e-GRO Nutritional Monitoring



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Nutritional Monitoring Series

Goji

(Lycium barbarum)

Goji requires medium fertility levels between 150 and 200 ppm N. Insufficient fertility can cause chlorosis (yellow), reddening, or purpling on the lower foliage and stunted plant growth. Optimal substrate pH values for goji range from 5.5 to 6.5.

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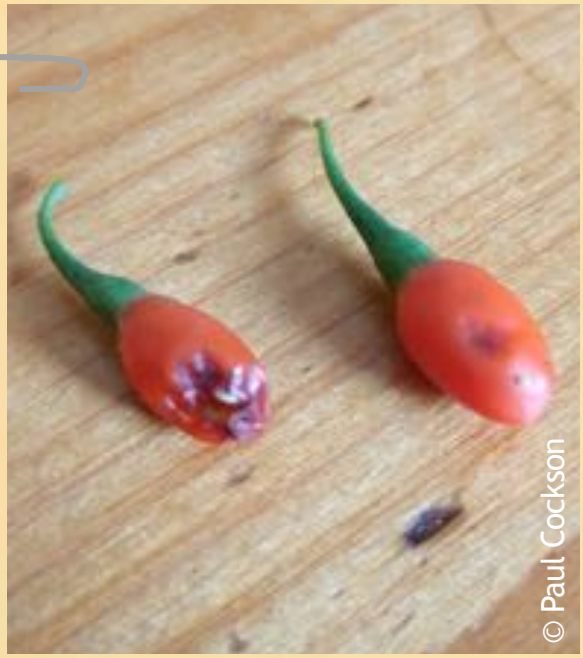

Figure 1. Blossom end rot like symptoms on developing goji berries. Notice the onset of symptoms in the berry to the right as a necrotic blemish at the terminal end of the ovular fruit. This necrotic region will be soft to the touch. The berry on the left is displaying advanced goji berry blossom end rot showing severe wrinkling and shriveling of the terminal end of the berry along with more severe necrosis.

Target Nutrition Parameters

pH Category II & III:
5.5 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:
2.0 to 3.0 mS/cm

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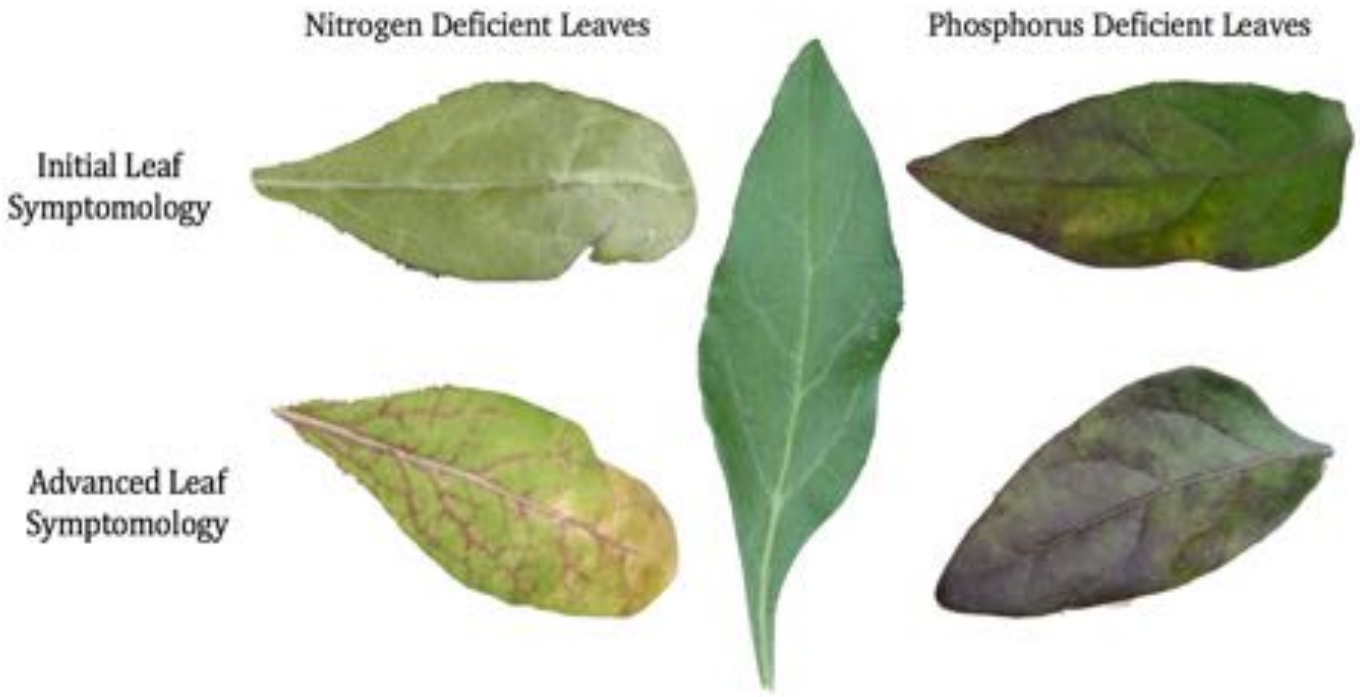

Figure 2: Nitrogen (N) (left) and phosphorus (P) (right) symptomology is compared to a normal healthy goji (*Lycium barbarum*) leaf (center). The symptomology progresses from initial (top) to advanced (bottom). Note specifically the unique symptomology of the purpling veins. Nitrogen deficient leaves will initially be a lighter yellow (top left) than the phosphorus deficient plants, and phosphorus deficient leaves will have olive green mottling (top right). In advanced symptomology, N deficient leaves will become much lighter in color with starkly colored veins (bottom left) and P deficient leaves will turn a dark purple and also contain colored veins (bottom right). Photo by: Paul Cockson.

Fertility Management of Goji

The goji plant requires moderate fertility. A target range of 150 – 200 ppm N with a complete fertilizer should be maintained (Proven Winners, 2017). Using a calcium plus magnesium fertilizer will be beneficial as the goji has a high requirement for those nutrients. If growing out for berry production or for ornamental purposes, as soon as green berries emerge after pollination, it is highly recommended that a calcium plus magnesium fertilizer be added into the fertilizer mix. This will ensure that berry quality is maintained and nutrient deficiencies are avoided. If stressed, goji fruit will develop blossom end rot much like a tomato (Fig. 1) (Cockson, unpublished data). The target EC levels are 0.6 – 0.9 mS/cm using a 2:1 extraction method, 1.3 – 2.0 mS/cm for SME, and 2.0 – 3.0 mS/cm for PourThru extraction of top irrigated plants during the main growing season.

In a trial conducted at North Carolina State University, nutrient disorders were induced on goji plants. Nitrogen, manganese, and phosphorous deficiencies were the first to appear (Fig. 2). Iron deficiency was next to manifest (Fig. 3). Iron and manganese deficiency can be an issue if the pH is too high. These nutrients should be monitored as they will be most likely to be nutritional issues that growers encounter.

Substrate pH should be monitored during goji production. The optimal substrate pH range for goji is 5.5 – 6.5 (Cockson, unpublished data). A pH that is too high will result in chlorosis and stunting (Fig. 4) (Cockson and Whipker, 2016). To adjust substrate pH, limestone applications can be applied to raise the pH or acid water drenches to lower the substrate pH. A PourThru method will help you monitor both the pH and EC and should be done at the beginning, middle, and end of the production cycle. Fertilizers can also affect pH, as most mixed fertilizers are acidic. To avoid altering the pH through your fertilizer, choose a neutral reacting fertilizer mix.

Summary
Providing medium fertility of 150 to 200 ppm N and maintaining a pH of 5.5 to 6.5 will help prevent most nutritional disorders.

Literature Cited

Cockson, P. and Whipker, B. E. 2016. Goji berry: high pH induced chlorosis. e-Gro Alert 6.26.

Proven Winners®. 2017 Sweet Lifeberry™ Goji Berry *Lycium*. 2017. Cultural Information: Proven Winners®.

Table 1. Published foliar nutrient concentrations for goji (*Lycium barbarum*).

Element		Recommended Range [1]
Nitrogen (N)	(%)	5.24
Phosphorus (P)		1.17
Potassium (K)		6.46
Calcium (Ca)		1.06
Magnesium (Mg)		1.00
Sulfur (S)		0.47
Iron (Fe)	(ppm)	95.75
Manganese (Mn)		25.03
Zinc (Zn)		21.95
Copper (Cu)		7.51
Boron (B)		38.42
Molybdenum (Mo)		7.13

[1]Source: Cockson, P., I. McCall, and B. Whipker. 2018. A Refinement and Categorization of Lycium barbarum Substrate pH Values and Nutrient Disorders. ISHS Acta. (In Press).

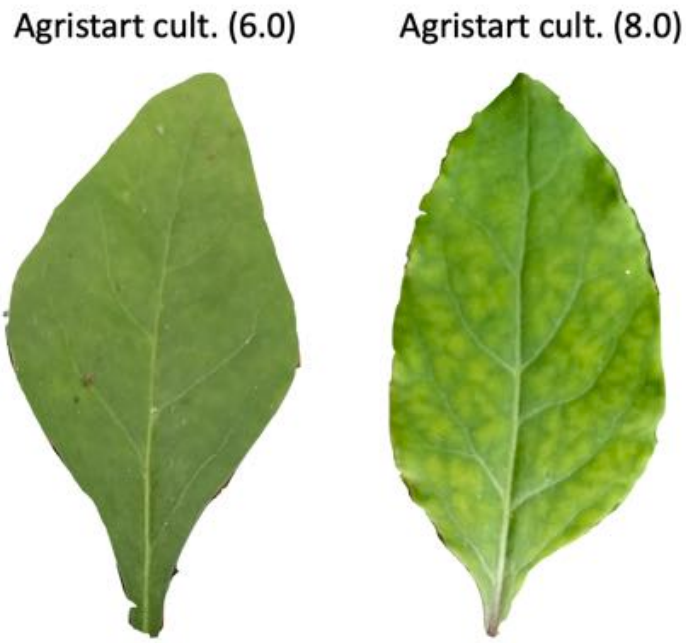

Figure 3: Iron deficient leaf (right) as opposed to normal and healthy leaf (left). This photo indicates how high pH can induce iron deficiency. Photo by: Paul Cockson.

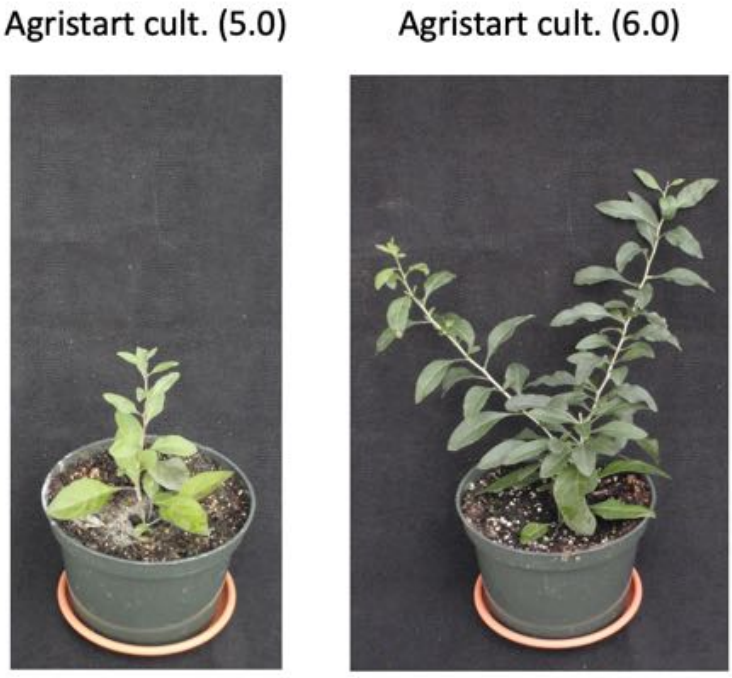

Figure 4: Stunting of the entire plant due to low pH (left) as opposed to normal and healthy plant grown within the optimal substrate pH range (right). Photo by: Paul Cockson.

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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