e-GRO Nutritional Monitoring



W. Garrett Owen[1] Josh Henry[2] Brian E. Whipker[3]

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Nutritional Monitoring Series

Crossandra

(*Crossandra infundibuliformis*)

Crossandra require medium fertility levels of 150 to 200 ppm N. Optimal substrate pH values range from 5.8 to 6.5. Substrate pH values above 6.5 inhibit iron availability and induce faint interveinal chlorosis (yellowing) and chlorotic cast of young leaves. Insufficient fertility levels induce lower leaf interveinal chlorosis and reddening.

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Figure 1. Providing insufficient fertility [low electrical conductivity (EC)] during crossandra (*Crossandra infundibuliformis*) production can result in lower leaf interveinal chlorosis (yellowing). Photo by Garrett Owen.

Crossandra

Target Nutrition Parameters

pH Category III, 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:
1.3 to 3.0 mS/cm

[1]University of Kentucky
wgowen@uky.edu

[2]Former graduate student

[3]NC State University
bwhipker@ncsu.edu

Figure 2. Insufficient fertility [low electrical conductivity (EC)] during crossandra (*Crossandra infundibuliformis*) production can cause lower leaves to develop interveinal chlorosis (yellowing) and reddening of the veins. Photo by Garrett Owen.

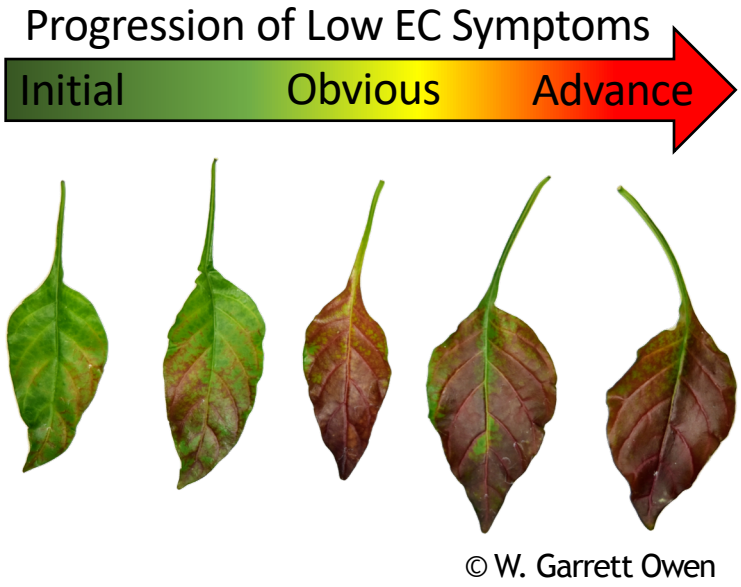

Figure 3. Insufficient fertility [low electrical conductivity (EC)] during crossandra (*Crossandra infundibuliformis*) production can cause lower leaves to develop red colored veins and leaves. Photo by W. Garrett Owen.

Fertility Management of Crossandra

Crossandra propagated from seed or vegetative cuttings should be grown with a pH range of 5.8 to 6.5. Use recommended 1:2 Extraction, SME, or PourThru methods to determine and monitor substrate pH and soluble salts [referred to as electrical conductivity (EC)] values. Additionally, conduct routine foliar analysis tests to monitor crop nutrient status. Tissue nutrient levels found in healthy, newly expanded leaves of crossandra are listed in Table 1. Monitoring substrate pH and nutrient status will enable growers to avoid pH induced nutritional disorders.

For seed propagated crossandra, beginning at Stage 2 (cotyledon emergence), initiate weekly applications of 50 to 75 ppm N delivered from a 14-0-14 fertilizer. During Stage 3 (true leaf development), increase fertility to 100-150 ppm N weekly, alternating between 20-10-20 and 14-0-14 (Nau, 2011). At Stage 4 (toning; hardening off), a single application of 100-150 ppm N delivered from a 14-0-14 fertilizer is recommended (Nau, 2011).

For crossandra propagated from vegetative cuttings, apply 175 ppm N weekly beginning 14 days after sticking cuttings (Sakata® Ornamentals, 2017). Once vegetative cuttings have rooted, a constant liquid fertilizer providing 150 to 200 ppm N delivered from a complete fertilizer or 20-10-20, alternating with 14-0-14 is often used.

After crossandra plugs or liners are transplanted, providing medium fertility of 150 to 200 ppm N is recommend during the first six weeks of the vegetative growth phase (Nau, 2011). Fertilize at every other irrigation with 150 to 200 ppm N delivered from 20-10-20, alternating with 14-0-14. This fertility regime is also recommended (Nau, 2011) during the last six weeks of production or floral initiation and development stage. Insufficient

fertility levels (low EC) will result will result in lower leaf interveinal chlorosis (yellow; Fig. 1) and intensifies turning leaf veins red (Fig. 2) and overall leaf reddening (Fig. 3).

High EC (nutrition), warm temperatures, and long-days (short-nights) are conducive to promote flowering. Dole and Wilkins (1997, 2005) reported magnesium (Mg), iron (Fe), and manganese (Mn) are critical nutrients for growth. Regular applications of supplemental Mg at 30 to 50 ppm and Fe and Mn provided by a micronutrient fertilizer program is beneficial (Sakata® Ornamentals, 2017) to produce healthy crossandra crops.

Routinely check substrate EC and maintain below 0.9, 2.0, or 3.0 mS/cm, based on the 1:2 Extraction, SME, or PourThru methods, respectively. Lack of fertility or low potassium levels can result in small, weak-stemmed plants (Nau, 2011). Slow growth or flowering and early flowering on small plants may be related to low EC or other environmental or cultural production practices. High EC can cause hardened or stunted plant growth while slow growth or flowering may be due to low fertility, production temperatures, or light levels (Nau, 2011).

High substrate pH above 6.5 can inhibit Fe uptake causing newly developed leaves to develop a faint interveinal chlorosis (Fig. 4). If Fe deficiency symptoms progress, recently matured leaves will exhibit an overall chlorotic cast (Figs. 5A and B). Plant growth can also become stunted. Corrective procedures for high substrate pH should begin within the range of 6.3 to 6.5.

Figure 4. Substrate pH above 6.5 or over irrigation can inhibit iron (Fe) uptake causing newly developed and recently matured crossandra (*Crossandra infundibuliformis*) leaves to become Fe-deficient and exhibit a faint interveinal chlorosis (yellowing). Photo by: Josh Henry.

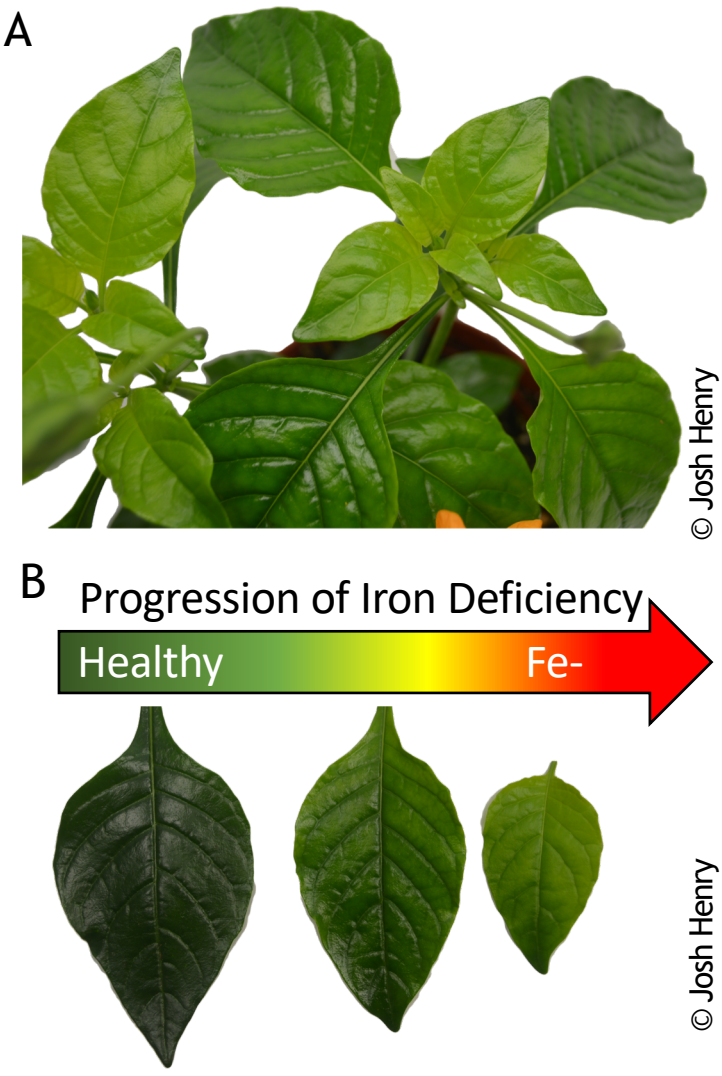

Figure 5. Substrate pH above 6.5 can inhibit iron (Fe) uptake causing newly developed crossandra (*Crossandra infundibuliformis*) leaves to become Fe-deficient (A) and exhibit an overall chlorotic (yellowing) cast (B). Photo by: Josh Henry.

Summary
Providing crossandra with a moderate level of fertility ranging from 150–200 ppm N and maintaining a substrate pH of 5.8 to 6.5 will prevent most nutritional disorders from occurring.

Literature Cited

Bryson, G.M. and H.A. Mills. 2014. Plant analysis handbook IV. Micro Macro Publishing, Athens, GA.

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Table 1. Leaf tissue nutrient sufficiency range recommended for crossandra (*Crossandra infundibuliformis*).

Element		Recommended Range [1]
Nitrogen (N)	(%)	3.0 – 4.0
Phosphorus (P)		0.25 – 0.40
Potassium (K)		3.0 – 4.0
Calcium (Ca)		1.2 – 1.6
Magnesium (Mg)		0.4 – 0.6
Sulfur (S)		0.16 – 0.26
Iron (Fe)	(ppm)	32 – 76
Manganese (Mn)		32 – 66
Zinc (Zn)		21 – 34
Copper (Cu)		6 – 14
Boron (B)		9 – 21
Molybdenum (Mo)		0.09 – 0.23

Source: [1] 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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CONTRIBUTORS

Dr. Nora Catlin
Floriculture Specialist
Cornell Cooperative Extension
Suffolk County
nora.catlin@cornell.edu

Dr. Chris Currey
Assistant Professor of Floriculture
Iowa State University
ccurrey@iastate.edu

Dr. Ryan Dickson
Greenhouse Horticulture and
Controlled-Environment Agriculture
University of Arkansas
ryand@uark.edu

Nick Flax
Commercial Horticulture Educator
Penn State Extension
nzf123@psu.edu

Thomas Ford
Commercial Horticulture Educator
Penn State Extension
tgf2@psu.edu

Dan Gilrein
Entomology Specialist
Cornell Cooperative Extension
Suffolk County
dog1@cornell.edu

Dr. Joyce Latimer
Floriculture Extension & Research
Virginia Tech
jlatime@vt.edu

Heidi Lindberg
Floriculture Extension Educator
Michigan State University
wolleage@anr.msu.edu

Dr. Roberto Lopez
Floriculture Extension & Research
Michigan State University
rglopez@msu.edu

Dr. Neil Mattson
Greenhouse Research & Extension
Cornell University
neil.mattson@cornell.edu

Dr. W. Garrett Owen
Greenhouse Extension & Research
University of Kentucky
wgowen@uky.edu

Dr. Rosa E. Raudales
Greenhouse Extension Specialist
University of Connecticut
rosa.raudales@uconn.edu

Dr. Beth Scheckelhoff
Extension Educator - Greenhouse Systems
The Ohio State University
scheckelhoff.11@osu.edu

Dr. Ariana Torres-Bravo
Horticulture/ Ag. Economics
Purdue University
torres2@purdue.edu

Dr. Brian Whipker
Floriculture Extension & Research
NC State University
bwhipker@ncsu.edu

Dr. Jean Williams-Woodward
Ornamental Extension Plant Pathologist
University of Georgia
jwoodwar@uga.edu

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