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BA Application Timing Affects Offset Formation in Hosta[1]

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Abstract

A study was conducted to determine the effects of timing of benzyladenine (BA) application following division and potting of hosta on offset formation as a means of accelerating propagation. Stock plants of two cultivars, 'Francee' and 'Frances Williams', were divided and potted. Plants received a single foliar spray application of 3000 ppm BA immediately after potting (0) or 1, 2, 3, 4, 5, or 6 weeks after potting. BA stimulated the outgrowth of axillary and rhizomic buds in both cultivars, but in most cases, only for plants in which BA application was delayed 3 or more weeks after potting. Compared to the non-treated control, plants treated with BA 3 or more weeks after potting produced more offsets; however, plants treated 0, 1, or 2 weeks after potting produced similar numbers of offsets as the control. Offsets on plants treated with BA formed more leaves than offsets on non-treated control plants, but application timing did not affect leaf number. 'Francee' produced offsets with more leaves than offsets of 'Frances Williams'. Neither application timing nor BA affected growth index.

Index words: plantain lily, hosta, cytokinin, plant growth regulator.

Species used in this study: hosta, *Hosta* Tratt. (*Funkia* K. Spreng; *Niobe* Salisb.) 'Francee', and *H. sieboldiana* (Lodd.) Engl. [*H. glauca* (Siebold ex Miq.) Stearn 'Frances Williams'.

Plant growth regulators used in this study: benzyladenine (BA), N-(phenylmethyl)-1*H*-purine-6-amine.

Significance to the Nursery Industry

Hostas are popular clump-forming herbaceous perennials that increase in size by forming offsets. Crown division, the traditional propagation method for hosta, yields few offsets on an annual basis because many cultivars are slow to form new offsets. Benzyladenine (BA) can stimulate the outgrowth of rhizomic and apical buds, resulting in more rapid offset formation in hosta if there is sufficient root mass to support the growth of vegetative buds. Results of this study indicate that hosta's response to BA increases when BA application is delayed 3 or more weeks after division and potting. A good practical indicator of hosta's ability to respond to BA is evidence of surface root development. Understanding the effects of application timing relative to division and potting on hosta's response to BA provides valuable information necessary for growers to take full advantage of a non-micropropagation system for the accelerated propagation of this perennial.

Introduction

Outgrowth of axillary and rhizomic buds in hosta is inhibited by apical dominance, a process regulated by an internal balance between auxin and cytokinins (2). This balance of hormones is affected by water availability (5, 9, 12). Benzyladenine (BA) is a synthetic cytokinin effective in promoting elongation of inhibited buds (2) that induced offset formation in hosta (6). Plants with no offsets at the time of BA application produced more offsets than plants with multiple offsets (8). These offsets could be removed and rooted under intermittent mist. The percentage of offsets that rooted and survived was positively correlated with the number of unfurled leaves on the offsets (7). Garner et al. (3) reported that BA response was cultivar dependent, and sequential applications of BA were necessary to continue the positive response to BA after offset removal (4).

Loss of roots, which occurs in crown division, without a reduction in shoots causes a decrease in the root:shoot ratio, resulting in water stress that affects many metabolic processes necessary for growth (10). Shoot growth is dependent upon the supply of water and nutrients from roots (1). Water stress alters the balance of hormones, specifically auxin, which affects apical dominance (9). Recent literature suggests that a decrease in water availability promotes apical dominance (5, 9). Mineral nutrients absorbed by roots also affect inhibition of buds (2), but not to the degree of water availability (9).

Although BA-induced offset formation has been a fast and effective method for propagating hosta, the role of potting date relative to treatment date has not been examined. In previous studies conducted at Auburn University, BA application was delayed until surface roots were present at the substrate-container interface, approximately 4 weeks after potting. However, when BA was applied shortly after potting in a commercial nursery, minimal stimulation of offset formation occurred (personal observation). The objective of this study was to examine the effects of timing of BA application relative to division and potting on offset formation in two hosta cultivars.

Materials and Methods

The two cultivars selected for this study, *H.* 'Francee' and H. *sieboldiana* 'Frances Williams', are widely used in the landscape; however, 'Frances Williams' forms fewer offsets than 'Francee' (2). On May 7, 1997, stock plants of each cultivar were divided into single-eye plants and potted into 3.8 liter (#1) pots using a pinebark:sand (6:1 by vol) medium amended per m^3 (yd^3) with 10.8 kg (18 lb) Polyon 22N–1.8P–11.7K (22–4–14), 3 kg (5 lb) dolomitic limestone, and 0.9 kg (1.5 lb) Micromax. A 3000 ppm BA solution (+BA) at 0.2 liter/m^2 (0.5 gal/100 ft^2) was applied 0, 1, 2, 3, 4, 5, or 6 weeks after potting (WAP) using a CO_2 sprayer at 137 kPa

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(20 psi). Buffer-X (Kalo Agr. Chemicals, Overland, KS) at 0.2% was added to the BA solutions as a surfactant before spraying. Temperature and relative humidity when BA was applied ranged from 22.2–28.9C (72–84F) and 50–87%, respectively. A non-treated control group of each cultivar was included for comparison.

Offsets for controls and plants that had received a BA application were counted 6 weeks after potting (WAP), and 30 and 60 days after the last BA treatment was applied (DALT). Growth index (GI) [(height + width at widest point + width 90° to first width) / 3] and number of unfurled leaves (stage of offset development, SOD) for each offset were recorded 60 DALT with SOD 1 = elongated bud with first leaf furled, SOD 2 = one unfurled leaf, SOD 3–6 = 2–5, respectfully, unfurled leaves.

Treatments in this 2 × 7 (cultivar × BA timing) factorial experiment were completely randomized and replicated with 10 single plants. Analysis of variance (ANOVA) was used to test for significance of main effects and interactions using SAS General Linear Model procedure (11). Comparisons between cultivars and among BA applications were made using single degree of freedom orthogonal contrasts. Comparisons between BA application dates and the control were made using Dunnett's T test (11).

The experiment was repeated in 1998 using similar methodology with the following exceptions. Plants were divided and potted and the first application of BA was made on April 20, 1998. Temperatures at the time of BA application ranged from 24.4–28.9C (76–84F); relative humidity was between 63% and 73%. In 1997, most data were collected 30 and 60 DALT. It appeared that basing data collection on DALT was not detecting treatment effects that may have occurred earlier but had dissipated. Hence, offsets for each BA application and controls were counted 30 and 60 days after each treatment was applied (DAT). SOD and GI were recorded 60 DAT.

Results and Discussion

Offset number. In 1997, there were no significant interactions between cultivar and BA application timing for any offset counts. Across cultivars, offset number changed cubically ($P \leq 0.01$) for BA timing 6 WAP (Table 1). Plants treated 1, 2, or 3 WAP produced 187% to 287% (2 and 3 weeks after potting, respectively) more offsets than plants treated at potting. Plants treated 4 or 5 WAP produced similar numbers of offsets as those treated at potting. The lack of positive response in plants treated 4 or 5 WAP was probably due to data being collected just 1 or 2 weeks after treatment and plants not having as long to respond to BA as plants treated 1, 2, or 3 WAP. Offset number increased linearly with BA application at increasingly later times 30 and 60 DALT. At 30 DALT, plants treated 3 or more WAP produced 29% to 51% more offsets than plants treated at potting. At 60 DALT, plants treated 3 or more WAP produced 11% to 22% more offsets than plants treated at potting, and probably is due to insufficient root development needed to support shoot growth (1, 5, 9).

Compared to control plants, plants treated with BA 1, 2 or 3 WAP produced 279% to 314% more offsets 6 WAP (Table 1). By 30 DALT, plants treated 3 or more WAP produced 79% to 106% more offsets than control plants. Plants treated 3, 5, or 6 weeks after potting produced 78% to 81% more offsets than controls 60 DALT. Plants treated 1 or 2 WAP were different from controls 6 WAP, but not 30 or 60 DALT, probably due to the natural increase in offsets over time for control plants. The trend of diminished response to BA over time agrees with prior work that reported, compared to controls, offset increase in response to BA is stronger 30 DAT than 60 DAT (6), and sequential applications are necessary to continue the response (4). Differences between cultivars were not significant for offset number 6 WAP (data not shown), but 'Francee' produced 54% more offsets 30 DALT and 48% more 60 DALT than 'Frances Williams' (Table 2); these cultivars differences agree with previous research (3).

In 1998, there was a significant interaction between cultivar and BA timing for offset numbers. Offsets for 'Francee' plants increased linearly with BA application at increasingly later times 30 and 60 DAT, which agrees with the results from 1997 (Table 3). Plants treated 2 or more WAP produced 109% to 318% (2 and 3 WAP, respectively) more offsets than plants treated immediately after potting at 30 DAT. The 60 DAT response was not as strong as that at 30 DAT, but plants treated 3 or more WAP produced 130% to 143% more offsets than plants treated at potting. There were no significant regression responses for offset numbers for 'Frances Williams' 30 or 60 DAT, although plants treated 3 or 5 weeks

Table 1. BA application timing comparisons across cultivars for offset number 6 weeks after potting (WAP), and 30 and 60 days after last treatment (DALT), and offset stage of development (SOD), 1997.

BA application timing	Offset number			
WAP	6 WAP	30 DALT	60 DALT	SOD[z]
0	1.5	4.5	5.5	4.4
1	5.0*[y]	5.0	4.8	4.5
2	4.3*	4.5	5.5	5.1
3	5.8*	5.9*	6.6*	5.2
4	1.0	5.8*	6.1	5.5
5	1.5	6.4*	6.7*	5.8
6	—[x]	6.8*	6.7*	5.9
Control	1.4	3.3	3.7	5.5
Significance[w]				
Linear	*	**	*	***
Quadratic	***	NS	NS	NS
Cubic	**	NS	NS	NS

[z]SOD 1 = elongated bud with first leaf furled, SOD 2 = one unfurled leaf, SOD 3–6 = 2–5, respectfully, unfurled leaves.

[y]Means followed by an asterisk are significantly different from the control based on Dunnett's T test, P = 0.05.

[x]BA treatment not applied until after data collection.

[w]Nonsignificant (NS) or significant regression response at $P \leq 0.05$ (*), $P \leq 0.01$ (**), or $P \leq 0.001$ (***); control not included in regression analysis.

Table 2. Cultivar comparisons across BA application timing for offset number in hosta 30 and 60 days after last BA treatment (DALT), 1997.

	Offset number	
Cultivar	30 DALT	60 DALT
'Francee'	6.3a[z]	6.8a
'Frances Williams'	4.1b	4.6b

[z]Means separated within a date by F-test; $P \leq 0.05$.

Table 3. BA application timing comparisons within cultivar and cultivar comparisons within BA treatment for offset number 30 and 60 days after treatment (DAT), 1998.

BA application timing	Offset number			
	'Francee'		'Frances Williams'	
WAP	30 DAT	60 DAT	30 DAT	60 DAT
0	2.2	4.0a[z]	0.5	0.9b
1	3.0	4.5	0.9	2.0
2	4.6a*[y]	5.0a	0.5b	0.6b
3	9.2a*	9.2a*	1.1b*	1.3b
4	7.2a*	8.9a*	0.8b	1.0b
5	7.1a*	8.3a*	2.3b*	2.5b
6	8.9a*	9.7a*	1.3b*	1.7b
Control[x]	1.4	2.8	0.2	0.6
Significance[w]				
Linear	***	***	NS	NS
Quadratic	NS	NS	NS	NS
Cubic	NS	NS	NS	NS

[z]Means for cultivars within a BA application timing treatment and DAT are separated by single degree of freedom contrast; $P \leq 0.05$.

[y]Means followed by an asterisk are significantly different from control; P = 0.05.

[x]Control not included in regression analysis.

[w]Nonsignificant (NS) or significant regression response at $P \leq 0.001$ (***).

after potting produced 120% to 360%, respectively, more offsets than plants treated at potting 30 DAT and 44% to 170%, respectively, 60 DAT. The low offset counts recorded in all treatments 30 and 60 DAT are typical of 'Frances Williams'; this cultivar is slower than 'Francee' to establish and form offsets and is also less tolerant to high summer temperatures (3).

Certain comparisons between BA treatments and the control were significant for offset number for both cultivars 30 DAT and for 'Francee' 60 DAT. 'Francee' plants treated 2 or more WAP produced 229% to 557% more offsets than control plants 30 DAT, and plants treated 3 or more WAP produced 196% to 246% more offsets than controls 60 DAT (Table 3). 'Frances Williams' +BA plants treated 3, 5, or 6 WAP produced 1.1–2.3 offsets, while controls produced 0.2 offsets at 30 DAT. These results were similar to 1997 results and reinforced that BA stimulates rapid offset formation within 30 DAT when applied to established division. But, due to the normal rate of offset formation over time in controls, the difference in offset numbers between treated and non-treated plants is decreased. As reported in earlier studies, sequential applications of BA are necessary to continue the response (4). 'Francee' produced 209% to 820% more offsets than 'Frances Williams' 30 DAT for plants treated 2–6 WAP (Table 3), and 232% to 800% more offsets 60 DAT for plants treated 0 and 2–6 WAP.

Stage of development. In 1997, the interaction between BA application timing and cultivar for SOD was not significant. SOD increased linearly with BA application at increasingly later times across cultivars (Table 1). Prior work reported that rooting percentage increased as SOD increased (7). 'Francee' offsets had a 21% higher SOD than 'Frances Williams' (5.7a versus 4.7b, P = 0.05). BA application timing and control comparisons were not significant for SOD.

In 1998, BA application timing was not significant for SOD (data not shown); however, cultivar was significant for SOD. 'Francee' offsets had a 125% higher SOD than 'Frances Williams' (7.2a versus 1.6b, P = 0.05). Dunnett's T-test revealed that compared to controls, plants treated 5 or 6 WAP produced offsets with a 74% and 79% higher SOD, respectively across cultivars (6.6a and 6.8a, respectively, versus 3.8b, P = 0.05).

Growth index. There were no significant BA timing effects or BA × cultivar interactions for GI in 1997 or 1998. In addition, none of the BA application timing treatment effects were significant when compared to the control. These results support previous research, which showed BA application has minimal effects on plant size (3, 6).

BA-induced offset formation is an effective method to accelerate propagation of hosta; however, BA is most beneficial when plants are allowed to establish prior to application. In the South, this establishment period is usually 3 or 4 weeks after potting; however, the establishment period is cultivar dependent. A good indicator of root establishment used in previous work (3, 6) is evidence of surface root development. Results of this study support previous work conducted in which BA was not applied until plants were established. Allowing plants to establish prior to BA application will increase hosta's response to BA by increasing offset formation and possibly SOD, resulting in higher rooting percentages, thereby minimizing cropping time.

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