Antitranspirant Effects on Water Use Efficiency in Impatiens©

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MBI-501, an antitranspirant, was evaluated for the potential to enhance drought tolerance by determining water use efficiency of *Impatiens walleriana* Super Elfin™ Series, XP White impatiens. MBI-501 was foliar-applied weekly, at 0.0X, 0.5X, 1.0X or 1.5X to impatiens grown under three water stress treatments: 0 (daily), 3, or 6 days between watering (DBW). To determine drought tolerance, final growth indices (FGI), shoot dry weight (SDW), root dry weight (RDW), photosynthesis (Pn), midday leaf water potential (Ψ_{stem}), water use efficiency (WUE) and mean water applied (MWA) were collected. Application of MBI-501 at the 1.0× rate resulted in greater RDW compared to the 1.5X rate. Ψ_{stem} was greater (more negative) in impatiens treated with the 1.5X rate of MBI-501 at 6 DBW compared to the nontreated (0.0×) at 6 DBW, suggesting that applying MBI-501 above the 1.0× use rate may cause adverse effects. There was a rate × DBW effect on WUE. Generally, increasing the DBW reduced growth of impatiens with MBI-501 having no effect on enhancing drought tolerance.

INTRODUCTION

Antitranspirants and other exogenously applied compounds have been used to try and reduce water loss in plants since the 1950s (Biai et al., 2011; Kettlewell et al., 2010). Typical antitranspirants are made up of emulsions of wax or latex which creates a thin film over the surface of the plant, and kaolin clay or chitosan which serves as a reflective-type material (Goreta et al., 2007; Patil and De, 1976). By applying a thin film or using a reflective-type material, transpiration can be reduced. More recent research has evaluated foliar-applied abscisic acid (s-ABA). Kim and van Iersel (2008) reported extended shelf life in *Salvia splendens* after ABA treatment; however, they also observed a correlation between leaf drop and ABA. Waterland et al. (2010) reported delayed wilting symptoms in impatiens, seed geranium, petunia, marigold, salvia, and pansies following application of s-ABA. Although antitranspirants may reduce water loss, there have been reports they decrease photosynthesis. del Amor et al. (2010) reported reduced photosynthesis in fully irrigated pepper plants after the use of an antitranspirant.

With stricter water use guidelines and regulations (Warsaw et al., 2009), reducing water loss in plants may reduce the amount of daily irrigation. Therefore, the objective of this experiment was to evaluate drought tolerance and water use efficiency of *Impatiens* *walleriana* Super Elfin™ Series, XP White impatiens following application of MBI-501, a reflective type antitranspirant.

MATERIALS AND METHODS

On 24 June 2010, impatiens plugs were potted into 15 cm (6-in). containers with Sunshine Mix 1 potting substrate. After potting, impatiens were watered in and placed in a controlled environment greenhouse located on Mississippi State University's R.R. Foil Plant Science Research Facility under 60% shade and 70°F/65°F (21.1°C/18.3°C) (day/night) set point temperatures.

The experiment was initiated on 26 July 2010 by recording actual substrate volumetric water content (AVWC) and watering each container to 85% target substrate volumetric water content (TVWC); thereafter, containers were watered at 0 (daily), 3, or 6 days between watering (DBW). Substrate volumetric water content was first determined by characterizing the physical properties of Sunshine Mix 1, fit to a regression model, giving: VWC = 0.00076503*MW – 0.79736 (where MW = target mass wetness defined as a percentage). There were four rates of MBI-501 based on the recommend label rate of 0.93 $oz{\cdot}gal^{-1}$: 0X (nontreated), 0.5X (1 $ml{\cdot}L^{-1}$), 1X (2 $ml{\cdot}L^{-1}$), and 1.5X (3 $ml{\cdot}L^{-1}$). Foliar applications of MBI-501 were made once per week, three hours after watering containers to TVWC. At the end of the experiment, final growth indices [FGI= ((height + width + perpendicular width) ÷ 3)], shoot dry weight (SDW), and root dry weight (RDW) were collected. Shoots and roots were oven dried in a forced air drier at 149°F (65°C) for 72 h before obtaining dry weights. Water use efficiency (WUE), was determined as previously described (Burnett and van Iersel, 2008) using shoot and root dry weight [WUE = (SDW + RDW) ÷ total water applied]. Midday leaf water potential (Ψ_{stem}) (-Mpa) was measured using a Scholander-type pressure chamber according to Kjelgren et al. (2009); leaves were wrapped in plastic wrap, followed by aluminum foil for at least one hour prior to measurement. Total water applied per container, was recorded throughout the experiment. The experiment was conducted using four rates of MBI-501 and three moisture levels arranged as a split plot design (MBI-501 rate as the main plot factor) with six replications. A single plant represented an experimental unit. Data were analyzed using linear models with the GLIMMIX procedure of SAS (versions 9.2; SAS Institute Inc, Cary, North Carolina) with mean separation according to the Holm-Simulation method (α=0.05).

RESULTS

Shoot growth (FGI and SDW) were similar among all rates of MBI-501; however, FGI and SDW were affected by water stress treatment (Table 1). Watering impatiens at 3 or 6 DBW reduced FGI and SDW compared to daily watering (0 DBW). RDW was 20% greater in the 1.0X MBI-501 rate compared to the 1.5X rate. Similar to FGI and SDW, RDW was greater when impatiens were watered at 0 DBW compared to 3 or 6 DBW. Pn was not affected by application of MBI-501 at 14 or 28 days after initial application of MBI-501 (DAIM) (Table 2). At 28 DAIM, Pn was 45% and 72% greater when impatiens were watered at 0 DBW compared to 3 and 6 DBW. Ψ_{stem} was not affected by rate at 14 DAIM; however, as DBW increased, Ψ_{stem} decreased. At 28 DAIM, there was a rate × DBW interaction for Ψ_{stem} indicating the 0.0X rate of MBI-501 to impatiens with 6 DBW had higher (less negative) Ψ_{stem} compared to the 1.5X rate with 6 DBW (Fig. 1). This indicates MBI-501 applied greater than the label rate had an adverse effect on Ψ_{stem} of drought stressed plants. Conversely, Ψ_{stem} was similar among all other rates and DBW treatments. There was a rate × DBW interaction in WUE of impatiens at 28 DAIM. WUE was greater in impatiens treated with the 1.0X rate of MBI-501 at 6 DBW compared to the 0.0X, 0.5X, 1.0X, and 1.5X rates at 0 DBW and to the 1.5 rate at 3 DBW treatment. WUE was similar regardless of MBI-501 rate within DBW treatments. Therefore, water stress treatment impacted WUE more than the rate of MBI-501. Mean water applied (MWA) to impatiens treated with MBI-501, regardless of rate, was similar to the nontreated (0.0X). There was no rate × DBW effect on MWA (Fig. 2).

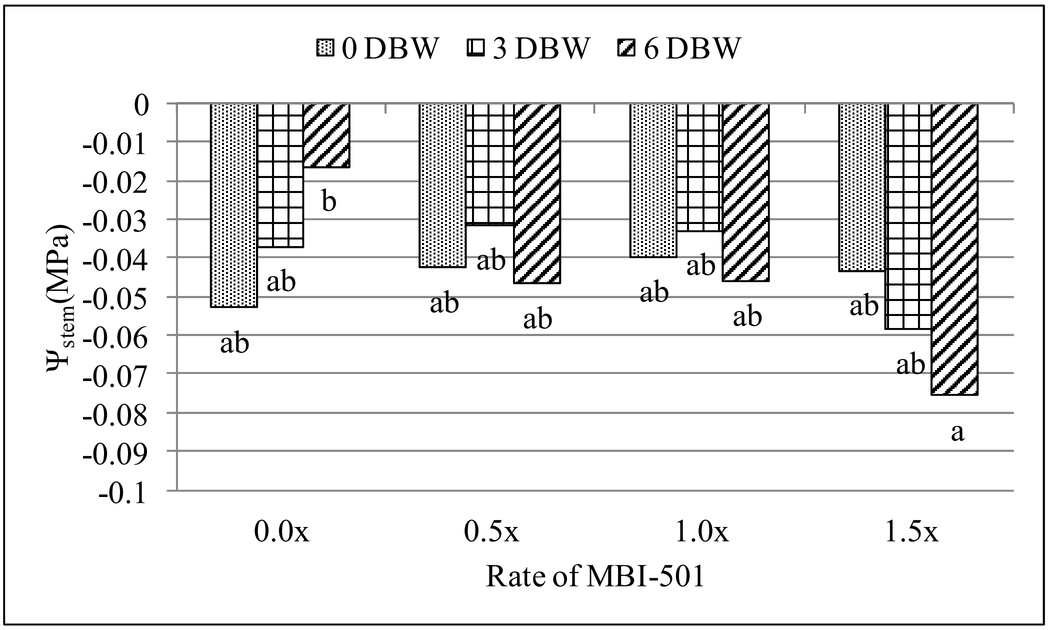

Fig. 1. Midday leaf water potential (Ψ_{stem}) of *Impatiens walleriana* Super Elfin™ Series, XP White impatiens following foliar application of MBI-501 at the 1.0X rate (2 ml·L^{-1}) to plants grown in containers at 0, 3, or 6 days between watering (DBW). Means with the same letters are not statistically different according to the Holm-simulation method α=0.05.

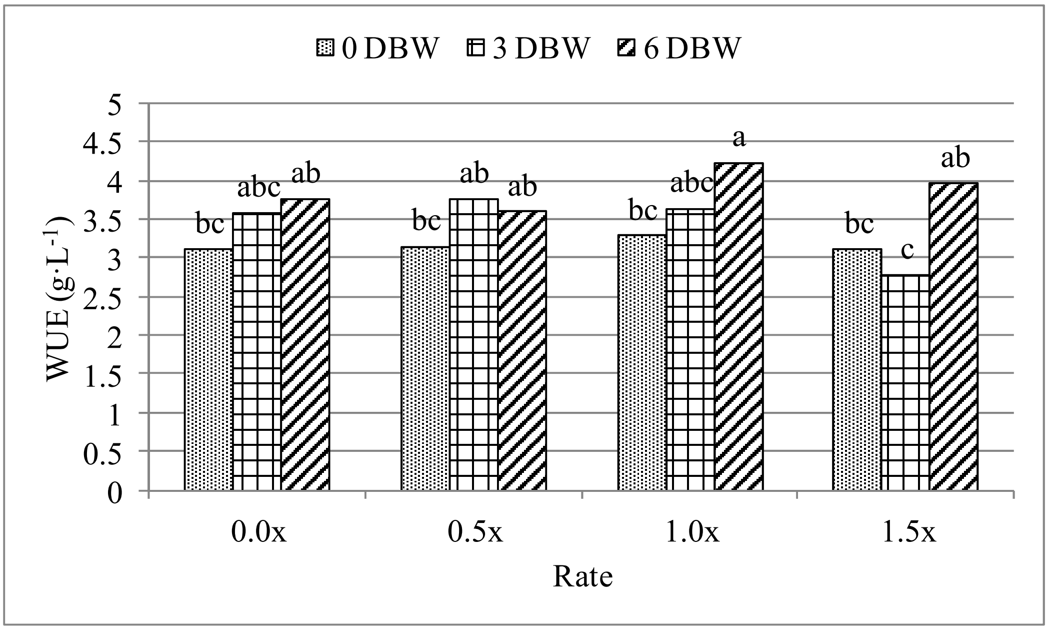

Fig. 2. Water use efficiency [WUE = ((shoot + rood dry weight) ÷ total water applied)] following weekly foliar application of MBI-501 at the 1X rate (2 ml·L^{-1}) to plants grown in containers watered at 0, 3, or 6 days between watering (DBW). Means with the same letters are not statistically different according to the Holm-simulation method α=0.05.

Table 1. Growth of *Impatiens walleriana* Super Elfin™ Series, XP White following weekly foliar applications of MBI-501 based on the 1× rate (2 ml·L^{-1}) to plants grown in containers at 0 (daily), 3 or 6 days between watering (DBW).

	FGI[z] (cm)	SDW[y] (g)	RDW[x] (g)
Rate			
0.0×	21.7 a[w]	5.2 a	0.42 ab
0.5×	22.1 a	5.2 a	0.42 ab
1.0×	22.3 a	5.8 a	0.47 a
1.5×	21.6 a	4.8 a	0.38 b
DBW			
0	24.3 a	7.0 a	0.55 a
3	21.6 b	5.0 b	0.39 b
6	19.7 c	3.8 c	0.33 b
Effects			
rate	0.7105[v]	0.1306	0.0484
DBW	<.0001	<.0001	<.0001
rate×DBW	0.7106	0.0918	0.1708

[z]FGI: final growth indices [(height + width + perpendicular width)/3].
[y]SDW: shoot dry weight, oven dried for 72 h at 65°C (149°F).
[x]RDW: root dry weight, oven dried for 72 h at 65°C (149°F).
[w]Means within a column and main effect (rate and DBW) with the same letters are not statistically different according to the Holm-Simulation method for mean comparison, α=0.05.
[v]P value.

DISCUSSION

Results of this study indicate water-stress treatments affected FGI and SDW but differing rates of MBI-501 did not. These findings were similar to Blanusa et al. (2009) showing reduced growth of impatiens and petunia under water stress. Additionally, RDW was greater in impatiens treated with the 1.0X rate of MBI-501 compared to the 1.5X rate indicating that the 1.0X rate may be the maximum tolerated rate of MBI-501. Previous reports have indicated reduced photosynthesis after the use of antitranspirants (del Amor et al., 2010); however, the results reported in this paper showed MBI-501 did not reduce Pn. Furthermore, the effects on Ψ_{stem} and WUE do not appear to be from MBI-501 rates alone, but from the water stress treatments. These findings are similar to Goreta et al. (2007) who reported no significance in gas exchange or leaf water potential in plants treated with film-forming materials compared to nontreated plants. Overall, there was no evidence suggesting WUE was increased with the use of MBI-501.

Table 2. Water use efficiency (WUE) of *Impatiens walleriana* Super Elfin™ Series, XP White impatiens following weekly foliar applications of MBI-501 at the 1X rate (2 $ml\cdot L^{-1}$), to plants grown in containers watered with 0 (daily), 3, or 6 days between watering (DBW).

	Pn ($\mu mol\cdot m^{-2}\cdot s^{-1}$)[z]		Ψ_{stem} (-Mpa)[y]		WUE ($g\cdot L^{-1}$)[x]	MWA (L)[w]
	Days after initial application of MBI-501					
	14	28	14	28	28	28
Rates						
0.0x	13.2 a[v]	5.7 a	-0.09 a	-0.04 a	3.5 ab[x]	1.6 a
0.5x	16.1 a	6.6 a	-0.07 a	-0.04 a	3.5 ab	1.6 a
1.0x	13.5 a	7.6 a	-0.09 a	-0.04 a	3.7 a	1.7 a
1.5x	11.3 a	7.1 a	-0.11 a	-0.06 a	3.3 b	1.6 a
DBW						
0	15.8 a	11.0 a	-0.08 b	-0.04 a	3.2 c	2.3 a
3	14.2 a	6.3 b	-0.06 b	-0.04 a	3.4 b	1.5 b
6	10.6 b	3.0 c	-0.14 a	-0.05 a	3.9 a	1.0 c
Effects						
Rate	0.2375[u]	0.4825	0.6445	0.0642	0.0494	0.4690
DBW	<.0001	<.0001	0.0037	0.4318	<.0001	<.0001
Rate×DBW	0.2161	0.3466	0.9881	0.0346	0.0190	0.7719

[u]P value.

[v]Means within a column and main effect (rate and DBW) with the same letters are not statistically different according to the Holm-Simulation method for mean comparison, α=0.05.

[w]MWA: mean water applied.

[x]WUE = (shoot + root dry weight) ÷ total water applied.

[y]Midday leaf water potential was measured using a Scholander-type pressure chamber by first wrapping the leaf in plastic film, followed by aluminum foil for at least one hour prior to measurement.

[z]Leaf photosynthetic rate measured using a CIRAS-2 (PPSystems, Amesbury, Maryland) at 14 and 28 days after initial application of MBI-501.

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