



W. Garrett Owen¹



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Nutritional Monitoring Series

Bougainvillea (*Bougainvillea hybrids*)

Bougainvillea require medium fertility levels between 150 and 200 ppm N. Optimal substrate pH values for bougainvillea range from 5.8 to 6.2. Bougainvillea can develop both low and high substrate pH disorders. High substrate pH above 6.5 inhibits Fe availability and causes interveinal chlorosis (yellowing) of the upper foliage.



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Figure 1. Low substrate pH below 5.8 will inhibit magnesium (Mg) uptake causing lower or older leaves of bougainvillea (*Bougainvillea hybrids*) to become Mg-deficient and exhibit interveinal chlorosis (yellowing). Photo by W. Garrett Owen.

Target Nutrition Parameters

pH Category III:
5.8 to 6.2

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

Bougainvillea

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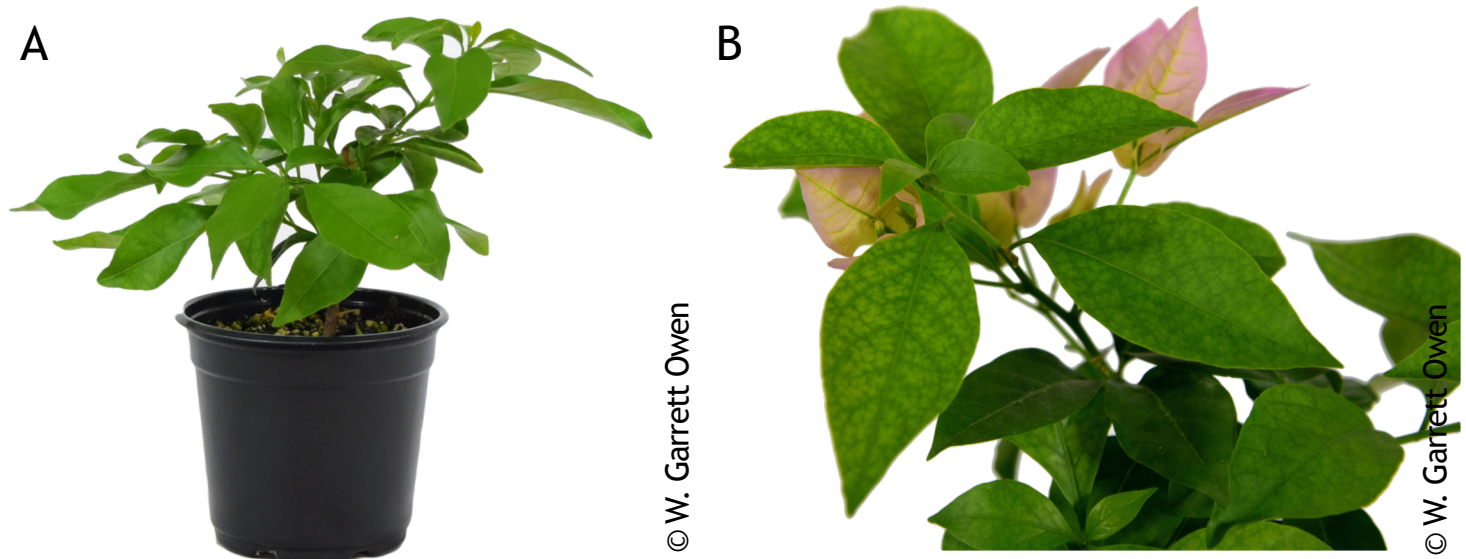


Figure 2. High substrate pH above 6.5 can inhibit iron (Fe) uptake causing newly developed leaves of bougainvillea (*Bougainvillea hybrids*) to become Fe-deficient and exhibit chlorosis (yellowing; A) and exhibit interveinal chlorosis (B). Photos by W. Garrett Owen.

Fertility Management of Bougainvillea

Bougainvillea propagated from vegetative cuttings should be grown with a substrate pH range of 5.8 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 leaves of bougainvillea are listed in Table 1. Monitoring substrate pH and nutrient status will enable growers to avoid pH induced nutritional disorders.

Substrate pH values below 5.8 causes increased uptake of iron (Fe) and manganese (Mn) and may induce toxicity symptoms (Criley, 1997). Plants exhibiting Fe and/or Mn toxicity will exhibit lower leaf interveinal chlorosis (yellowing). Additionally, substrate pH below 5.8 will inhibit magnesium (Mg) uptake causing lower or older leaves to become Mg-deficient and exhibit interveinal chlorosis (yellowing; Fig. 1). Corrective procedures for low substrate pH should begin within the range of 5.5 to 5.8. Regular or 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 is recommended to prevent Mg deficiency and symptomology development.

High substrate pH above 6.5 can inhibit iron (Fe) uptake causing newly developed leaves to become Fe-deficient and exhibit chlorosis and interveinal chlorosis (Figs. 2A-B). If plants become severely Fe-deficient, interveinal chlorosis intensifies and leaves become yellow or almost bleached [white; (Fig. 3)]. Corrective procedures for high substrate pH should begin within the range of 6.2 to 6.4. Applications of soluble micronutrients will prevent chlorosis. Chelated Fe-spray or drench applications are recommended.



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Figure 3. High substrate pH above 6.5 can inhibit iron (Fe) uptake causing newly developed leaves of bougainvillea (*Bougainvillea hybrids*) to become Fe-deficient and over time, can intensify where leaves become bright yellow or almost bleached (white). Photos by W. Garrett Owen.



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Figure 4. Providing insufficient fertility [low electrical conductivity (EC)] during bougainvillea (*Bougainvillea hybrids*) production can result in an overall chlorotic (yellow) cast of the plant. Photo by W. Garrett Owen.



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Figure 5. Providing excessive fertility [high electrical conductivity (EC)] during bougainvillea (*Bougainvillea hybrids*) production can result in excessive vegetative growth. Photos by W. Garrett Owen.



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Figure 6. Overfertilization (high EC) during bougainvillea (*Bougainvillea hybrids*) production may result in chlorosis (yellowing) and interveinal chlorosis. Photo by: W. Garrett Owen.

Once transplanted, bougainvillea can be fertilized with a slow- or controlled-release fertilizer (CRF) or constant liquid feed. Applications of CRFs are often top-dressed and is recommended during long-term production (Criley, 1997). Constant liquid feed providing medium fertility levels between 150 and 200 ppm N delivered from fertilizers with ratios of 1:1:1 or 1:2:1 N:P:K are recommended. Nau (2011) reported fertilizing bougainvillea with a 20-10-20 fertilizer. Insufficient fertility levels (low EC) will result in stunted plant growth or an overall chlorotic cast (Fig. 4). Overfertilization (high EC) results in excessive vegetative growth (Fig. 5). Increased levels of N encourage vegetative growth, while additions of K at high N levels or high N and short-days have been reported to

enhance flowering (Criley, 1997). If plants are grown cool, avoid fertilizers providing ammonium (NH₄). However, Broschat (1998) reported urea- or NH₄-based CRFs reduced chlorosis and increased flowering under higher light environments compared to nitrate-based fertilizers. High EC has also been reported to cause chlorosis, interveinal (Fig. 6), and root damage (Broschat, 1998; Dole and Wilkins, 2005).

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.

Summary

Providing bougainvillea with a moderate level of fertility ranging from 150 to 200 ppm N and maintaining a substrate pH of 5.8 to 6.2 will prevent most nutritional disorders from occurring.

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Table 1. Leaf tissue nutrient sufficiency range recommended for bougainvillea (*Bougainvillea hybrids*).

Element		Reference Bougainvillea ¹
Nitrogen (N)	(%)	2.5 - 4.5
Phosphorus (P)		0.25 - 0.75
Potassium (K)		3.0 - 5.5
Calcium (Ca)		1.0 - 2.0
Magnesium (Mg)		0.25 - 0.75
Sulfur (S)		0.20 - 0.50
Iron (Fe)	(ppm)	50 - 300
Manganese (Mn)		50 - 200
Zinc (Zn)		20 - 200
Copper (Cu)		8 - 50
Boron (B)		25 - 75
Molybdenum (Mo)		0.12 - 1.00

Source: ¹ 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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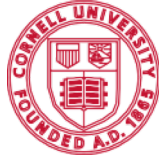
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