TECH TRAINING:
AVOIDING IRON & MANGANESE TOXICITY

While most crops rarely develop iron (Fe) or manganese (Mn) toxicity, there are some species that are particularly prone to these nutrient disorders. Geraniums, New Guinea impatiens, pentas and marigolds are among the most frequently-affected species. These toxicities are largely a function of substrate pH—as Fe and Mn become much more available for uptake at low pH values, typically below 5.8. Growers can manipulate factors like substrate, water quality and fertilizer selection to achieve the right pH for a particular crop. *Monitoring substrate pH and using products to correct pH are essential for preventing Fe and Mn toxicity.*

Tip 1: Understand Your Inputs

- ***Affected Crops:*** Species including geraniums, New Guinea impatiens, pentas and marigolds are prone to Fe and Mn toxicity. Focus on these crops to scout and monitor.
- ***Substrate:*** Growers can start with a "high pH" substrate with a higher lime charge to prevent low pH.
- ***Water Quality:*** Alkalinity contributes greatly to substrate pH *and* the ability to change pH over time.
- ***Fertilizer Selection:*** Pick neutral to basic fertilizers like 17-5-17 or 15-5-15 to prevent low substrate pH.

Fig 1. Lower leaf black spotting on argyranthemum.

Tip 2: Monitor Substrate pH and Scout for Symptoms

- Use the PourThru, 1:2 Dilution or Saturated Media Extract (SME) to monitor substrate pH.
    - Sensitive crops should be kept at a pH between 5.8 and 6.5 to prevent issues.
- Symptoms of Fe and Mn toxicity include lower leaf marginal bronzing and necrotic or black spotting.
    - Symptomatic leaves ***will not recover*** and corrective procedures must be implemented to stop progression.

Fig 2. Advanced lower leaf necrotic margins on geranium.

Tip 3: Use Corrective Procedures to Raise pH

- If substrate pH falls below optimal levels, use flowable lime at 1 to 2 quarts per 100 gallons or potassium bicarbonate ($KHCO_3$) at 2 pounds per 100 gallons to increase pH.
    - Note that these products must be rinsed off the foliage to prevent leaf burn.
    - $KHCO_3$ will increase EC and should be leached out one day after application.
    - Topdressing with powdered lime is NOT advisable, as it can provide inconsistent results.

Fig 3. Lower leaf bronzing and necrotic spotting on pentas.

DEEPER DIVE: THE WHY

Commonly-Affected Crops: Certain species including geraniums, New Guinea impatiens, pentas and marigolds are particularly sensitive to substrate pH levels below 5.8 due to increased availability of iron (Fe) and manganese (Mn). These elements can accumulate in the lower leaves, leading to visible symptoms such as bronzing, black spotting, and eventually marginal necrosis in more advanced stages. This issue typically emerges later in the production cycle as the initial lime charge in the growing medium becomes depleted. To prevent or correct these symptoms, it's important to select appropriate fertilizers and regularly monitor both substrate pH and irrigation water quality.

Understanding Inputs: When growing crops that prefer a higher pH, it can help to use a "high pH" substrate that uses higher rates of lime to buffer the pH. Other factors like irrigation water quality and fertilizer selection can also make a big impact on substrate pH throughout the production cycle. Irrigation water alkalinity can be thought of as the buffering capacity of the water. When alkalinity is high, it can be difficult to change pH, but when alkalinity is low, pH adjustments can be made more quickly. If crops that are sensitive to low pH are grown with low alkalinity water, they are at a higher risk of developing low substrate pH. This is why it is so important to test irrigation water *at least annually*. If acid injection is used, verify that alkalinity at the hose end falls within recommended levels—typically 80 to 180 ppm $CaCO_3$.

Fertilizer Selection: Fertilizers play a major role in substrate pH and are often considered acidic, neutral or basic depending on the ratio of ammoniacal (NH_4^+) or nitrate (NO_3^-) nitrogen they contain. High-ammonium fertilizers like 20-10-20 are considered acidic and tend to lower pH over time. For crops that prefer a higher pH, such as geraniums, neutral to basic fertilizers like 17-5-17 or 15-5-15 are more suitable. Most water-soluble fertilizers include a label statement about their potential basicity or acidity, which is a helpful tool when selecting a product to maintain optimal pH for these crops.

Monitor Substrate pH: Regular monitoring of substrate pH and electrical conductivity (EC) is essential for maintaining balanced nutrition throughout the crop cycle. Simple testing methods such as the PourThru and 1:2 Dilution can provide quick, reliable readings. For crops sensitive to low pH, keeping values between 5.8 and 6.5 is usually ideal. If pH rises above 6.5, crops may develop Fe and Mn deficiency symptoms (interveinal chlorosis on the new growth.)

Raise Substrate pH: When substrate pH drops below the recommended range, corrective actions may be needed. Start by confirming that water parameters like alkalinity and acidification are within target ranges and that the fertilizer is not contributing excess acidity. The most common ways to raise pH include applying flowable lime or potassium bicarbonate ($KHCO_3$). Typical application rates are 1 to 2 quarts per 100 gallons for flowable lime or 2 pounds per 100 gallons for $KHCO_3$. Always rinse foliage after application. Note that $KHCO_3$ contributes 933 ppm of potassium, so a heavy clear water drench *the next day* helps prevent high EC issues. No matter which option is used, ***always follow label instructions***.

For more information, check out these additional resources:

GrowerTalks: ***Controlling Your Growing Media pH***
e-GRO: ***Diagnosing Low Substrate pH Disorders: Steps for pH and Tissue Testing***
e-GRO: ***Corrective Procedures for Modifying Substrate pH and Electrical Conductivity***
Michigan State University: ***Lower leaf chlorosis, spotting, and necrosis of New Guinea impatiens induced by low substrate pH***