Incidence of Boron Deficiency in Bedding Plants Caused by Drought Stress or Abscisic Acid Application

Growers have reported boron (B) deficiency in pansy (Viola *x wittrockiana)* plug production, specifically in plugs grown in the high heat and humidity conditions of summer. Past studies have reported that moisture levels affect B availability more than any other micronutrient. Though drought stress is not common in greenhouse production, the small volume of soil in a plug tray may be susceptible to surface drying that restricts the movement of B into a plant. The objectives of these experiments were to investigate how single or repeated water stress and the application of abscisic acid (ABA) affect B concentrations in pansy seedling tissue.

'Dynamite Yellow' pansy seeds were sown in 288-plug trays cut into 6x6 cell flats. In Experiment 1, plants were exposed to water stress at 10 or 20 days after sowing (DAS) or after every irrigation by letting the substrate dry out to 40, 30, or 20% container capacity (CC). In Experiment 2, ABA was applied as either a drench or foliar spray in concentrations of 150 or 300 mg L^{-1} at 10 or 20 DAS. Tissue samples were harvested at 33 DAS for both experiments and analyzed for nutrient content via inductively coupled plasma-optical emission spectroscopy. Transpiration was quantified gravimetrically for both experiments 3/wk, and the area of the plant canopy was calculated using digital photography and PixelCounter 1.0 software.

Plants allowed to dry to 20 or 30% CC on 10 DAS, to 20% CC on 20 DAS, or to 20 or 30% CC continuously lost significantly less water due to transpiration (Table 1).

Table 1. Boron concentration of 'Dynamite Yellow' pansy shoots, water loss (ml per rep.) due to transpiration (average of 10 d), and transpiration/area of canopy (ml cm^{-2}) from plants 33 DAS allowed to dry to 40, 30 or 20% container capacity (CC); treatments were imposed at 10 or 20 DAS or on a continual basis and transpiration values are averages of 10 days.

Treatment	B (mg L^{-1} dry wt.)	Trans	Trans/area[z]
Treated 10 DAS			
Control	24.52	4.42a	0.066a
40% CC	23.42	3.77a	0.054ab
30% CC	22.20	1.18b	0.009bc
20% CC	23.29	0.48b	-0.018c
P-value[y]	NS	***	*
Treated 20 DAS			
Control	24.52b	5.94a	0.059
40% CC	45.09a	6.83a	0.039
30% CC	22.46b	5.32a	0.050
20% CC	24.40b	1.88b	0.056
P-value[y]	**	***	NS
Treated continuously			
Control	24.52	4.42a	0.067
40% CC	23.37	3.61a	0.076
30% CC	20.87	0.28b	-0.053
20% CC	21.39	0.95b	0.099
P-value[y]	NS	***	NS

[z] Values with negative numbers indicate the value used for evaporation from the substrate surface of unplanted vessel was greater than total water loss of planted vessel in that treatment.
[y] NS, *, ***, Not significant, significant at $P \leq 0.05$ or $P \leq 0.001$. Mean separations are shown by day of treatment in columns.

All treatments yielded B tissue concentrations above those determined to cause deficiency symptoms. In Experiment 2, ABA applied as a 300 mg L^{-1} drench or a 150 or 300 mg L^{-1} foliar spray caused a significant decline in water loss due to transpiration (Table 2). When applied 20 DAS, only the foliar sprays lost significantly less water due to transpiration. B tissue concentrations were above deficiency levels, but concentrations from all treatments were significantly lower than the untreated control.

Drought conditions did not affect the amount of water loss due to transpiration, but did affect transpiration per leaf area. Reduced transpiration and transpiration/leaf area ratios, as shown with ABA application, may be responsible for the B deficiency observed in pansy production.

Table 2. Nutrient concentration of 'Dynamite Yellow' pansy shoots, water loss (ml per rep.) due to transpiration (average of 11 d), and transpiration/area of canopy (ml cm^{-2}) from plants 33 DAS treated with abscisic acid as a drench (150 or 300 mg L^{-1}) or a foliar spray (150 or 300 mg L^{-1}) 10 or 20 DAS; transpiration values are averages of 11days.

Treatment	B (mg L^{-1} dry wt.)	Trans	Trans/area[z]
Treated 10 DAS			
Control	32.75a	1.91a	0.038a
Drench (mg L^{-1})			
150	22.71b	0.76ab	0.018a
300	23.58b	-2.42d	-0.048c
Foliar spray (mg L^{-1})			
150	24.65b	-0.90c	-0.028bc
300	24.95b	-0.08bc	-0.015b
P-value[y]	*	***	***
Treated 20 DAS			
Control	32.75a	1.83a	0.018a
Drench (mg L^{-1})			
150	24.68b	0.72ab	0.001ab
300	24.78b	0.32ab	-0.001ab
Foliar spray (mg L^{-1})			
150	24.77b	-0.25b	-0.012b
300	23.39b	-1.20b	-0.020b
P-value[y]	*	*	*

[z] Values with negative numbers indicate the value used for evaporation from the substrate surface of unplanted vessel was greater than total water loss of planted vessel in that treatment.
[y] NS, *, ** Not significant, significant at $P \leq 0.05$ or $P \leq 0.01$. Mean separations are shown by day of treatment in columns under each element.

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Krug, B.A., B.E. Whipker, W.C. Fonteno, I. McCall, and J. Frantz. 2011. Incidence of boron deficiency in bedding plants caused by drought stress or abscicic acid application. Acta Hort. 891:141-147.