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Root Mass and BA Affect Offset Formation in Hosta[1]

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Abstract

A study was conducted to determine the effects of root mass and benzyladenine (BA) on offset formation in hosta. Stock plants of two cultivars, 'Francee' and 'Frances Williams', were divided, and offsets were placed in either small, medium, or large root mass groups. Offsets were potted and, when surface root development was evident, half of the plants in each root mass group received a foliar spray application of 3000 ppm BA, while half served as BA controls. Offset formation was positively correlated with increasing root mass, regardless of BA application. BA stimulated the outgrowth of axillary and rhizomic buds in both cultivars. Offsets on plants treated with BA were at a more advanced stage of development (SOD) than offsets on BA controls, but root mass did not affect SOD. Root mass, but not BA, affected whole plant growth index, which increased with increases in root mass.

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

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

Significance to the Nursery Industry

Hostas increase in size by forming offsets that arise from axillary and rhizomic buds. Crown division, the traditional propagation method for hosta, yields few offsets on an annual basis because many cultivars are slow to form new offsets. Offset formation in hosta is dependent on initial root mass. Benzyladenine (BA) can stimulate the outgrowth of rhizomic and apical buds, but the response to BA is also affected by root mass. Application of BA to divisions with minimal root mass is less effective, therefore growers should either ensure adequate root mass at division or allow sufficient time for root mass development prior to BA application. Information on the effects of root mass on hosta's response to BA provides valuable insight into developing a system for the accelerated propagation of this plant.

Introduction

Outgrowth of axillary and rhizomic buds in hosta is inhibited by apical dominance, a process regulated by an internal balance between auxins and cytokinins (2). Root loss during division and potting can affect this balance of hormones, thus affecting shoot growth (12). When water is a limiting factor, apical dominance is stronger (5, 9). Reduced water supply from roots also limits leaf expansion and shoot growth (1).

Benzyladenine (BA) is a synthetic cytokinin effective in promoting elongation of inhibited buds (2). Keever (6) observed that BA application induced offset formation in hosta. Plants without offsets at the time of BA application produced more offsets than those with multiple offsets (8). These offsets could be harvested and rooted under intermittent mist propagation. Rooting percentage was positively correlated with the number of unfurled leaves on the offsets (7). Garner et al. (3) found that the response to BA was cultivar dependent, and sequential applications of BA were necessary to continue the positive response to BA after offset removal (4).

Although BA-induced offset formation was demonstrated as a fast and effective method for propagating hosta, results have often been highly variable within treatments, even though efforts were made to ensure plant uniformity (personal observation). In previous studies conducted at Auburn University, plants were graded primarily for shoot uniformity and secondarily for root uniformity. Loss of roots, which occurs in crown division, without a reduction in shoot size results in water stress and affects many metabolic processes necessary for growth (10). Recent literature strongly suggests that water availability is a limiting factor for the outgrowth of inhibited buds (5, 9). Mineral nutrients absorbed by roots also affect inhibition of buds (1), but to a lesser extent than water availability (9). The role of root mass and its interaction with BA on offset formation in hosta has not been examined; therefore, the objective of this study was to determine the effects of root mass and BA on offset formation in hosta.

Materials and Methods

Stock plants of *Hosta* 'Francee', a cultivar that readily forms offsets, and *H. sieboldiana* 'Frances Williams', which forms offsets more slowly than 'Francee', were divided into single-eye plants on July 11, 1997, in Auburn, AL. Divisions were grouped according to root mass (RM = small, medium, and large) 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. Plants were grown under 47% shade and irrigated twice per day for 30 minutes each by overhead rotary nozzles. On August 14, 1997, when surface root development was evident (when roots reached the sides of the pots), ten single plant replications of each cultivar from each root mass group were sprayed with 3000 ppm BA (+BA, Abbott Laboratories, Chicago, IL) at 0.2 liter/m^2 (0.5 gal/100 ft^2) using a CO_2 sprayer at 137 kPa (20 psi). Buffer-X (Kalo Agr. Chemicals,

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Overland, KS) at 0.2% was added to each BA solution before spraying. Temperature and relative humidity at the time of BA application were 29C (84F) and 67%, respectively. Ten single plant replications from each RM group were BA controls (–BA). Root dry weights of 5 plants from each RM group were recorded at division and at BA application (Table 1). Offsets were counted 30 and 60 days after treatment (DAT). Growth index [GI = (height + width at widest point + width 90° to first width) / 3] and offset stage of development (SOD 1 = elongated bud, first leaf furled; SOD 2 = 1 unfurled leaf; SOD 3 = 2 unfurled leaves, etc.) for each offset were recorded 60 DAT. Treatments in this 2 × 3 (BA × root mass) factorial experiment were completely randomized across cultivars. Analysis of variance (ANOVA) was used to test main effects and interactions using SAS General Linear Models procedure. Significance of interactions was at $P = 0.05$ unless otherwise stated. Comparisons among RM groups and between controls and the BA treatment were made using single degree of freedom orthogonal contrasts (11).

The experiment was also conducted in Mobile, AL, in 1997 with the following differences: potting and BA application dates were March 21 and April 22, respectively, and temperature and relative humidity at the time of application were not recorded. In 1998, 'Frances Williams' was tested in Auburn and 'Francee' in Mobile. Potting and application dates for 'Francee' were March 29 and June 3, respectively; temperature and relative humidity at the time of BA application were 32C (90F) and 63%, respectively. 'Frances Williams' plants were potted on April 20 and treatments were applied on May 18. Temperature at the time of application was 24C (76F) and relative humidity was 68%.

Results and Discussion

Offset number. In 1997 at both locations there was a significant 3-way interaction between cultivar, RM, and BA therefore cultivars were analyzed separately. In Auburn, the interaction between RM and BA was significant for offset number in 'Francee' 30 DAT and in both cultivars 60 DAT (Table 2). In +BA plants, large RM 'Francee' formed 40% and 85% more offsets at 30 DAT and 52% and 81% more offsets at 60 DAT than medium and small RM groups, respectively. In –BA 'Francee', medium RM plants produced more offsets than large RM plants 30 DAT, but offset counts were similar among RM groups 60 DAT. Differences among RM groups in 'Frances Williams' were not significant 30 DAT (data not shown); however, across all RM groups, +BA plants produced 1233% more offsets than –BA plants (4.0 versus 0.3, respectively). In +BA 'Frances Williams', medium RM plants produced 74% more offsets than small RM plants 60 DAT, but a similar number to large RM plants (Table 2). In 'Francee', +BA plants produced more offsets than corresponding –BA plants in each RM group 30 DAT (small = 292%, medium = 170%, large = 1350%) and for medium and large RM plants 60 DAT. 'Frances Williams' offset numbers were higher in +BA plants with medium (315%) or large (350%) RM 60 DAT than in corresponding –BA plants (Table 2).

In 1997 at the Mobile location, there was a significant interaction between RM and BA for offset number in both cultivars 30 DAT and in 'Francee' 60 DAT (Table 3). In 'Francee' offsets counts increased as RM increased for +BA plants 30 DAT and for –BA 60 DAT. At 60 DAT, +BA plants with large RM produced 431% more offsets than plants with small RM, but numbers similar to plants with medium RM. +BA 'Francee' with medium (3900%, 30 DAT) or large (2450% and 73%, 30 and 60 DAT, respectively) RM produced more offsets than corresponding –BA 'Francee'. This response is typical of previous research (6, 7); the greatest benefit from BA is usually within 30 DAT, with diminishing returns thereafter, especially for 'Francee', a cultivar that naturally forms many offsets. Large RM 'Frances Williams' produced more offsets than small or medium RM plants 30 (Table 3) and 60 DAT (small: 0.3b, medium: 0.4b, large: 1.2a), but only in +BA plants 30 DAT. Compared to corresponding –BA plants, offset numbers were higher for +BA 'Frances Williams' plants with medium or large RM 30 DAT (Table 3) and across all RM groups 60 DAT (+: 1.0a, –: 0.2b).

In 1998, results followed trends similar to those in 1997. In Mobile, there was a significant interaction between RM and BA for offset number in 'Francee' 30 DAT (Table 4). Large RM +BA plants produced 125% and 65% more offsets than small and medium RM classes, respectively. Me-

Table 1. Average root dry weight ± standard deviation (SD) at potting and BA treatment for 'Francee' and 'Frances Williams' root mass (RM) groups in 1997 and 1998 at Auburn and Mobile, AL.

Root mass class	Root dry weights (g) ± SD							
	Auburn				Mobile			
	'Francee'		'Frances Williams'		'Francee'		'Frances Williams'	
	Potting	Treatment	Potting	Treatment	Potting	Treatment	Potting	Treatment
	1997							
Small	1.7[z] ± 1.0	2.2 ± 1.0	2.0 ± 0.5	2.8 ± 0.4	0.3 ± 0.2	0.5 ± 0.1	0.2 ± 0.1	1.6 ± 0.8
Medium	8.6 ± 3.1	9.1 ± 3.1	9.4 ± 3.5	10.4 ± 3.7	2.1 ± 0.7	4.8 ± 1.6	3.7 ± 1.1	4.7 ± 0.6
Large	17.4 ± 3.2	19.8 ± 3.3	26.4 ± 4.0	27.9 ± 4.3	8.8 ± 0.7	9.2 ± 1.0	11.3 ± 4.1	11.2 ± 3.2
	1998							
Small	—[y]	—	0.8 ± 0.1	1.6 ± 0.2	0.3 ± 0.1	1.1 ± 0.9	—	—
Medium	—	—	7.2 ± 0.3	8.4 ± 0.3	1.6 ± 0.8	2.4 ± 1.0	—	—
Large	—	—	16.7 ± 0.3	18.5 ± 0.2	4.5 ± 2.9	8.0 ± 2.4	—	—

[z]Values are means of 5 samples.

[y]This cultivar was not included in that location in 1998.

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Table 2. **Root mass (RM) and BA effects on offset number in hosta 30 and 60 days after treatment (DAT), Auburn 1997.**

Root mass class	Offset number		
	'Francee'		'Frances Williams'
	30 DAT	60 DAT	60 DAT
	+BA		
Small	4.7b[z]*[y]	4.7b	3.1b
Medium	6.2b*	5.6b*	5.4a*
Large	8.7a*	8.5a*	4.5ab*
	–BA		
Small	1.2ab	3.7a	2.0a
Medium	2.3a	3.2a	1.3a
Large	0.6b	2.7a	1.0a

[z]BA × RM interaction significant at P = 0.05 for each DAT; mean separation among RM within +/– BA by single degree of freedom contrasts. BA × RM interaction not significant for offset number in 'Frances Williams' at 30 DAT. Means are representation of 10 single plant replications.

[y]Means for +BA treatments followed by an asterisk are significantly different from corresponding root mass class means for –BA treatments; P = 0.05. Means are representation of 10 single plant replications.

Table 3. **Root mass (RM) and BA effects on offset number in hosta 30 and 60 days after treatment (DAT), Mobile 1997.**

Root mass class	Offset number		
	'Francee'		'Frances Williams'
	30 DAT	60 DAT	60 DAT
	+BA		
Small	0.0c[z]	1.3b	0.6b
Medium	4.0b*[y]	3.3ab	0.7b*
Large	10.2a*	6.9a*	2.4a*
	–BA		
Small	0.2a	1.5c	0.1a
Medium	0.1a	3.2b	0.0a
Large	0.4a	4.0a	0.3a

[z]BA × RM interaction significant at P = 0.05 for each DAT; mean separation among RM within +/– BA by single degree of freedom contrasts. BA × RM interaction not significant for offset number in 'Frances Williams' at 60 DAT. Means are representation of 10 single plant replications.

[y]Means for +BA treatments followed by an asterisk are significantly different from corresponding root mass class means for –BA treatments; P = 0.05. Means are representation of 10 single plant replications.

dium and large +BA RM classes produced 186% to 267% more offsets than corresponding –BA RM classes. At 60 DAT, large RM 'Francee' produced 81% and 61% more offsets than small and medium RM classes, respectively (small: 1.6b, medium: 1.8b, large: 2.9a), and +BA plants produced twice the offsets as –BA plants (+: 2.8a, –: 1.4b). Offset numbers for + BA plants in Mobile were lower than those in 1997, probably due to higher temperatures; treatments were applied more than a month later (June) in 1998 than in 1997 (April). In Auburn, there were no significant treatment effects for offset counts in 'Frances Williams' 30 DAT; however, the RM × BA interaction was significant for offset numbers in 'Frances Williams' 60 DAT (Table 4). Large RM +BA plants produced 1133% more offsets than the small RM group and 429% more offsets than large RM –BA plants. Although not compared statistically, 'Francee' produced more offsets than 'Frances Williams' at both locations and during both years, which agrees with previous research (3).

Stage of development. In Auburn in 1997, SOD of 'Francee' offsets was higher for +BA plants than –BA plants in both cultivars ('Francee', 4.8a versus 3.0b, respectively; 'Frances Williams', 3.0a versus 1.4b, respectively), but was not affected by RM. In Mobile in 1998, SOD for 'Francee' was higher for +BA plants (5.9a) than –BA plants (4.2b). SOD was not significant for RM in 'Francee' or for BA in 'Frances Williams' in 1998 (data not shown). In Auburn in 1998, SOD for 'Frances Williams' was significant for RM only; the large RM plants had a higher SOD than the small RM (small = 0.7b, medium = 1.6ab, large = 2.9a).

Growth index. In 1997, large RM 'Francee' had a 17% larger GI than medium RM plants and 30% larger GI than small RM plants (53.2a versus 45.3b and 40.8b, respectively). Large RM 'Frances Williams' had a 21% larger GI than small RM plants (38.9a versus 32.1b). In 1998, GI of large RM 'Francee' was 17% larger than that of small RM plants (37.6a versus 32.2b) and GI for 'Frances Williams' increased 48–116% with increasing RM (small = 18.8b, medium = 27.5b, large = 40.6a). In agreement with previous research (3, 4, 6), BA had no significant effect on GI for either cultivar at Auburn in 1997 or at either location in 1998 (data not shown).

Generally, offset formation was positively correlated with increasing RM in both cultivars, regardless of BA application, although the greatest differences were between large RM and medium or small RM groups. BA was effective in

Table 4. **Root mass and BA effects on offset number in 'Francee' at Mobile 30 days after treatment (DAT) and 'Frances Williams' at Auburn 60 DAT, 1998.**

Root mass class	Offset number	
	'Francee'	'Frances Williams'
	30 DAT	60 DAT
	+BA	
Small	1.5b[z]	0.3b
Medium	2.0b*[y]	1.7ab
Large	3.3a*	3.7a*
	–BA	
Small	0.9b	0.5a
Medium	0.7b	0.9a
Large	0.9a	0.7a

[z]BA × RM interaction significant at P = 0.05 for each DAT; mean separation among RM within +/– BA by single degree of freedom contrasts. BA × RM interactions not significant for offset number in 'Francee' at 60 DAT and in 'Frances Williams' at 30 DAT. Means are representation of 10 single plant replications.

[y]Means for +BA treatments followed by an asterisk are significantly different from corresponding root mass class means for –BA treatments; P = 0.05. Means are representation of 10 single plant replications.

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inducing outgrowth of axillary and rhizomic buds in hosta, but the response was often more evident in plants with medium or large RM than in plants with small RM, possibly due to greater water uptake (5, 9). SOD was higher for +BA plants than –BA plants in both cultivars, and earlier research reported that rooting percentage increased as SOD increased (7). GI increased with increases in RM, and as previously reported (7), BA did not influence GI. Efforts to preserve as much root mass as possible at division will decrease water stress, allowing greater absorption of nutrients and water for shoot growth (2). Ensuring adequate RM at the time of division and potting enhances hosta's response to BA resulting in increased offset production and offsets at a more advanced SOD. In addition, larger RM was correlated with larger whole plant GI. All of these responses should contribute to minimizing cropping time.

Literature Cited

1. Borchert, R. 1975. Endogenous shoot growth rhythms and indeterminate shoot growth in oak. Physiol. Plant. 35:153:157.

2. Cline, M.G. 1988. Apical Dominance. Bot. Rev. 57:318–358.

3. Garner, J.M., G.J. Keever, D.J. Eakes, and J.R. Kessler. 1997. BA-induced offset formation in hosta dependent on cultivar. HortScience 32:91–93.

4. Garner, J.M., G.J. Keever, D.J. Eakes, and J.R. Kessler. 1998. Sequential BA applications enhance offset formation in hosta. HortScience 33:707–709.

5. Hsiao, A.I. and G.I. McIntyre. 1984. Evidence of competition for water as a factor in the mechanism for root-bud inhibition in milkweed (*Asclepias syriaca*). Can. J. Bot. 62:379–384.

6. Keever, G.J. 1994. BA induced offset formation in hosta. J. Environ. Hort. 12:36–39.

7. Keever, G.J., D.J. Eakes, and C.H. Gilliam. 1995. Offset stage of development affects hosta propagation by stem cuttings. J. Environ. Hort. 13:4–5.

8. Keever, G.J., and T.J. Brass. 1998. Offset increase in hosta following benzyladenine application. J. Environ. Hort. 16:1–3.

9. McIntyre, G.I. 1987. The role of water in the regulation of plant development. Can. J. Bot. 65:1287–1298.

10. Percival, G., and J. Gerritsen. 1998. The influence of plant growth regulators on root and shoot growth of containerized trees following root removal. J. Hort. Sci. Biotech. 73:353–359.

11. SAS Institute. 1988. SAS/SAT user's guide, release 6.03. SAS Institute. Cary, NC.

12. Smith D.J., and W.W. Schwabe. 1980. Cytokinin activity in oak (*Quercus robur*) with particular reference to transplanting. Physiol. Plant. 48:27–32.

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