Choosing Your Fertilizer Based on Your Water Quality

by Sue Bottom

Most of the well water and public water supply in the St. Augustine area is derived from wells in limestone so the water tends to be moderately to very alkaline. This will cause white lime deposits to precipitate onto leaves and plug leaf pores as well as to minimize the uptake of the needed and naturally occurring calcium and magnesium. You can compensate for this poor water quality by using a water soluble fertilizer (about one quarter or one eighth strength) that will tend to neutralize the natural alkalinity. Water soluble fertilizers with nitrogen in the ammoniacal form generate acidity. Organic matter (like fir bark, coconut husks or redwood bark) in the potting mix will also buffer the pH and generate acidity. Once or twice a month thoroughly flush your pots to leach out residual salts. Here are some good fertilizers for our area that are readily available:

- For moderately to highly alkaline water, choose a fertilizer that has about half of the available nitrogen in the ammonia form (the other half being nitrate, avoid urea formulas). A balanced 20-20-20 fertilizer, available at retail outlets, will generate acidity and help neutralize some of the alkalinity in the root zone. SAOS offers a 20-20-20 which will generate acidity, contains micronutrients and is great for moderately to highly alkaline water, though supplemental magnesium will be required.

- For pure to moderately alkaline water or if you grow in a highly organic mix like bark or coconut husk, you can choose a non acidity generating fertilizer. The Peters Excel 15-5-15 Cal Mag available from SAOS is a low phosphorus MSU type fertilizer with calcium and magnesium.

- During the summer growing season, consider adding supplemental calcium nitrate (available at the local feed store) and magnesium sulfate (Epsom salts) monthly. Apply ½ to 1 teaspoon monthly with your fresh water flush, do not apply together (they will react and precipitate out of solution).

1.0 Understanding Water Quality

1.1 Terminology

There are certain technical aspects of water quality that are important to orchid growers.

Table 1
Definition of Water Quality Terms

Water Quality	Definition	Its Importance
pH	pH is a direct measurement of the balance between acidic hydrogen ions (H^+) and basic hydroxide ions (OH^-), and can be measured with a pH meter. The pH of a solution can range	When it comes to managing the pH of a substrate, the water alkalinity concentration has a much greater effect than does the water pH though water pH is still important for orchid growing. Even though it has little impact on the substrate, water pH does affect the

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	between 0 (very acidic) and 14 (very basic). At a pH of 7.0, the solution is said to be neutral. Irrigation waters should fall in the range of 6 to 7.5.	availability of nutrients and micronutrients, the solubility of fertilizers, and the efficacy of insecticides and fungicides. Generally, the higher the water pH, the lower the solubility of these materials.
Alkalinity	Alkalinity is a measure of how much acid it takes to lower the pH below a certain level, also called acid-buffering capacity. The ions that have the greatest effect on alkalinity are bicarbonates and to a lesser extent carbonates. The concentration of all of the ions that makes up the alkalinity term are combined and reported as equivalents of calcium carbonate (CaCO3).	Alkalinity is the most critical item to measure because it has a great effect on growing media pH. A certain amount of alkalinity is good, because it will buffer the solution from acidic influences such as peat moss and fertilizer. Excessively high or low alkalinity levels will directly impact the availability of micronutrients in growing media. Low alkalinity may lead to depressed growing media pH and micronutrient toxicities, while high levels of alkalinity can increase the growing medium pH over time and lead to micronutrient deficiencies.
Soluble Salts	Soluble salts or electrical conductivity (EC) is a general measure of the total concentration of salts dissolved in the water. An irrigation source is best if EC levels fall between 0.2 and 1.2 mmhos/cm.	Salt accumulation in the root zone can damage roots causing root tip burn. Regular monthly or bimonthly flushing of orchid pots will help dissolve and remove accumulated salts. Since the EC measurement does not identify which elements—helpful or harmful—are in the water, a complete nutrient analysis of water is necessary.
Calcium	Calcium is an essential element for plant growth that is often present in irrigation waters.	Calcium is required in large quantities by young growing tissues, strengthening stems and promoting strong overall plant growth. Low levels will lead to poorly developed younger leaves or buds and other growing point disorders. Scotts recommends that irrigation waters have a minimum of 40 to 75 ppm Ca. When calcium levels are below these levels, it's necessary to supplement additional calcium for optimum results.
Magnesium	Magnesium is an essential element for plant growth that is often present in irrigation waters.	Magnesium is an important component of chlorophyll, the green pigment that is responsible for photosynthesis. Irrigation waters should have a minimum 30 to 50 ppm Mg. Pure waters will generally not have sufficient magnesium, and deficiencies may occur unless the nutritional program addresses the need. Symptoms are generally expressed

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		as interveinal chlorosis of the older leaves first. Also, remember to maintain a good calcium-to-magnesium ratio in the growing media (2:1 is recommended).
Sodium	Sodium is an undesirable ion found in well water if wells are screened in a salty shell layer or the aquifer is impacted by salt water intrusion.	Sodium is toxic to orchids at elevated levels. Ideally the irrigation water will contain less than 10 mg/l sodium. Levels above 50 mg/l are considered potentially harmful.
Sources: Understanding pH Management and Plant Nutrition Part 2: Water Quality, Bill Argo, Blackmore Company, and Product Use Guide, Peters ABC Selection System		

1.2 Your Source of Water

Your water quality can vary greatly depending on its source.

- *Rainwater and Distilled Water* – have very low dissolved solids content, which is great. There pure waters also have virtually no buffering capacity so the addition of fertilizer can cause precipitous drops in pH and the water can end up with the acidity of vinegar, very deadly for your plants. If you are using this type of pure water, you will need to use a non acid generating fertilizer with calcium, magnesium and micronutrients because they are generally absent. The slow release Dynamite may be a good fertilizer choice because it will not result in cause such an acidic water reaction.

- *Well Water or Public Water Supply* – in the St. Augustine area is high in alkalinity and total dissolved solids. The naturally occurring calcium and magnesium may not be easily available to your orchids because the water is too alkaline. Another major potential concern would be the presence of sodium, which is toxic to your orchids and not particularly healthy for you. (Never use softened water unless your water softener uses potassium chloride instead of sodium chloride).

1.3 Alkalinity of Irrigation Water

The most critical aspect of your water quality is the alkalinity, because this will largely determine the conditions that will prevail around the roots of your orchids. The pH of the substrate or potting medium rather than the irrigation water determines the availability of nutrients. Most orchids like a slightly acidic substrate. The macronutrients and micronutrients tend to be available at their optimum level at a slightly acidic pH.

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The water in the St. Augustine area tends to range from water type 2 (moderately low alkalinity) to water type 4 (very high alkalinity). If you notice a lot of white leaf spotting on your orchid leaves, it is likely that your water supply is highly alkaline.

Table 2
Categorize Your Water Quality

Water Type	Alkalinity	Calcium	Magnesium
1 – Very Low Alkalinity	< 60 ppm	< 60 ppm	< 30 ppm
2 – Moderately Low Alkalinity	60 – 150 pm	< 60 ppm	< 30 ppm
3 – Moderately High Alkalinity	150 – 200 ppm	> 50 ppm	< 30 ppm
4 – Very High Alkalinity	200 – 240+ ppm	> 50 ppm	< 30 ppm

Source: Product Use Guide, Peters ABC Selection System

To categorize your water quality, it is best to obtain an analysis. You can get a very rough estimate of your water quality by taking a sample to a local pool supply company. Their results will give you a gross estimate of your water quality (you will have to adjust the value they give you for calcium, because they report it as calcium carbonate which must be converted to calcium by multiplying by 0.4). A much more accurate analysis can be obtained by sending a sample of your water to OAL in Panama City at a cost of about $25. Request the irrigation water suitability assay (nitrate nitrogen, ammonium nitrogen, phosphorus, potassium, calcium, magnesium, sodium, iron, manganese, boron, copper, zinc, molybdenum, aluminum, chloride, bicarbonate, carbonate, sulfate, electrical conductivity, and pH).

1.4 Impact of Fertilizer on Substrate pH

Once you know your water type, choosing the right water soluble fertilizer is easy. For water types 1 and 2, an essentially neutral fertilizer formulation would be best to prevent an abrupt drop in the substrate pH. For water types 3 and 4, an acidic fertilizer formulation would help neutralize the effect of the water alkalinity and make the naturally occurring calcium and magnesium more available to the plant.

Fertilizers high in ammoniacal nitrogen produce an acidic reaction. For example, 20-20-20 (69% ammoniacal nitrogen) has enough acidity to effectively neutralize water containing around 200 ppm alkalinity. There are several drawbacks to using fertilizer for alkalinity control. Fertilizers high in ammoniacal nitrogen may cause excessive growth and are not effective when the temperature of the substrate is less than 60^{o}F. In addition, you lose flexibility because you can only choose commercial fertilizers based on ammonium content. For example, high ammonium fertilizers may lack calcium or other key nutrients.

Different fertilizers, their suitability for a given water type and the potential basicity and acidity of the fertilizer are summarized in the following table.

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Table 3
Peters/Scotts Fertilizers Suitable for Your Water Quality
(listed in order of increasing acidic reaction)

Fertilizer Name	**Formula** N-P-K Ca, Mg Micronutrients	**Description**	**Fertilizer Reaction** Pounds of acidity (A) or basicity (B) per ton of fertilizer
Peters Excel 15-5-15 Cal Mag Special*	15-5-15 5 Ca, 2 Mg micronutrients	Excellent all-purpose formulation combines high nitrate and low phosphate with extra calcium and magnesium. Ideal for type 2 irrigation water.	131 Basicity
Peters Excel 17-3-17 Peat Lite Neutral Cal Mag**	17-3-17 4 Ca, 1.5 Mg micronutrients	Premium all-purpose formulation produces a nearly neutral reaction to help maintain steady pH in growing media. Ideal for water types 1 and 2.	27 Basicity
Peters Professional 15-5-25 Peat Lite Flowering Crop Special***	15-5-25 2.5 Mg micronutrients	Proven high-nitrate, low-phosphate formula for many flowering crops that are sensitive to boron. Effective for all water types.	48 Acidity
Peters Excel Multi Purpose 21-5-20***	21-5-20 micronutrients	Moderately acidic formulation serves as an excellent all-purpose fertilizer for water types 2, 3 and 4.	300 Acidity
Peters Professional 18-8-17 Peat Lite High Mag Special**	18-8-17 2.5 Mg micronutrients	Highly effective stand-alone fertilizer with extra magnesium to maintain deep green foliage. Excellent stand-alone for water types 3 and 4; as a base in water types 1 and 2.	381 Acidity
Peters Professional 20-10-20 Peat Lite Special*	20-10-20 0.15 Mg micronutrients	Versatile formula can be used in year-around operations; acidifying action corrects excessive pH in growing media. Effective for all water types.	415 Acidity
Peters Professional 20-20-20 Ag & Landscape Special*	20-20-20 micronutrients	Classic formula. Acidifying action can help combat excessively high soil pH	570 Acidity

*Fertilizers are available from the St. Augustine Orchid Society
**Product not currently available from BWI in Apopka
***Fertilizer available from BWI in Apopka

1.5 Organic Matter in Potting Mix

The type and amount of organic matter present in potting mixes will also affect the pH of the substrate in the orchid pot. Pure water, such as rainwater or water low in alkalinity, will allow the substrate to exert a greater influence on root zone pH for a longer period of time

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- *Sphagnum Moss* – is a very water retentive medium that becomes so acidic (a pH of around 4) that bacteria and fungi cannot survive in it. It also breaks down fairly rapidly, with a life of one or perhaps two years. Some growers swear by sphagnum and others cannot successfully grow in sphagnum.

- *Organic Matter* – like fir bark, coconut husk and redwood bark and to a lesser extent tree fern will increase the ability of your potting mix to hold water and nutrients so they will be available to the plant for a few days after you water. They will decompose over time and one of the byproducts of their decomposition is increased acidity. Redwood bark in particular generates acidity.

- *Inorganic Matter* – like lava rock, hydroton, aliflor and charcoal has a large surface area that holds water for later uptake by the orchid. These materials are inert and will not degrade over time but will build up mineral deposits so it is important to flush the plant regularly. These substances have little pH buffering capacity.

2.0 Mineral Nutrition

A complete fertilizer program provides macronutrients needed in large quantities and the micronutrients needed in small quantities. The nutrient content of the irrigation water can supply a large percentage of nutrients, especially calcium and magnesium, to the plants. The macronutrients required for orchids are listed in the following table.

Table 4
Mineral Nutrition for Orchids

Macronutrients	Continuous Feed (ppm) Fertilize at Least Weekly	Periodic Feed (ppm) Fertilize Less than Weekly
Nitrogen, N	60 - 100	100 - 200
Phosphorus, P	10 - 20	20 - 40
Potassium, K	60 - 100	100 - 200
Calcium, Ca	40 - 80	80 - 160
Magnesium, Mg	20 - 40	40 - 80
Sulfur, S	15 - 25	25 - 50
Micronutrients		
Boron, B	trace	< 0.8
Iron, Fe	>0.5	2
Manganese, Mn	> 0.2	2
Zinc, Zn	1	2
Copper, Cu	trace	< 0.2
Molybdenum, Mo	trace	<0.05
Source: adapted from Bob and Lynn Wellenstein, AnTec Laboratory		

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If you match the acidifying effect of your water soluble fertilizer to the alkalinity of your irrigation water and are using a balanced low urea commercial fertilizer at a rate of 50 to 100 ppm nitrogen, your likely only serious mineral nutritional concerns are calcium and magnesium. Orchids grown in bark probably require twice that nitrogen level to compensate for the nitrogen consumed in bark decomposition.

2.1 Fertilization Rates

Using high fertilizer application rates will cause faster growth but it is possible the plant will be more susceptible to fungal and bacterial diseases.

- *Choose Target Nitrogen Level* - For a mixed collection, 70 ppm N should work well for weekly feeding. To calculate your total dissolved solids (TDS) and nitrogen concentration, get the N-P-K concentration (minus any urea) from the product formulation and enter it into this calculator from the First Rays website. Try to keep the TDS below around 200 ppm and adjust your fertilizer addition rate (teaspoons of fertilizer per gallon of water) to attain your desired nitrogen ppm.

- *Flush Pots Regularly* - Flush your pots religiously, once or twice a month, with your raw water. Water the plant until water runs out the bottom of the pot and then water some more. This will dissolve the salts. Wait 15 to 60 minutes and then repeat this flushing procedure, this will flush the dissolved salts out of your pot.

- *Calcium and Magnesium* – You can use a fertilizer that contains calcium and magnesium and/or use an acidifying fertilizer so the naturally occurring calcium and magnesium are available to your orchid. During the summer growing season, consider adding supplemental calcium nitrate (available at the local feed store) and magnesium sulfate (Epsom salt) monthly. Apply ½ to 1 teaspoon monthly with your fresh water flush, do not apply together (they will react and precipitate out of solution). Another alternative is to incorporate dolomitic lime into their potting mix or top dress pots with dolomitic lime, particularly for cymbidiums and paphiopedilums.

2.2 Nutrient Deficiencies

Table 5 addresses the signs of deficiency or an excess of nutrients that can be used to diagnose any deficiency in your fertilizer program. An element's translocatability in the plant is important in diagnosing deficiencies. If it is translocatable, the plant can remove it from tissue in one area and transport it for use in another, so symptoms of deficiency typically occur in the more expendable older tissue. Conversely, if the element is not translocatable, then the deficiency will show more in the new growing area of the plant. If you are fertilizing, the most likely cause of a mineral deficiency is the loss of the roots of the plant leaving the plant unable to absorb the needed nutrient levels.

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Table 5
Signs of Deficiency and Excess of Mineral Nutrients

Mineral Elements	Primary Functions in Plant	Signs of Deficiency	Trans-locatable ?	Signs of Excess
Nitrogen, N	Growth of green (leaf and stem) portions of plant	Reduced growth, vigor, chlorosis of older leaves first, premature leaf drop	Yes	Soft growth, spindly growth, leaf curl, reduced flowering, symptoms of potassium deficiency
Phosphorus, P	Essential for root growth, flowering and seed production	Older leaves affected first, an increase in anthocyanin pigment and a dark blue green coloration, sometimes with necrotic areas and stunting	Yes	Symptoms of nitrogen, zinc and iron deficiencies
Potassium, K	Root growth, sugar and starch production, cell membrane integrity	Dwarfing, chlorosis of older leaves first, leaf curling	Yes	Symptoms of nitrogen, magnesium, calcium, iron, zinc, copper and manganese deficiencies
Calcium, Ca	Cell wall formation, cell division, enzyme catalyst, neutralization of toxic metabolites	Poor growth, deformed or chlorotic newer leaves, blackened areas at leaf ends and new growths with a leading yellow edge, stunted, shortened roots, dead root tips	Slightly	Symptoms of magnesium deficiency
Magnesium, Mg	Chlorophyll and protein production, carbohydrate metabolism, enzyme activation	Interveinal and marginal chlorosis starting in the older leaves, increase in appearance of anthocyanin in leaves, necrotic spotting	Yes	Symptoms of calcium deficiency
Sulfur, S	Protein formation, photosynthesis and nitrogen metabolism	Root stunting, general chlorosis starting with younger leaves	No	
Boron, B	Sugar transport, DNA synthesis	Death of meristematic tissue, root stunting, no flower formation	No	Interveinal leaf necrosis
Iron, Fe	Component of cytochromes and ferrodoxin, synthesis of chlorophyll	Interveinal chlorosis of newer leaves	No	

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Mineral Elements	Primary Functions in Plant	Signs of Deficiency	Trans-locatable ?	Signs of Excess
Manganese, Mn	Enzyme activation in respiration and nitrogen metabolism	Interveinal chlorotic and necrotic spotting	No	Stunting, necrotic spotting of leaves
Zinc, Zn	Trytophan synthesis, electron carrier protein in chloroplast	Smaller, distorted leaves, stunting, interveinal chlorosis of older leaves, white necrotic spotting, resetting	No	Symptoms of magnesium and iron deficiencies
Copper, Cu	Enzyme component, electron carrier protein in chloroplast	Stunted misshapen growth	No	Symptoms of magnesium and iron deficiencies
Molybdenum, Mo	Nitrogen and potassium metabolism	Chlorotic interveinal mottling, marginal necrosis, folding of the leaf, no flower formation	Slightly	

Source: Bob and Lynn Wellenstein, AnTec Laboratory

3.0 Citations and Information Sources

Fertilizer ppm Calculators, Ray Barkalow, First Rays,available online at http://www.firstrays.com/fertcalc.htm

Mineral Nutrition for Slipper Orchid Growers, Bob and Lynn Wellenstein, AnTec Laboratory, available online at http://www.ladyslipper.com/minnut.htm

Peters Complete Product Use Guide, available online at http://everris.us.com/peters-complete-product-use-guide-usa
Peters ABC Selection System, available online at http://everris.us.com/plant-nutrition/water-soluble-fertilizers

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