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Elevated Relative Humidity Increases the Incidence of Distorted Growth and Boron Deficiency in Bedding Plant Plugs

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Abstract. High relative humidity (RH) can cause lower concentrations of boron (B) accumulating in plants. The common greenhouse practice of controlling excess temperatures by applying mist irrigation to young plants (plugs) can result in elevated RH levels, especially with plugs grown in high heat and humidity conditions of summer. ‘Dynamite Yellow’ pansy (*Viola ×wittrockiana* Gams.), ‘White Storm’ petunia (*Petunia ×hybrida* Vilm.), and ‘Festival Apricot’ gerbera (*Gerbera jamesonii* Bolus) plugs were grown in high or ambient RH conditions to determine the effect RH had on B uptake. Results indicate that an increase in RH decreased the amount of water the plant lost as a result of transpiration resulting in lower concentrations of B in shoot tissue. Boron concentrations in leaf tissue were 9.43, 10.56, and 17.81 mg·L⁻¹ in pansy, petunia, and gerbera plants, respectively, grown in high RH conditions. These values were significantly lower than pansy, petunia, and gerbera plants grown in ambient RH conditions (19.94, 25.49, and 42.71 mg·L⁻¹, respectively). Leaf distortion, consistent with B deficiency symptoms, was present in petunia and gerbera plants. Similar trends were observed when the experiment was repeated and leaf distortion was present in all species. This provides convincing evidence that the distorted growth observed in pansy, petunia, and gerbera plug production is the result of limited B caused by excessive humidity.

Boron moves passively into plants from the roots to the shoots through the transpiration stream through the xylem (Jones, 1991; Kochian, 1991; Kohl and Oertli, 1961; Raven, 1980). Relative humidity can be a major factor influencing the rate of plant transpiration and, therefore, the amount of B accumulated. The uptake of B has been reported to be negatively affected by elevated RH (Bowen, 1972; Halbrooks et al., 1986). Oertli (1963) reported lower concentrations of B in leaves of barley when plants were grown in higher RH conditions but also concluded that the lower B concentration may be the result of loss through guttation in high RH conditions. Plant uptake

of calcium (Ca) has also been extensively studied and it is known that Ca is taken up passively with water and is closely linked to transpiration (Clarkson, 1984; Marschner, 1995). Chang and Miller (2004) reported that Ca uptake increases with higher transpiration rates. Furthermore, Frantz et al. (2004) eliminated Ca deficiency in lettuce through enhanced transpiration by increasing the flow of low-humidity air directly over the meristem.

During germination, seeds of bedding plants are maintained in growing conditions near 100% RH. Once the plants have germinated, they are moved into a greenhouse and often held under mist to maintain high RH, particularly with seedlings grown during hot conditions. Plants can develop distorted growth of the youngest leaves, which is characteristic of B deficiency (Krug et al., 2009). Thus, it has been reported that high RH environments could be the cause of the B-deficient symptoms occurring in commercial production. Therefore, the objective of this study was to determine if elevated RH levels could cause lower tissue concentrations of B and lead to the development of visual symptoms of B deficiency.

‘Dynamite Yellow’ pansy, ‘White Storm’ petunia, and ‘Festival Apricot’ gerbera seeds were sown in 288-plug trays cut into 2 × 2-cell flats (each cell: 2 cm × 2 cm × 3 cm deep) on 5 Jan. 2007, referred to as “Expt. 1” from this point forward. The germination substrate was Berger BM 2 (Berger Peat Moss; St. Modestede, Quebec, Canada). Once sown, seeds were placed in a germination chamber with a temperature set point of 20 °C. Light was provided by fluorescent bulbs with a photosynthetic photon flux (PPF) of 24 to 75 μmol·m⁻²·s⁻¹ at plant canopy for 12 h·d⁻¹. The substrate was kept moist using tap water until seeds germinated. When the first true leaves began to emerge, the plants were moved to one of two environments in the greenhouse: ambient relative humidity (AH) or high relative humidity (HH) with day/night temperature set points of 23.9/17.8 °C. A 122-cm high plastic curtain was used to create the two environment chambers, each 152 cm × 267 cm. Plastic lined the bench to prevent airflow from below, but the top of the chamber was open. On average, the RH of the AH chamber was 65% and the RH was raised to 100% in the HH chamber using humidifiers (Model 707; Fedders Corp., Liberty Corner, NJ). RH and temperature were monitored using Hobo H8 data loggers (Onset Computer Corp, Bourne, MA). The experiment was a completely randomized design with 36 flats (2 × 2-cell flat) of each species for each treatment. An additional 36 unplanted flats (2 × 2-cell flat) were included in each treatment to use for transpiration data. Plants were fertilized at each irrigation after germination with 50 mg·L⁻¹ nitrogen (N) from Champion 13N–0.86P–10.79K Plug Special (Scotts, Marysville, OH). Plants were harvested 35 d after sowing (DAS). Tissue samples were taken by removing the entire shoot. To ensure sufficient tissue was available for tissue analysis, six 2 × 2-cell flats were combined and used as one replication for a total of six replications per treatment. The experiment was repeated with an initiation date of 10 May 2007, referred to as “Expt. 2” from this point forward, and harvest occurring 41 DAS. The RH was 81% and 100%, on average, for the AH and HH treatments, respectively, in Expt. 2.

Transpiration. Transpiration was quantified gravimetrically three times/week for the duration of the experiments. Values were averaged over 10 or 8 d for Expts. 1 and 2, respectively. Flats were weighed at dawn and dusk (0700 to 0830 and 1730 to 1900 HR, depending on daylength) to determine evapotranspiration (flats with plants) and evaporation (flats with substrate only). The average difference of the flats with only substrate was subtracted from the individual differences of the flats with plants, leaving the amount of water loss resulting from transpiration alone. Some reported values appear as negative numbers; these indicate when plants gained water over the course of the day.

Plant canopy area was recorded to base transpiration on leaf area. Plant canopy area was determined using digital photography

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