Effects of Uniconazole on Photosynthesis, Dark Respiration, and Water Use Efficiency of 'Spectabilis' Forsythia

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Nature of Work: Previous investigations have reported increased levels of photosynthesis (PN) for 'Spectabilis' forsythia treated with the plant growth regulator uniconazole (Valent U.S.A. Corporation, Walnut Creek, Calif.) (Thetford et al., 1992). Decreased plant size also occurs as a result of uniconazole inhibiting gibberellin biosynthesis (Warren et al., 1991). This paradox between suppressed plant size and increased levels of PN for uniconazole treated plants remains to be resolved.

Morphological changes in uniconazole treated plants can reduce water use as a result of altered canopy size, leaf area reduction or altered stomatal development (Gao et al., 1988, Hsiao and Acevedo, 1974). Water use efficiency (WUE), a physiological characteristic often used to assess a plants ability to withstand water stress, may be a useful tool for determining the effects of uniconazole application on water use of woody plants. The following experiment was initiated to: 1) investigate the effects of uniconazole on carbon efficiency of 'Spectabilis' forsythia via PN and dark respiration and 2) determine if uniconazole induced changes in plant morphology influence water use or water use efficiency of 'Spectabilis' forsythia.

A greenhouse experiment was conducted at North Carolina State University in which rooted stem cuttings of 'Spectabilis' forsythia were potted into 4-liter (#1) black plastic containers (7 July 1992) filled with a calcined clay substrate (Turface). Prior to uniconazole application container tops were covered with white polyethylene to minimize evaporative water losses. Treatments were a single foliar application of uniconazole (12/15 ml per plant of a 170 ppm solution) or a nontreated control (water) applied on 4 August, with ten plants per treatment in a randomized complete block design. Water loss by transpiration was obtained by weighing containers daily.

Net photosynthesis (PN) was determined as previously described (Thetford et al., 1992). P_N measurements were conducted between 10:00 and 12:00 AM (morning) and repeated between 1:00 and 3:00 PM (afternoon) 47 and 53 DAT. Leaf dark respiration was measured similarly with measurements commencing 1 min. immediately after the CO_2 concentration increased. Leaf dark respiration was measured between 10:00 PM and 2:00 AM 47 and 53 DAT. At termination of the experiment, plants were separated into leaves, stems, and roots and dried at

70°C (158°F) for 96 h. Before drying, total leaf area was determined using a LI-COR 3000 leaf area meter (LI-COR, Lincoln, Neb.). WUE was determined on the basis of total plant dry weight (WUE = total plant dry weight / water loss by transpiration). Differences among treatments ($P \leq 0.1$) were determined (within sample dates where appropriate) using analysis of variance procedures (SAS Institute, Inc., Cary, N.C.).

Results and Discussion: Uniconazole suppressed leaf area 36%. Leaf area suppression creates the concentrating effects that may contribute to the elevated carbon exchange rates of uniconazole treated plants (Dalziel and Lawrence, 1984). The sample date (47, 53 DAT) by treatment (uniconazole, control) and time of measurement (morning, afternoon) by treatment interactions were nonsignificant for P_N indicating a similar treatment effect for all sample times. P_N averaged across both sample dates and both sample times was elevated for uniconazole treated plants (Table 1). A similar increase in P_N for uniconazole treated 'Spectabilis' forsythia was previously reported (Thetford et al., 1992).

The sample date by treatment interaction was nonsignificant for leaf dark respiration indicating a similar response to treatments for both measurement dates. Leaf dark respiration averaged across both sample dates increased 19% for uniconazole treated plants (Table 1). High levels of P_N for uniconazole treated plants were consistently followed by high levels of leaf dark respiration. These responses suggest the concentrating effects of uniconazole induced leaf area suppression which compress the photosynthetic apparatus of treated plants also concentrate the respiratory functions resulting in higher levels of photosynthesis and respiration.

By 53 DAT uniconazole decreased total water use of 'Spectabilis' forsythia 59%. Changes in WUE appear related to changes in total leaf area. A 4% increase in WUE of uniconazole treated plants indicates improved efficiency as dry weight accumulation was increased per kg of water transpired.

Significance to Industry: Results herein demonstrate how uniconazole induced leaf area reduction can influence P_N, leaf dark respiration and total water use of woody landscape plants. Water use efficiency of uniconazole treated plants was improved by 4% for plants having a 36% reduction in leaf area. This suggests altered levels of water use for uniconazole treated plants result primarily from altered canopy size and leaf area and are not necessarily related to an alteration in the efficiency by which carbon is assimilated.

Literature Cited

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Table 1. Net photosynthesis and leaf dark respiration of 'Spectabilis' forsythia following application of uniconazole.[Z]

Uniconazole (ppm)	Net photosynthesis	Leaf dark respiration
0	15.5	1.04
170	21.5	1.24
Significance	0.0001	0.04

[Z]Net photosynthesis and respiration units = mg CO_2/dm^2 /sec.