e-GRO Nutritional Monitoring

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Nutritional Monitoring Series

Basil

(Ocimum basilicum)

Basil requires low levels of fertilization, growing best with 100 to 150 ppm N for containerized crops or 0.5 to 1.5 mS/cm for hydroponic nutrient solutions. Plants prefer a pH within the range of 5.8 to 6.2 for both soilless substrates and hydroponic solutions. This range prevents low substrate pH-induced iron (Fe) and manganese toxicities and Fe deficiency.

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Figure 1. Basil (*Ocimum basilicum*) grown in a substrate with a pH range of 5.8 to 6.2. Photo by: W. Garrett Owen.

Basil

Target Nutrition Parameters

pH Category III:
5.8 to 6.2
(substrate & hydroponic)

Fertility Category: Low
100 to 150 ppm N (substrate)
0.5 to 1.5 mS/cm (hydroponic)

EC Category A:
1:2 Extraction:
0.4 to 0.6 mS/cm

SME:
0.9 to 1.3 mS/cm

PourThru:
1.3 to 2.0 mS/cm

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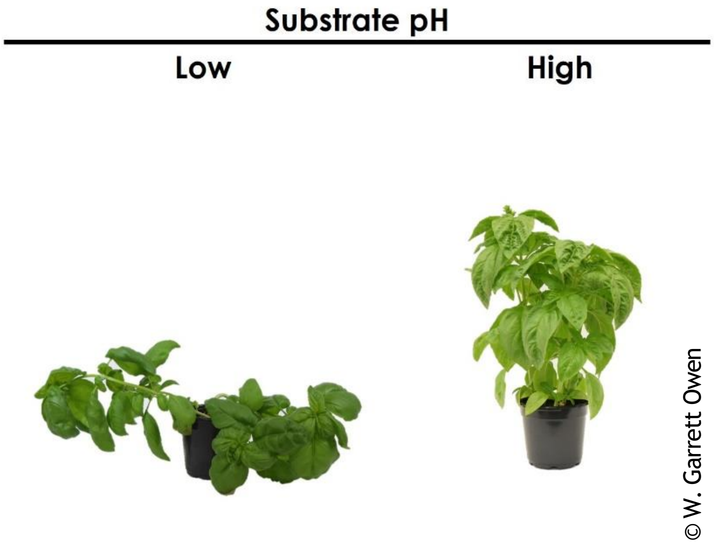

Figure 2. Basil (*Ocimum basilicum*) grown in substrates with a pH below 5.8 will become weak, easily topple. Photo by: W. Garrett Owen.

Figure 3. Basil (*Ocimum basilicum*) grown in substrates with a pH below 5.8 with exhibit brown to black spotting along the leaf margin progressing into the leaf as a result of iron (Fe) and/or manganese (Mn) toxicity. Photo by: W. Garrett Owen.

Fertility Management of Basil

Basil should be grown with a pH range of 5.8 to 6.2 (Fig. 1). 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 basil are listed in Table 1. Monitoring substrate pH and nutrient status will enable growers to avoid pH induced nutritional disorders.

Substrate pH below 5.8 causes plants to become weak, easily toppled (Fig. 2), and increase uptake of iron (Fe) and manganese (Mn) to toxic levels which will accumulate in leaf tissue. Plants exhibiting Fe and/or Mn toxicity will exhibit lower leaf chlorosis and brown to black spotting along the leaf margin progressing into the leaf (Fig. 3), and marginal necrosis (death; Fig. 4). Corrective procedures for low substrate pH should begin within the range of 5.5 to 5.7.

High substrate pH above 6.5 can inhibit Fe uptake causing newly developed leaves to become Fe deficient and exhibit interveinal chlorosis (Figs 2 and 5). Corrective procedures for high substrate pH should begin within the range of 6.2 to 6.4.

Basil plants are considered to require low levels of fertility. Plants underfertilized will exhibit chlorosis and become stunted while overfertilization will result in excessive growth (Fig. 6 and 7). Overfertilization with ammoniacal (NH4-N) –based fertilizers will cause excessive vegetative growth, leaf expansion, thereby reducing oil content by 28% (Adler et al., 1989) and thus, reducing flavor (Davis, 1992).

For direct-sown basil seeds, begin a fertilization program as soon as the first true leaves develop which typically begins 10 to 14 days under optimal greenhouse conditions. Provide young plants with 100 to 150 ppm N delivered from 20-10-20 and alternating with 14-0-14 or another calcium nitrate [$Ca(NO_3)_2$] or potassium nitrate (KNO_3) –based fertilizer at every second or third irrigation (Nau, 2011). Maintain substrate EC below 0.6, 1.3, or 2.0 mS/cm, based on the 1:2 Extraction, SME, or PourThru methods, respectively.

In hydroponic systems, basil can be grown with a wide range of nutrient solution ECs. As long as the EC is consistently maintained, 0.5 to 1.5 mS/cm will produce healthy plants with sufficient tissue nutrient concentrations. Increasing the EC of hydroponic nutrient solutions does not increase production of fresh mass.

Basil does have a higher requirement for magnesium (Mg). If water sources and/or fertilizers or nutrient solutions contain insufficient Mg, supplemental Mg should be provided with Epsom salts ($MgSO_4$). For fertilizing container-grown plants, a corrective drench of 2 pounds per 100 gallons can be applied or 1 lb per 100 gallons can be applied to prevent Mg deficiency.

Summary

Providing basil with low levels of fertility ranging from 100 to 150 ppm N or hydroponic nutrient solution EC 0.5 to 1.5 mS/cm and maintaining a pH of 5.8 to 6.2 will prevent most nutritional disorders from occurring.

Figure 4. Basil (*Ocimum basilicum*) grown in substrates with a pH below 5.8 with exhibit brown to black spotting along the leaf margin and marginal necrosis (death) as a result of iron (Fe) and/or manganese (Mn) toxicity. Photo by: W. Garrett Owen.

Figure 5. High substrate pH above 6.5 can inhibit iron (Fe) uptake causing newly developed basil (*Ocimum basilicum*) leaves to become deficient in Fe and exhibit interveinal chlorosis Photo by: W. Garrett Owen.

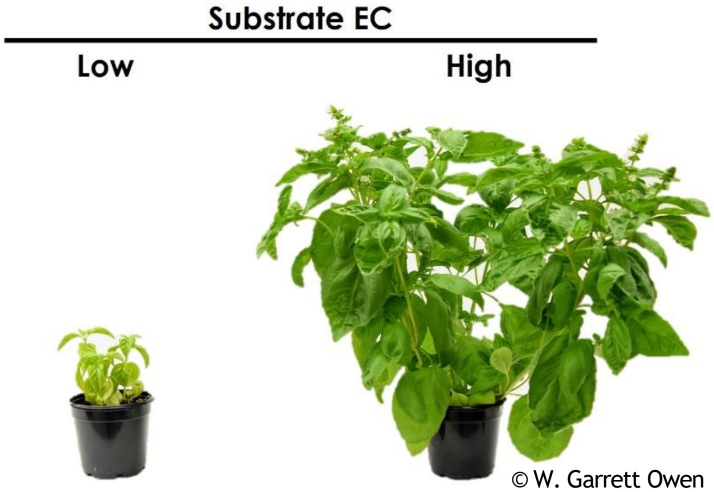

Figure 6. Basil (*Ocimum basilicum*) grown in substrates with a pH of 5.8 and provided with little to soluble salts [referred to as electrical conductivity (EC)] will exhibit chlorosis and become stunted (left) while overfertilization or high EC will result in excessive growth. Photo by: W. Garrett Owen.

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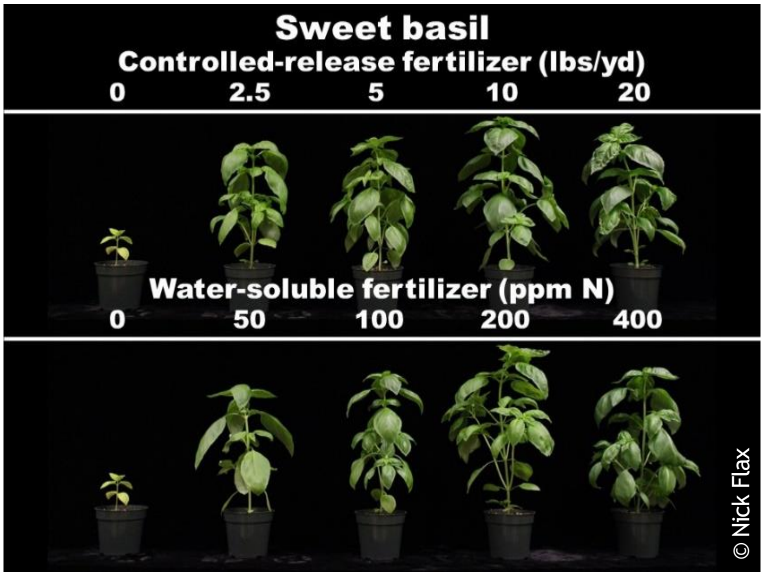

Figure 7. Comparison of basil (*Ocimum basilicum*) plants grown in substrates with a pH of 5.8 and fertilized with 0, 2.5, 5, 10, or 20 nitrogen (N) lbs/yd3 provided by a slow release fertilizer or 0, 50, 100, 200, 400 ppm N provided by a water soluble fertilizer. Photo by: Nick Flax.

Table 1. Leaf tissue nutrient sufficiency range recommended for basil (*Ocimum basilicum*).

Element		Sufficiency range [1]
Nitrogen (N)	(%)	4.00 – 6.00
Phosphorus (P)		0.62 – 1.00
Potassium (K)		1.55 - 2.05
Calcium (Ca)		1.25 - 2.00
Magnesium (Mg)		0.60 - 1.00
Sulfur (S)		0.20 - 0.60
Iron (Fe)	(ppm)	75 – 200
Manganese (Mn)		30 - 150
Zinc (Zn)		30 – 70
Copper (Cu)		5 – 10
Boron (B)		25 - 60
Molybdenum (Mo)		0.10 – 0.50

[1]Source: Bryson et al. (2014) for basil grown in production fields. These values represent matured leaves from new growth.

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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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