Editors' Note: This is the last in a seven-part series on research being performed at North Carolina State University in Raleigh, N.C.

Identifying Poinsettia Nutritional Disorders

By Brian Whipker, Ingram McCall and Jared Barnes

With poinsettia growing season just around the corner, this research will help growers recognize nutritional problems in their crops and how to avoid them.

Plant fertilization requirements, nutrient monitoring and nutrient disorders have been a major research and extension focus at North Carolina State University. With nutrient disorders, our group has induced, photographed and recorded symptomology and critical tissue concentrations in more than 50 crops.

Most growers have standard fertilization practices that result in healthy poinsettia plants year after year. Problems usually occur with a change to production practices (new cultivar, new water source, different substrate or fertilizer blend) or when a fertilization equipment malfunction occurs. With poinsettia season just around the corner, we wanted to share results of our research program and help you recognize poinsettia nutritional problems and what steps to take to avoid them.

Low Electrical Conductivity (EC). When the root substrate EC is too low, plants are stunted and mineral deficiencies occur. Deficiency symptoms such as lower leaf yellowing (nitrogen, Figure 1, page 38) or lower leaf speckling (phosphorus) are common when EC values are below 0.25 mS/cm (1:2 extraction), 0.75 mS/cm (SME extraction), or 1.0 mS/cm (PourThru extraction).

High EC. Even though poinsettias are heavy feeders, too much fertilizer also can be a problem. Plants can be darker green and stunted, similar to what occurs with PGR overdoses. If the plants are allowed to dry out, a marginal leaf burn also can occur (Figure 2, page 38).

Phosphorus Deficiency. Symptoms appear at the bottom of the plant. Older leaves may develop either of two patterns. With cold growing, having a waterlogged substrate or when root growth may have been impaired, older leaves will develop the classical reddish coloration (Figure 3, page 38).

Another symptom is also common when the growing conditions are optimal, but phosphorus is withheld: the lower leaves will initially turn a dull green, followed by yellow spotting in between the midrib and secondary veins. With advanced symptoms the entire

Table 1. Corrective procedures for overcoming poinsettia nutritional disorders.

Element	Correction Steps – take these steps when problems occur	Notes
Low EC'	a. Increase the fertilization rate. Apply one or two applications of 300- to 400-ppm N to increase the EC level. Typical target rates for continual fertilizations are 150- to 250-ppm N. b. Avoid clear water irrigations until the EC levels are within acceptable levels.	MISDIAGNOSED OR CONFUSED WITH: (see Nitrogen deficiency for additional details.)
High EC'	a. Lower the fertilization rate. Typical target rates are 150- to 250-ppm N. b. Switch to clear water irrigations to restore the EC within acceptable levels. c. Apply a 20 percent leaching fraction irrigation with clear water. If levels were excessive follow with a second leaching irrigation within an hour.	MISDIAGNOSED OR CONFUSED WITH: a. Water stress damage. b. Leaf burn when the shade is remove. c. Chemical burn (from drenches or other nutrients in the irrigation water)
Nitrogen [N]	a. Determine via substrate, fertilizer solution and tissue analysis if there is a problem of insufficient N being supplied. b. Provide one to three corrective application(s) of water-soluble fertilizer containing 300-ppm N, such as calcium nitrate with potassium nitrate. c. After making the corrective application(s), retest the substrate to determine if the plant is now receiving sufficient N levels.	MISDIAGNOSED OR CONFUSED WITH: a. Insufficient light levels can lead to lower leaf yellowing and abscission. (Determine if the plant spacing is too dense.) b. Drought stress can lead to lower leaf yellowing and abscission. (Review cultural/irrigation records.) c. Sulfur deficiency also results in overall yellow coloration, but symptoms are more pronounced at the top of the plant. (Conduct tissue analysis to determine sulfur and nitrogen concentrations.)
Phosphorus [P]	Target P levels are 5 to 15 ppm in the substrate (SME). Manage the amount of P supplied by rotating between a non-P containing fertilizer (ie: 15-0-15) and one containing P (ie: 20-10-20). Note: 20-10-20 applied at 200 ppm N also supplies 42 ppm P. a. Determine if the problem is a lack of P being supplied or a problem with the root system. b. Determine via substrate, fertilizer solution and tissue analysis if there is a problem of insufficient P being supplied. c. Provide one to three corrective application(s) of water soluble fertilizer containing 40 ppm P, such as 20-10-20. d. After making the corrective application(s), retest the substrate to determine if the plant is now receiving sufficient P levels.	Phosphorus is an essential element required by poinsettias for proper growth. While a low P fertilization program is suitable, a no P strategy is not. MISDIAGNOSED OR CONFUSED WITH: a. Poor root health due to root disease, injured roots, insect and nematode feeding, poor drainage or compact soil can result in a purple cast and red veination. (Inspect the root system.) b. Cold soil temperatures can inhibit the uptake of P. (Measure the substrate temperature level.) c. Wet soil conditions can inhibit the uptake of P. (Inspect the substrate for waterlogged conditions.)
Potassium [K]	Supply potassium at 150- to 200-ppm K. This can be accomplished with 20-10-20 at 200 ppm N, which will provide 166-ppm K.	Potassium deficiencies are rare. Conduct nutrient analysis to confirm.
Calcium [Ca]	a. Determine if the problem is a lack of Ca being supplied or a problem with the root system. b. Determine via substrate, fertilizer solution and tissue analysis if there is a problem of insufficient Ca being supplied. Confirm boron is adequately supplied. c. Provide one to three corrective application(s) of water-soluble fertilizer containing 200-ppm Ca, such as calcium nitrate. d. After making the corrective application(s), retest the substrate to determine if the plant is now receiving sufficient Ca levels. e. Apply Calcium foliar sprays to bracts. See the guide: Foliar Feeding of Calcium - Ecke Ranch website: http://www.ecke.com/html/tibs/tib_foliar_feeding.html.	MISDIAGNOSED OR CONFUSED WITH: a. Pesticide phytotoxicity. (Review cultural records.) b. Boron deficiency. (Conduct leaf tissue analysis to determine levels.)
Magnesium [Mg]	a. Determine if the problem is a lack of Mg being supplied or a problem with the root system. b. Determine via substrate, fertilizer solution and tissue analysis if there is a problem of insufficient Mg being supplied. c. Provide one or two corrective application(s) of water soluble magnesium sulfate (1 to 2 pounds per 100 gallons of water [119 to 238 grams per 100 liters of water]). d. After making the corrective application(s), retest the substrate to determine if the plant is now receiving sufficient Mg levels.	MISDIAGNOSED OR CONFUSED WITH: a. Potassium deficiency. (Conduct leaf tissue analysis to determine levels.) b. Heavy potassium or calcium applications can induce magnesium deficiencies (Conduct leaf tissue analysis to determine levels.) c. Insufficient magnesium being supplied to the plant. Lime rather than dolomitic limestone was used to adjust the pH. d. Excessive leaching of the dolomitic limestone from the soil can lead to magnesium deficiencies over time. e. High levels of sodium in the irrigation water can inhibit magnesium uptake by the plant.

Continued on page 36...

Table 1, continued from page 34.

Sulfur [S]	a. Determine via substrate, fertilizer solution and tissue analysis if there is a problem of insufficient S being supplied or a problem with waterlogging of the root system. b. Provide one or two corrective application(s) of water soluble magnesium sulfate (1 to 2 pounds per 100 gallons of water [119 to 238 grams per 100 liters of water]). Atmospheric SO_2 from industrial activities may supply sufficient levels of S. c. After making the corrective application(s), retest the substrate to determine if the plant is now receiving sufficient S levels.	MISDIAGNOSED OR CONFUSED WITH: a. Nitrogen deficiency – although the overall chlorosis symptoms are similar, N deficiency occurs on the oldest leaves. (Conduct leaf tissue analysis to determine levels.)
Molybdenum [Mo]	As a precaution, provide supplemental applications of Mo on a continual basis. To mix a 0.1 ppm Mo constant feed; use 1 oz (28.4 g) ammonium molybdate [$(NH_4)_6Mo_7O_2 \cdot 4H_2O$] or sodium molybdate [$Na_2MoO_4 \cdot 2H_2O$] per 2½ pints (40 fl. oz.) of water to create a stock solution. Add 1.5 fl. oz. of the stock solution per 10 gallons of water and apply through an 1:100 injector.	Poinsettias are heavy feeders of molybdenum.
pH [high] iron deficiency	Confirm the substrate pH. Problems generally occur with the pH is ≥ 6.3. a. Determine via substrate, fertilizer solution and tissue analysis if there is a problem of insufficient Fe being supplied or a problem with waterlogging of the root system. b. Apply either: (a) 5 oz. iron-EDDHA mixed in 100 gal. of water (37.4 g in 100 L water); (b) 5 oz. iron-DTPA mixed in 100 gal. of water (37.4 g in 100 L water); or (c) 4 to 8 oz. iron sulfate mixed in 100 gal. of water (30 to 60 g in 100 L water). Mist off the foliage soon after application. c. After making the corrective application, retest the substrate to determine if the plant is now receiving sufficient Fe levels.	MISDIAGNOSED OR CONFUSED WITH: a. Magnesium deficiency results in a similar interveinal chlorosis but of the lower leaves. b. Iron, manganese or zinc deficiencies – although the interveinal chlorosis symptoms are similar, these deficiencies occur on the youngest leaves. (Conduct leaf tissue analysis to determine levels.) c. Virus infection – although the interveinal chlorosis symptoms are similar, virus symptoms most commonly are visible on the youngest or recently mature leaves. (Conduct a virus screening to confirm.) In most cases, iron is being supplied in sufficient quantities to the soil, but Fe deficiency can be induced by high pH levels, waterlogging of the soil, cold soil temperatures, root injury, or root rot.

[1] EC = electrical conductivity

There are a number of additional resources available to aid in growing poinsettias and general nutritional disorders:

• If you want additional information about identifying poinsettia problems, a 54-page, color photograph guide to poinsettia diseases, insects, nutritional and physiological disorders can be ordered from the North Carolina Commercial Flower Growers' Association (www.nccfga.org).

• An excellent guide to applying calcium sprays is available on the Paul Ecke Ranch website at: http://www.ecke.com/html/tibs/tib_foliar_feeding.html.

• For bedding plants, we have published a guide to Nutrient Deficiencies in Bedding Plants: A Pictorial Guide for Identification and Correction, which is available from www.amazon.com.

• A series of podcasts covering poinsettia nutritional disorders can be viewed at: http://www.greenhousegrower.com/ggtv/?cid=2

leaf may yellow and grayish-green spots will be observed (the spotting differentiates it from nitrogen deficiency) (Figure 4, page 38).

Calcium Deficiency. Symptoms appear at the top of the plant. Young leaves may develop marginal leaf burn and distortion (Figure 5, page 39). Leaf edges may become necrotic. Typically, symptoms in young plants occur during periods of overcast weather when the plant's ability to uptake calcium is inhibited. Bracts also can develop a marginal necrosis and late season preventative applications of calcium chloride can be made.

Magnesium Deficiency. Lower leaves develop interveinal chlorosis (Figure 6, page 39). Under advanced conditions, the leaf margins turn necrotic. On younger plants symptoms appear on the lower leaves. On flowering poinsettias, symptoms tend to develop on the top half of the plant (Figure 7, page 39).

Sulfur Deficiency. The upper portion of the plant develops an overall yellowish coloration (Figure 8, page 40) and is most commonly observed during the last half of the growing season. Sulfur deficiency symptoms vary from both nitrogen deficiency (or low EC), which occurs on the lower leaves and from iron deficiency caused by high pHs, which is an interveinal chlorosis of the upper leaves.

Molybdenum Deficiency. Symptoms appear as chlorosis (yellowing) of the recently mature leaves (middle of the plant), rolling of the leaves and leaf edge burn (Figure 9, page 40). The leaf chlorosis of molybdenum deficiency resembles magnesium deficiency, except that the thin, marginal band of chlorosis is expressed from the leaf tip to the leaf base. Molybdenum deficiencies can cause distorted leaves due to the failure of the interveinal areas to expand normally.

High pH. High substrate pH can induce nutrient problems in

Figure 1. Low EC levels can result in stunted growth and lower leaf loss.

Figure 2. Slow-release fertilizer released and resulted in elevated EC levels and marginal leaf burn.

Figure 4. Phosphorus deficiency can also develop on the lower leaves as an overall dull green coloration, followed by yellow spotting in between the midrib and secondary veins.

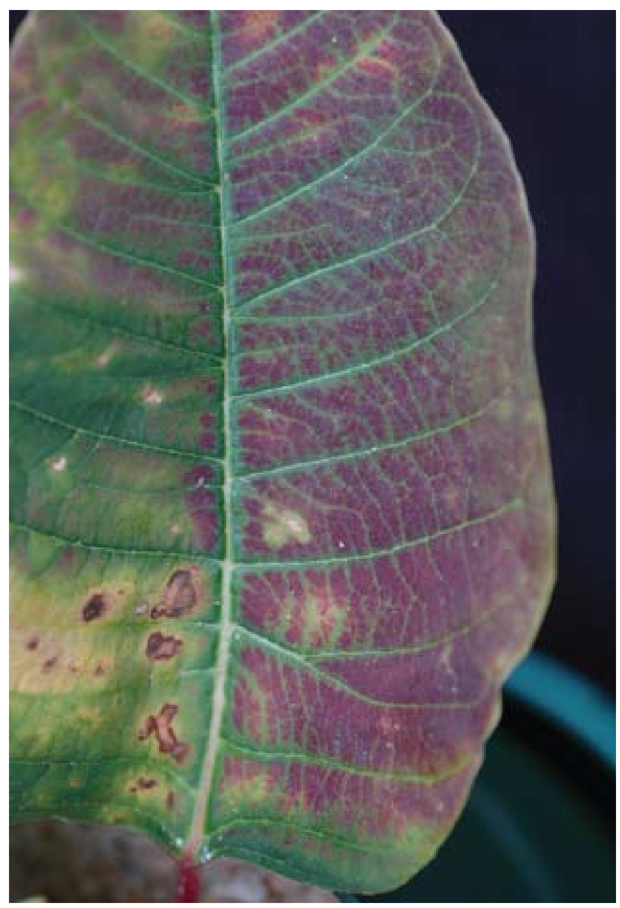

Figure 3. Phosphorus deficiency occurs on the older leaves as a reddish coloration.

Figure 5. *Young leaves may develop marginal leaf burn and distortion due to an environmentally induced calcium deficiency.*

Continued on page 40...

Figure 6. *Magnesium deficiency develops on the lower leaves as an interveinal chlorosis, which over time the leaf margins turn necrotic.*

Figure 7. *Late season magnesium deficiency develops under the bracts. This can easily be confused with high pH induced iron deficiency.*

__Figure 8.__ Sulfur deficiency results in the entire leaf turning pale yellow. This occurs at the top of the plant.

__Figure 9.__ Molybdenum deficiency symptoms appear as chlorosis (yellowing) of the recently mature leaves (middle of the plant), rolling of the leaves and leaf edge burn.

__Figure 10.__ A high substrate pH can limit the availability of iron and lead to interveinal chlorosis of the upper leaves.

poinsettias. The recommended pH range in a soilless substrate is 5.8 to 6.5. Iron deficiency is the most common problem at substrate pHs above 6.5. New leaves exhibit an interveinal chlorosis (yellowing) (Figure 10, above). Generally poinsettias do not exhibit foliar symptoms of low pH like other crops such as geraniums or marigolds. Slow plant growth may be the only symptom observed.

Monitoring what is occurring in the root zone by continual sampling the fertilizer solution and the substrate for pH, EC and nutrient levels. This will help assure your poinsettia crops' success.

Brian Whipker is a professor of floriculture, Ingram McCall a technician and Jared Barnes a graduate student at North Carolina State University. Whipker can be reached at brian_whipker@ncsu.edu.