

Characterization of Nutrient Disorders of Gerbera Hybrid 'Festival Light Eye Pink'

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Abstract

Gerbera hybrid 'Festival Light Eye Pink' plants were grown in silica sand culture to induce and photograph nutritional disorder symptoms. Plants were grown with a complete modified Hoagland's all nitrate solution: (macronutrients in mM) 15 NO₃-N, 1.0 PO₄-P, 6.0 K, 5.0 Ca, 2.0 Mg, and 2.0 SO₄-S, plus µM concentrations of micronutrients, 72 Fe, 18 Mn, 3 Cu, 3 Zn, 45.0 B, and 0.1 Mo. The nutrient deficiency treatments were induced that included a complete nutrient formula and a complete minus one of the nutrients. Reagent grade chemicals and deionized water of 18-mega ohms purity were used to formulate treatment solutions. Boron toxicity symptoms were also induced by increasing the element 10× higher than the complete nutrient formula. The plants were automatically irrigated every 2 hours and the solution drained from the bottom of the pot and recaptured for use. A complete replacement of nutrient solutions was done weekly. Plants were monitored daily to document and photograph sequential series of symptoms as they developed. Typical symptomology of nutrient disorders and critical tissue concentrations are presented.

INTRODUCTION

Gerbera (Asteraceae family) is a popular ornamental plant for cut flowers, potted plants, and bedding plants. Gerberas for pot plant production are considered moderate feeders. This moderate level of fertility produces a plant with a proportional leaf area to flower ratio. Sub-optimal fertility leads to lower leaf yellowing due to nitrogen deficiency. Excessive fertility can lead to lush growth and delayed flowering. Balancing the plants needs and periodic monitoring will help assure the nutritional requirements are being met. Tjia and Joiner (1984) documented and photographed the nutrient deficiency symptoms of *Gerbera jamesonii* used for cut flowers. The symptomology of most nutrient disorders with critical tissue concentration for greenhouse pot plant production have not been described. When growers face nutritional problems with visual symptoms, knowing key symptoms of nutrient disorders would assist growers in problem identification. Also, the critical leaf tissue concentration is highly significant to determine nutritional status of plants.

MATERIALS AND METHODS

Gerbera liners (2.3 × 2.3 × 3.7 cm cell size) of 'Festival Light Eye Pink' were transplanted on November 30, 2007 into 13.74 cm diameter (1.29 L) plastic pots containing acid washed silica-sand [Millersville #2 (0.8 to 1.2 mm diameter); Southern Products and Silica Co., Hoffman, NC]. The experiment was conducted in a glass greenhouse in Raleigh, NC at 35°N latitude. Plants were grown at 20°C day and 18°C night temperatures. An automated, recirculating, irrigation system was constructed out of 10.2 cm diameter PVC pipe (Charlotte Plastics, Charlotte, NC). The system consisted of 2 blocks with each block assigned to a single bench. There were 28 separate irrigation lines (each 1.82 m long) per block with each line containing six openings (12.7 cm diameter) to hold the pots. Three replications per block, each consisting of one pot with one plant, were assigned to each elemental treatment. Control plants were grown with a

complete modified Hoagland's all nitrate solution: (macronutrients in mmol) 15 NO₃-N, 1.0 PO₄-P, 6.0 K, 5.0 Ca, 2.0 Mg, and 2.0 SO₄-S (Hoagland and Arnon, 1950), plus μ M concentrations of micronutrients, 72 Fe, 18 Mn, 3 Cu, 3 Zn, 45.0 B, and 0.1 Mo. In order to induce nutrient deficiency treatments, the plants were irrigated with complete nutrients solution excluding one of the nutrients. The B toxicity treatment was conducted by increasing B concentration (450 μ M) in Hoagland's solution. Reagent grade chemicals and deionized water of 18-mega ohms purity were used to formulate treatment solutions (Pitchay, 2002). The plants were automatically irrigated every 2h using a drip system utilizing sump-pumps (model 1A, Little Giant Pump Co., Oklahoma City, Oklahoma). The solution drained out from the bottom of the pot and was recaptured for reuse. Nutrient solutions were replaced weekly. Plants were monitored daily to document and photograph sequential series of symptoms on youngest, young, recently mature, and mature leaves as they developed.

When the initial deficient symptom of each treatment occurred, plant shoot dry weight was recorded and the fully expanded leaves were sampled to evaluate the critical tissue concentration for each element. The harvested leaves were washed in a solution of 0.5 N HCl for 1 min, and rinsed with deionized water before drying at 70°C for tissue analysis. Dried tissue was ground in a Foss Tecator Cyclotec™ 1093 sample mill (Analytical Instruments, LLC, Golden Valley, MN) to pass a ≤ 0.5 mm sieve. Tissue analysis for N was performed with a C-H-N analyzer (Model 2400 series II, Perkin-Elmer, Norwalk, CT) by weighing 3.5 mg of dried tissue into tin cups and placed into the analyzer. Other nutrient concentrations were determined with inductively coupled plasma optical emission spectroscopy (ICP-OES; Model IRIS Intrepid II, Thermo Corp., Waltham, Mass.).

RESULTS AND DISCUSSION

Tissues sampling was conducted on three different dates as initial symptoms occurred for each element.

Nitrogen

Initial symptom of N deficient plants was a yellowish-green chlorosis on the young and youngest leaves, and the entire plant was lighter green than control. Tjia and Joiner (1984) reported that N deficiency symptoms start from oldest leaves and young leaves may not develop visual symptoms. However, in this study the entire plant was lighter green when grown without N as compared to plants grown with a complete nutrient solution. Nitrogen deficient plant size was smaller than that of control plants (Fig. 1). Plant dry weight of N deficient plants (-N) was significantly smaller (Fig. 8C). Tissue N concentrations were 1.6% and 5.7% for the N deficient and control plants, respectively. Nitrogen deficiency is common in commercial production when insufficient N is applied. Low cation exchange capacity media and over-watering can also cause N deficiency in cut flower production (Tjia and Joiner, 1984).

Phosphorus

Phosphorus deficiency appeared with darker green leaves as the initial symptom. As symptoms advanced, the leaves turned lighter green to yellow-green with some purple coloration on the lower leaves (Fig. 2, left). Phosphorus deficiency (-P) resulted in reduced plant dry weight and plants were significantly smaller than the controls (Fig. 8B). Tissue P concentration of deficient plants was 0.07%, and 0.55% for the control plants.

Potassium

Potassium deficient plants initially developed a symptom as a light tannish-brown necrosis on mature leaves within 1 cm of leaf margin. The necrosis started from the tip of leaves, and the center of leaves remained green (Fig. 2, right). The necrotic area expanded as the leaves enlarged over time. Potassium deficiency (-K) resulted in reduced dry weight of plants (Fig. 8C). While tissue K concentration of the control plants was 4.0%, K

deficient plants contained 0.4% K in the leaf tissue.

Calcium

Calcium deficiency was expressed as necrotic spots between the veins on recently matured leaves and leaves in the last half of expansion (Fig. 3, left). Necrotic spots enlarged over time. Necrosis progressed further down the plant and appeared on the older leaves. When the initial symptom was observed, the tissue Ca concentration was 0.13% (1.2% for control plants).

Magnesium

Magnesium deficiency symptoms initially develop on the recently matured leaves as interveinal chlorosis (Fig. 3, right). Tissue Mg concentrations were 0.06% and 0.36% for the deficient and control plants, respectively. Magnesium deficiency is a common problem in gerbera production (Tjia and Joiner, 1984; Dole and Wilkins, 2005), and supplemental Mg applications are required to avoid deficiencies.

Sulfur

Initially, sulfur deficient plants had lighter green leaves compared to control plants (Fig. 4). Recently matured leaves developed uniform chlorosis. Interveinal chlorosis was not observed. The tissue S concentration of deficient plants was 0.11%, and 0.38% for control plants.

Boron

No visual symptom of B deficiency was observed in this study, however B toxic plants developed visual symptoms. The leaves of B toxic plants became yellowing from the margins, which progressed to an interveinal chlorosis (Fig. 5, left). As symptoms advanced, a bleached-white band developed along the leaf margin, and over time became a light tannish-brown (Fig. 5, right). Boron toxic plants (+B) were significantly smaller than controls (Fig. 8A). Tissue B concentrations were 394.5 and 48.4 mg·kg⁻¹, respectively, for the toxic and control plants. Low substrate pH can cause high availability of B in substrate and tissue (Gibson et al., 2007).

Copper

The symptoms of copper deficient plants developed as distorted young leaves, and interveinal chlorosis on the recently matured leaves (Fig. 6, left). When initial Cu deficient symptoms were observed, tissue Cu concentrations were 1.8 mg·kg⁻¹ (4.2 mg·kg⁻¹ for control plants).

Zinc

Upper young leaves developed a completely uniform yellow-green color between the veins. Only along the midrib and about half length of the axillary vein were green and some green spots remained within yellowish-green (chlorotic) region (Fig. 6, right). The leaves of Zn deficient plants were thicker and smaller as compared to control plants. Significant reductions in dry weight of Zn deficient plant (-Zn) was recorded (Fig. 8B). Tissue Zn concentrations of deficient and control plants were 6.5 and 11.7 mg·kg⁻¹, respectively.

Iron

The initial symptom of iron deficient plants developed as interveinal chlorosis on recently matured leaves (Fig. 7, left). About a week after the first symptoms, the interveinal chlorosis developed over almost the entire plant (Fig. 7, middle). As symptoms advanced, the entire leaves had severe interveinal chlorosis. Necrotic spots were developed in the severely chlorotic area (Fig. 7, right). When initial symptoms developed, tissue Fe concentration was 40.0 mg·kg⁻¹, as compared to 67.4 mg·kg⁻¹ for control plants.

Manganese

Visual Mn deficient symptoms were not observed.

Molybdenum

Visual Mo deficient symptoms were not observed.

CONCLUSIONS

The descriptions of visual symptoms derived from each nutrient deficiency were presented for gerbera plants. When initial symptoms were occurred, tissue nutrient concentration was analyzed as critical tissue nutrient levels. The standards will provide guidelines for commercial growers when trying to diagnose nutritional problems in gerbera.

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Figures



Fig. 1. Control (left) and nitrogen deficiency (right).



Fig. 2. Phosphorus (left) and potassium (right) deficiency.



Fig. 3. Calcium (left) and magnesium (right) deficiency.



Fig. 4. Control (left) and sulfur deficiency (right).



Fig. 5. Boron toxicity.



Fig. 6. Copper (left) and zinc (right) deficiency.



Fig. 7. Iron deficiency.