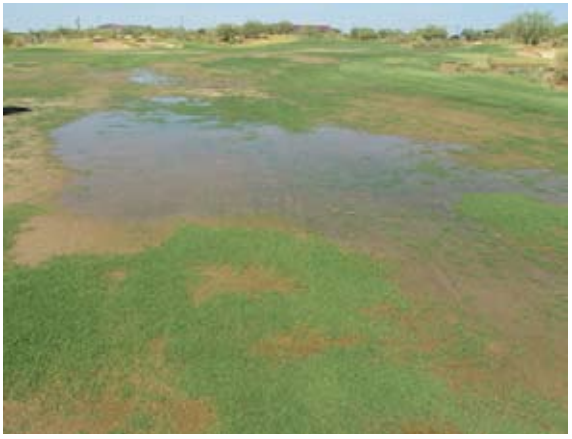
Gypsum and Other Calcium Sources

Their properties and chemical processes when applied to soil. ***by Dr. Jim Walworth***

Calcium can help stabilize the aggregate structure of soils. The most commonly used calcium sources include gypsum, agricultural lime, and a few other calcium salts. In some soils, existing calcium minerals can be dissolved, releasing the calcium they contain. It is important to be familiar with the properties of these various calcium materials and to understand the chemical processes that occur when additives are applied to soil.

IS CALCIUM EFFECTIVE?

In this brief article there is not space to provide a thorough review of the interactions between cations and soil particles. In brief, negatively charged soil clay particles can be bound together into clumps or aggregates by positively charged molecules (cations). The formation of stable soil aggregates, a process called flocculation, encourages water infiltration and drainage, and prevents surface soil crusting. Flocculation is promoted by high levels



Golf course soils may become dispersed when sodium (Na^+) accumulates in relation to calcium and magnesium. Dispersed soils have very poor water infiltration properties and may ultimately result in turf loss. Calcium can help stabilize the aggregate structure of such soils.

Special Interest Articles:

Jim Miller
Sales Manager
843-241-5717

Bo Phillips
Regional
Account Manager
210-382-4079

AQUA-AID, INC.
Corporate Office
800-394-1551

Calcium Sources Continued . . .

Table 1
Relative flocculating power of major soil cations

Ion	Chemical Symbol	Relative Flocculating Power
Sodium	Na^+	1.0
Potassium	K^+	1.7
Magnesium	Mg^{2+}	27.0
Calcium	Ca^{2+}	43.0

of salinity (which may not be conducive to plant growth) and by the presence of cations that are strong flocculators. The dominant soil cations in medium to high-pH soils are the monovalent cations (one positive charge per molecule) sodium (Na^+) and potassium (K^+), and the divalent cations (two charges per molecule) magnesium (Mg^{2+}) and calcium (Ca^{2+}). In highly acidic soils the trivalent aluminum cation (Al^{3+}) may be present.

The ability of the dominant soil cations to flocculate soil clays is a function of their charge and size, and is shown in Table 1. In this table the flocculating power of Na^+ is assigned a value of 1, and the other cations are assigned values relative to Na^+. We can see that K^+ is a stronger flocculator than Na^+, but that Mg^{2+} and Ca^{2+} are much more powerful flocculators than either of the monovalent cations.

Calcium is clearly the cation of choice for flocculating soil clays.

In soils without adequate soluble Ca^{2+}, increasing the Ca^{2+} in solution will help to flocculate clay particles. There are two methods that can be used to accomplish this process. One is to solubilize calcium already present in the soil; the other is to add a supplemental calcium source.

CALCIUM ALREADY PRESENT

Let's look at the first option, solubilizing existing soil calcium. This strategy works only if there is an excess of calcium carbonate minerals in the soil. Soils with excess or solid-phase calcium carbonate ($CaCO_3$) are referred to as calcareous soils. They can be identified through a soil analysis. Look for free lime on the soil test. It will usually be reported in general categories such as high, medium, or low. You can test for the presence of carbonates yourself by putting a drop of dilute acid on them and observing whether or not they effervesce (fizz) as the $CaCO_3$ reacts with the acid (sulfuric acid in the equation below) to produce carbon dioxide (CO_2) gas:

Sulfuric or sulfurous acid applied directly to a calcareous soil creates a reaction whereby lime is dissolved, producing calcium sulfate, carbon dioxide (seen as the fizzing bubbles), and water.

$$H_2SO_4 + CaCO_3 \Rightarrow CO_2 + H_2O + Ca^{2+} + SO_4^{2-}$$

In calcareous soils, acid can be applied to dissolve soil calcium carbonate. The products of the reaction of calcium carbonate and sulfuric acid are CO_2, water (H_2O), sulfate (SO_4^{2-}), and Ca^{2+}. The Ca^{2+} released from the soil $CaCO_3$ can now act as a flocculant.

Any acid can dissolve soil calcium carbonate and release the bound calcium. Sulfuric acid is most common because it is relatively inexpensive and adds less salt to the soil than hydrochloric acid (HCl). Sulfurous acid (H_2SO_3) can be produced by combustion of elemental sulfur in a sulfur burner, and it is a popular alternative to sulfuric acid. Additionally, acid-forming materials such as elemental sulfur can be used. Elemental sulfur is converted to sulfuric acid by sulfur oxidizing bacteria, producing the same effect as sulfuric acid. Sulfur conversion is a biological process, however, and requires several weeks to months to take place (depending on soil conditions), unlike acids, which react instantly.

"Your time is limited so don't waste it living someone elses life."
Steve Jobs

"A weed is a plant that has mastered every survival skill except, figuring out how to grow in rows".
Doug Larson

Calcium Sources Continued . . .

Acids and acid-forming materials will only be effective in calcareous soils.

The soil should effervesce when acid is applied, or have medium to high or very high free lime soil test levels.

BEST CALCIUM ADDITIVE

Now let's look at calcium additives.

There are several calcium-bearing salts that can be used to add Ca^{2+} to soil, but in order to be effective they must be soluble. A salt is a compound made up of a cation and an anion (a negatively charged molecule). Calcium salts, of course, contain Ca^{2+} as their cation. The anion could be sulfate (SO_4^{2-}) for calcium sulfate, carbonate (CO_3^{2-}) for calcium carbonate, chloride (Cl^-) for calcium chloride, nitrate (NO_3^-) for calcium nitrate, etc.

GYPSUM AND CALCIUM SULFATE ANHYDRITE

The most widely used calcium soil additive is gypsum. Gypsum is one of the family of calcium sulfates. The chemical formula for gypsum is $CaSO_4 \bullet 2H_2O$. This means that each gypsum molecule contains one calcium cation, one sulfate anion, and two waters. There are other calcium sulfates, such as calcium sulfate anhydrite ($CaSO_4$). Chemically, these two salts are closely related, the difference being that calcium sulfate anhydrite does not contain water. Consequently, calcium sulfate anhydrite contains more calcium on a weight basis than gypsum. Calcium sulfate anhydrite contains 29.4% calcium, whereas gypsum contains 23.2% calcium.

Both of these calcium salts are mined and then ground into a powder for use as soil additives. Additionally, by-product gypsum materials and waste products of phosphate fertilizer production (phosphogypsum) and from power plant stack scrubbers (flue gas desulfurization gypsum) also are used.

Gypsum is a good choice for calcium addition because it is inexpensive, nontoxic, safe to handle, and it is relatively soluble. We are interested both in solubility (how much of the salt will dissolve in the soil water) and the rate of dissolution (how fast the salt dissolves in water). Mined gypsum is well-crystallized, having formed over millions of years. Waste gypsum, on the other hand, is formed rapidly during industrial processes and is less crystallized. Although they have the same chemical formula, the waste gypsum materials dissolve more rapidly than mined gypsum. Sometimes powdered gypsum is prilled in order to reduce dust and to improve handling properties, and this slows its rate of dissolution. A study that compared dissolution rates of gypsum sources found that flue gas gypsum dissolved 3.6 times faster than mined gypsum, whereas phosphogypsum dissolved 2.2 times faster than mined gypsum (Bolan et al., 1991). The rate of dissolution is particularly important for treatment of soil crusting, which is caused by dispersion of clay particles at the soil surface. In this situation, rapid dissolution is critical to maintain a high level of dissolved Ca^{2+} in the surface soil as raindrops or irrigation water leach cations from the uppermost layer of soil. However, for general treatment of soil structure, the rate of dissolution is less important than the overall solubility.

Calcium sulfate anhydrite also can be used as a calcium supplement. The solubilities of gypsum and calcium sulfate anhydrite are similar, however the dissolution rates differ. Published reports indicate that the dissolution rate of calcium sulfate anhydrite is slower than that of gypsum – anywhere from 5% to 72% that of mined gypsum. In addition to the chemical composition, the dissolution rates of both gypsum and calcium sulfate anhydrite are dependent on type and degree of crystallization, particle size, presence of impurities, and method of manufacture for non-mined salts.

LIME

Calcium carbonate or limestone is another mined calcium salt. It's often referred to as lime or agricultural lime, although agricultural lime may be a combination of calcium and magnesium carbonates if it is made from dolomitic rather than calcitic limestone deposits. The main use of lime is to raise soil pH (to reduce acidity). In the same manner that $CaCO_3$ neutralizes sulfuric acid in the equation above, it also neutralizes acidity in low-pH soils. Unlike gypsum and calcium sulfate anhydrite, lime solubility is dependent on soil pH. Its solubility increases in acid soils and decreases as soil pH increases. When soil pH is above

"My wife's a water sign, I'm an earth sign. Together we make mud."
Rodney Dangerfield

"Life is friendship set to music."
Joseph Campbell

Calcium Sources Continued . . .

"Success is how high you bounce when you hit bottom."
George S Patton

approximately 8.2, lime becomes quite insoluble. This is why most soils with a pH above this threshold are also calcareous, meaning that they contain solid mineral calcium carbonate. In acidic soils, supplemental calcium carbonate will dissolve, but in alkaline soils it will not; adding calcium carbonate to calcareous soils accomplishes nothing.

CALCIUM CHLORIDE AND CALCIUM NITRATE

Calcium salts that contain Ca^{2+} and a monovalent anion such as Cl^- (calcium chloride) or NO^{3-} (calcium nitrate) are very highly soluble. They are not usually used as calcium amendments because of their expense and their high salt content. Applying enough of these salts to promote soil aggregation would generally increase soil salinity to unacceptable levels.

CALCIUM FOR PLANT USE

Calcium is a critical component of cell walls and is therefore an essential plant nutrient. It is needed for cell division and growth and for redistribution of carbohydrates within the plant. Calcium deficiency related to lack of available soil calcium is rarely encountered in moderate- to high-pH soils and is usually limited to very acidic or sandy soils. Calcium supply and translocation within plants is dependent on an adequate and continuous supply of water. As such, calcium deficiencies are usually the result of drought stress rather than low soil calcium levels. However, if the supply of available soil calcium is inadequate, supplemental calcium can improve plant nutrition. In this case, any soluble calcium material can be used to alleviate calcium deficiency. Lime (in acidic soils only) and gypsum are the most widely used soil-applied calcium fertilizers, whereas calcium chloride and calcium nitrate are often used for foliar application.

SUMMARY

Acid or acid-forming amendments are acceptable additives for increasing soluble Ca^{2+} in calcareous soils only. In all soils, regardless of pH, gypsum is a good Ca^{2+} additive. Calcium sulfate anhydrite will also supply Ca^{2+}, but it will dissolve more slowly than gypsum. With either gypsum or calcium sulfate anhydrite, it is important to know the composition of the material you select.

Table 2
Calcium additives and their appropriate use as affected by soil pH

Material	Soil pH <7.0	Soil pH >7.0	Comments
Acids	NO	YES*	Only effective in calcareous soils (*calcareous soils contain lime and usually have a pH>8.0)
Gypsum	YES	YES	Will not change soil pH
Lime	YES	NO	Raises soil pH; not soluble in higherpH soils
$CaSO_4$ (Anhydrite)	YES	YES	Dissolves more slowly than gypsum; will not prevent surface crusting
$CaCl_2$	YES	YES	Can raise soil salinity to unacceptable levels
$Ca(NO_3)_2$	YES	YES	Can raise soil salinity to unacceptable levels

DR. JIM WALWORTH, walworth@ag.arizona.edu, Department of Soil, Water and Environmental Science University of Arizona.

"A dream without ambition is like a car without gas... you're not going anywhere."
Sean Hampton

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Third Quarter 2012

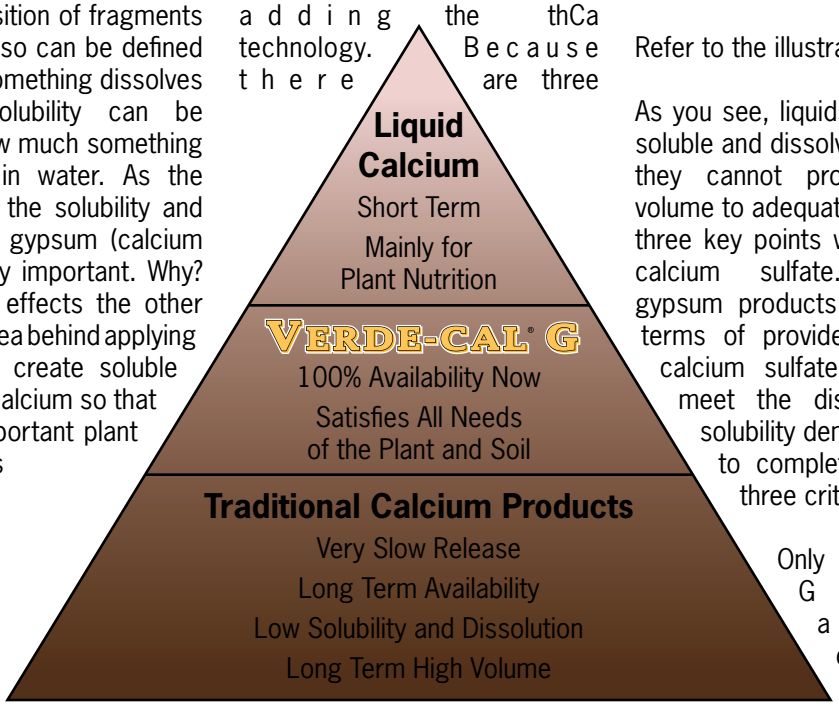
Verde-Cal G: Solubility and Dissolution

Dissolution can be defined as the decomposition of fragments or parts. It also can be defined as how fast something dissolves in water. Solubility can be defined as how much something will dissolve in water. As the USGA states, the solubility and dissolution of gypsum (calcium sulfate) is very important. Why? Because one effects the other greatly. The idea behind applying calcium is to create soluble and dissolve calcium so that three very important plant and soil needs are met.

Those being:

1. Plant uptake of Ca.
2. Leaching of Ca
3. Interaction with the soil to flocculate.

Verde-Cal G supports both dissolution and solubility by adding the thCa technology. Because there are three important criteria to meet when adding calcium, one must have the most soluble product available.



Refer to the illustration.

As you see, liquids can be very soluble and dissolved. However they cannot provide enough volume to adequately satisfy the three key points when applying calcium sulfate. Traditional gypsum products are good in terms of provided volume of calcium sulfate, but cannot meet the dissolution and solubility demands needed to completely treat the three criteria.

Only VERDE-CAL G will provide adequate dissolution, solubility and volume. Now you can satisfy the plant needs as well as leaching and soil flocculation.

AcidipHy: Mining Calcium Already Present in Soil

The USGA states in the their article that you can either add calcium to flocculate soil and feed the plant… Or… you can release what is already present. If you plan to track your soils with a standard soil test and paste test than you can accurately track the amount of calcium you put into solution by dissolving what is already present in that soil profile. This can take a lot of work! Timing of soil and paste tests is critical. And continuation of these tests must go on for accurate data collection. After all, you are budgeting dollars for this process and you must know if they are being spent wisely.

The USGA states that "any acid can dissolve soil calcium carbonate and release the bound calcium".

The products of choice are:

1. Sulfuric acid (injected)
2. Hydrochloric acid (not recommended)
3. Elemental Sulfur (applied granular)

Or, our product of choice:

4. AcidipHy (granular soil acid treatment)

There are setbacks to the first three options. Holding tanks, corrosion, burn and high rates to get the job done all effect these common sulfur products. So even though the USGA is right, the facts are that these products have a lot of limitations. Be sure you know what you are getting into before setting a course of treatment with any of these products. AQUA-AID's AcidipHy – granular soil acid treatment has shown some excellent results when releasing calcium already existing in the soil.

"I'm not upset that you lied to me, I'm upset that from now on I can't believe you."
Friedrich Nietzsche

"A little more persistence, a little more effort, and what seemed hopeless failure may turn to glorious success."
Elbert Hubbard

AcidipHy Continued . . .

AcidipHy is three synthetic acids, one organic acid, and Mn Sulfate. All on a porous ceramic carrier with two different particle sizes - sgn 75 or 150. Either particle size works great for specific target areas. AcidipHy is also available as a liquid in several convenient container sizes.

Visit www.aquaaid.com/products/acidiphy.html for more information about AcidipHy.

AcidipHy was developed so the turf manager will have a versatile means of treating troubled areas specifically resulting from poor water quality. All the problems that go with bad water are targets for AcidipHy. In fact, the worse the water, the better this product will perform.

AcidipHy works by releasing tied up calcium already present in the soil. The acidifying effect of AcidipHy also helps to balance the solution of the soil and thus providing Volumetric Release of calcium and other essential elements. The higher the rate of AcidipHy, the longer the effect lasts from the treatment. What this means is that many turf managers don't have to apply this product as often as other products acting as acidifiers.

AcidipHy is target site specific. Spread or spray it to the areas you need to treat. Injection products don't have this ability and cannot provide the volumetric release.

The test data below shows AcidipHy testing performed on June 15, 2009. It was run for two months.

"A perfection of means, and confusion of aims, seems to be our main problem."
Albert Einstein

AcidipHy Field Testing 2009

	Nursery Green Top 2" Root Zone				Nursery Green Lower 4" Root Zone			
	15-Jun Bench Mark	30-Jul	Aug. 14	Sept. 1	15-Jun Bench Mark	30-Jul	Aug. 14	Sept. 1
CEC	2.96	2.36	3.15	3.35	3.1	1.58	2.12	1.98
pH Soil	8.7	7.5	6.4	6.7	8.4	7.4	6.4	6.6
Sulfur ppm	10	15	14	23	21	13	8	11
Base Saturation:								
Calcium	73.55	64.48	60.83	65.53	82.57	66.01	60.55	64.43
Magnesium	7.61	20.82	17.21	14.69	5.04	20.63	17.28	20.11
Potassium	9.89	6.46	5.13	5.52	2.61	5.13	4.71	4.9
Sodium	6.47	5.3	2.81	3.52	6.81	5.44	3.35	4.21
Hydrogen	0	0	9	7.24	0	0	9	3
Other bases	2.7	2.9	5	3.5	3	2.9	5	3.4
Boron ppm	0.35	0.49	0.38	0.45	0.31	0.48	0.38	0.42
Iron ppm	40	53	53	57	49	65	48	52
Manganese ppm	6	24	24	24	2	8	15	10
Copper ppm	0.28	0.8	1.05	0.91	0.25	0.34	0.36	0.32
Zinc ppm	1.1	4.29	4.05	4.32	0.62	0.66	0.59	0.58
Bicarbonates (HCO3 ppm)	525	110	107	122	525	71	78	88
Salts (mmhos/cm)	0.11	0.11	0.09	0.12	0.12	0.08	0.06	0.08

For more information on how to interpret the soil test results, visit www.verde-cal.com/testing-brochure.pdf.

Water Made Easy

"People can lie about numbers but numbers can't lie about people."
Bernie Cronin

If you're a Turfnet follower, you may have seen the "Turf Zeolit's" recent request for feedback regarding what you or your customer is doing to treat bad water issues.

In his article he referenced a great chart that was developed at the Arizona State university. It really simplifies water. I recently wrote an article for Florida Turf Digest and used this chart.

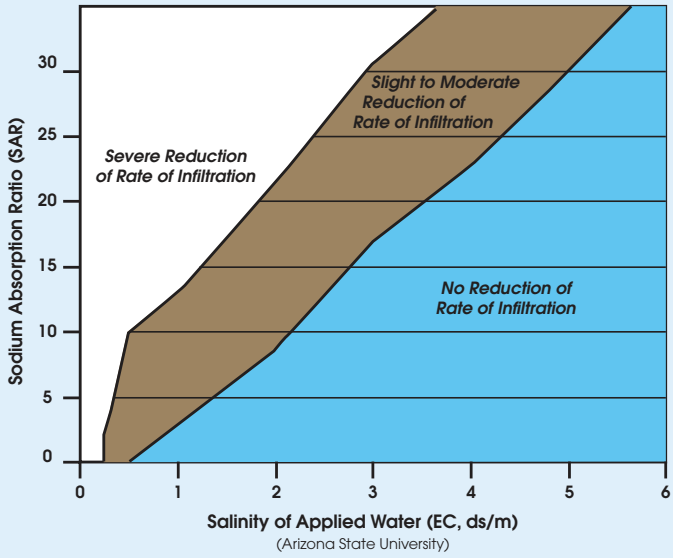
Here at AQUA-AID we made some additions to the chart to help you better develop an understanding for the situation you may have. It is a great reference guide to print and keep.

Water Continued . . .

Use this chart to help you better understand how soil issues can arise when irrigation water quality deteriorates. There are so many products available to the turf manager today, but are they really necessary? By knowing your Sodium Absorption Ratio (SAR) and your Electrical Conductivity (EC), you can use the chart to determine what you should be doing based on the potential for problems in the soil.

Many times I see a facility invest a lot of money in equipment or product that they may not necessarily need. Florida's overall weather patterns are quite easy to predict! (I may be the first to actually believe this.) By this I mean that Florida has a very predictable dry season and an equally predictable wet season. The dry season calls for every turf manager to be ready to amend soils properly to offset potential salt problems in the soil. The wet season usually does not provide enough flushing rainfall to adequately exchange the sodium built up on the soil colloid if those soils haven't been amended properly during the dry season.

I have found that it takes 85 lbs per acre of soluble calcium derived from calcium sulfate to establish a "base level" of calcium sulfate to adequately flush damaging salt such as sodium and bicarbonate. That is the bare minimum level necessary to lower high sodium base saturation effectively. After that, the rate can be dropped to about 45–50 lbs of soluble calcium sulfate per acre per month to maintain sodium base saturation the rest of the season. Do this properly and you move closer to the blue section of the chart referenced above, even with moderate to severe water problems.



Treatment Prescription

- **Gypsum and/or Soil and Water acidifiers. Acid water treatment REQUIRED.**
- **Gypsum and/or Soil and Water acidifiers. Acid water treatment potentially not needed.**
- **Gypsum and/or Soil and Water acidifiers as needed.**

Potash and magnesium play a role as well. Bermuda and paspalum will utilize at least 6 lbs or more of potash per 1000 sq ft per year. These same grasses will also utilize about 1 lb of magnesium per 1000 sq ft per year. Calcium, magnesium and potassium are all critical salts required to help keep sodium salts down and buffer the soil solution. I have seen success utilizing this very simple approach.

Regardless of the product you choose and the quality of your water source, strive for proper volume of nutrient, solubility and timing whether it is a dry or wet season. When dealing with poor water quality, you have to think outside the box a bit more. Nutrients such as calcium, magnesium and potassium can be more effective and efficient when derived from a granular application. These nutrients are needed in greater volume in the soil to buffer the soil solution.

And finally, keep aerification equipment tuned up and ready to go. You have already invested in this equipment, so put it to use to prevent the soil from compacting near the surface due to high salts. Coring, venting and pencil tining are excellent practices to use during the dry season and higher stress seasons to keep soil surfaces open and loose.

Integrating all of the above tactics into your current "water strategy" can help to increase the quality of your soil without creating excess strain on our dwindling water supply.

If you need more literature, please request some to be mailed to you by contacting one of the following:

maryanne@aquaaid.com
scott@aquaaid.com

Specify how much you need and where to mail it to.

FEED THE SOIL AND THE SOIL WILL FEED THE PLANT.