e-GRO Nutritional Monitoring



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Volume 1 Number 23 June 2018

Nutritional Monitoring Series

Zinnia

(Zinnia elegans)

Zinnias are excellent bedding and summer color plants. Plants require low to medium levels of fertility, growing best with 100 to 200 ppm N. The target substrate pH values are between 5.8 and 6.2. The most common nutritional disorders of are insufficient fertility, which results in lower leaf chlorosis (yellowing) and drop; high substrate pH, which results in interveinal chlorosis of the youngest leaves; and low substrate pH which results in black spotting of the older leaves.

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Figure 1. Low soluble salts [referred to as electrical conductivity (EC)] results in lower leaf chlorosis (yellowing) of zinnia (*Zinnia elegans*). Photo: Brian E. Whipker.

Zinnia

Target Nutrition Parameters

pH Category III:
5.8 to 6.2

Fertility Category:
Low to Medium
100 to 200 ppm N

EC Category 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. If the electrical conductivity (EC) is too low early in the production cycle of zinnia (*Zinnia elegans*), plant growth will be checked or even stunted (right plant, versus a well fertilized plant on the left). Photo: Brian E. Whipker.

Figure 3. High soluble salts [referred to as electrical conductivity (EC)] due to an over-application of fertilizer can lead to marginal leaf browning and death (necrosis) of zinnia (*Zinnia elegans*). Symptoms are typically observed after the plants were drought stressed. Photo: Brian E. Whipker.

Fertility Management of Zinnia

Zinnias require low to medium levels of fertility at 100 to 200 ppm N. Growers should maintain fertilization at 100 to 200 ppm N during periods of normal growth. Low soluble salts [referred to as electrical conductivity (EC)] results in lower leaf chlorosis (yellowing; Fig. 1). If the EC is too low early in the production cycle, plant growth will be checked or even stunted (Fig. 2).

On the opposite end of the spectrum is excessive EC. High EC can lead to marginal chlorosis or browning (necrosis) of the lower leaves (Fig. 3). If the EC increases beyond optimal levels, apply a few irrigations with clear water to lower it. If the EC is excessively high, apply two clear water irrigations to leach excess salts (but this more drastic step results in wasting your fertilizer investment and can be avoided by monitoring the EC and taking action before it becomes excessive).

Substrate pH should be maintained between 5.8 and 6.2. Lower or higher values beyond this range commonly lead to low or high pH induced nutritional disorders. High substrate pH greater than 6.4 inhibits iron (Fe) uptake, causing interveinal chlorosis of the upper foliage (Fig. 4).

Low pH causes excessive uptake of Fe and manganese (Mn), which leads to toxicity symptom development. Toxicity of Fe and Mn exhibits symptoms of a lower leaf purplish coloration with black (Fig. 5) or red spotting (Fig. 6). Foliar Fe and Mn concentrations should remain below 300 ppm (Bryson and Mills, 2014). Monitoring substrate pH and periodic tissue sampling can help to determine if symptoms are due to high or low Fe and Mn (Table 1). Iron deficiency can be remedied with an application of iron chelate, while Fe and Mn toxicity can be remedied by flowable lime application to adjust (raise) the pH.

In addition, especially for summer crops, tip burn of the youngest leaves around the flower bud is associated with an environmentally induced calcium (Ca) deficiency (Fig. 7). More details can be found in e-GRO Alert 3-44 (Whipker, 2014).

Summary
Maintaining low to moderate fertility at 100 to 200 ppm N and a pH of 5.8 to 6.2 will enable you to grow healthy zinnias while preventing high or low pH induced nutritional disorders.

Literature Cited

Bryson, G.M. and H.A. Mills. 2014. Plant analysis handbook IV. Micro-Macro Publishing, Inc., Athens, GA.

Gibson, J.L., D.S. Pitchay, A.L. Williams-Rhodes, B.E. Whipker, P.V. Nelson, and J.M. Dole. 2007. Nutrient deficiencies in bedding plants: A pictorial guide for identification and correction. Ball Publishing, Inc., West Chicago, IL.

Whipker, B.E. 2014. Zinnia: Tip burn of Young Leaves. e-GRO Alert 3-44, p. 5.

Figure 4. High substrate pH leads to interveinal chlorosis (yellowing) on the upper foliage of zinnia (*Zinnia elegans*). Photo: Brian E. Whipker.

Figure 5. Low substrate pH leads to black spotting on the lower, older foliage of zinnia (*Zinnia elegans*). Photo: Brian E. Whipker.

Figure 6. Low substrate pH leads to red spotting on the lower, older foliage of zinnia (*Zinnia elegans*). Photo: Brian E. Whipker.

Table 1. Recommended range of leaf tissue analysis for zinnia (*Zinnia elegans)*.

Element	Recommended Range [1]	NC State Critical Range[2]
Nitrogen (%)	3.50 – 5.78	1.66
Phosphorus (%)	0.40 – 0.74	0.10
Potassium (%)	2.40 – 3.25	0.89
Calcium (%)	1.75 – 2.37	0.53
Magnesium (%)	0.89 – 1.48	0.10
Sulfur (%)	0.25 – 0.37	0.11
Iron (ppm)	80 – 150	47.0
Manganese (ppm)	200 – 300	10.8
Zinc (ppm)	50 – 115	9.2
Copper (ppm)	5 – 23	0.9
Boron (ppm)	35 – 67	23.4
Molybdenum (ppm)	0.3 – 0.5	No data

[1] Source: Bryson and Mills (2014)
[2] Gibson et al. (2007). Based on when deficiencies were first observed.

Figure 7. Tip burn on the leaves surround the flower bud is the result of limited calcium (Ca) in zinnia (*Zinnia elegans*). Photo: Brian E. Whipker.

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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