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Manage pH using water soluble fertilizers

The pH of the growing media can drift up or down during production, affecting nutrient uptake. Learn how to adjust the acidity and basicity of the fertilizer program to help stabilize pH.

Peat and bark-based growing media used in container production typically have poor buffering against changes in pH. Even if the starting pH of the media is around 6.0, pH can drift above or below the recommended range of 5.8 to 6.4 and result in crop nutritional problems. This article focuses on how to stabilize pH and prevent drift using water soluble fertilizers.

Why pH matters

The pH of the media affects the solubility of fertilizer nutrients and uptake by plants, especially for micronutrients such as iron and manganese that decrease in solubility as pH increases. For example, inorganic ferric iron (Fe^{3+}) decreases in solubility 1000-fold when pH increases by one unit (Lindsay, 1979). Iron/manganese deficiency can occur if media pH drifts too high whereas toxicity can occur if pH drifts too low (Figure 1). For the majority of crops, keeping media pH between 5.8 and 6.4 results in micronutrients being adequately soluble for uptake without becoming toxic (Argo and Fisher, 2002).

Fertilizer acidity and basicity

Water soluble fertilizers can have either an acidic (lowers pH) or basic (raises pH) reaction in the media. You cannot tell how a fertilizer will react and affect media pH by measuring the pH in the stock tank or fertilizer solution from the hose. The fertilizer label provides information on

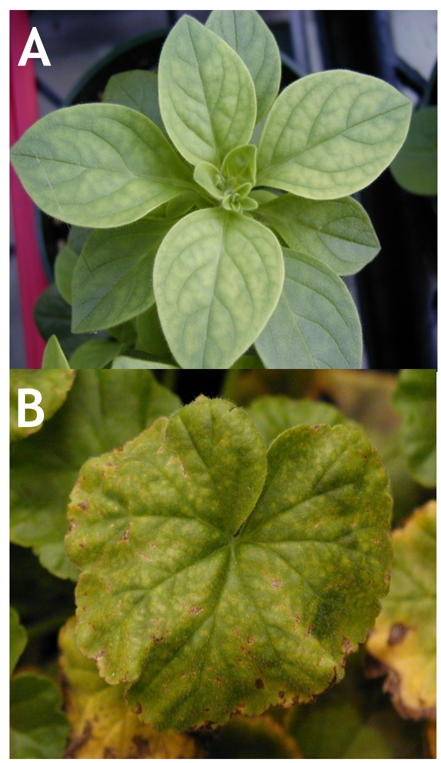

Figure 1. Interveinal leaf chlorosis from high pH induced iron/manganese deficiency in petunia (A). Marginal lower leaf necrosis from low pH iron/ manganese toxicity in geranium (B). Photos courtesy of Paul Fisher.

GUARANTEED ANALYSIS

For Continuous Liquid Feed Programs

Total Nitrogen (N)	15%
1.20% Ammoniacal Nitrogen	
11.75% Nitrate Nitrogen	
2.05% Urea Nitrogen	
Available Phosphate (P_2O_5)	5%
Soluble Potash (K_2O)	15%
Calcium (Ca)	5%
Magnesium (Mg)	2%
2.0% Water Soluble Magnesium (Mg)	
Boron (B)	0.015%
Copper (Cu)	0.007%
0.007% Water Soluble Copper (Cu)	
Iron (Fe)	0.075%
0.075% Chelated Iron (Fe)	
Manganese (Mn)	0.037%
0.037% Water Soluble Manganese (Mn)	
Molybdenum (Mo)	0.007%
Zinc (Zn)	0.040%
0.040% Water Soluble Zinc (Zn)	

Derived from: Ammonium Nitrate, Calcium Nitrate, Potassium Nitrate, Urea Phosphate, Magnesium Nitrate, Boric Acid, Copper Sulfate, Iron EDTA, Manganese Sulfate, Ammonium Molybdate, Zinc Sulfate.

Potential Basicity: 141 lb. Calcium Carbonate equivalent per ton.

Figure 2. The guaranteed analysis on the label includes information about the acidity or basicity of the fertilizer, such as the Potential Acidity or Basicity in terms of calcium carbonate equivalents (lower box). A high percentage of acidifying nitrogen (ammonium and urea) of total nitrogen (top box) indicates that the fertilizer will likely decrease pH over time.

whether the fertilizer reaction is acidic or basic in terms of “calcium carbonate equivalents” (CCE) per ton, which is a relative measure of the tendency of the fertilizer to decrease or increase media pH over time.

The label also tells you the type and percentage of the different forms of nitrogen (ammonium, urea, and nitrate), which is often a better indication of fertilizer acidity or basicity. In general, ammonium has a strongly acidic reaction and drives media pH down. This is because roots rapidly take up ammonium and release acid, and nitrifying bacteria in the media consume ammonium and also produce acid. Urea also lowers media pH, but tends to be less acidic compared to ammonium. It is important to note that in cool and wet conditions, ammonium and urea are less effective at lowering pH and can become toxic. In addition, ammonium and urea-based fertilizers often contain high phosphorus, which can promote soft growth and stem stretch if used excessively.

Nitrate tends to have a weak to moderately basic reaction and increases media pH. Nitrate increases pH only when taken up by the roots, and therefore supplying small or stressed plants with nitrate nitrogen will have little effect on pH.

Tips on using water-soluble fertilizers to manage pH

Determine the percentage of acidifying nitrogen in the fertilizer. The percentage of acidifying nitrogen refers to the percentage of ammonium and urea of total nitrogen in the fertilizer. For example, the label in Figure 2 shows that 15% of the fertilizer is total nitrogen, with 1.20% as ammonium and 2.05% as urea. The sum of ammonium and urea (3.25%) divided by total nitrogen (15%) equals the percentage of acidifying nitrogen (21.7%). Acidic fertilizers usually contain at least 30% acidifying nitrogen whereas basic fertilizers usually contain less than 20% acidifying nitrogen when applied at typical rates (100 to 200ppm-N). Fertilizer options to help stabilize media pH include alternating between acidic and basic fertilizers, such as 20-10-20 (40% acidifying nitrogen) and 15-0-15 (<10% acidifying nitrogen), or selecting one water soluble fertilizer with an intermediate amount of acidifying nitrogen (between 20% and 30%).

Match the fertilizer with the alkalinity. Alkalinity is the concentration of dissolved bicarbonates and carbonates in the irrigation water, and irrigating with high alkalinity water (above 150ppm $CaCO_3$ of alkalinity) has a basic reaction that raises media pH. Basic (low ammonium) fertilizers can be used with low-alkalinity to prevent a decreasing pH. Acidic fertilizers (high ammonium) can be used with high-alkalinity to help prevent an increasing pH (although not recommended in cool, dark weather). High alkalinity can be reduced by injecting acid into the irrigation water. The amount of acid needed can be determined using the Purdue University and North Carolina University acid calculator (www.ces.ncsu.edu/depts/hort/floriculture/software/alk.html).

Know that plant species also affect media pH. Floriculture species differ in their effect on media pH even when supplied the same fertilizer (Argo and Fisher, 2002; Johnson et al., 2013). For example, geranium tend to push pH down whereas petunia tend to push pH up. Therefore, geranium require low-ammonium fertilizers to help prevent pH from decreasing and petunia can be supplied with more ammonium to help keep pH from increasing. Watch out for plant species that appear to increase or decrease pH more rapidly than others, and consider adjusting the fertilizer program or starting media pH if these crops consistently run into nutritional problems.

Figure 3. Seedling plug and liner crops are grown in relatively small cells, and media pH and EC can fluctuate more rapidly compared to larger container crops. Photo courtesy of Paul Fisher.

Be aware that media pH can change rapidly in seedling plug/liner crops. Seedling plugs and liners have a relatively low volume of root area compared to container crops, which means less media and incorporated limestone per plant to buffer against pH change. In addition, roots quickly dominate the cell in plug and liner trays, which increases the effect of the plant on media pH (see above). Micronutrient disorders in plugs and liners can therefore occur very quickly, and so it is important to monitor pH closely and adjust the fertilizer program if needed.

Perform regular testing of media pH and electrical conductivity (EC). Regular testing of media pH and EC (every 1-2 weeks) can help with making fertilizer decisions by alerting growers to problems before symptoms become too severe. Make sure to test media pH in a few crops that are susceptible to micronutrient disorders. For example, geranium and marigold are susceptible to iron/manganese toxicity as pH decreases below 5.8 (iron/manganese are more soluble), especially when a high fertilizer rate and micronutrient concentration is applied. Petunia and calibrachoa are examples of species that are susceptible to iron/manganese deficiency as pH increases above 6.2 (iron/manganese are less soluble). Media testing can also help you verify whether a problem is related to high or low pH.

Literature cited:

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