# "But My Trays Were Clean!"

## *Part II: Micronutrient toxicity: fertilizer, soilless mixes, and pH testing*

By Barbara Pershing

Micronutrient toxicity in African violets (or any plant) is a combination of factors, including: water source, water quality, and pH; fertilizer; and growing media pH and components. Identification of micronutrient symptoms, pH, and water were discussed in Part I. This told only part of the micronutrient toxicity story. 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. pH testing should be a part of every African violet grower's regimen.

### Fertilizer

Most African violet fertilizers tend to lower pH of the growing medium. I have experimented with a couple of fertilizers in both well water and reverse osmosis water, and the solution pH was lower by about 0.1 pH in the well water and 0.2 in the reverse osmosis water. More experiments are needed to confirm this tendency in the potting mix with plants, as the acid buildup from repeated applications of fertilizer may contribute to the lowering of the pH of the growing medium. Allison Brigham, in helping me analyze the problem, stated: "If using a fertilizer that contains ammonium nitrate, the pH of a solution will go down, i.e., become more acidic. If the water is weakly buffered or has been treated by reverse osmosis, the pH will go down considerably more. Fertilizers containing calcium nitrate may actually raise the soil pH. The raw water source + fertilizer should contain some buffering ions, such as bicarbonate anions which were not present in the reverse osmosis water and is the reason the city-water-using members did not experience the same degree of grief that those using rainwater or RO water experienced." Fertilizers vary in components and nutritional analysis, which are listed on most fertilizer labels, but the labels do not give information on the acidity of the product.

### Nutrient elements

pH affects the form and availability of nutrient elements in the water, fertilizer solutions, and the growing medium. When the pH of a potting mix is below 6.0, the major nutrient elements (micronutrients), nitrogen, phosphorus, and potassium, especially phosphorus, are "locked-up" and not available to the plant. At 6.5 to 6.8 pH, phosphorus will keep the micronutrients from becoming a toxic level; however, if the phosphorus is "locked-up" and unavailable to the plant at pH below 6.0 and above 7.0, the micronutrients, such as Boron, Manganese, Copper, Iron, Molybdenum, and Zinc may be released in amounts toxic to the plant.

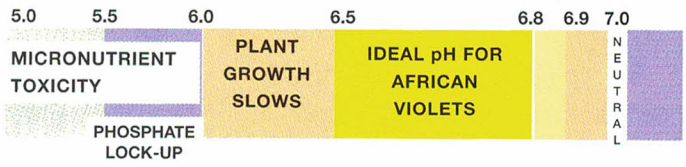


*Figure 2. Effect of pH range of growing medium on African violets*

### Soil Mix Ingredients

Both too low pH (acid) and too high pH (alkaline) will produce harmful results in plants, but the peat in soilless mixes, which generally contributes the most to the mix acidity, can measure as low as pH 3.5 to 5.5 and tends to become more acid as it decomposes. Therefore, there isn't much need to worry about high alkalinity in soilless mixes with a peat base. Good quality, light colored Canadian sphagnum peat is the ideal for soilless mix, but peat can vary in pH and quality from source to source.

Other components of soilless mixes may also affect the pH. Perlite is an expanded volcanic material that is classified as chemically inert and has a pH of approximately 7. It is a coarse, bulky material, which resists compaction and keeps the mix loose and well aerated, promoting good drainage and allowing oxygen to flow to roots. Perlite has little capacity to hold nutrients or to buffer pH and has no nutrient value. Polyurethane foam beads (Styrofoam), pumice, and lava rock or lava sand are other ingredients that serve to promote drainage and aeration but may have disadvantages including cost and availability. Lava rock or lava sand, used in hydroponic growing medium, has a high water retaining ability and is porous, allowing air to be available in the root zone. Lava sand/rock, of volcanic origin, may vary in pH and in minerals from source to source. Small amounts in the mix are not likely changing the pH but should be monitored. Volkmann mixes are made with Styrofoam rather than perlite, and many use this mix successfully for wicking. Foam beads have low density, high water capacity and do not decompose. Be aware that anything added to the mix can affect the pH.

The pH of vermiculite may vary from source to source and may have a pH high enough to affect the pH of the mix. Vermiculite has been thought to be neutral, but vermiculite has a pH range of from 6.0 to 9.5 according to the Vermiculite Association. "The characteristics of vermiculite can change from deposit to deposit, year to year, and should be among those ingredients for which some testing needs to be done." (www.vermiculite.com). Vermiculite provides water and nutrient holding capacity and has a high buffering capacity, which slows changes in pH.

Charcoal is an ingredient in many soil mix recipes. It is neutral (pH 7.0) and "has the capacity for absorbing and holding nitrogen until the plant can use it and has a buffering ability to keep the pH level of the mix from becoming dangerously low. " (Leland, 1981) Use only horticulture charcoal, which is available at most plant supply centers.

Dolomite lime (calcium-magnesium carbonate pH 8.8) is an important ingredient in soilless mixes necessary to correct the acidity of peat and to maintain optimum pH of the growing medium for African violets. Use only dolomite lime in soil mixes. **Do not use hydrated lime**. Water dissolves it quickly, and it leaches down to soil levels and out of the potting mixture where it cannot be used by the plant. Because of the quick action, it may burn the roots. (Worse than no lime!) I could not find dolomite lime locally and finally ordered it from a source I found on the Internet. Local nurseries tried to sell me calcium-magnesium carbonate in chunk form, ag lime which is the same minerals but not fine enough to dissolve readily (I wanted "instant success!"), and hydrated lime, which I bought on advice at a local nursery. (I was just beginning my quest for information!) This was the final "nail in the coffin" for my plants. I mixed a small batch of soilless mix with a new bale of peat, perlite, large vermiculite, charcoal and . . . the hydrated lime. NO pH Test! The hydrated lime was in and out of the mix and left a VERY acid mix with no buffering. Thankfully, I put only a few plants in this mix before I realized the error, but these plants were already toxic from the combination of the acidic club mix and reverse osmosis water which provided no buffering, and this really put them over the top! (Of the compost heap, that is!)

Dolomite is sold as powdered/flour or as mixed grind (different size particles) of dolomitic limestone. The finer dolomite is ground, the quicker it reacts to reduce acidity in the potting mix, but the powdered form doesn't last long and disappears all at once, requiring frequent repotting - ideally every 2 months for miniatures and semiminiatures and 3 to 4 months for standards and others.

Mixed grind dolomitic limestone is sold at garden centers in the Midwest as "Hi-Yield" brand agricultural limestone and contains both finely ground particles and coarser particles that resemble sand. With the different size particles, the dolomite doesn't all dissolve simultaneously, and plants may not need to be repotted as frequently.

Mixed grind dolomitic lime in moistened mix takes several days to affect the pH test. When it was suggested that I use the mixed grind dolomitic lime, I went into a "show me" mode! After what I had been through, I wanted "instant success!" I also wanted to know – so I experimented with the powdered dolomite and the mixed grind. The immediate pH tests showed very little change in pH in either sample, but after being moistened with distilled water, changes in pH were evident in 24 hours with the powdered dolomite, while it took a week to ten days to get the same pH change with the mixed grind dolomite. With either form of dolomite, the mix should be moistened and tested until the pH stabilizes before using the potting mix. Repeat tests should be made after the mix has been moistened for several days. The pH of the plants in a mix with powdered dolomite will need to be monitored for a decline in pH over time. Watering plants with 1 T. dolomite lime per gallon of water occasionally, for regular watering, helps to keep the acidity of the potting mix from increasing, but should only be used after determining the pH level to be below 6.5. This will "buy some time" for repotting.

### Soil mixes

Hundreds of soil mix recipes are found in back issues of the *African Violet Magazine.* It is amazing what our grandmothers used in their 'soil' for African violets, and the plants survived! There are many recipes and commercial mixes available today. A formula for soilless mix - 1 or 2 part peat, 1 part perlite, 1 part vermiculite, dolomite lime and charcoal (See Montague, July/Aug 2005 AVM, p. 27) is a popular formula which works well for most methods of watering. Many growers tweak soilless mix formulas until they find what works best for their methods of growing. Regardless of the formula - your own mix, a commercial mix . . . the most important thing a grower can do is to **check the pH! DON'T GUESS! TEST!**

Several sources of information mentioned the soil-plant relationship based on the millions of bacterial organisms in the soil. A certain group of bacteria, necessary for the break down of the nutrients for the plant's use, thrive in the designated pH range and are influenced by the temperature of the soil. There are many variables interacting which are at their optimum when the pH of the growing medium – soilless mix, water, fertilizer – are in the 6.5 to 6.8 range.

### Testing soil and water pH

"There are two major items that contribute to a successful mix design with an optimum pH in the range of 6.5 to 7.0: (1) Pre-testing the pH of each component to be used in the mix, each time a new package is opened, and testing each completed batch of potting mix, adjusting the pH as needed prior to using the mix, and (2) dampening the peat before incorporating it into the mix. This helps prevent segregation of the dry, granular components during mixing." (Leland, 1981) A new batch of mix should be moistened (not saturated) and let sit a week to 10 days to come to 'equilibrium' before testing. This helps activate the lime and adjusts the pH in the mix.

Numerous articles in the magazine tell growers to test for pH but not how to go about doing it. Is this something everyone knows how to do? I don't think so! I've talked to too many people who haven't done pH tests to believe otherwise!

The first thing needed is a way to test the soil and water. pH test strips can be purchased at aquarium supply departments at pet stores or WalMart, pool and spa supply stores, or ordered from the internet. Testing with pH test strips will give adequate information to determine the pH of mixes and of the soil in potted plants. Follow instructions on the pH test strip

package carefully. Some pH strips must be left in the water for 15 or more seconds and then compared to the color chart on the package; others must be dipped into the water, removed, and read immediately.

Soil test probes that sell for around $25 at garden supply centers are designed for compact garden soil and do not work in loose soilless potting mixes. For more accurate testing, hand-held pH testers are available for under $100. These testers are easy to use and measure to within 0.1 pH. A web search for electronic pH testers or pH meters will produce several sources of information, including <www.nysaes.cornell.edu/necfe/pubs/pdf/Venture/venture2>.

Two methods of obtaining samples for a soil pH test are the "pour-thru" or saturated media procedure and the "slurry" or soil suspension method. For either method, using distilled water will give the pH of the mix without the influence of the pH of the water and/or fertilizer, but the pH of the combination of potting mix, water, and fertilizer will give more useful information for managing the pH of the growing medium.

**How to do a pour-thru soil test for pH:**

- To check the pH of potting mix: Fill a 3 or 4" pot with moistened potting mix; add distilled water to saturate the mix to the capacity of water it will hold. Some will leach out into a saucer. Let the moistened mix sit for 30 minutes to 2 hours for equilibrium of nutrients in the container solution; drain off the excess water and discard. Place the container in a shallow saucer. Pour distilled water slowly over the surface of the soil until it drains into the saucer. Test the leached water with pH test strips. Read and record the results. Note the formula or source of the mix and date of test. Repeat the test using the fertilizer-water you use with your violets and record the pH and date of the test. [Adapted from: "Using the Pour Thru procedure for checking EC and pH for Nursery Crops" North Carolina State Univ. Horticulture Information Leaflet 450]
- To check the soil in a potted plant, ensure that it has been watered several days ahead so it is moist but not saturated. Take a volume of distilled water (enough to run through the pot) and pour it through the pot, collecting what flows out. Test the water with a pH test strip.

**Slurry Test for pH**

- Mix a 1:1 solution of distilled water and potting mix in small container; mix vigorously. Allow mixture to stand without agitation about 30 minutes. Stir well. Strain the solution through a fine mesh or cheesecloth. Test and record results as above. [This method works well with an electronic pH tester as it is not necessary to strain the solution for the electronic tester.]

Allison Brigham offered me a bit of advice: "Just do not get too carried away or obsess overmuch. If you use a soil mix with good Canadian Sphagnum peat, repot reasonably frequently, use a mixed grind source of dolomitic lime to adjust the pH into acceptable range for various gesneriads, and use a raw water supply that is within the alkalinity range, things should be fine."

End of story! There is really no end; I am still experimenting and learning, but my new plants are doing very well in the soilless mix that I am now "doing myself." I am monitoring pH with my new electronic pH tester, using dolomite lime, mixing my reverse osmosis and well water, and maintaining the pH of my growing medium – mix, water, fertilizer - at 6.5 to 6.8. I have kept a few of the 'toxic' plants, just to see whether they ever grow out of "it". And, I have discovered a way to have clean trays! (Another story!)

**Resources:**


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- Leland, Emory E. "The Importance of PH To Your Potting Mix," *African Violet Magazine* September1969; "Understand And Use pH to Grow Better African Violets," November 1974; "AVs Grow Better In Soilless Mixes Designed With Optimum pH," Nov. 1981; "African Violet Maladies Related To Nutrients, pH and Soil," AVM Jan 1982