e-GRO Nutritional Monitoring

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Nutritional Monitoring Series

Fuchsia

(Fuchsia × hybrida)

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Fuchsia require low to medium fertility levels between 100 and 200 ppm N. Optimal substrate pH values for fuchsia range from 5.5 to 6.2. Fuchsias can develop both low and high substrate pH disorders. If the substrate pH drifts lower than 5.5, iron (Fe) and manganese accumulate at toxic levels and are observed as lower leaf black spotting. Substrate pH values above 6.5 inhibit Fe availability and induce interveinal chlorosis and stunted plant growth.

Figure 1. Lower leaves of fuchsia (*Fuchsia × hybrida*) exhibiting lower leaf red spotting due to a low substrate pH-induced iron (Fe) toxicity.
Photo by: W. Garrett Owen.

Fuchsia

Target Nutrition Parameters

pH Category II - III:
5.5 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

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Figure 2. Lower leaves of fuchsia (*Fuchsia* × *hybrida*) exhibiting lower leaf interveinal reddening or purpling due to a low substrate pH-induced iron (Fe) toxicity.
Photo by: W. Garrett Owen.

Figure 3. Substrate pH above 6.5 or over irrigation can inhibit iron (Fe) uptake causing newly developed and recently matured fuchsia (*Fuchsia* × *hybrida*) leaves to become Fe-deficient and exhibit interveinal chlorosis (yellowing).
Photo by: Brian Whipker.

Fertility Management of Fuchsia

Fuchsia should be grown with a substrate pH range of 5.5 to 6.2. 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 fuchsia leaves and critical tissue values for fuchsia 'Dark Eyes' and 'Giant Bicentennial' are provided in Table 1, which can help in diagnosing suspected nutrient disorders. Monitoring substrate pH and nutrient status will enable growers to avoid pH induced nutritional disorders.

Substrate pH below 5.5 causes increase uptake of iron (Fe) and manganese (Mn) to toxic levels which will accumulate in leaf tissue. Plants exhibiting Fe and/or Mn toxicity exhibit lower leaf spotting (Fig. 1) and interveinal reddening or purpling (Fig. 2). Corrective procedures for low substrate pH should begin at 5.4. For more information about low pH-induced iron toxicity, refer to e-GRO Alert 6-24: Fuchsia: Lower Leaf Purpling. Substrate pH below 5.4 to 5.6 will inhibit magnesium (Mg) uptake causing lower or older leaves to become Mg-deficient and exhibit interveinal chlorosis [yellowing; (Erwin, 1997)]. Monthly applications of supplemental Mg in the form of magnesium sulfate ($MgSO_4$; Epsom salts) at a rate of 8 oz./100 gal. of water in areas with naturally occurring Mg in the water supply or 16 oz./100 gal. of water in areas lacking Mg in the irrigation water will prevent Mg deficiency and symptomology development.

High substrate pH above 6.4 can inhibit Fe uptake causing newly developed and recently matured leaves to become Fe-deficient (Fig. 3). If Fe deficiency symptoms progress, interveinal chlorosis intensifies and leaves may become bleached [white; (Figs. 4A-B)].

Figure 4A. As a result of high substrate pH, severely iron (Fe)-deficient fuchsia (*Fuchsia* × *hybrida*) exhibit intensified interveinal chlorosis where recently matured leaves become entirely chlorotic (yellow). Photo by: Brian Whipker.

Figure 4B. As a result of high substrate pH, severely iron (Fe)-deficient fuchsia (*Fuchsia* × *hybrida*) exhibit intensified interveinal chlorosis where recently matured leaves become entirely chlorotic (reddening). Photo by: Brian Whipker.

Plant growth can also become stunted (Fig. 5). Corrective procedures for high substrate pH should begin within the range of 6.2 to 6.4.

During fuchsia production, maintain a low to medium level of fertility at 100 to 200 ppm N. Insufficient fertility levels (low EC) will result in stunted plant growth (Fig. 6) and poor branching (Nau, 2011). Overfertilization (high EC) results in excessive vegetative growth (Nau, 2011), reduced leaf size, and marginal leaf necrosis [death; (Erwin, 1997)]. If EC values become excessive, leach the substrate with clear irrigation water twice before providing fertility. It is best to monitor the crop to avoid excessive EC values than to waste fertilizer by leaching it from the pots. Fertilizers high in ammoniacal-nitrogen (NH_4-N) may cause lower leaf marginal chlorosis as a result of NH_4 toxicity (Erwin, 1997). Avoid fertilizers high in phosphorus (P), but P deficiency can develop as reddish spotting on the lower leaves when plants are grown at air temperatures <55 °F (13 °C; Nau, 2011).

Summary

Providing low to medium fertility at 100 to 200 ppm N and maintaining a substrate pH of 5.5 to 6.2 will help prevent most nutritional disorders in fuchsia.

Literature Cited

Dole, J.M. and H.F. Wilkins. 2005. Floriculture: Principles and species. 2nd ed. Pearson Education, Inc., Upper Saddle River, NJ.

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

Fuchsia 'Giant Bicentennial'
Substrate pH

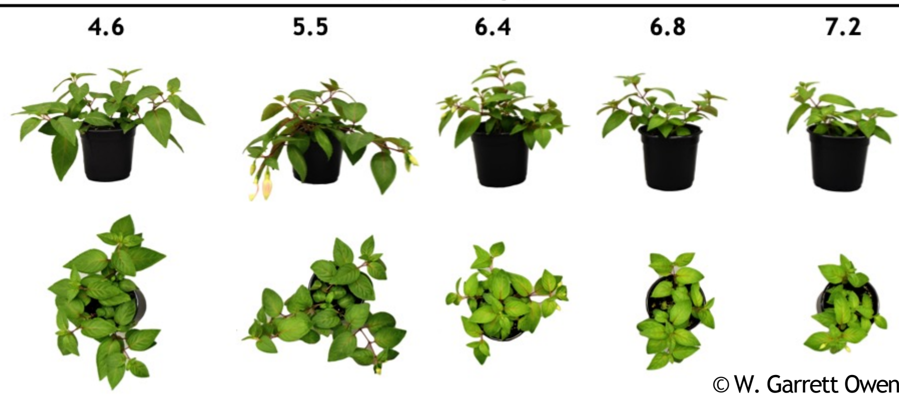

Figure 5. High substrate pH above 6.4 can result in stunted fuchsia (*Fuchsia* × *hybrida*) plant growth. Photo by: W. Garrett Owen.

Fuchsia 'Dark Eyes'
Electrical Conductivity

Figure 6. Providing insufficient fertility [low electrical conductivity (EC)] during fuchsia (*Fuchsia* × *hybrida*) production can result stunted plant growth. Photo by: W. Garrett Owen.

Table 1. General recommended foliar nutrient concentrations for fuchsia (*Fuchsia* × *hybrida*) and critical tissue values for fuchsia 'Dark Eyes' and 'Giant Bicentennial' grown in peat-based substrates with a substrate pH of 4.6 (low pH), 5.5 (optimal pH), and 6.8 (high pH).

Element		Recommended Range [1]	Substrate pH [2]					
			'Dark Eyes'			'Giant Bicentennial'		
			Low	Optimal	High	Low	Optimal	High
Nitrogen (N)	(%)	2.8 – 4.6	3.70	4.17	3.51	4.63	4.15	3.65
Phosphorus (P)		0.4 – 0.6	0.42	0.45	0.48	0.46	0.42	0.52
Potassium (K)		2.2 – 2.5	2.15	1.73	3.32	0.47	2.44	4.75
Calcium (Ca)		1.6 – 2.4	1.25	1.45	2.35	1.11	1.33	2.10
Magnesium (Mg)		0.4 – 0.7	0.58	0.53	0.49	0.47	0.58	0.49
Sulfur (S)		---	0.61	0.52	0.65	0.53	0.59	0.56
Iron (Fe)	(ppm)	95 – 335	102.2	79.1	49.7	305.6	77.3	63.4
Manganese (Mn)		75 – 220	50.1	26.9	48.4	61.2	28.7	28.5
Zinc (Zn)		30 – 45	49.4	36.4	36.5	38.5	33.5	32.2
Copper (Cu)		5 – 10	9.2	5.9	5.4	9.3	6.2	7.9
Boron (B)		25 – 35	35.8	30.7	31.5	36.1	36.4	33.9

Source:
[1] Dole and Wilkins (2005)
[2] Owen (2017)

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, <u>or less.</u>
- Can split applications.

Hydrated Lime

- Mix 1 pound in 3 to 5 gallons of <u>WARM</u> 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.
- <u>*Provides 933 ppm K.*</u>
- <u>Leach heavily</u> the following day with a complete fertilizer to reduce substrate EC and restore nutrient balance.
- Rates <u>greater than</u> 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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