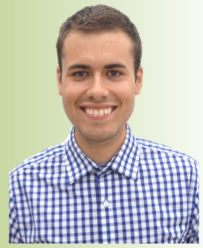
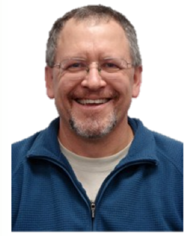
e-GRO Nutritional Monitoring


Josh Henry[1]


Brian E. Whipker[1]


W. Garrett Owen[2]

Volume 2 Number 2 April 2019

Nutritional Monitoring Series

Heliotrope

(Heliotropium arborescens)

American Floral Endowment
Funding Generations of Progress Through Research and Scholarships
eGRO Electronic Grower Resources Online
Project Sponsor

Heliotrope requires low to medium levels of fertility between 100 and 200 ppm N. Optimal substrate pH values range from 5.8 to 6.2. Heliotrope can develop both low and high substrate pH disorders. High pH inhibits iron (Fe) uptake, leading to symptoms of interveinal chlorosis (yellowing) on the upper leaves. Low pH induces toxic accumulation of Fe and manganese (Mn) in the lower leaves, leading to black spotting.

Figure 1. Excessively high soluble salts [referred to as electrical conductivity (EC)] causes necrotic (brown) spotting on the lower leaves of heliotrope (*Heliotropium arborescens*). Photo by: Josh Henry.

Heliotrope

Target Nutrition Parameters

pH Category III:
5.8 to 6.2

Fertility Category:
Low to Medium
100 to 200 ppm N

EC Category: A, B
1:2 Extraction:
0.4 to 0.9 mS/cm

SME:
0.9 to 2.0 mS/cm

PourThru:
1.3 to 3.0 mS/cm

[1]North Carolina State University
bwhipker@ncsu.edu
[2]Michigan State University
wgowen@msu.edu

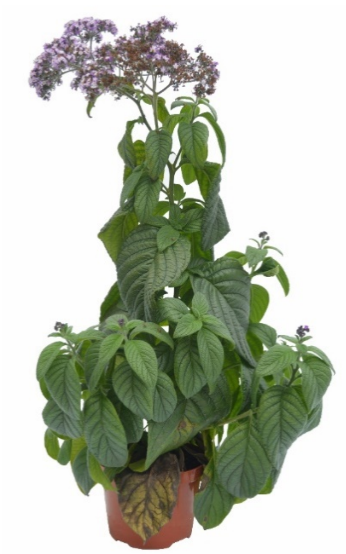


Figure 2. Excessively high soluble salts [referred to as electrical conductivity (EC)] causes excessive growth and necrotic (brown) spotting on the lower leaves of heliotrope (*Heliotropium arborescens*). Photo by: Josh Henry.

Figure 3. Low soluble salts [referred to as electrical conductivity (EC)] causes chlorosis (yellowing) in heliotrope (*Heliotropium arborescens*). Photo by: Josh Henry.

Fertility Management of Heliotrope

Heliotrope can be propagated by seeds and vegetative cuttings. The optimal substrate pH for seed grown heliotrope is 5.5 to 5.8 and the soluble salts [referred to as electrical conductivity (EC)] should remain below 0.75 mS/cm (Nau, 2011). Fertilization can begin once cotyledons have expanded using 14-0-14 at a rate of 50 to 75 ppm N (Nau, 2011). Increase to 100 to 150 ppm N once the first true leaves expand, and begin alternating between 14-0-14 and 20-10-20 (Nau, 2011). Mature seed grown plugs may be fertilized once a week with 100 to 150 ppm N using 14-0-14 (Nau, 2011).

Vegetative cuttings should be fertilized in propagation with a foliar feed of 50 to 75 ppm N weekly with 15-0-15. Once root initials develop, cuttings may be fertilized with of 100 ppm N alternating between 15-0-15 and 20-10-20 (Nau, 2011). When roots are well developed, fertilization can increase to 200 ppm N, alternating between 15-0-15 and 20-10-20.

After transplant, heliotrope should be fertilized with a low to medium level of fertility. This may be achieved by fertilizing with 100 to 200 ppm N provided by a complete fertilizer such as 13-2-13 or 15-5-15. Another option is to alternate between a high and a low phosphorus (P) fertilizer such as 20-10-20 and 15-0-15 (Nau, 2011). It is recommended to fertilize only at every other irrigation as to prevent fertilizer salt accumulation and injury or burn. High substrate EC can cause necrotic (brown) spotting on the lower foliage (Fig. 1) and can lead to an excessively large plant (Fig. 2). Low substrate EC causes chlorosis (Fig. 3) and stunting (Fig. 4).

Substrate pH should be maintained between 5.8 and 6.2 to prevent low or high pH induced nutrient disorders. Values below 5.8 can rapidly cause Fe and Mn to become highly available for uptake and can cause Fe and/or Mn toxicity. This is worsened by the fact that the roots of heliotrope can have a natural acidifying effect on the substrate (Nau, 2011). Avoid high Fe and high ammonium (NH_4^+) fertilizers to prevent low pH. Symptoms of low pH induced Fe and Mn toxicity appear as black spotting on the lower leaves (Figs. 5, 6, & 7). Tissue samples from symptomatic 'Fragrant Delight' heliotrope plants (Figs. 5, 6, & 7) with a substrate pH of 3.9 and EC of 4.42 (obtained via PourThru) had Fe and Mn values that were eight- and nine-fold greater than the recommended sufficiency range (Table 1).

High substrate pH initially causes plants to develop a lighter green coloration. High pH limits Fe uptake and can induce Fe deficiency, leading to a light chlorotic (yellow) appearance on the upper foliage (Figs. 8 & 9).

Summary

Maintaining low to medium fertility at 100 to 200 ppm N and a pH of 5.8 to 6.2 can help you to produce healthy heliotrope without pH or EC related nutrient disorders.

Figure 4. Low soluble salts [referred to as electrical conductivity (EC)] causes stunting and chlorosis (yellowing) in heliotrope (*Heliotropium arborescens*). Photo by: Josh Henry.

Figure 5. Low substrate pH causes toxic iron (Fe) and manganese (Mn) accumulation and symptoms of black spotting on the lower leaves of heliotrope (*Heliotropium arborescens*). Photo by: W. Garrett Owen.

Figure 6. Low substrate pH causes toxic iron (Fe) and manganese (Mn) accumulation and symptoms of black spotting on the lower leaves of heliotrope (*Heliotropium arborescens*). Photo by: W. Garrett Owen.

Literature Cited

Bryson, G.M. and H.A. Mills. 2015. Plant analysis handbook IV. Micro Macro Publishing, Athens, GA.

Nau, J. 2011. Ball Redbook volume 2: Crop production. 18th ed. Ball Pub., West Chicago, IL.

Figure 7. Low substrate pH causes toxic iron (Fe) and manganese (Mn) accumulation and symptoms of black spotting on the lower leaves of heliotrope (*Heliotropium arborescens*). Photo by: W. Garrett Owen.

Figure 8. High substrate pH limits iron (Fe) availability, leading to symptoms of interveinal chlorosis (yellowing) on the upper leaves of heliotrope (*Heliotropium arborescens*). Photo by: Josh Henry.

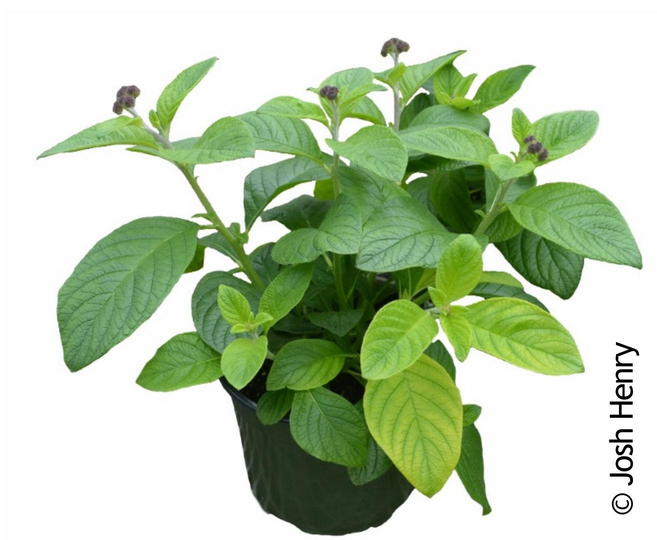


Figure 9. High substrate pH limits iron (Fe) availability, leading to symptoms of interveinal chlorosis (yellowing) on the upper leaves of heliotrope (*Heliotropium arborescens*). Photo by: Josh Henry.

Table 1. Recommended foliar tissue sufficiency ranges for heliotrope (*Heliotropium arborescens*) compared with values obtained from 'Fragrant Delight' heliotrope plants experiencing low pH (3.9) induced iron and manganese toxicities.

Element		Recommended Range [1]	Low pH
Nitrogen (N)	(%)	3.3 – 3.8	3.8
Phosphorus (P)		0.5 – 0.8	0.5
Potassium (K)		3.0 – 5.1	3.4
Calcium (Ca)		2.0 – 3.5	3.1
Magnesium (Mg)		0.5 – 1.5	1.5
Sulfur (S)		0.2 – 0.8	0.5
Iron (Fe)	(ppm)	**174 - 314**	**2560**
Manganese (Mn)		**105 - 122**	**1140**
Zinc (Zn)		77 – 110	108
Copper (Cu)		10 – 13	10.8
Boron (B)		35 – 80	81.1

[1] Source: Bryson and Mills (2015).

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.

American Floral Endowment
Funding Generations of Progress Through Research and Scholarships
eGRO Electronic Grower Resources Online
Project Sponsor

e-GRO Alert

www.e-gro.org

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
Floriculture Outreach Specialist
Michigan State University
wgowen@msu.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. Paul Thomas
Floriculture Extension & Research
University of Georgia
pathomas@uga.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

Cooperating Universities

Cornell University
Iowa State University
University of New Hampshire Cooperative Extension
PennState Extension
Virginia Tech
Michigan State University
UConn
Purdue University
The University of Georgia
The Ohio State University
NC State University
Division of Agriculture Research & Extension, University of Arkansas System

In cooperation with our local and state greenhouse organizations

Maumee Valley Growers — Choose the Very Best.
Metro Detroit Flower Growers Association
NC Flower Power
Western Michigan Greenhouse Association
Connecticut Greenhouse Growers Association
Indiana Flower Growers Association
LIFGA
Michigan Floriculture Growers Council
New Hampshire Plant Growers — Quality Garden Centers & Growers
NYSFI — New York State Flower Industries, Inc.
Virginia Flower Growers Association — Since 1954