Growth Regulators

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Growth Regulation of *Vinca minor*

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Index Words: Plant growth regulator, plant growth retardant, growth regulation, *Vinca minor* L., periwinkle

Nature of Work: Common periwinkle (*Vinca minor* L.) is one of the most widely planted ground covers in USDA Cold Hardiness Zones 4 to 8. With lilac-blue flowers in spring and prolific, mat-forming evergreen shoots or runners, common periwinkle can spread indefinitely. While lending itself to rapid establishment in the landscape, common periwinkle's vigorous horizontal growth habit results in intertwined runners that aren't easily mechanically pruned during production and can be damaged during handling. Because of the limitations of hand pruning, we evaluated the use of several plant growth retardants (PGRs), B-Nine/Cycocel, Sumagic, Cutless and Atrimmec, as alternatives to mechanical pruning. None of these PGRs are specifically labeled for greenhouse or nursery use on *Vinca minor*, however Atrimmec is labeled for use on established common periwinkle in the landscape. Of these PGRs only Sumagic has been tested on common periwinkle. Sumagic applied at 2 or 4 mg a.i. (80 and 160 ppm) as a soil drench or foliar spray in 25 ml (0.75 fl. oz.) to plants in 3.8 liter (full gal.) pots resulted in a 51% reduction in shoot length 52 days after application (1).

On Aug. 22, 2003, *Vinca minor* in 1203 cell packs were repotted into 0.95 liter (1 qt.) round containers of a pinebark:sand substrate (7:1, v/v) amended per m^3 (yd^3) with 8.3 kg (14 lb) of 17N 2.2P 9.13K (PolyOn™ 17-5-11, Pursell Industries, Sylacauga, AL), 0.9 kg (1.5 lb) Micromax (The Scotts Company, Marysville, OH) and 3 kg (5 lb) dolomitic limestone. Plants were spaced on benches in a double-polyethylene greenhouse [heat/vent set points of 18.3C (65F) / 26.5C (78F)] shaded with 47% shadecloth and hand watered daily. On Sep. 3 and Oct. 17, 2003, 6 weeks after initial treatment (WAT), the following growth regulator treatments were applied: B-Nine/Cycocel at 2500/1500, 5000/1500, and 7500/1500 ppm; Sumagic at 15, 30, and 45 ppm; Cutless at 30, 60, and 90 ppm; Atrimmec at 1500, 3000, and 4500 ppm; and an untreated control. Treatments were reapplied on Jan. 16, 2004, 19 WAT, to all plant, except those receiving Atrimmec, which exhibited adverse effects from previous applications. Treatments were applied with a CO_2 sprayer in solution volumes of 0.2 liter/m^2 (2.0 qt/100 ft^2). Treatments were arranged in a completely randomized design and replicated with 9 single plants.

Lengths of the three longest runners and total runner counts were determined every two weeks for 30 weeks. Only data from 6 and 30 weeks WAT are reported. Data were subjected to analysis of variance procedures, and orthogonal contrasts were used to test linear and quadratic response trends to PGR rates.

Results and Discussion: All PGRs resulted in linear decreases in runner length at 6 WAT (Table 1). Decreases ranged from 37 to 64% with B-Nine/Cycocel, 24 to 35% with Sumagic, 24 to 45% with Cutless, and 42 to 82% with Atrimmec. Only Atrimmec adversely affected plant appearance (severe stunting and chlorosis). Runner counts were reduced linearly with increasing rates of Cutless (19 to 47%) and Atrimmec (0 to 31%), but not affected by B-Nine/Cycocel or Sumagic rates (data not shown). Runner length was still significantly reduced by increasing rates of all PGRs at 30 WAT, 11 weeks after the last application of B-Nine/Cycocel, Sumagic and Cutless, and 24 weeks after the last Atrimmec application. Runner length decreased linearly, from 13 to 19%, with increasing rates of B-Nine/Cycocel, and quadratically with increasing rates of Sumagic (10 to 20%), Cutless (13 to 24%), and Atrimmec (13 to 35%). The lower percent reductions in runner lengths at 30 WAT compared to 6 WAT reflect a dissipation in growth control with all PGRs, probably due to the longer interval between application and data collection. Runner counts were not affected by any PGR at 30 WAT. Plants treated with Atrimmec continued to display older growth that was stunted and off-color, although new growth appeared normal.

Significance to Industry: These results suggest that runner lengths of common periwinkle can be controlled during greenhouse production with foliar applications of B-Nine/Cycocel, Sumagic, Cutless, or Atrimmec by varying rate and frequency of application. Because of the severe stunting and foliar chlorosis exhibited following Atrimmec application, plants were not considered marketable for several months. The relative safety of the other PGRs offers growers viable options to mechanical pruning when common periwinkle is grown in small containers at a close spacing, conditions that allow rapid intertwining of runners.

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Table 1. Runner length of *Vinca minor* as affected by plant growth regulators (PGR).

		% reduction in runner length[y]	
PGR[z]	Rate (ppm)	6 WAT[x]	30 WAT
Control	—	(36.0)[w]	(87.8)
B-Nine/Cycocel	2500/1500	36.7	15.3
	5000/1500	56.1	12.7
	7500/1500	64.3	18.6
	Significance[v]	L***	L**
			Sumagic
			15
			25.1
			13.0
	30	23.5	19.8
	45	35.3	10.4
	Significance	L***	Q*
Cutless	30	23.7	23.5
	60	24.4	23.6
	90	45.1	12.8
	Significance	L***	Q**
Atrimmec	1500	42.0	13.1
	3000	70.3	35.3
	4500	81.6	13.0
	Significance	L***	Q*

[z]Treatments were applied at week 0, 6 and 19, except Atrimmec was not reapplied at week 19.

[y]The 3 longest runners on each plant were measured; % reduction relative to the untreated control.

[x]Weeks after initial treatment.

[w]Values for the control are actual runner lengths in cm.

[v]Significant linear (L) or quadratic (Q) response at P=0.05 (*), 0.01 (**) or 0.001 (***), based on trend analysis of actual runner lengths.

Paclobutrazol Drenches Influence Growth of Container-grown Ornamental Napiergrass

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Index words: Bonzi, Elephant grass, growth regulator, Napiergrass, paclobutrazol, *Pennisetum purpureum*

Significance to Industry: A study was conducted to evaluate the response of a new ornamental selection of Napiergrass (*Pennisetum purpureum* 241-8) with purple foliage to substrate drenches with the growth regulator Bonzi (paclobutrazol). Plants shifted in mid-April from 3 in. liners to #5 containers were salable in 70 days. A substrate drench of 16 mg a.i./ #5 container applied 30 days after shifting was the only treatment to reduce plant growth at 40 days after treatment (DAT) and at a cost of $0.58 per container would not be economical for commercial growers. Pruning plants at 40 DAT back to the original height at the start of the study (11 in.) resulted in smaller plants 97 DAT compared with most plants treated with Bonzi, thus pruning may be the most economical procedure for controlling growth.

Nature of Work: The ornamental grass *Pennisetum purpureum* 241-8 is a semi-dwarf, purple-foliaged ornamental grass being evaluated for release by the U.S. Department of Agriculture and the University of Georgia. This selection is cold hardy in USDA hardiness zones 8-10 and can be grown as a vigorous annual in more northern climates. Research is needed to determine the best way to produce this grass in containers for nursery sales. Previous work has indicated that paclobutrazol was effective in controlling the growth of pampas grass in 6 in. containers (1). This study was initiated to evaluate the efficacy of paclobutrazol (Bonzi) drenches applied to container-grown plants of ornamental napiergrass selection 241-8 for controlling plant growth.

Rooted cuttings of *P. purpureum* 241-8 grown in 3 in. liners (SR-325, Nursery Supplies Inc., Chambersburg, PA) were shifted to #5 containers (C-2000, 14.6 liters, Nursery Supplies) on 15 April, 2003. The substrate consisted of 75% aged bark, 20% Canadian peat moss, and 5% sand (% by vol.) plus substrate amendments. Plants were fertigated daily with a solution containing 50 ppm N, 10 ppm P, and 60 ppm K (Big Bend Supply Inc., Cairo, GA). Plants were cut back to a height of 11 in. on 15 May, 2003 and drench applications (450 ml/container) of Bonzi were applied at the rates of 1, 2, 4, 8, and 16 mg a.i. plus a non-treated control. The experiment was a completely randomized design with eight single plant replicates.

At 40 DAT (25 June, 2003), growth indices [height + width 1 + width 2 (perpendicular to width 1)/3] were measured. Plants were cut back to their original height of 11 in. and all foliage extending past the outer diameter of the container was pruned off, collected, and weighed after drying to a constant mass in a forced-air oven at 80C (175F). Number of stems per plant were also counted. At 97 DAT (21 August, 2003), final height measurements were recorded. Also, the number of stems in which the terminal bud had not been removed at the 25 June pruning date was noted. Data were subjected to analysis of variance using PROC-GLM (SAS version 8.0 for Windows, Cary, NC). Mean separation was conducted using Dunnett's t-test for compared treated plants to a non-treated control.

Results and Discussion: Container grown plants were considered salable 70 days after shifting from liners to #5 containers or 40 days after treatments were initiated. Plant height, growth index, and clipping dry mass were only reduced (16%, 8%, and 15%, respectively) by the 16.0 mg a.i./container treatment at 40 DAT. At 97 DAT, plants treated with Bonzi at 2, 4, 8, and 16 mg a.i./container were significantly taller than the control. The reason for this is when the plants were pruned at 40 DAT, the plants treated with the higher rates of paclobutrazol had not elongated to the point where the terminals were removed when pruned. Thus, the control plants had to break lateral buds to initiate new growth, whereas the plants treated with paclobutrazol continued normal elongation. For the non-treated control, only 23% of the stems did not have their terminals removed, compared to 84% for the 16 mg a.i./container treatment. As a result of having to initiate lateral buds to continue shoot elongation, non-treated control and 1.0 mg a.i./container plants were ~20% shorter 97 DAT than plants treated with higher rates of paclobutrazol.

With limited growth reductions at rates as high as 16.0 mg a.i./container (cost = $0.58), treating this selection of napiergrass with paclobutrazol is not economically feasible. Hard pruning as needed results in shorter plants with a full canopy. Further work is needed to evaluate other growth regulators on ornamental grasses.

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Responses of *Lagerstroemia indica*, *Catharanthus roseus*, and *Zinnia elegans* to AuxiGro® Applications During Nursery Production

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Index Words: container production, crape myrtle, gamma aminobutyric acid, growth regulators, L-glutamic acid, plant nutrition, vinca, zinnia.

Significance to Industry: No commercially significant beneficial growth or flowering responses were found for *L. indica, C. roseus*, or *Z. elegans* during nursery production in response to bi-weekly foliar sprays or substrate drenches of AuxiGro® at one or four times the label rate under our test conditions.

Nature of Work: AuxiGro® WP plant metabolic primer (Emerald BioAgricutlure Corp., Lansing, MI) is a "proprietary blend of naturally-occurring amino acids, protein, emulsifier, adjuvant, and clay" (2). Active ingredients are reported as 29.2% L-glutamic acid and 29.2% gamma aminobutyric acid, but some controversy on this topic exists (4). Antidotal reports of growth and yield responses have been attributed to foliar applications of AuxiGro® during production of various vegetable and fruit crops (3). Improvements in yield in various crops and disease resistance in *Citrus L.* have been attributed to an enhanced micronutrient status as a response to applications, but no information is available in refereed journals nor is there published information on its potential for application to ornamental crops. The purpose of the work presented herein was to test the responses of three species from different families during container nursery production to a range of drench and spray applications of AuxiGro®. *Lagerstroemia indica* L. 'Baton Rouge', *Catharanthus* roseus G. Don 'Pacifica Punch', and *Zinnia elegans* N.J. von Jacquin 'Cherry Red' represent the Lythraceae J.H.J. St.-Hilaire, Apocynaceae A.L. de Jussieu, and Asteraceae B.C.J. Dumortier (Compositae) families, respectively (1). *Lagerstroemia indica* represents a longer term woody crops, whereas *C. roseus* and *Z. elegans* represent faster growing herbaceous species (1).

Small liners of *L. indica* (Hines Nursery, Houston, TX) and *C. roseus* (grown from seed on site) from 2.5 in (5 cm) pots were transplanted to #1 (2.3 L) black plastic nursery containers filled with a 4 pine bark : 1 peat moss : 1 coarse builders' sand (by vol.) substrate on 30 June 2003 and 11 August 2003, respectively. The substrate was amended with a base level of controlled release fertilizer (18N-6P-12K Osmocote, Scotts Corp., Marysville, OH) at the rate of 2 lb N $\cdot$ yd^{-3} (0.69 kg$\cdot$ m^{-3}) 9 lb$\cdot$$yd^{-3}$ (4.1 kg$\cdot$ m^{-3}) of dolomitic lime, 3 lb$\cdot$$yd^{-3}$ (1.4 kg$\cdot$ m^{-3}) of gypsum and Micromax at 1.5 lb·yd-3 (0.6 kg· m-3). Three seeds of *Z. elegans* (Wildseed Farms, Fredericksburg, TX) were direct sown in nursery containers on 11 August 2003, and then thinned at true leaf stage to one plant per container. Irrigation water was injected with sulfuric acid to a target pH of 6.5 and applied as needed by hand. AuxiGro® applications were made at one (0.053 oz$\cdot$1000 ft^{-2}, 1.5 g $\cdot$ 92.9 m^{-2}) (1X) and four (0.212 oz$\cdot$1000 ft^{-2}, 6.0 g $\cdot$ 92.9 m^{-2}) (4X) times the manufacturer's recommended rate as either a spray (3.38 oz carrier / pot, 100 ml carrier / pot) or a drench (6.76 oz carrier / pot, 200 ml carrier / pot) at two week intervals throughout the study. Check plants received equivalent applications of water as a control drench or spray. Plants were arranged in a completely randomized design with twenty individual plant replications per treatment. Trials with each species were conducted and analyzed as separate experiments. Height and canopy diameter in two directions and flower number (individual flowers for *C. roseus* (monthly), panicles for *L. indica* (bi-monthly), and heads for *Z. elegans* (monthly) were recorded. Plant index was calculated as height x width in the row x width perpendicular to the row to provide a pseudo-volumetric measurement of canopy size. A subsample of ten plants per treatment combination were destructively harvested to determine effects on dry matter partitioning when studies were terminated with *L. indica* on 9 October 2003, *C. roseus*, on 25 September 2003, and *Z. elegans* on 19 September 2003. Shoot and root dry mass was determined separately, and total plant dry mass and root to shoot dry mass ratios were calculated. This work was sponsored by a grant from Whitmire Micro-Gen Res. Lab. (St. Louis, MO).

Results and Discussion: The only significant differences in height, plant index, flower number, shoot, root, total plant or root to shoot dry masses are presented in Table 1 and Fig. 1. Mean height of *L indica* across time was reduced 4.1 cm by the 1X spray application compared to the control and 4X spray application (Table 1). Total dry mass of *C. roseus* was substantially less for the 4X spray application compared to the other AuxiGro® applications, but did not differ statistically from the control (Table 1). The 1X drench application produced taller *Z. elegans* than the 4X drench of AuxiGro®, but neither treatment differed significantly ($P \leq 0.05$) from the control (Table 1). The only significant interaction among the AuxiGro® treatments over time was observed with flowering of *Z. elegans* (Fig. 1). Flowers were not present on any treatment until the final measurement at which time the 1X spray produced 0.25 more flowers than the control, while the 4X spray and 1X drench were similar to the control, and the 4X drench as 0.35 less than the control. The small increase in flowers with the 1X concentration was the only statistically significant positive effect for any growth parameter measured on the three species relative to the control treatment. Although economic costs of the applications were not analyzed in this study, it is unlikely that the small growth and flowering responses observed for these three species to AuxiGro® under our test conditions would justify the substantial labor costs associated with biweekly applications, independent of materials costs.

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Table 1. Main effects of AuxiGro® applications at one (1X) or four (4X) times the label rate when applied as a foliar spray or substrate drench compared to the control of *Lagerstroemia indica, Catharanthus roseus*, and *Zinnia elegans* grown in #1 (2.3 L) black plastic containers.

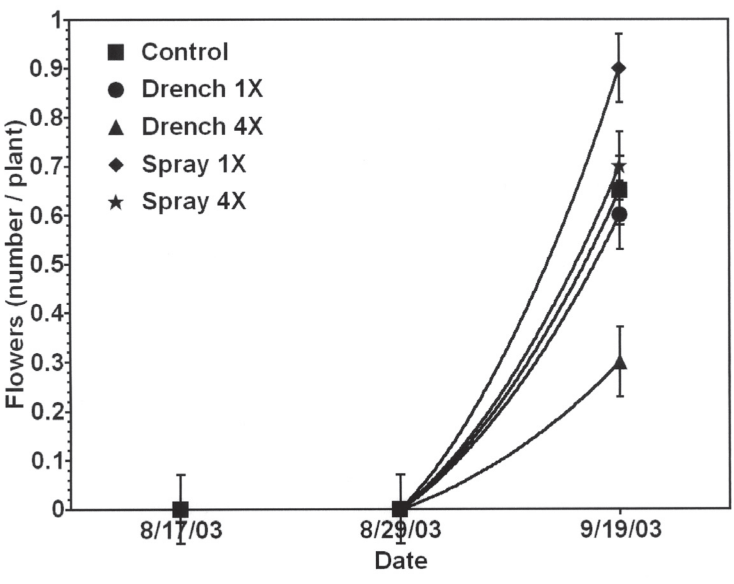
Treatment	*L. indica* height (cm)	*C. roseus* dry mass (g)	*Z. elegans* height (cm)
Control	18.4 a[xy]	6.80 ab[z]	8.8 ab[y]
Drench 1X	16.3 ab	7.52 a	10.2 a
Drench 4X	16.7 ab	7.90 a	8.3 b
Spray 1X	14.3 b	7.86 a	9.8 ab
Spray 4X	18.7 a	4.80 b	9.7 ab

[x]Means within a column followed by the same letter are not significantly different using a least squares means test at $P \leq 0.05$.

[y]n = 60.

[z]n = 10.

Fig. 1. Interactions over time among AuxiGro® applications at one (1X) or four (4X) times the label rate when applied as a foliar spray or substrate drench compared to the control on the flower production of *Zinnia elegans* grown in #1 (2.3 L) black plastic containers.



Flower Buds for Container Grown Hybrid Rhododendron

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Index of Words: Sumagic, rhododendron

Significance to the Industry: The superphosphate top dress treatments did not consistently increase the number of flower buds on ‘Roseum Pink’ hybrid rhododendrons. Sumagic increased the number of flower buds, but increasing the rate from 12.5 to 50.0 ppm had no effect on the number of buds. These results vary from field grown rhododendrons because the rhododendrons in the field experiments were growing in phosphorus deficient soils rather than in a container medium with adequate phosphorus nutrition provided by the controlled release fertilizer.

Nature of Work: Hybrid rhododendrons with flower buds or in flower are most attractive to spring retail customers. However, many cultivars do not readily produce flower buds on hybrid rhododendron plants in #3 and smaller containers. Bir and Conner (1) reported increasing the number of flower buds per plant under growing conditions at multiple nurseries using plant growth regulators, but many growers remain reluctant to adopt new practices into their production system.

Traditionally, many NC mountain growers have applied a phosphorus nutrition source in addition to normal controlled release fertilizers to increase flower bud set on container grown hybrid rhododendrons. This was based on unpublished research with field grown rhododendrons conducted by Dr. Jim Shelton in the 1970’s (2).

A test was established to evaluate the effectiveness of Sumagic foliar sprays compared with top dressing 0-46-0 in April or in June on the cultivar ‘Roseum Pink’. Plants grown in 100% pine bark potting media were fertilized either with Harrell’s 19-6-12 or Multicote4 14-14-16 at 40 g per #3 container following potting in early April then top dressed with a rounded tablespoon of 0-46-0 either April 24 or June 19. There were five plants per treatment. All other cultural practices were those of the cooperating nursery. Sumagic was applied on July 8 to plants which were growing under standard nursery practice.

Results and Discussion: All plants showed good vigor and color with normal growth. Except for the difference in numbers of flower buds, all plants were considered salable and were relatively uniform. There was no significant difference in numbers of flower buds per treatment due to controlled release fertilizer source or superphosphate treatment.

Controlled Release Fertilizer	0-46-0 treatment	Flower buds/plant[NS]
Harrell's 19-6-12		0
Harrell's 19-6-12	April	0
Harrell's 19-6-12	June	1
Multicote 14-14-16		3
Multicote 14-14-16	April	5
Multicote 14-14-16	June	0

Sumagic, when applied at the proper stage of growth, which is at the end of the first vegetative flush and before the second flush has started, significantly increased the number of flower buds per plant. There was no significant difference in plant response among the treatment rates.

Sumagic Treatment (ppm)	Flower buds/plant**
0	4 a
12.5	16 b
25.0	17 b
50.0	19 b

**Rp01 Means within a column followed by the same letter are not significantly different at the 1% level using Duncan's New Multiple Range Test.

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