# BA Application Promotes Offset Formation in Hosta Cultivars[1]

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## Abstract

A foliar spray of 0, 1250, 2500, or 3750 ppm BA was applied to 10 hosta cultivars. BA application promoted offset formation in 8 cultivars at 30 days after treatment (DAT) and in all cultivars at 60 DAT. At 30 DAT, no offsets had formed in controls (0 ppm BA) of 'Halcyon' or 'Samuel Blue', but plants receiving 3750 ppm BA averaged 3.1 and 5.5 offsets, respectively. In the remaining cultivars at 30 DAT, maximum increases in offsets compared to controls ranged from 0.9 offset for 'Stiletto' to 6.2 offsets for 'Hyacinthina'. Untreated plants of 'Halcyon' formed no offsets by 60 DAT, whereas plants receiving 3750 ppm BA averaged 3.8 offsets. In the remaining cultivars at 60 DAT, maximum increases in offsets compared to controls ranged from 2.1 offsets for 'Great Expectations' to 7.6 offsets for 'Stiletto'. Offset stage of development, based on number of unfurled leaves, was more advanced in treated plants than in controls of two cultivars, less than that of controls in two cultivars, and similar to controls in the remaining cultivars. No phytotoxic symptoms were noted for any cultivar, and plant size was either increased or not affected by BA treatment.

**Index words:** cytokinin, growth regulators, plantain lily.

**Species used in this study:** plantain lily, *Hosta* Tratt. (*Funkia* K. Spreng; *Niobe* Salisb.) 'Fragrant Blue', 'Great Expectations', Golden Tiara', 'Halcyon', 'Hyacinthina', 'Patriot', 'Samuel Blue', 'Shade Fanfare', 'Stiletto', *H. undulata* 'Medio-variegata'.

**Growth regulator used in this study:** Pro-Shear, benzyladenine (BA), 6-benzylaminopurine, *N*-(phenylmethyl)-1*H*-purin-6-amine.

### Significance to the Nursery Industry

Hostas are conventionally propagated by tissue culture or crown division, but these methods can be costly or slow. An accelerated propagation system for hosta which employs the synthetic cytokinin BA application in a range of 1250–3750 ppm to stimulate the outgrowth of offsets could facilitate the rapid multiplication of a wider range of cultivars than previously reported, including cultivars that do not readily form offsets. This method can provide an effective alternative to conventional propagation methods, but understanding the cultivar-dependent response of hosta is necessary to fully exploit the potential uses of BA application.

### Introduction

Hostas are herbaceous perennials in the Liliaceae family. They were the most popular of all perennials in both 1992 and 1993 (9), and are well suited for use in the shaded landscape. Hostas are conventionally propagated by vegetative means such as crown division or tissue culture, but there are

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limitations to these methods. Division yields relatively few plants per clump and is typically accomplished only once annually (12). Tissue-cultured explants are costly and frequently may not be true to type (7). Moreover, propagation of plants by tissue culture requires skilled technicians, specialized materials, and expensive facilities unavailable to most growers. Rapid and economical increases in plant numbers and the introduction of new cultivars may be impeded by these limitations.

Vegetative buds and roots of hosta grow from rhizomes (11), and the rhizomic apex may suppress outgrowth of axillary and rhizomic buds by apical dominance. A primary factor in the mechanism of apical dominance is a hormonal interaction between auxins and cytokinins (1). Cytokinins, including benzyladenine (BA), can release lateral buds from inhibition when applied exogenously (6), and a previous study has demonstrated the effectiveness of BA in promoting the outgrowth of rhizomic and axillary buds in hosta (4). Furthermore, offsets formed from BA-induced buds can be removed from the mother plant soon after elongation and rooted under intermittent mist. A higher percentage of rooting was found in offsets with more formed leaves when removed from the mother plant (5). Initial studies were conducted using *Hosta sieboldiana* (Lodd.) Engl., yet considerable differences in response to BA application may be expected among the more than 1500 hosta cultivars available (11). Cultivar-dependent responses to BA have been noted in citrus (8) and apple (2). To address this factor, a study was conducted in 1995 to determine differences among hosta cultivars in response to BA (3). Of 10 cultivars evaluated, BA application promoted offset formation in five cultivars. To more fully understand the response of hosta cultivars to BA, this study evaluated ten additional hosta cultivars.

## Materials and Methods

Dormant, bare-root divisions of 10 hosta cultivars were potted on March 25, 1996, in 2.7-liter (#1) containers of a pine bark:sand medium (6:1 by vol) amended per $m^3$ ($yd^3$) with 3 kg (5 lb) dolomitic lime, 0.9 kg (1.5 lb) Micromax (The Scotts Co., Marysville, OH), and 5.7 kg (9.7 lb) 24N–1.8P–10K (Polyon 24–4–14, 12-month formulation, Pursell Industries, Sylacauga, AL). Cultivars evaluated included: 'Fragrant Blue' (FB); 'Great Expectations' (GE); 'Golden Tiara' (GT); 'Halcyon' (HC); 'Hyacinthina' (HY); 'Patriot' (PT); 'Samuel Blue' (SB); 'Shade Fanfare' (SF); 'Stiletto' (ST); and *H. undulata* (Otto & A. Dietr.) L.H. Bailey 'Mediovariegata' (UM). Plants were grown under 47% shade and irrigated by overhead rotary nozzles twice daily for 30 minutes per application, for a total of 3 cm (1.2 in) per day.

On June 4, 1996, plants were selected for uniformity, and the number of initial offsets present was recorded for each plant. In a completely randomized design, ten single-plant replications of each cultivar were assigned to each of four BA (Pro-Shear, Abbott Laboratories, N. Chicago, IL) rates: 0, 1250, 2500, or 3750 ppm. Buffer-X (Kalo Agr. Chemicals, Inc., Overland Park, KS) at 0.2% was added to all BA solutions as a surfactant prior to foliar application at 0.2 liter/$m^2$ (0.5 gal/100 $ft^2$). Application was made with a $CO_2$ sprayer fitted with a cone nozzle at 207 kPa (30 psi). Temperature and relative humidity at the time of application were 27C (81F) and 85%, respectively.

At 30 and 60 days after treatment (DAT), visible offset counts and a growth index [(height + width at widest point + width 90° to first width) ÷ 3] were determined for each plant. At 60 DAT, stage of development (SOD) was determined for each offset, with SOD 1 = elongated bud with first leaf furled; 2 = one unfurled leaf, and; 3–8 = 2–7 unfurled leaves, respectively. The number of initial offsets present was subtracted from offset counts of each plant at 30 and 60 DAT to determine the increase in offset number following BA application. Data were subjected to analysis of variance using the SAS General Linear Model procedure to test main effects and interactions (10). Rate responses to BA were determined by single degree of freedom orthogonal contrasts. Mean separation among cultivars was accomplished by Duncan's multiple range test ($P = 0.05$).

## Results and Discussion

BA application promoted offset formation in all cultivars evaluated, but the response to BA concentration was cultivar-dependent. At 30 DAT, offset counts in treated plants were higher than those of controls in 8 of the 10 cultivars (Table 1), and optimal BA concentration varied among cultivars. Offsets formed in controls of all cultivars except HC and SB at 30 DAT. Plants of HC receiving 3750 ppm BA averaged 3.1 offsets, and plants of SB receiving 1250 averaged 5.9 offsets. In treated plants of the remaining cultivars, increases in offsets at the numeric optimum of the tested rates ranged from 0.9 offset for ST to 6.2 offsets for HY, compared to controls. There was a linear increase in offsets in FB, HC, HY, and PT with increasing BA concentration, and a quadratic increase in GE, GT, SB, and SF with the numeric maximum offset numbers produced at 1250 ppm. Offset counts in treated plants of ST and UM were similar to controls at 30 DAT. Controls of GT formed more offsets than those of other cultivars, except SF, and GT and SF formed more offsets than other cultivars at 30 DAT when treated with BA.

At 60 DAT, offset counts for treated plants were higher than those of controls in all cultivars. In HC, no offsets formed in controls by 60 DAT, but plants receiving 3750 ppm BA averaged 3.8 offsets. In the remaining cultivars, at the numeric optimum of the three BA rates, increases in offsets among treated plants at 60 DAT ranged from 2.1 offsets in GE to 7.6 offsets in ST, compared to controls. There was a linear increase in FB, HC, HY, PT, and ST with increasing BA rate, and a quadratic response in GE, GT, SB, and SF with the numeric maximum offset numbers produced at 1250 ppm. Controls of GT and SF formed more offsets than those of other cultivars except HY and ST, and ST formed more offsets than other cultivars at 60 DAT when treated with BA.

Influence of BA on offset SOD at 60 DAT was also cultivar-dependent. Compared to controls, offset SOD was more advanced in treated plants of PT and SB, and less advanced in treated plants of GE and UM (Table 2). There were no differences in offset SOD between BA treated plants and controls in the remaining six cultivars. Offset SOD at 60 DAT was > 4 in all treatments for all cultivars except HC and SB, and with these, some level of BA treatment resulted in SOD 4. Previous studies reported 88% rooting for SOD 4, with less rooting reported for lower stages (4). In most cases, offsets at 60 DAT possessed autonomous root systems and required minimal care for establishment following removal from the mother plant.

Compared to controls, growth index of treated plants was increased or unaffected by BA treatment (Table 3). At 30

**Table 1. Offset counts of hosta cultivars at 30 and 60 days after treatment (DAT) with four BA rates.[z]**

| BA rate (ppm) | 'Fragrant Blue' | 'Great Expectations' | 'Golden Tiara' | 'Halcyon' | 'Hyacinthina' | 'Patriot' | 'Samuel Blue' | 'Shade Fanfare' | 'Stiletto' | 'Medio-variegata' |
|---|---|---|---|---|---|---|---|---|---|---|
| | Cultivar | | | | | | | | | |
| | 30 DAT | | | | | | | | | |
| 0 | 0.4de[y] | 0.1e | 3.5a | 0.0e | 1.6bcd | 1.0cde | 0.0e | 2.4ab | 1.4bcd | 1.9bc |
| 1250 | 3.1c | 2.2cd | 6.8ab | 0.2e | 6.9ab | 3.8c | 5.9b | 8.3a | 1.0de | 3.9c |
| 2500 | 1.8de | 2.2de | 6.5b | 1.0e | 4.9bc | 3.6cd | 4.9bc | 7.7a | 2.0de | 2.4de |
| 3750 | 3.1c | 1.9c | 5.6b | 3.1c | 7.8a | 5.5b | 5.5b | 7.1ab | 2.3c | 3.0c |
| 0 vs. BA[x] | ** | *** | *** | * | *** | *** | *** | *** | NS | NS |
| BA rate[w] | | | | | | | | | | |
| L | * | ** | ** | *** | *** | *** | *** | *** | NS | NS |
| Q | NS | ** | *** | NS | NS | NS | ** | *** | NS | NS |
| | 60 DAT | | | | | | | | | |
| 0 | 1.7d | 0.6e | 4.3a | 0.0e | 2.9abc | 2.3bc | 0.1c | 4.3a | 3.5ab | 2.2bc |
| 1250 | 3.6b | 2.7b | 6.9a | 0.2c | 8.1a | 4.0b | 6.9a | 8.5a | 7.1a | 4.4b |
| 2500 | 4.2de | 2.4ef | 6.5bc | 1.5f | 5.0cd | 3.8de | 5.4cd | 7.7ab | 9.4a | 2.8ef |
| 3750 | 3.8de | 2.3e | 5.7cd | 3.8de | 8.9b | 5.7cd | 5.9cd | 7.2bc | 11.1a | 3.7de |
| 0 vs. BA | ** | *** | *** | ** | *** | *** | *** | *** | *** | * |
| BA rate | | | | | | | | | | |
| L | * | * | NS | *** | *** | *** | *** | ** | *** | NS |
| Q | NS | * | ** | NS | NS | NS | ** | *** | NS | NS |

[z]Cultivar × BA interaction significant ($P \leq 0.001$) at 30 and 60 DAT.

[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, *, **, ***: linear or quadratic response significant at the 5% (*), 1% (**), or 0.1% (***) level; control included in regression analysis.

DAT, the growth index was higher for treated plants than for controls of HY and PT, with the growth index increasing linearly with increasing BA rate. Growth index for treated plants was similar to controls in other cultivars at 30 DAT. At 60 DAT, the growth index was higher for treated plants than for controls in PT, SB, and ST, and similar to controls for all other cultivars. No phytotoxic symptoms were noted in any treatments in this study, and in many cases, plant appearance was enhanced by BA application due to outgrowth of BA-induced offsets.

BA application appears to increase fractions of total dry weight allocated to lateral shoots by redirecting source-sink relationships and allowing lateral structures to receive a preferential supply of assimilates and nutrients (13). This change in resource allocation may result in a pronounced flush of new growth in offsets that can enhance plant appearance in many cultivars. The petioles and laminae of control plants were of sufficient dimensions to result in relatively high growth index values, while new growth from induced offsets was typically compact and added little to the growth index values at 30 and 60 DAT in many cases. Other measures such as dry weight or leaf area may be more accurate in quantifying these treatment effects on growth and biomass.

**Table 2. Offset stage of development (SOD) of hosta cultivars at 60 days after treatment (DAT) with four BA rates.[z]**

| BA rate (ppm) | 'Fragrant Blue' | 'Great Expectations' | 'Golden Tiara' | 'Halcyon' | 'Hyacinthina' | 'Patriot' | 'Samuel Blue' | 'Shade Fanfare' | 'Stiletto' | 'Medio-variegata' |
|---|---|---|---|---|---|---|---|---|---|---|
| | Cultivar | | | | | | | | | |
| 0 | 4.5b[y] | 6.9a | 7.8a | — | 5.2b | 4.7b | 1.0c | 6.8a | 8.1a | 7.6a |
| 1250 | 4.0d | 6.1bc | 7.7a | 2.0e | 5.6c | 5.6c | 4.0d | 7.2ab | 7.9a | 6.8abc |
| 2500 | 4.4cd | 6.0b | 7.9a | 4.8c | 5.9b | 6.0b | 3.5d | 7.3a | 7.6a | 6.0b |
| 3750 | 4.5fg | 6.0de | 7.2abc | 4.1gh | 5.4ef | 6.6bcd | 3.3h | 7.3ab | 7.9a | 6.2cde |
| 0 vs. BA[x] | NS | * | NS | NS | NS | * | * | NS | NS | * |
| BA rate[w] | NS | L | NS | NS | NS | L** | Q* | NS | Q* | L** |

[z]Cultivar × BA interaction significant ($P \leq 0.01$) at 60 DAT; SOD 1 = elongated bud, first leaf furled; 2 = 1 unfurled leaf; 3–8 = 2–7 unfurled leaves, respectively.

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

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

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

**Table 3. Growth index of hosta cultivars at 30 and 60 days after treatment (DAT) with four BA rates.[z]**

| BA rate (ppm) | Cultivar | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 'Fragrant Blue' | 'Great Expectations' | 'Golden Tiara' | 'Halcyon' | 'Hyacinthina' | 'Patriot' | 'Samuel Blue' | 'Shade Fanfare' | 'Stiletto' | 'Medio-variegata' |
| | 30 DAT | | | | | | | | | |
| 0 | 17.8d[y] | 33.1a | 26.2b | 26.9b | 26.4b | 21.1c | 20.3cd | 35.1a | 14.6e | 34.1a |
| 1250 | 18.7f | 34.7a | 27.6c | 26.7cd | 31.0b | 24.0de | 23.7e | 36.9a | 19.1f | 34.3a |
| 2500 | 17.7ed | 33.8b | 24.9d | 26.5cd | 28.7c | 25.9cd | 24.2d | 37.4a | 18.3e | 36.1ab |
| 3750 | 17.9e | 32.8b | 24.5cd | 26.8c | 31.8b | 26.7c | 22.1d | 33.7a | 18.5e | 34.0ab |
| 0 vs. Ba[x] | NS | NS | NS | NS | ** | ** | NS | NS | NS | NS |
| BA rate[w] | NS | NS | L* | NS | L* | L*** | Q* | Q* | NS | NS |
| | 60 DAT | | | | | | | | | |
| 0 | 18.4e | 33.6b | 26.7c | 26.4c | 31.9b | 22.7d | 20.4de | 36.3a | 18.3e | 38.8a |
| 1250 | 18.3f | 34.8bc | 26.9d | 27.0d | 34.3c | 25.5de | 23.7e | 38.4a | 20.3f | 37.4de |
| 2500 | 18.1d | 34.5b | 25.2c | 26.6c | 30.0b | 27.6c | 24.8c | 38.5a | 20.1d | 38.9a |
| 3750 | 18.7g | 32.5c | 25.2e | 26.4de | 34.9bc | 29.0d | 22.3f | 38.2a | 20.5fg | 35.3b |
| 0 vs. BA | NS | NS | NS | NS | NS | *** | * | NS | ** | NS |
| BA rate | NS | Q* | L* | NS | NS | L*** | Q* | NS | L* | NS |

[z]Cultivar × BA interaction significant ($P \le 0.01$) at 30 and 60 DAT; growth index = (height + width at widest point + width 90° to first width) ÷ 3, in cm.
[y]Mean separation within rows by Duncan's multiple range test, $P = 0.05$.
[x]NS,*, **, ***: nonsignificant (NS) 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.

Promotion of offset formation by BA application as reported in this study is supported by previous research (3, 4). Results of this study indicate that foliar application of BA can promote offset formation in a wide range of cultivars. BA application resulted in higher offset counts for plants of all evaluated cultivars within 60 days of BA application. Rate response was cultivar-dependent, with the numerical optimum of the tested BA rates at 1250 ppm for half the cultivars evaluated and at 3750 ppm for the remaining cultivars.

BA application to hosta may reduce costs and accelerate production for a wide range of cultivars, including cultivars which are slow to produce offsets. In previous work (3), BA application promoted offset formation in 60% of the cultivars evaluated, while in this study, BA application promoted offset formation in all cultivars within 60 DAT. These findings suggest that BA is effective in promoting offset formation in a wider range of cultivars than previously demonstrated. Our study indicates a cultivar-dependent response to BA application, and understanding this response appears to be a key factor in capitalizing on BA-induced offset formation and development during hosta production.

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