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Calcium Deficiency in Cattleyas **Understanding Orchids with Roy Tokunaga – Part 2**

by Sue Bottom, sbottom15@gmail.com



1. Roy Tokunaga of H&R Nurseries, dedicated to mastering the art of orchid growing.

Roy Tokunaga of H&R Nurseries in Hawaii has spent countless hours during his orchid growing career trying to understand how the best growers grow their orchids, studying the science underlying cultural practices and experimenting with different approaches to test these theories. Here are some of his insights on calcium deficiency in orchids, what can cause it and how to prevent it from occurring.

You already know that calcium is an essential nutrient required for optimal growth of your orchids. Calcium is absorbed through the roots and moved upward through the xylem via the transpiration process. It increases cell wall thickness and strength among other things as well as a plant's resistance to fungal and bacterial disease. The plant requires calcium the most during periods of active growth, while it is building new tissue. It must be supplied to the plant ratably in proportion to its growth rate. Calcium is mostly immobile in the phloem so the plant cannot translocate it from the older growths to the newer growth, like it can some of the other essential elements. An easy way to supply calcium to your plants is through water soluble calcium bearing fertilizers or calcium nitrate applications and many growers use media supplements like dolomitic lime (which supplies magnesium as well as calcium), gypsum (calcium sulfate) and calcium carbonate supplements (egg shells, oyster shells, etc.).



2. Despite using a Cal Mag fertilizer and other calcium supplements, black necrotic tissue at the leaf tips, often with a yellow halo, suggestive of calcium deficiency occurred through the growing season.



3. Just because it is black and rotting, do not mistake the signs of calcium deficiency for the fast moving summer rots from excess leaf wetness (shown here) or the deadly black rot from the water molds.



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The most obvious sign of the deficiency is rapidly expanding tissue that becomes necrotic, such as a newly forming leaf or pseudobulb. Do not mistake this damage for the black rot caused by water molds just because it is black and the tissue looks like it is rotting. Black rot is a fast moving disease that often starts at the base of pseudobulbs and moves upward through the plant, killing within days. The necrotic tissue from calcium deficiency slowly continues to blacken. It is unsightly but not fatal to the plant. If you have been supplying enough calcium to your orchids in your fertilizer program but are still seeing the signs of calcium deficiency, there is some other cultural issue for you to diagnose and correct.



4 a, b and c. Black leaf tips plagued me all summer long, the necrosis just kept moving down the leaf even after cutting damaged tissue away.

The plants in my greenhouse receive lots of calcium in their diet, from what is naturally present in the water as well as Cal Mag fertilizer and calcium nitrate applications. Despite the high calcium diet, there were still black leaf tips on cattleyas during the growing season, a characteristic sign of calcium deficiency. I suggested to Roy Tokunaga, who was visiting on a speaking tour, that it was impossible for my plants to have a calcium deficiency. Roy, if he had been wearing his deerstalker hat, might have said "...once you eliminate the impossible, whatever remains, no matter how improbable, must be the truth". Roy just smiled and then proceeded to explain how a damaged root system, an accumulation of salts in the root zone or inadequate hydration can all impede calcium uptake.

Root Damage. Despite your best efforts to supply sufficient calcium, your plants can still suffer from deficiency if something interferes with the uptake of this critical element. Calcium is mostly absorbed through the roots so a compromised root system can easily manifest itself in signs of calcium deficiency. Root function can be disrupted for many reasons. One of the most common causes of root damage is the repotting process itself, particularly when orchids are repotted when new roots are not actively forming. The older roots are damaged in the repotting process and the plant must send out new roots to stabilize. Chewing pests like snails and roaches can eat the tender new root tip. Once damaged, the roots need to regrow before the plant will stabilize and be able to absorb water and nutrients. A waterlogged potting mix can suffocate roots. Water logging does



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not occur as a result of overwatering per se, it occurs when there is insufficient air around the roots because the potting mix is too fine or the organic matter has degraded and compacted around the roots.



7. Catasetums are heavy feeders, so they get both water soluble and timed release fertilizers. Even though they are flushed by summer rains, look at the salt accumulation on this pot after a single growing season. If you see salt deposits on the outside of your clay pots, you can assume the roots on the inside of the clay pot are also exposed to a high salt content, flush!

Salt Build Up Around Roots. As long as the concentration of salts in the potting media is less than that inside the root, water is pushed into the root by osmotic pressure, termed root pressure. Salts naturally present in your water supply or added by fertilizers can build up in the potting mix from the repeated wetting and drying cycles. Organic matter like peat and sphagnum moss tends to retain salts. Unless flushed from the pot, high salt levels can build up to unsafe levels so that water will tend to move out of the root rather than into the root. The root damage might be obvious, roots look stunted and may have brown markings. A sure sign of excess salts is when the root looks fine until it touches the clay pot or top of the media and then blackens.

Inadequate Hydration. Calcium uptake is directly related to the transpiration rate, the process by which most of the water absorbed by the roots is pulled upward through the vascular tissue and ultimately evaporated from the stomata (openings) in the leaves. Plants that are not transpiring at a high rate do not take up large amounts of calcium. One adaptation to an epiphytic orchid lifestyle is a thick cuticle with few stomata to limit water loss. Cattleyas and other CAM orchids have adapted to a xeric environment by keeping their stomata closed during the day, only opening at night when temperatures are a little cooler and humidity is higher, in an effort to prevent water loss. When humidity is very low, the stomata may remain closed both night and day, in which case transpiration cannot occur severely limiting the amount of calcium that can be absorbed. If grown under too dry conditions, there may not be enough moisture taken up by the roots or that can be robbed from adjacent cells for there to be a continuous flow of water from the roots to the leaves for transpiration. A strong transpirational pull is essential for calcium uptake.

Excess Phosphorus Levels. Different cations can compete for uptake. High phosphorus levels have been found to increase die back symptoms in cattleyas (Poole and Sheehan) because excess phosphorus is antagonistic to calcium absorption by the root system. The phosphorus level of 100 ppm used in their experiments to induce leaf-tip die-back is



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probably more representative of what might be expected when using bloom booster fertilizers, those with a high middle number in the fertilizer formula. As long as you are not using bloom boosters too frequently or acidifying your water with phosphoric acid, excess phosphorus levels are probably not a concern for the orchid hobbyist. To a lesser extent, potassium and some other nutrients can be antagonistic to calcium uptake but this would not be expected to occur with most fertilizer formulations.



5. Roots should be a uniform white when dry with nice green root tips, not these stunted roots that have brown discoloration.



6. The damaged roots on this bifoliate are just starting to regrow, you can see the branching rootlets emerging from the older roots.

Unusually High Temperatures. In their article *Leaf-tip Die-back of Cattleya – What's the Real Cause*, Poole and Sheehan postulate that unusually high temperatures in the absence of the cooling effects of frequent watering can interfere with calcium uptake:

Several factors must therefore be present in order for die-back symptoms to occur. First, the plant must be in active vegetative growth, especially the stage of rapid leaf expansion which would require high light intensities, good fertilization and warm temperatures. Second, temperatures surrounding the root system must be higher than normal. The epiphytic medium can be expected to reach temperatures comparable to the high air temperatures of a greenhouse during the summer months unless some control of root temperatures is used, such as more frequent watering. However, any cultural factor that would injure the roots and affect their capacity to absorb calcium during periods of active vegetative growth could in itself induce calcium deficiency without high root temperatures. Third, the degree of susceptibility is dependent upon the genetics of the plant. We have noted symptoms on Cattleya hybrids, Epidendrum anceps, Stanhopea species and possibly Vanda from which we did not take tissue samples.

Lessons Learned. Roy is not the kind of guy that walks into your growing area and tells you what you're doing wrong. He does not like to make a diagnosis based on a simple



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visual impression after a walk through, but his powers of observation are keen and after much discussion, he offered his opinion as to why some of the cattleyas were suffering from calcium deficiency despite their high calcium diet. The verdict: inadequate hydration compounded possibly by inadequate flushing of salts from the pot. Some of the roots on the plants with calcium deficiency symptoms looked stunted and perhaps the potting media being too dry during an extraordinarily hot July could have exacerbated the problem.

The contrast between the plants grown under cover in the greenhouse and those grown in the new shade structure without a roof was significant. Both receive the same fertilizers but shade structure plants were better hydrated from the morning dews and summer rains, which also helped flush excess salts. Plants growing in the shade house were also cooler in the heat of the day than those in the greenhouse because of the more buoyant air movement and more frequent watering schedule. These cattleyas are potted in an ultra-coarse, freely draining mix to be able to withstand a week of rainy weather during the tropical storm season.

Roy's suggested solution was pretty simple, adjust the watering practices in the greenhouse. Roy recounted advice from his mentor, Wilbur Chang, who recommended an initial watering followed by a second more thorough watering an hour or so later, to mimic the water uptake that might occur in a gentle rain. The velamen surrounding the roots has an opportunity to change from the hydrophobic state in which the velamen functions to limit water loss to the hydrophilic state in which it swells and absorbs moisture like a sponge. Dycus and Knudson documented how orchid roots absorb moisture the fastest during the first 90 minutes after immersion in water, and then continuously though at a decreasing rate for the next 7 days. Perhaps even though I water frequently, not enough moisture is retained in the coarse mix after a single watering pass. The double watering step not only helps hydrate your plants, it also helps leach salts every time you water, similar to the practice recommended by Bergman in his excellent article about leaching salts from the medium. The more dissolved solids are present in your water, and the more organic matter in your mix, the more critical it is to leach salts away from the roots to prevent salt toxicity. Roy had another suggestion, consider top-dressing the pots with sphagnum moss or cypress mulch, anything that will retain moisture in the top of the pots that the plants can use to keep the roots a little cooler and better hydrated during the hot summer months.

These two changes, double watering and top dressing cattleyas after repotting, were instituted immediately. The growth response from double watering was impressive with the plants just looking happier. The next growing season confirmed that the combination of healthy, hydrated and cooler roots in addition to plenty of calcium prevented the young cattleya leaf tips from turning black.



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Orchid growers spend a lot of time worrying how best to supply the proper nutrition to their plants. Not only do you have to give them enough calcium, you need a healthy root system that can absorb the calcium. There must be sufficient moisture available for the calcium to move upward in the plant with the transpiration stream. It is all about the roots, a healthy root system is the key to your orchid growing success.

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References and Additional Reading:

Adam, Sinclair, The Power of Calcium, *Greenhouse Management*, September 2016. Accessed October 5, 2016: <http://www.greenhousemag.com/article/the-power-of-ca/>

Bergman, Fred, 2004. Leaching - A Practice for Growing Quality Plants, *Orchids*, 73(5): 372-377.

Doyle, Arthur Conan, *The Sign of the Four*, ch. 6 (1890). Sherlock Holmes in *The Sign of the Four* (Doubleday p. 111)

Dycus, Augustus M., and Lewis Knudson. 1957. The Role of the Velamen of the Aerial Roots of Orchids. *Botanical Gazette*, 119(2), 78-87. Retrieved from <http://www.jstor.org/stable/2473023>

Holding, David R., Anne M. Streich, *Plant Growth Processes: Transpiration, Photosynthesis and Respiration*, EC1268, University of Nebraska Lincoln Extension

Poole, Hugh A. and T.J. Sheehan. 1970. Effects of levels of phosphorous and potassium on growth, composition and incidence of leaf-tip die-back in *Cattleya* Orchids. *Proc. Fla. State Hort. Soc.* 83: 465-469.

Poole, Hugh A. and T.J. Sheehan. 1973. Leaf-tip Die-back of *Cattleya* — What's the Real Cause? *Am. Orchid Soc. Bull.* 42(3):227-230.