

...but my trays were clean!

Part I: Micronutrient Toxicity, pH, and Water

By Barbara Pershing



Culture break; brittle foliage; tight, deformed center; color change; suckers; center leaves twisted. Young plantlet from plantlet that appeared normal when removed from mother leaf taken from plant in photo 2.

Where do I start my saga? With the desire to have clean trays? With the pH of the soilless mix and water? With my “head in the sand” concerning the symptoms I was seeing in my plants? Diagnosing and solving the problem with the plants in my collection has been a learning experience that I want to share, hoping that it will prevent others from experiencing the same disaster.

Looking back on the success I’ve had with violets, I recognize that I have not had the quality of violets I had before I installed a reverse osmosis system several years ago. I had been using well water and was tired of the ever-present buildup of minerals in my wicking trays. (Loved those clean trays with the reverse osmosis water!) Reverse osmosis takes all of the ‘hardness’ minerals out of the water, and I didn’t have to scrub trays! That’s good! So why would this be one of the suspected variables?

Put the potting mix into this equation. Our club obtained potting mix from a company that mixes for nurseries in the Midwest. We had the mix made with 1 part Canadian sphagnum peat, 1 part perlite, and 1 part vermiculite, plus dolomite lime as a buffer for the acidic peat. It is probable the company assumed that most people in the Midwest use well water, which is quite alkaline; therefore, they didn’t add much dolomite lime. Also, the acidity of peat varies from batch to batch, so this is an unknown variable. Club members had concerns over time from batch to batch, but other than calling the company and discussing our concerns did we ever do anything so simple as checking the pH of the mix – another “head in the sand” situation! I have read articles about pH but just didn’t connect this with the

symptoms I was seeing in my plants. Emory Leland wrote several articles (1969, 1974, 1981, and 1982) in the *African Violet Magazine* on pH and violets. I identified with him when I read in the first paragraph of one of his articles: “Never did I suspect that the pH of my

soilless potting mixture might possibly be the root of my trouble” [Leland, 1984].

How does this fit together? The ideal pH range for African violets is 6.5 to 6.8. My well water tested 7.9 pH. This water had enough calcium carbonate and other minerals to buffer the acidity of the soil mix I was using before reverse osmosis. When I started using the reverse osmosis water with a pH of 7.0 and all of the minerals removed, it did not have buffering ability for the acidic mix, and my plants started to show symptoms of what I now know as *micronutrient toxicity*. . . but my trays were clean! I would never have figured this out if Joyce and Kent Stork hadn’t looked at the photos I sent them and suggested I visit with Tom Bruning, Greenhouse Manager, University of Nebraska – Omaha, for help in identifying the problem.

What to look for? Micronutrient toxicity syndrome is the accumulation over time of excessive levels of trace



Shows culture break, deformed and twisted foliage.

elements in the tissues of the plant. “Toxicity symptoms are difficult to recognize visually (only someone with a lot of experience can do it) and are usually mistaken as deficiency symptoms. Visual identification of the problem is difficult in the absence of information (laboratory analysis) and damage may be occurring that is not yet visible.

By the time it becomes visible, the damage may be irreversible.” [Pasian, 1998]

Symptoms of micronutrient toxicity include: slow, stunted growth; light green to yellowish green foliage; dark, brittle older foliage; few small blossoms that may not open or may be small and off color; small, tight, crisp center leaf growth; extensive suckering; and, culture break between larger older leaves and new growth, depending on when the toxic effects began in the growth cycle of the plant. Leaf deformity usually occurs in older, lower leaves, but recently matured leaves will twist and curl, and eventually the new center leaves will be twisted and deformed. The plants don’t “die”, and the roots look fine, but eventually, the centers will deteriorate, and what is left isn’t pretty! I suspect many plants have gone to the compost before they get this bad.

By the time a diagnosis of micronutrient toxicity was made I had exhausted all possibilities – too much light, not enough light, too much fertilizer, not enough fertilizer, mites, other pests, change this, throw out plants, change that, throw out more plants. Micronutrient toxicity is irreversible; the plants will not grow out of the toxicity, and leaves and



Older plant showing effects of micronutrient toxicity over period of several months.



*Deformed blossoms;
culture break.*

leaves, showed toxicity symptoms within a few weeks and were sent to the compost along with most of the plants in my collection. Sad, but my trays were clean! I had to find out more.

Different species of plants have different pH requirements and levels at which micro-nutrients are toxic to the plant, and the genetics of the plant may determine why some cultivars are more susceptible than others. From observations of my violets, variegates were the first to show symptoms and some cultivars, both variegated and green foliage, were more susceptible than others. Trailers weren't as affected as standards, but when trailers did develop toxicity symptoms, the plant developed many tight crowns with leaves that were very small and brittle. The semi-minatures were the first to show signs of trouble and the first to go to the compost. Other gesneriads may have different pH requirements. Chiritas and some other gesneriads do well at pH closer to 7.0, and with the low pH soil I was using, most of the other gesneriads in my collection did not survive. Most general information on pH and plants



*Culture break; recent
toxic conditions.*



*Mother leaf from toxic
plant with one
deformed plantlet.*

suggests that plants need pH levels at 6.0 or above to thrive. The ideal pH range for African violets is slightly acid soil having a 6.5 to 6.8 pH. The mix I was using with reverse osmosis water tested well below 5.5, the lowest the pH test strips measured, which is about 50 to 100 times too acid.

Since the problem has been identified, I have read everything I could find



*Culture break; showing
color change in foliage.*

suckers taken from toxic plants will not produce healthy plantlets. When I began to see problems with my plants, the first defensive thing I did was to put down leaves. Not a good idea! Only a few leaves produced plantlets, and a few healthy looking plantlets, when separated from mother

about soil and water pH, reverse osmosis, soil mixes, micronutrient toxicity, water quality, nutrient requirements of African violets and anything else related to this. I found several sources of information on the Internet, many articles in *African Violet Magazines* from the past 60 years pertaining to these topics (the AVM Index served me well!), and e-mail communications with several experts.

Several factors are involved: water source, quality, and pH; growing media pH and components; and fertilizer. I will rely on these many sources of information to bring this together.

What is pH? pH is a measure of the degree of acidity or alkalinity of a substance. It is an arbitrary scale of values set from 0 (strong acid) to 14 (strong alkaline) with 7.0 as



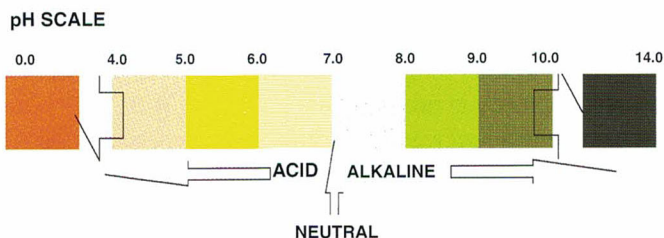
*'Frozen In Time' shows
deformed center,
culture break, brittle older
leaves, deformed blossoms
and suckers.*



*'Alliance' shows most of
the symptoms of
micronutrient toxicity -
brittle, deformed older
leaves, color change,
culture break, and small,
deformed center.*

neutral (neither acid or alkaline). Distilled water is an example of neutral pH. The pH scale is exponential and indicates the relative strength of the acidity-alkalinity of a substance. A unit change in pH represents a ten-fold change in acidity or alkalinity. A soil of 6 is ten times as acid as one of pH 7. A soil of pH 5 is one hundred times

as acid as one of pH 7.0 and a pH of 4.0 one thousand times as acid as 7.0.



Water

Irrigation water, i.e., the water used for plants, differs a great deal in pH and minerals depending on the source and treatment – well water, city water, rainwater, reverse osmosis or distilled water. Most ground water sources from wells are alkaline with pH above 7.0 and may be as high as 8.0 depending on the aquifer source, time of year, water table and weather. A professional testing lab can test water pH and alkalinity. These tests cost between \$12 and \$15 each. Rainwater and treated water such as reverse osmosis and distilled water are normally neutral but can be slightly acid. Information on pH and components of municipal water should be available from the city water department.

Alkalinity should not be confused with the term 'alkaline', which describes the situation where pH levels exceed 7.0. Alkalinity is not pH. Alkalinity is the concentration of soluble compounds including calcium, magnesium, and sodium bicarbonate that has the ability to neutralize acids in the water. Alkalinity is related to pH, because water with high alkalinity has a high "buffering capacity" or capacity for neutralizing added acids and has a big effect on potting mix pH. Alkalinity can be thought of as the "liming content" of water; alkaline water and limestone react very similarly when added to a potting mix. The primary problem associated with low alkalinity of water (rain water, reverse osmosis water, distilled water) is a tendency for the soil-pH to drop over time, which can cause micronutrient toxicity problems. The raw water source should have an alkalinity of about 80 to 100 mg/L calcium carbonate for horticultural purposes. Most municipal water sources are in this range. The alkalinity of my well water tested 196 mg/L. While my plants are doing well with this water now that I have the pH of the mix in the 6.5 to 6.8 pH range, Allison Brigham suggested, "If it is much higher than 80 to 100 mg/L calcium carbonate, consider adjusting the pH; adding a compound – usually an acid – that will convert enough of the bicarbonate ions to carbon dioxide and lower the pH." Mixing reverse osmosis and well water may be an option for me as the nutrients and buffering of the well water will still be available, the pH of the water will be lowered, the alkalinity will be reduced, and . . . some of the minerals that cause the scale buildup on my trays will be reduced.

Often, alkalinity and hardness are equated. 'Hardness' is the measure of water's ability to form scale in plant trays! (My nemesis!) Hardness is really a measure of the combined concentration of calcium and magnesium in the water because it is insoluble salts of ions, like calcium carbonate that form the scale. Hardness tells little about a water's ability to supply nutrients to a plant, and plants tolerate high levels of these elements, so toxicity is not normally a problem with hard water. Water softeners remove the calcium and magnesium ions and replace them with an ion that doesn't cause scale, like sodium or potassium. With hardness removal, the carbonates and bicarbonates remain in the water, but they have been changed to sodium or potassium bicarbonate. Thus, hardness removal has no effect on pH management. Do not use softened water! The sodium or potassium chloride used in water softeners will cause salts to build up in the soil and will be hazardous to the plants. I was told by a water conditioner salesperson that water softened with potassium chloride was safe to use on plants and; I have noticed that this information is on the potassium chloride bags. However, according to Robey (*African Violets: Gifts From Nature*) potassium chloride is only slightly less of a potential salt problem than sodium chloride. The result would be trading one problem for another!

Many growers use rainwater successfully. Rainwater is usually neutral pH unless there is considerable pollution in the

air. If the pH of the soilless mix is between 6.5 and 6.8 and the fertilizer regimen supplies all needed minerals, there should be no problem, but it is essential to keep the pH at this level as there will be no buffering from this water.

Reverse osmosis (RO) water was not the cause of the micronutrient toxicity in my plants, but it was a contributing factor. Softened water is fed into reverse osmosis systems where the potassium or sodium salts and most mineral ions are removed by the reverse osmosis process. The pH of RO water is 7.0 (neutral), and there are no minerals left to buffer the acidity of the peat. When there is little buffering available in the water, the rate at which the dolomite lime is used increases. Also, the reverse osmosis process will remove essential elements that are important to the plant, and if not supplemented, may cause an imbalance between nutrients or cause nutrient deficiencies. The same would be for rainwater or distilled water.

Micronutrient toxicity in African violets (or any plant) is the result of low (acidic) pH. A combination of factors, including water and growing media pH, fertilizer, and nutrient availability contribute to the diagnosis and solution. Part II, in the May '07 AVM, will discuss fertilizer, growing media pH, and pH testing, which should be a part of every African violet growers' regimen. The combination of fertilizer, soilless mix variables, and water must be considered when maintaining a pH of 6.5 to 6.8 for optimum growth of African violets.

Resources:

- Argo, Bill "Understanding pH management and plant nutrition – Part 2: Water Quality" <www.repotme.com/IPA/Part_2_waterquality.pdf>
- Bruning, Tom (e-mail communications)
- Brigham, Allison (e-mail communications)
- Hulme, F., and Ferry S. "How to Avoid Micronutrient Toxicity Syndrome" <www.greenbeam.com>
- Iowa State University Horticulture Guide, "Irrigation Water Quality for Container-grown Plants," Pm1699. Feb. 1999.
- Leland, Emory E. "African Violet Maladies Related To Nutrients, pH and Soil," African Violet Magazine, January 1982.
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- University of Tennessee Agricultural Extension Service. "Irrigation Water Quality for Greenhouse Production" <www.utextension.utk.edu/publications/pbfiles/pb1617.pdf>