Benzyladenine-Induced Offset Formation in Hosta Dependent on Cultivar

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Ten hosta cultivars were treated with either 0, 1250, 2500, or 3750 ppm benzyladenine (BA). Response to BA treatment was cultivar dependent, with BA promoting offset formation in half of the cultivars tested. At 30 days after treatment (DAT), increases in offsets ranged from 116% for 'Francee' to 3500% for 'Francis Williams' at 3750 ppm BA. At 60 DAT, responses to 3750 ppm BA ranged from 150% with 'Royal Standard' to 2250% with 'Francis Williams'. The number of unfurled leaves on offsets (stage of development) was cultivar and BA dependent. However, all cultivars treated with 3750 ppm BA had an average offset stage of development of three unfurled leaves or greater at 60 DAT. Control plants of 40% of cultivars averaged less than three unfurled leaves. No phytotoxic symptoms were noted in any cultivars, and growth index was either increased or not affected by BA rate.

INTRODUCTION

Hostas are conventionally propagated by annual division of the crown or by tissue culture. However, there are certain limitations to these techniques. Division yields relatively few plants per clump, and tissue-cultured explants are costly and frequently may not be true to type. Increase in plant numbers and introduction of new cultivars may be impeded by these factors.

Vegetative buds and roots of hosta grow from rhizomes, and the rhizomic apex suppresses outgrowth of lateral axillary and rhizomic buds by apical dominance. Although the precise mechanisms of apical dominance are not fully understood, a primary factor in this phenomenon is the interaction of the plant hormones auxins and cytokinins (Cline, 1991). Cytokinins, such as benzyladenine (BA), release lateral buds from inhibition when applied exogenously, and previous studies have demonstrated the efficacy of BA in promoting the outgrowth of rhizomic and axillary buds in hosta (Keever, 1994). Furthermore, it has been demonstrated that offsets formed from BA-induced buds can be removed from the mother plant soon after elongation and rooted under intermittent mist with a higher percentage of rooting for offsets at a more advanced stage of development (Keever et al., 1995). Earlier studies were conducted using only *H. sieboldiana,* however, and considerable differences in response to BA application may be expected among the diverse range of hosta cultivars available. The objective of this study was to determine differences among hosta cultivars in response to BA application.

MATERIALS AND METHODS

Dormant, bareroot, divisions of 10 hosta cultivars were potted in 1-gal containers on 20 February 1995. Cultivars included *Hosta fortunei* var. *obscura* 'Aureomarginata' (AM), *H.* 'Big Daddy' (BD), *H.* 'Francee' (FR), *H.* 'Frances Williams' (FW), *H.* 'Gold Standard' (GS), *H.* 'Krossa Regal' (KR), *H. montana* 'Aureomarginata' (MA) [Bot. Ed. note: *H. montana* is one of the parents and the correct name is *H.* 'Aureomarginata'], *H.* 'Royal Standard' (RS), *H. undulata* var. *albomarginata* (UA), and *H.* 'Wide Brim' (WB). Plants were grown under 47% shade in an amended pine bark medium and irrigated by overhead rotary nozzles twice daily for 30 min.

On 7 July 1995, single-eye (no offsets) plants were selected for uniformity, and 10 single-plant replicates of each cultivar were assigned to each of four BA rates (0, 1250, 2500, or 3750 ppm BA). Buffer-X, 0.2%, was added to all BA solutions as a surfactant prior to foliar application at 1.9 liters m^{-2} (2 quarts 100 ft^{-2}). At 30 and 60 days after treatment (DAT), growth index [(height + width at widest point + width 90° to first width) ÷ 3], and visible offset count were determined for each plant. At 60 DAT offset stage of development (SOD) was determined for each offset, with SOD 1= elongated buds with first leaf furled, SOD 2 = one unfurled leaf, SOD 3 = 2 unfurled leaves, etc.

RESULTS AND DISCUSSION

Offset formation in response to BA application was cultivar dependent. With increasing BA rate, offset counts increased in cvs. FR, FW, and RS at 30 DAT (Table 1). Compared to controls, increases in offset counts ranged from 116% (FR) to 3500% (FW). In cultivar KR, optimal response was achieved at an intermediate rate. In cultivar BD, offset counts were greater with treated plants compared to controls but were similar among BA rates. Offset counts for treated plants were similar to that for controls in cultivars AM, GS, MA, UA, and WB. Offset counts generally increased between 30 and 60 DAT, and at 60 DAT response of most cvs. (AM, BD, FW, GS, KR, RS, UA, and WB) to BA was similar to that observed at 30 DAT. In FR, sufficient offsets had formed in control plants at 60 DAT such that offset counts were similar to those of treated plants. In contrast to 30 DAT, MA offset counts among BA-treated plants were greater than those of controls at 60 DAT.

Among control plants at 30 DAT, GS, RS, and WB formed more offsets than BD, FW, KR, or MA, while at 60 DAT, AM, FR, GS, RS, UA, and WB formed more offsets than BD, FW, KR, or MA. Among treated plants, BD, GS, KR, and RS formed more offsets at both 30 and 60 DAT than other cultivars in the study. Cultivars BD and KR which did not readily form offsets in the absence of BA were seen here to produce more offsets than other cultivars when treated with BA.

Influence of BA on offset stage of development (SOD) was also cultivar dependent. Offset SOD increased with increasing BA rate in cvs. BD, FW, KR, and MA, and decreased in GS, WB, and RS. With RS it appeared that the formation of a greater number of offsets decreased average offset SOD. In cvs. AM, FR, and UA, there was no difference in SOD between BA-treated plants and controls at 60 DAT. Offset SOD is an important factor for propagators of hosta. Results of earlier studies showed that offset stem cuttings in a more advanced stage of development rooted more readily. Rooting percentage for offsets with 3 unfurled leaves (SOD 4) was greater than 85%, compared to 56% rooting for elongated buds with the first leaf yet furled (SOD1) (Keever et al., 1995). Based on results of the aforementioned study it appears that offset stage of development has a direct effect on propagation

Table 1. Offset counts of hosta cultivars treated with four BA rates[z].

BA rate (ppm)	Cultivars									
	AM	BD	FR	FW	GS	KR	MA	RS	UA	WB
30 DAT										
0	2.1c[y]	0.4d	1.9c	0.1d	3.9a	0.5d	0.2d	2.9abc	2.5bc	3.4ab
1250	3.1bc	4.7ab	2.5cd	1.0de	5.9a	5.2a	0.1e	6.3a	2.2cd	2.7cd
2500	3.2bc	4.1b	2.9bc	1.6c	3.4bc	6.9a	1.5c	8.6a	2.2bc	2.7bc
3750	2.6de	4.8c	4.1cd	3.6cd	4.6c	5.4b	0.7e	10.4a	3.3cd	2.5de
0 vs. BA[x]	NS	***	NS	**	NS	***	NS	***	NS	NS
BA rate	NS[w]	Q**	L**	L***	NS	Q***	NS	L***	NS	NS
60 DAT										
0	3.4a	0.5b	3.7a	0.2b	4.4a	0.8b	0.5b	4.4a	4.0a	3.7a
1250	3.7bc	5.4ab	2.9cd	0.9de	5.6ab	5.7ab	0.5e	6.7a	5.0ab	2.9cd
2500	4.6b	4.3b	4.6b	1.9d	4.6b	7.7a	2.4cd	9.0a	5.5b	3.9bc
3750	3.0cd	5.6b	4.5bc	4.7bc	4.2bc	5.7b	2.1d	11.0a	5.1bc	3.1cd
0 vs. BA	NS	***	NS	**	NS	***	**	***	NS	NS
BA rate	NS	Q*	NS	L***	NS	Q***	L***	L***	NS	NS

[z] Cultivar × BA interaction significant ($p < 0.01$) at 30 and 60 DAT; see materials and methods for listing of cultivars.
[y] Mean separation within rows by Duncan's multiple range test, $P = 0.05$.
[x] NS,*, **, ***: nonsignificant, or significant at the 5% (*), 1% (**) or 0.1% (***) level.
[w] NS, L, Q: nonsignificant, linear, or quadratic response, respectively, at the 5% (*), 1% (**), or 0.1% (***) level; control included in regression analysis.

Table 2. Mean offset stage of development (SOD) by cultivar and BA rate, 60 DAT[z].

BA rate (ppm)	**Cultivars** AM	BD	FR	FW	GS	KR	MA	RS	UA	WB
0	5.8bc[y]	1.8d	5.8bc	1.4d	9.0a	3.1cd	1.8d	9.7a	8.1ab	9.2a
1250	5.4bc	4.4cd	4.3cd	2.3de	8.2a	6.1abc	1.5e	7.9ab	6.0abc	6.3abc
2500	5.3abc	4.0cd	4.7abcd	2.7d	5.7abc	6.0abc	4.4bcd	6.4ba	6.8a	5.0abc
3750	4.6d	5.0cd	7.2abc	4.9d	7.1abc	7.4ab	5.3bcd	8.3a	8.9a	7.3ab
0 vs. BA[x]	NS	***	NS	NS	*	***	NS	***	NS	*
BA rate	NS[w]	L***	Q**	L*	L**	L***	L**	Q***	NS	Q*

[z] Cultivar x BA interaction significant ($p < 0.01$) at 30 and 60 DAT; SOD 1 = elongated bud, first leaf furled, SOD 2 = 1 unfurled leaf, SOD 3 = 2 unfurled leaves, etc; see materials and methods for listing of cultivars.

[y] Mean separation within rows by Duncan's multiple range test, P = 0.05.

[x] NS,*, **, ***: nonsignificant or significant at the 5% (*), 1% (**) or 0.1% (***) level.

[w] NS, L, Q: nonsignificant, linear, or quadratic response, respectively, at the 5% (*), 1% (**), or 0.1% (***) level; control included in regression analysis.

Table 3. Growth index of hosta cultivars treated with four BA rates[z].

BA rate (ppm)	Cultivars									
	AM	BD	FR	FW	GS	KR	MA	RS	UA	WB
30 DAT										
0	28.1b[x]	21.5c	27.4b	32.8a	32.6a	22.1c	26.9b	34.9a	32.0a	25.1bc
1250	29.7b	25.3d	26.7bcd	34.3a	35.5a	29.1bc	25.6cd	34.9a	28.2bcd	25.5cd
2500	30.5cd	25.0f	31.3cd	32.7bc	37.2a	33.2bc	28.8de	34.7ab	30.0cde	27.1ef
3750	23.8e	25.6de	31.3b	33.4ab	32.9ab	31.8b	27.9cd	35.0a	31.0bc	27.2d
0 vs. BA[y]	NS	**	*	NS	NS	***	NS	NS	*	NS
BA rate[x]	NS[w]	L**	L***	NS	Q*	Q**	NS	NS	Q*	NS
60 DAT										
0	30.0bc	22.7d	30.6bc	33.0ab	32.3ab	21.7d	27.2c	35.6a	33.1ab	27.0c
1250	30.4c	26.8d	27.0d	35.2a	35.0ab	31.7bc	27.2d	35.9a	32.6abc	25.0d
2500	30.4def	27.1f	31.7cde	35.2bc	34.3bcd	36.2b	31.3cde	40.4a	34.0bcd	28.2ef
3750	27.1f	27.0f	34.7bc	36.3ab	31.8cd	34.4bc	30.8de	38.6a	34.4bc	28.2ef
0 vs. BA	NS	**	NS	NS	NS	***	*	NS	NS	NS
BA rate	NS	Q*	Q*	NS	Q*	Q**	L**	L*	NS	NS

[z] Cultivar × BA interaction significant ($p < 0.01$) at 30 and 60 DAT, growth index = (height + width at widest point + width 90° to first width) ¸ 3, *in cm; ; see materials and methods for listing of cultivars.*

[y] Mean separation within rows by Duncan's multiple range test, P = 0.05.

[x] NS,*, **, ***: nonsignificant or significant at the 5% (*), 1% (**) or 0.1% (***) level.

[w] NS, L, Q: nonsignificant, linear, or quadratic response, respectively, at the 5% (*), 1% (**), or 0.1% (***) level; control included in regression analysis.

of hosta by stem cuttings. With few exceptions, offset SOD of plants treated with BA was at stage 4 or greater, whereas, among control plants 40% of cultivars averaged less than SOD 4 (Table 2).

Growth index (GI) either increased or was not affected by BA rate. Growth index generally increased with increasing BA rate in BD, FR, and KR at 30 DAT, and BD, FR, KR, MA, and RS at 60 DAT. In general, cvs. FW, GS, and RS showed greater increase in growth index at both 30 and 60 DAT than other cvs. (Table 3). At 30 DAT cvs. AM, FW, GS, MA, RS, and WB did not show differences in GI between controls and treated plants. This trend was also seen at 60 DAT in cvs. AM, FW, GS, UA, and WB. No phytotoxic symptoms were noted in any cultivars in this study, and plant appearance was not adversely affected by BA. In many cases, plant appearance was enhanced by BA application. For example, GI increased for treated KR plants at all BA rates while growth index declined for controls between 30 and 60 DAT due to foliar necrosis in the mother plants. Expansion of BA-induced offsets appeared to enhance growth and appearance of this cultivar and account for the difference in GI.

These results indicate a cultivar-dependent response to BA for the hosta cultivars evaluated. Offset counts increased with increasing BA rate in FR, FW, KR, MA and RS, but were similar to controls in AM, GS, UA, and WB. Offsets generally increased between 30 and 60 DAT. Generally, offsets developed more readily in control plants of cvs. AM, FR, GS, RS, UA, and WB than for BD, FW, KR, or MA. Among BA-treated plants, however, BD, GS, KR, and RS formed more offsets than AM, FR, FW, MA, or UA. Growth index either increased or was not affected by BA rate, and FW, GS, and RS showed the greatest increases among the cultivars in this study. Plants displayed no phytotoxic symptoms as a result of BA application, and plant appearance was often enhanced by the outgrowth and development of BA-induced offsets. BA application generally enhanced offset SOD, and 90% of all BA-cultivar combinations showed an average SOD $\geq$ stage 4. Offset SOD of plants in most BA-cultivar treatments at 60 DAT was so advanced that division would have provided offsets with roots, thus requiring minimal care for establishment. Based on earlier research (Keever et al., 1995), earlier removal would have yielded rootable stem cuttings. A practical system for the rapid production of hosta that employs BA application may be of benefit to growers by allowing them to produce a wide range of cultivars efficiently and economically, including certain cultivars which are otherwise slow to produce offsets. These findings are a significant step toward development of such a system. Understanding cultivar-dependent response to BA application appears to be a key factor in BA-induced offset formation and development.

LITERATURE CITED

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