

Root Growth of Southern Magnolia Following Exposure to High Root-zone Temperatures

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Abstract. Root growth of southern magnolia (*Magnolia grandiflora* Hort. 'St. Mary') was studied for 16 weeks after an 8-week exposure to 30, 34, 38, or 42 ± 0.8C root-zone temperature (RZT) treatments applied for 6 hours daily. Immediately after RZT treatments, total root length of trees responded negatively to increased RZT in a quadratic pattern and the shoot and root dry weight of trees was similar. However, 8 and 16 weeks after RZT treatments, total root length responded linearly in a negative pattern to increased RZT, and shoot and root dry weight responded negatively to increased RZT in a linear and quadratic pattern, respectively. Root dry weight of trees exposed to 42C RZT treatment was 29% and 48% less than 38 and 34C RZT treatments, respectively, at week 8. By week 16, root dry weight as a function of RZT had changed such that the 42C RZT was 43% and 47% less than 38 and 34C RZT, respectively. Differences in root growth patterns between weeks 8 and 16 suggest that trees were able to overcome the detrimental effects of the 38C treatment, whereas growth suppression by the 42C treatment was still evident after 16 weeks.

High temperatures common in container media suppress growth of selected windy plant species (Johnson and Ingram, 1984; Martin and Ingram, 1989). Transplanting container-

ized trees and shrubs into the landscape may place roots in a more favorable environment (Graves et al., 1989) compared to that in a container (Martin and Ingram, 1988). The objective of this study was to quantify root growth of *Magnolia grandiflora* 'St. Mary' (southern magnolia) following exposure to selected root-zone temperatures (RZT).

Softwood stem cuttings (5 to 8 cm long) harvested during Summer 1988 were rooted for 12 weeks and potted, one per pot, into 25.0 × 7.5-cm polyethylene sleeves containing Metro-Mix 500 (Grace-Sierra, Cambridge, Mass.) and grown in a temperature-controlled glasshouse. Light intensity at canopy height inside the greenhouse was 1450

μmol·s⁻¹·m⁻² at 1100 HR on 15 Sept. 1989, a cloudless day. Natural daylength was supplemented with 3 h (2200 to 0100 HR) of incandescent lighting (90 cm above average tree canopy). Air temperatures were 28 to 30C/day gradually changing to 20 to 22C/night. Relative humidity was 40% day/80% night. All trees were fertigated daily with a 500-ml solution of soluble 20N-8.8P-16.6K fertilizer (Peters 20-20-20, Grace-Sierra) at 50 mg N/liter and 1.25 ml 1 N NaOH/liter. Root-zones at 30, 34, 38, or 42 ± 0.8C were sustained 6 h·day⁻¹ (1000 to 1600 HR) for 8 weeks during Aug. through Oct. 1989, using an electronically controlled root-heating system (Ingram et al., 1990).

Following the root-heating period, trees were transplanted into 21-liter containers (30 cm high, 30 cm mean diameter) with Metro-Mix 500 medium and grown for 16 weeks in the greenhouse. Root-zone temperatures after transplanting were recorded half-way down the container profile in the center and ranged from 25C/day to 20C/night. Following transplanting, each tree was top-dressed with 25 g of Osmocote 14N-6.2P-11.6K (Grace-Sierra, Milpitas, Calif.). Trees were irrigated to container capacity every 4 days. Six trees per RZT were harvested for root and shoot growth analyses, 0, 8, and 16 weeks following the root-heating treatments. Root systems were severed at the soil line and thoroughly washed. Total root length was measured with a Delta-T area meter (Decagon Devices, Pullman, Wash.) and Ikegami model ITC-510 camera (Ikegami Electronics, Inc., Tampa, Fla.) (Barnett et al., 1987). Roots and shoots were then oven-dried at 70C for 48 h and dry weights were determined. The experiment was arranged in a completely randomized-block design with single tree replicates in 18 blocks. Regression analysis was used to test linear and quadratic responses of total root length and shoot and root dry weights to increasing tem-

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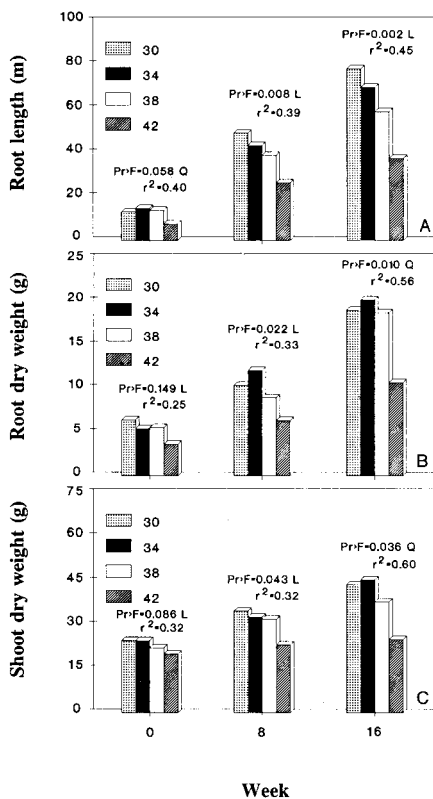


Fig. 1. Root growth of southern magnolia immediately following (week 0), and 8 and 16 weeks following 8 weeks of 30, 34, 38, or 42 \pm 0.8C root-zone temperature treatments; (A) total root length, (B) root dry weight, and (C) shoot dry weight. L = linear, Q = quadratic, and n = 6.

peratures. Regression coefficients were tested for homogeneity of fit using the F test.

Immediately after root heating (week 0), root length responded quadratically to increased RZT (Fig. 1). Mean total length of roots at 34C was 1.9 times greater than that for those at 42C. Root systems exposed to

42C appeared partially water-soaked and/or necrotic, an indication of direct injury to root tissue (Levitt, 1980). Eight and 16 weeks following transplanting, total root length decreased linearly with increased RZT. Total length of roots previously exposed to 30C was 2.5 and 2.3 times greater than that of roots at 42C at weeks 8 and 16, respectively.

Immediately after root-heating, mean root and shoot dry weights were similar for all RZT treatments. However, after the 16-week, post-transplant growth period, root and shoot dry weights were negatively and quadratically correlated to RZT. Root dry weight responded linearly and quadratically to increased RZT 8 and 16 weeks after transplanting, respectively (Fig. 1). Dry weight of roots previously heat-treated at 42C was 29% and 48% less than for roots held at 38 or 34C, respectively, at week 8. By week 16, the distribution of root dry weight as a function of RZT had changed; mean dry weight of roots previously treated at 42C was 43% and 47% less than that for roots held at 38 or 34C, respectively. Shoot dry weight responded linearly and quadratically to increased RZT 8 and 16 weeks after transplanting, respectively (Fig. 1). At week 16, shoot dry weight of roots treated at 42C was 34% and 45% less than that for the 38 and 34C RZTS, respectively. Since there were similar reductions in shoot and root dry weights with increased RZT, there was no change in the shoot : root ratio as a function of increased RZT.

Our study shows that preconditioning southern magnolia roots with heat treatments can inhibit new shoot and root growth. Changes in the response of shoot and root dry weights to RZT between weeks 8 and 16 suggest that trees were able to overcome the growth-inhibiting effects of the 38C RZT within 16 weeks; however, post-transplant suppression of growth caused by the 42C RZT was still evident at week 16. The direct injury of root tissue by

the 42C RZT and/or the possible depletion of stored carbohydrates may have inhibited new root growth (Ingram et al., 1986). However, the data also indicate that, at week 16, the relative suppression of longitudinal root growth caused at 38C was greater than the suppression of root biomass accumulation. This result suggests the development of fewer, thicker roots in favor of many, fine roots and could be detrimental to the tapping of new sources of soil water and/or nutrients by previously heat-stressed trees after transplanting into the landscape. In conclusion, prior exposure of southern magnolia roots to root-zone temperatures >38C suppressed post-transplant growth and could lengthen the establishment period of trees in landscapes.

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