BA-Induced Offset Formation in Hosta[1]

Gary J. Keever[2]
Department of Horticulture
Alabama Agricultural Experiment Station
Auburn University, Auburn, AL 36849

Abstract

Axillary and rhizomic budbreak and offset formation in *Hosta sieboldiana* were promoted by a single foliar application of BA at 125–4000 ppm or drench application at 5–120 mg a.i./0.8 l (5 in) pot, compared to an untreated control. Based on offset counts following various periods of dormancy, optimal foliar rates ranged from 2000–3000 ppm and drench rates from 20–40 mg a.i./0.8 l (5 in) pot. Foliar application of 3000 or 4000 ppm BA or drench application at 80, 100, or 120 mg a.i./pot induced marginal necrosis within 2 weeks after treatment; however, growth following dormancy appeared normal. Generally, growth indices were not affected by foliar application of BA, but decreased with increasing rates of drench-applied BA.

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

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

Species used in this study: blue hosta (*Hosta sieboldiana* (Lodd.) Engl.).

Significance to the Nursery Industry

Most hosta cultivars produce very few offsets per year, which limits the rapid introduction of new cultivars at affordable prices for growers without tissue culture capabilities. The synthetic cytokinin BA, applied as a foliar spray or medium drench, can stimulate offset development from axillary and rhizomic buds, leading to more rapid clonal multiplication. Optimal foliar spray rates of BA were 2000 or 3000 ppm and drench rates were 20 or 40 mg a.i./0.8 l (5 in) pot. Although the higher rates of BA applied caused foliar necrosis shortly after application, following a period of dormancy offsets appeared normal, survived division and developed extensive root systems.

Introduction

Hosta, a herbaceous perennial in the lily family, is popular for partial-to-full shade areas in landscapes. Vegetative buds and roots grow from rhizomes, compact crowns of stem tissue below ground. Growth from the crown suppresses development of buds in the leaf axils and from the rhizomes by apical dominance. Plants are usually clonally propagated in the spring by crown division, a process that produces only a few plants per clump, causing the introduction of new cultivars to take several years. Tissue culture offers potential for rapid clonal multiplication of hosta (7, 11, 12); however, laboratories are expensive to establish, propagation requires skilled labor and sterile techniques, and explants may not be true to type (Mike Henrietta, Plants Unlimited, Afton, VA, personal communication).

Cytokinins induce differentiation of adventitious buds (14), break bud dormancy (15), release lateral buds from apical dominance (13), and stimulate elongation of axillary buds (4). The application of cytokinins, including BA, has enhanced shoot formation and branching, especially in woody plants such as holly (5), photinia (5, 10), azalea (5) and rose (9). Cytokinins also enhance the branching of herbaceous crops, including poinsettia (2), gerbera (6), geranium (1), and *Dieffenbachia* (3). This study was conducted to determine the effects of rates and method of application (foliar or drench) of BA on shoot development (offsets) from dormant axillary and rhizomic buds of blue hosta.

Materials and Methods

Experiment 1. Uniform 11 cm (4.3 in) liners of blue hosta were transplanted from 36-cell flats to 0.8 l (5 in) azalea pots containing Metro-Mix 360 (Grace Horticultural Supplies, Cambridge, Mass.) on July 14, 1992. Plants were placed in a double-layer polyethylene greenhouse with ventilation and heat setpoints of 25.6°C (78°F) and 21°C (70°F), respectively. On July 28, single foliar sprays of 125, 250, 500, 1000 or 2000 ppm BA applied to the plants to runoff (≈ 5.4 ml (0.18 oz)/plant) or single drenches of 5, 10, 20, 40 or 80 mg a.i./pot were applied to plants. An untreated control was included for comparison. Buffer-X at 0.2% was added as a surfactant to all spray solutions, and drenches were applied in a volume of 50 ml (1.7 oz)/ container. Temperature and relative humidity at time of application were 26.7°C (80°F) and 85%, respectively. When treated, plants had 7 to 8 leaves, a mean growth index [(height + width at the widest point + width perpendicular to the first width) ÷ 3] of 16 cm (6.3 in) and only one growing point (no offsets). Plants were fertilized 3 times per week with 300 ppm N from 20N-4.3P-16.6K (20-10-20) Peters Peatlite Special (Grace-Sierra, Fogelsville, Pa.). Growth indices and offset counts were determined 30, 60 and 90 days after treatment (DAT). Plants were transferred to a coldframe on November 21 and allowed to enter dormancy. On April 15, 1993, plants were placed in a shadehouse with 47% light exclusion. Growth indices and offset counts were determined on June 3, ≈ 300 DAT. On June 21, offsets were cut from the mother plants and placed in open flats of Metro-Mix 360 under intermittent mist (5 sec/5 min) in a double-layer polyethylene greenhouse. Six weeks later, % rooting and root density were evaluated. Treatments were completely randomized with 7 single-plant replicates. Statistical analyses included contrast statements to compare methods of application and regression analysis to determine rate response to BA.

Experiment 2. A second experiment examined the effects of higher spray and drench rates of BA, as well as several

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[2]Professor of Horticulture.

rates used in previous experiments, on plant size and offset number. Methods were identical to those in the first experiment except as noted below. Plants were transplanted August 24, 1992, and treated on September 10 with single foliar sprays of 250, 500, 1000, 2000, 3000 or 4000 ppm BA or single drenches of 20, 40, 60, 80, 100 or 120 mg a.i./pot. Plants were transferred to a coldframe on December 11, 1992, and final growth indices and offset counts were determined June 4, 1993, ≈ 260 DAT.

Results and Discussion

Experiment 1. By 7 DAT with drench application of 80 mg BA/pot, the foliage of blue hosta had extensive phytotoxicity. Symptoms began as a distal bleaching of leaf margins that spread toward the midrib and leaf base. New leaves that developed during 1992 were smaller than those of plants in other treatments and were often twisted or strap-shaped. Foliage that developed in 1993 following a period of dormancy appeared normal. No phytotoxicity occurred on plants receiving the other treatments.

Growth indices of plants receiving a single foliar spray were not affected by the BA rate, while growth indices for plants receiving a drench application decreased linearly with increasing rate 30, 60 and 90 DAT (Table 1). Most of the difference in mean growth indices values occurred between control plants and those receiving 40 or 80 mg BA/pot; the decrease for plants treated with 40 or 80 mg a.i. were 8.6 or 15.8%, 6.0 or 14.3%, and 7.2 or 14.4% 30, 60, and 90 DAT, respectively. The large decrease in growth indices of plants drenched with 80 mg BA/pot was primarily due to foliar necrosis and a concomitant loss of leaf tissue. Following a period of dormancy (≈ 300 DAT), growth indices were similar among treatments, regardless of application method or rate.

Within 14 days of treatment, elongation of rhizomic and axillary buds was evident on plants sprayed with 1000 or 2000 ppm BA or drenched with 20, 40, or 80 mg BA/pot. At all sampling dates, offset counts increased linearly or quadratically with increasing rates of foliar or drench-applied BA, and were similar for the 2 methods of application. No offsets developed from control plants during the experiment. Offset counts of plants drenched with BA were numerically highest at the 40 mg a.i. treatment 30, 60 and 90 DAT and with the 20 mg a.i. treatment 300 DAT. Offset counts for plants receiving the optimal drench rate were 95, 141, 177 and 52% higher than those of plants receiving the lowest drench rate 30, 60, 90, and 300 DAT, respectively. Within a treatment, offset counts often decreased between 30 and 60 DAT or between 60 and 90 DAT with both foliar and drench application of BA. This decrease reflected the abortion of random offsets and may represent another expression of phytotoxicity. Lateral buds of other species have been stimulated to develop after applying synthetic cytokinins, but induced buds may fail to elongate and not increase branching (8).

All offsets cut from the mother plant and placed under intermittent mist developed into plants having well-developed, root systems within 6 weeks after offset removal (data not shown).

Experiment 2. Linear increases in offset counts from increased foliar rates of BA in the first experiment indicated that possibly optimal rates had not been applied. In the second experiment, 2 higher foliar spray and drench rates, in addition to the rates previously tested, were applied. Exten-

Table 1. Effects of single foliar sprays or drenches of BA on growth indices and offset counts of blue hosta, experiment 1.

Method of application	Rate	Growth indices[z] 30 DAT	60 DAT	90 DAT	300 DAT	Offset counts 30 DAT	60 DAT	90 DAT	300 DAT
	(ppm)								
Foliar	125	20.6	21.4	21.5	41.2	1.4	1.6	1.3	1.6
	250	22.5	24.4	25.0	40.0	0.7	1.0	0.7	1.6
	500	22.3	23.6	24.2	37.6	2.9	2.4	2.6	3.0
	1000	23.4	24.0	23.9	40.8	2.1	2.6	2.4	2.4
	2000	23.4	24.0	24.3	39.4	3.9	4.0	3.4	3.7
	(mg a.i./pot)								
Drench	5	20.7	22.1	22.3	37.5	1.9	1.7	1.3	2.7
	10	22.0	23.7	24.2	40.2	0.4	0.4	0.4	1.7
	20	23.1	24.0	24.6	39.4	2.9	2.7	2.6	4.1
	40	20.2	21.6	21.9	36.5	3.7	4.1	3.6	3.9
	80	18.6	19.7	20.2	32.7	2.9	3.4	3.0	3.0
Control	—	22.1	23.0	23.6	37.4	0.0	0.0	0.0	0.0
Contrast[y]									
Foliar vs. drench		*	*	NS	NS	NS	NS	NS	NS
Significant terms[x]									
Foliar		NS	NS	NS	NS	L***	L***	L***	L*
Drench		L**	L**	L**	NS	Q*	Q*	Q**	Q*

[z]Growth indices = (height + width at widest point + width 90° to first width) ÷ 3, in cm.

[y]NS, *: Nonsignificant or significant at the 5% level.

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

sive marginal necrosis developed on foliage within 2 weeks of plants drenched with 80, 100, or 120 mg BA/pot, and new foliage was frequently reduced in size, twisted or strap-shaped. Minor tip and marginal bleaching occurred on plants after spraying with 3000 or 4000 ppm BA, but no phytotoxic symptoms occurred on foliage that developed in 1993.

Growth indices of plants receiving a foliar spray were not affected by rate 30, 60, or 90 DAT; however, following a period of dormancy (≈ 260 DAT), growth indices decreased linearly with increasing rate (Table 3). Growth indices of plants sprayed with 250 or 4000 ppm BA were 7.2% and 16.7%, respectively, smaller than those of control plants. Growth indices of plants receiving a drench application decreased quadratically 30, 60, and 90 DAT and linearly 260 DAT with increasing rate. As in earlier experiments, much of the decrease in growth indices in 1992 appeared due to foliar necrosis following drench application at the higher rates of BA.

Offsets increased quadratically or cubically with increasing spray or drench rate at all sampling dates, indicating that optimal rates for both methods of application had been exceeded. Based upon offset counts 260 DAT, optimal foliar and drench rates were 3000 ppm and 40 mg a.i./pot, respectively. Offset counts of plants receiving these rates were 262% and 74% higher than those of plants treated with the lowest foliar and drench rates, respectively. These rates compared to optimal foliar and drench rates of 2000 ppm and 20 mg a.i./pot, respectively, in the first experiment. As in the earlier experiment, few or no offsets developed on control plants, and offset counts of treated plants generally decreased between 30 and 90 DAT. However, offset counts also decreased between 90 and 260 DAT with a 4000 ppm foliar application or with a 100 or 120 mg a.i. drench. All excised offsets survived and developed extensive root systems.

In summary, foliar or drench application of BA was found to stimulate offset production in blue hosta, with offset counts being similar from spray and drench applications. Optimal rates of foliar-applied BA ranged from 2000 ppm, the highest tested rate in the first experiment, to 3000 ppm in the second study. The optimal rates of drench-applied BA were 20 mg a.i./pot in the first experiment and 40 mg a.i./pot in the second. Generally, growth indices were not affected by foliar application of BA, but decreased with increasing rates of drench-applied BA. Phytotoxicity to the mother plant was transient and had no effect on offsets following a period of dormancy. Survival and rooting of excised offsets indicated no adverse effects during propagation. These data demonstrate that use of BA can be an effective means for increasing the number of offsets in hosta.

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Table 2. Effects of single foliar sprays or drenches of BA on growth indices and offset counts of blue hosta, experiment 2.

Method of application	Rate	Growth indices[z] 30 DAT	60 DAT	90 DAT	260 DAT	Offset counts 30 DAT	60 DAT	90 DAT	260 DAT
	(ppm)								
Foliar	250	20.9	21.0	21.1	37.2	0.7	0.4	0.3	1.3
	500	19.0	19.1	19.1	36.8	1.9	1.6	1.0	2.1
	1000	18.9	18.9	19.1	35.6	3.6	2.9	2.6	3.1
	2000	19.1	19.3	19.4	36.4	4.1	3.0	2.6	2.6
	3000	20.1	20.1	20.7	35.4	5.4	4.6	4.4	4.7
	4000	19.7	20.0	20.1	33.4	3.6	3.4	2.9	2.6
	(mg a.i./pot)								
Drench	20	22.2	22.5	23.3	40.4	2.0	1.7	1.6	2.3
	40	20.2	20.3	20.7	35.2	4.6	3.7	3.6	4.0
	60	22.6	22.6	19.9	35.3	2.9	2.4	2.4	3.1
	80	20.1	18.8	18.9	31.4	3.9	3.1	2.9	3.3
	100	19.8	18.3	18.6	29.8	3.9	3.6	3.1	2.4
	120	15.4	15.1	14.0	27.2	4.6	3.9	3.9	2.0
Control	—	18.7	18.8	18.8	40.1	0.0	0.0	0.0	0.3
Contrast[y]									
Foliar vs. drench		NS	NS	NS	**	NS	NS	NS	NS
Significant terms[x]									
Foliar		NS	NS	NS	L*	Q***	Q**	Q**	Q**
Drench		Q***	Q***	Q***	L***	Q*	Q*	C*	Q***

[z]Growth indices = (height + width at widest point + width 90° to first width) ÷ 3, in cm.

[y]NS, **: Nonsignificant or significant at the 1% level, respectively.

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

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Factors Influencing the Supply of Four Landscape Services[1]

Wojciech J. Florkowski,[2] E. E. Hubbard,[3] and Gary L. Wade[4]
University of Georgia
Department of Agricultural and Applied Economics
Georgia Experiment Station
Griffin, GA 30223-1797

Abstract

The landscape industry is a rapidly growing segment of the economy. Growth of the industry is attributed to increasing affluence of the population and leisure time. Increasing awareness of the importance of the environment will further undergird future industry growth. A survey sample of 140 landscape firms located in Georgia yielded 137 usable questionnaires. Four equations representing the statistical relationships between the four types of landscape services 1) design, 2) installation, 3) maintenance, 4) seasonal color and independent variables representing firm characteristics were specified and estimated using logit procedure. A surveyed firm was more likely to supply landscape design services if it also supplied pruning services, landscaping was its main business activity, and the firm was located outside the Atlanta metropolitan area (AMA). The installation service supply was less likely to be among a firm's services if the firm was located within the Atlanta metro area but more if it purchased plants from other sources, and the firm practiced subcontracting. Maintenance services were impacted positively by the supply of pruning but negatively by fertilization services and location in metropolitan Atlanta. Firms in which landscaping was the main business activity and accounted for an increasing share of revenue were more likely to include seasonal color among services supplied.

Index words: design, maintenance, installation, seasonal color, survey.

Significance to the Nursery Industry

In general, the larger the firm in terms of landscaping as business activity, the more likely it was to supply all types of services, but each provided service was also influenced by other, specific factors. Those factors may differ among regions and may be different from those identified by this study for the Atlanta metropolitan area (AMA). Specific factors influencing the supply of landscape services in the AMA included: the availability of design service was more likely if a firm also supplied pruning service. Installation services were more likely supplied by firms purchasing plants from outside sources. Therefore, firms installing landscapes stimulate business activity among greenhouse firms and nurseries. Firms were more likely to provide maintenance services if they offered pruning services. Seasonal color service is added by large firms diversifying and broadening the supply of services. Firms focusing on the landscape services as the main source of revenues were more likely to deliver all four types of services discussed. In the AMA, firms tend to specialize in providing a specific landscape service or the production of landscape plants rather than combining plant production with offering landscape services.

Introduction

Urban expansion and the desire for recreation and beautification increase the demand for landscape services. Landscape services enhance the appearance of commercial, institutional, recreational, and residential properties, and in turn, the perceived value of a property. Landscaping projects the desired image of a company or a homeowner.

Landscape services together with the greenhouse and nursery industries are often called the Green Industry. The U.S. Green Industry has grown rapidly and was the sixth largest

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[2]Associate Professor.

[3]Research Coordinator I.

[4]Associate Professor and Extension horticulturist/landscape management specialist with the Georgia Cooperative Extension Service, Athens, GA 30602.