e-GRO Nutritional Monitoring



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Volume 1 Number 2 January 2018

Nutritional Monitoring Series

Geraniums

(Pelargonium ×hortorum)

Geraniums require medium levels of fertilization, growing best with 150 to 200 ppm N. Optimal substrate pH values are between 5.8 and 6.5. Geraniums are susceptible to both low and high pH disorders, developing iron (Fe) and manganese (Mn) toxicity at low pH and Fe deficiency at low pH.

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Figure 1. Low soluble salts [referred to as electrical conductivity (EC)] can cause lower leaf yellowing (chlorosis) or reddening. Photo by: Brian E. Whipker.

Geraniums

Target Nutrition Parameters

pH Category III to IV:
5.8 to 6.5

Fertility Category:
Medium
150 to 200 ppm N

EC Category B:
1:2 Extraction:
0.6 to 0.9 mS/cm

SME:
1.3 to 2.0 mS/cm

PourThru:
2.0 to 3.0 mS/cm

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Figure 2. High soluble salts [referred to as electrical conductivity (EC)] can lead to marginal yellowing (chlorosis) and browning (necrosis). Photo by: Brian E. Whipker.

Figure 3. High substrate pH leads to interveinal yellowing (chlorosis) on the upper foliage. Photo by: Brian E. Whipker.

Fertility Management of Geraniums

Geraniums require medium levels of fertility. Growers should provide fertilization at 150 to 200 ppm N. Low soluble salts [referred to as electrical conductivity (EC)] from inadequate fertilization can cause yellowing (chlorosis) or reddening on the lower foliage (Fig. 1). High EC is an issue during propagation, as cuttings and seedlings are sensitive to root burning (plasmolysis) and lower leaf browning (necrosis). For this reason, fertilization should be maintained at 100 ppm N during propagation (Dole and Wilkins, 2005). Excess salts may build up in the substrate during stock plant production, leading to plasmolysis and lower leaf necrosis (Fig. 2). Frequent leaching with clear water should be implemented to control EC and prevent symptom development (Dole and Wilkins, 2005).

Substrate pH should be maintained between 5.8 and 6.5. Values beyond this range commonly lead to high or low pH induced nutritional disorders (Whipker and Henry, 2017). High pH inhibits iron (Fe) uptake, causing interveinal chlorosis of the upper foliage (Fig. 3). Low pH causes excessive uptake of Fe and manganese (Mn), which leads to toxicity symptom development. Symptoms of Fe and Mn toxicity include a lower leaf bronzing with dark brown to black spotting (Fig. 4).

Foliar Fe and Mn concentrations should remain below 500 ppm (Dole and Wilkins, 2005). Previous reports of low pH induced Fe and Mn toxicity document foliar concentrations of these two elements to be ~10× higher than in asymptomatic plants (Henry and Whipker, 2016). Monitoring substrate pH and periodic tissue sampling can help to determine if symptoms are due to high or low Fe and Mn (Table 1). Iron deficiency can be remedied

with an application of Fe chelate, while Fe and Mn toxicity can be remedied by providing flowable lime to raise the pH.

Summary

Maintaining moderate fertility at 150 to 200 ppm N and a pH of 5.8 to 6.5 should enable you to grow healthy geraniums while preventing low or high pH induced nutritional disorders.

Literature Cited

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Figure 4. Low pH leads to iron (Fe) and manganese (Mn) toxicity, causing symptoms of yellowing (chlorosis) with dark brown to black spotting (necrosis). Photo by: Brian E. Whipker.

Table 1. Recommended range of leaf tissue analysis for geranium (*Pelargonium ×hortorum*).

Element	Sufficiency Range [1]
Nitrogen (%)	3.29 – 4.80
Phosphorus (%)	0.30 – 1.24
Potassium (%)	2.50 – 6.26
Calcium (%)	0.80 – 2.40
Magnesium (%)	0.19 – 0.51
Sulfur (%)	0.25 – 0.70
Iron (ppm)	100 – 580
Manganese (ppm)	40 – 325
Zinc (ppm)	7 – 100
Copper (ppm)	5 – 25
Boron (ppm)	30 – 75
Molybdenum (ppm)	0.14 – 0.66
[1] Source: Bryson and Mills (2014)	

Corrective Procedures for Modifying Substrate pH and Electrical Conductivity (EC)

When the pH or substrate electrical conductivity (EC) drifts into unwanted territory, adjustments must be made. Below are the standard corrective procedures used to modify the substrate pH and EC for greenhouse grown crops in soilless substrates.

1. Low Substrate pH Correction

When Fe and Mn toxicity becomes a problem, adjust (raising) substrate pH to the recommended pH range. Corrective procedures to raise low pH levels are listed below. Switching to a basic fertilizer when the substrate pH is nearing the lower limit will help stabilize the pH. If the pH is below the recommended range, then corrective procedures will need to be implemented. Flowable lime is one option. Using a rate of 2 quarts per 100 gallons of water will typically increase the substrate pH by roughly 0.5 pH units. Two quarts can be used through an injector. Additional applications can be made if needed. Potassium bicarbonate ($KHCO_3$) can also be applied. A rate of 2 pounds per 100 gallons of water will increase the substrate pH by roughly 0.8 pH units. This treatment will also provide excessive potassium (K) and cause a spike in the substrate EC. A leaching irrigation with clear water is required the following day to restore the nutrient balance (the ratio of K:Ca:Mg) and lower the EC. As always, remember to recheck your substrate pH to determine if reapplications are needed.

pH Adjustment Recommendations

Flowable Lime

- Use 1 to 2 quarts per 100 gallons of water.
  Rinse foliage.
- Avoid damage to your injector by using rates of 2 quarts per 100 gallons of water, or less.
- Can split applications.

Hydrated Lime

- Mix 1 pound in 3 to 5 gallons of WARM water. Mix twice. Let settle. Decant liquid and apply through injector at 1:15.
- Caustic (rinse foliage ASAP and avoid skin contact)

Potassium Bicarbonate ($KHCO_3$)

- Use 2 pounds per 100 gallons of water
- Rinse foliage immediately.
- *Provides 933 ppm K.*
- Leach heavily the following day with a complete fertilizer to reduce substrate EC and restore nutrient balance.
- Rates greater than 2 pounds per 100 gallons of water can cause phytotoxicity!

2. High Substrate pH Correction

The target pH for many species is between 5.8 and 6.2. Higher pH values will result in Fe deficiency and lead to the development of interveinal chlorosis on the upper leaves. Check the substrate pH to determine if it is too high. Be careful when lowering the substrate pH, because going too low can be much more problematic and difficult to deal with.

Acid-based Fertilizer
If the substrate pH is just beginning to increase, then first consider switching to an acidic-based fertilizer. These ammoniacal-nitrogen (N) based fertilizers are naturally acidic and plant nitrogen uptake will help moderate the substrate pH over a week or two.

Acid Water Drench
Some growers use this intermediate correction if pH levels are not excessively high and a quick lower of the substrate pH is desired. Use sulfuric acid to acidify your irrigation water to a pH 4.0 to 4.5. Apply this acid water as a substrate drench providing 5 to 10% excessive leaching of the substrate. Rinse the foliage to avoid phytotoxicity. Results should be visible within 5 days. Retest the substrate pH and repeat if needed.

Iron Drench
If the levels are excessively high, then an Fe chelate application can be made to the substrate.
Below are the options.

Iron Chelate Drench (options)
- Iron-EDDHA: mix 5 ounces in 100 gallons of water
- Iron-DTPA: mix 5 ounces in 100 gallons of water
- Iron sulfate: mix 4-8 ounces in 100 gallons of water

- Apply as a substrate drench with sufficient volume to leach the pot.
- Rinse foliage immediately.
- Avoid use on iron efficient plants (geraniums).

3. Low EC Correction

If low EC problems occur, increase the fertilization rate to 300 ppm N for a few applications before returning to the recommend fertilization rate for the crop.

4. High EC Correction

Excessively high fertilization rates will result in a marginal leaf burn. Check the substrate EC to confirm your diagnosis. Values greater than 6.0 mS/cm based on the PourThru sampling method can be problematic for many plants.

Switch to Clear Water Irrigations
If the substrate EC is just beginning to increase over time, then leach with a few clear water irrigations to lower EC levels by flushing out the salts.

Clear Water Leaching
If the EC values are excessively high, leach the substrate twice with back-to-back clear water irrigations. Then allow the substrate to dry down normally before retesting the EC. If EC levels are still too high, repeat the double leach. Once the substrate EC is back within the normal range, use a balanced fertilizer at a rate of 150 to 200 ppm N.

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