Growth Regulators

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Drench Volume And Substrate Composition Affect Bush Morning Glory Responses To Paclobutrazol Applications

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Nature of Work: *Ipomoea carnea* B. von Jacquin subsp. *fistulosa* (K. Von Martinus *ex* J. Choisy) D. Austin, bush morning glory, is an attractive large subtropical or tropical shrub or small tree that can be effectively utilized as a fast growing summer annual (1). It is valued for its rapid growth rate, bold texture, and abundance of large trumpet shaped lavender to white flowers that are borne from spring through frost (1). It is well adapted to container culture, but requires growth regulator applications to induce a more compact growth form on small plants to enhance its consumer appeal in retail outlets (2). Some variation in growth regulator applications was noted in studies with different substrate components (2).

The objectives of this study were 1) to determine the efficacy of paclobutrazol applications as affected by substrate composition at rates found effective in previous studies and 2) to determine the effects of applying equal amounts of paclobutrazol in drench volumes that contacted different proportions of the substrate.

Terminal 5 in (12.7 cm) bush morning glory cuttings were taken on June 18, 2001, placed under intermittent mist in propagation flats filled with 0.5 in (1.3 cm) diameter or less milled pine bark, and then removed from the mist on June 28, 2001. The rooted cuttings were acclimated under 55% light exclusion for three days and then planted in trade 1# (2.3 L) black plastic nursery containers filled with 100 % milled pine bark, 75% milled pine bark and 25% peat moss, or 100% vermiculite substrates on 1 July, 2001. Containers with each substrate type were drenched with 1 oz (30 ml) volume of solution containing either 80 or 160 ppm ($mg{\bullet}L^{-3}$) paclobutrazol [(2RS,3RS)-1-(4-chlorophenyl)-4,4-dimethyl-2-1,2,4-triazol-1-yl-pentan-3-ol, formulated as Bonzi, Uniroyal Chemical Co., Middlebury, CT]. Additional containers of with each substrate were drenched with the same amounts of paclobutrazol diluted with distilled water to obtain a total drench volume of 10 oz (300 ml) per container. Five containers were used for each substrate, concentration, and drench volume combination. This resulted in a three substrate x two paclobutrazol application x two drench volume factorial with five single plant replications per combination.

Twice daily fertigation was supplied as a constant feed with N at 50 ppm (mg•L^{-1}) from a 24N-3.5P-13K water soluble fertilizer (Scotts Co.) with Roberts Spot Spitters (#9 spot spitters, Roberts Irrigation, San Marcos, CA) placed one per container. Sulfuric acid (93.2% H_2SO_4, Harcros Chemicals Inc., Kansas City, MO) was injected into the irrigation stream to achieve an irrigation water target pH of 6.5.

The study was terminated on 30 July, 2001, when the majority of the plants were deemed marketable. Plant height and canopy width in two perpendicular directions were measured. A plant index was calculated for each plant as the product of the height and both widths giving a pseudo-volume measure of the canopy.

Results and Discussion: Mean plant indices of bush morning glory across application volumes and substrate compositions declined with increased concentrations of paclobutrazol, 354 in^3 (5802 cm^3) versus 232 in^3 (3798 cm^3) for 80 ppm (mg•L^{-3}) and 160 ppm (mg•L^{-3}) concentrations, respectively. This was consistent with the results of Arnold et al. (2) who reported good vegetative growth control with paclobutrazol at 40 to 80 ppm (mg•L^{-3}) with 1.0 oz (30 ml) carrier applications on bush morning glory grown in predominantly pine bark based substrates.

Million et al. (3, 4) reported that three to fourteen fold greater concentrations of paclobutrazol were necessary to achieve similar growth reductions on *Brassica oleracea* L. var. *botrytis* L. (broccoli) and *Petunia* x *hybrida* Hort. Vilmorin-Andrieux ‘Madness Red’ in pine bark based substrates compared to those containing peat moss. Like paclobutrazol, uniconazole required greater concentrations in pine bark to achieve similar responses as paclobutrazol in peat moss when growing *Chrysanthemum* x *morifolium* T. de Ramatuelle (4). However, chlormequat was more active in pine bark than in a peat moss based substrate (4). In the present study, a significant ($P < 0.01$) interaction occurred for plant indices of bush morning glory between the substrate type and the application volume of the growth regulator across concentrations (Fig. 1). At 10 oz (300 ml) applications, which induced leaching volumes of up to 25% and wetted the substrate throughout the container, few statistically significant ($P < 0.05$) differences in response occurred among substrate types. However, when the same quantity of growth regulator was delivered in a smaller volume of carrier, 1 oz (30 ml), substantial differences in response occurred among substrates (Fig. 1). With all substrates, growth regulators were more effective at reducing plant indices with larger volumes of carrier. With a reduced carrier volume of 1.0 oz

(30 ml), perlite was the most effective substrate in decreasing plant indices, followed by a pine bark and peat moss combination, with a pine bark alone substrate being least effective (Fig. 1).

Significance to Industry: This study demonstrates the importance of knowing not only different plant taxa responses to growth regulator applications but the relative effectiveness of the compounds in alternative substrates for a given plant type. In addition, this study indicates the importance of choosing a drench volume that contacts the entire substrate volume to ensure the most uniform responses across substrate types.

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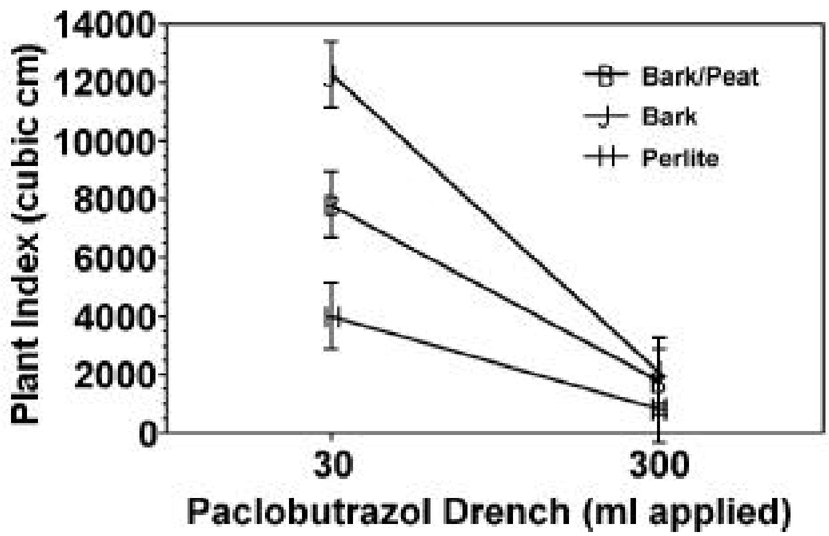

Figure 1. Effects of the volume of paclobutrazol drench applications on the growth responses of bush morning glory plants grown in #1 (2.3 L) black plastic containers filled with three different substrates, n = 10.

Ornamental Vegetable Growth Responses to Ancymidol, Daminozide, and Uniconazole

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Index Words: Ornamental Vegetables, Mustard, *Brassica juncea,* Kale, *Brassica oleracea*, *Brassica napus*, PGRs, A-Rest, Ancymidol, B-Nine, Daminozide, Sumagic, Uniconazole

Nature of Work: Ornamental vegetables are popular landscape plants for the fall, winter, and spring gardens of the southeastern United States. With their attractive foliage and tolerance to cool temperatures, ornamental vegetables provide an aesthetic value, offering texture and color during a predominantly dormant period for most gardens. . Commercial production of these plants is relatively simple, seeds are either directly sown in pots or are transplanted from plug trays. Most ornamental vegetables are vigorous growers and their rapid growth rate can result in a plant that is disproportionate to the pot size.

The need for chemical growth regulators (PGRs) is of primary concern for commercial growers. Research on *Brassica juncea* 'Red Giant', showed that B-Nine (daminozide) at 2500 ppm was effective in controlling height (3). A-Rest (ancymidol) is another promising PGR for ornamental vegetable growth control as it is known to limit shoot elongation in pansies, Easter lilies, and other bulb crops (1). Sumagic (uniconazole) has been recommended for other ornamental vegetables like ornamental cabbage and kale for height control (2). The purpose of this study was to determine the suitability of A-Rest, B-Nine, or Sumagic for growth control of seven ornamental vegetable cultivars.

Seeds of ornamental kale cultivars (Table 1) and mustard cultivars (Table 2) were sown on 16 Aug. 2000 in a 128-cell plug tray. Seedlings were then transplanted into 8-inch mum pans on 5 Sept. The root substrate was Fafard, 4-P (Fafard, Anderson, SC), which contained (v/v): 4 sphagnum peat : 2 pine bark : 2 vermiculite: 1 perlite. Plants were fertilized at each watering with 200 ppm N using Peters, 20-10-20 (Scotts, Marysville, Ohio) (20-N-4.4P-16.6K). The plants were grown under natural daylength.

PGR foliar sprays (in ppm) were applied on 23 Sept. using a volume of 204 $mL \cdot m^{-2}$. Treatments consisted of B-Nine foliar sprays at 2500, A-Rest at 30, or Sumagic at 7.5, 15, 30, and 60 ppm. The experiment was a randomized complete-block design with five single-plant replications of the nine treatments. On 9 Oct., total plant height (measured from the pot rim to the top of the foliage) was recorded. Data were tested by analysis of variance by general linear model (SAS Inst., Cary, NC). Means were separated by least significant differences (LSD) at *P* £ 0.05.

Results and Discussion: Ornamental kale cultivars Red Bor and Red Russian (*Brassica oleracea*) responded to A-Rest foliar sprays with 18% and 29% shorter plant heights, respectively, when compared to untreated plants (Table 1). The other two cultivars had similar plant heights to the control when sprayed with A-Rest. Although effective in limiting shoot elongation A-Rest sprays of 30 ppm would not be economically feasible for growers as the cost per pot was $0.24.

Effective and economical sprays for ‘Red Bor’ and ‘Winterbor’ were B-Nine at 2500 ($0.01/ pot) or Sumagic at 7.5 ppm ($0.06/ pot). Red Russian kale (*Brassica napus*) became stunted when sprayed with B-Nine at 2500 ppm (47% shorter than the control) or Sumagic at 7.5 ppm (54% shorter than the control) (Table 1). B-Nine rates lower than 2500 should provide sufficient control of shoot elongation for this feather-leafed kale. B-Nine at 2500 ppm was not effective for ‘Toscano’ (*Brasscia oleracea*), but Sumagic sprayed at 7.5 ppm controlled shoot elongation of this upright growing kale cultivar. Rates of Sumagic greater than or equal to 15 ppm caused all ornamental kale cultivars to appear stunted and would cost the grower $0.11 a pot.

Ornamental mustard cultivars Red Giant and Southern Giant (*Brassica juncea*) responded to the A-Rest foliar spray of 30 ppm. Although these plants were shorter than untreated plants, growers would not apply A-Rest because of the high cost per pot ($0.24). B-Nine foliar sprays of 2500 ppm produced 28% and 19% shorter ‘Red Giant’ and ‘Southern Giant’ mustard plants, respectively, when compared to the control. Sumagic sprays of 7.5 ppm produced 43% and 39% shorter ‘Red Giant’ and ‘Southern Giant’ plants, respectively, but these rates gave the plants a slightly stunted appearance. The cultivar Osaka Purple (*Brassica juncea*) was not responsive to A-Rest or B-Nine and should be sprayed with Sumagic at 7.5 ppm. Similar to what occurred with the ornamental kales, ornamental mustards sprayed with Sumagic greater than or equal to 15 ppm appeared stunted.

Significance to Industry: Ornamental vegetables are increasing in popularity among growers who wish to produce other plants besides fall pansies and garden mums. Commercial production of the crop is geared towards both the wholesale industry as well as retail. In order for growers to sell and ship the product at a more efficient level, one needs to control plant height until a market date. A B-Nine foliar spray of 2500 ppm was effective in controlling the height of most ornamental vegetable cultivars at a cost of $0.01 per pot, with the exception of 'Toscano' and 'Osaka Purple'. Applying Sumagic at 7.5 ppm ($0.06/pot) may be appropriate for cultivars like 'Red Bor', 'Toscano', 'Winterbor', and 'Osaka Purple'.

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Table 1. Height response of four ornamental kale cultivars to A-Rest, B-Nine, and Sumagic.

		Plant height (cm)			
Treatment	**RATE (ppm)**	**'Red Bor'**	**'Red Russian'**	**'Toscano'**	**'Winterbor'**
Untreated Control	0	22.1	23.8	23.7	14.4
A-Rest	30	18.1	17.0	24.8	14.2
B-Nine	2500	15.7	12.6	19.6	11.4
Sumagic	7.5	17.0	10.9	18.2	10.3
	15	12.3	5.8	12.0	8.7
	30	7.4	5.2	8.5	6.2
	60	6.9	4.1	4.5	4.3
Significance[z]		***	***	***	***
LSD (µ£ 0.05)		2.60	1.99	4.41	2.16

[z] *** Significant at the *P* £ 0.001.

Table 2. Height response of three mustard cultivars to A-Rest, B-Nine, and Sumagic.

		Plant height (cm)		
Treatment	**RATE (ppm)**	**'Osaka Purple'**	**'Red Giant'**	**'Southern Giant'**
Untreated Control	0	21.5	23.4	25.1
A-Rest	30	19.8	19.5	21.8
B-Nine	2500	20.5	16.9	20.4
Sumagic	7.5	16.3	13.3	15.3
	15	12.5	6.8	7.5
	30	9.9	6.8	6.5
	60	7.2	5.9	5.5
Significance^z		***	***	***
LSD (µ£ 0.05)		2.38	2.40	2.77

^{z} *** Significant at the *P* £ 0.001.

Response of Spaced and Unspaced Woody Shrubs to Growth Regulators

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Index Words: Plant Growth Regulators, *Buddleia davidii* 'Nanho Blue', *Ilex glabra* 'Shamrock', *Spirea japonica* 'Anthony Waterer', Atrimmec, Florel, Sumagic

Nature of Work: Space is a precious commodity at most nurseries. Spacing of plants at the optimum time is not always possible because adequate space may not be available or because of personnel time constraints. Improperly spaced plants tend to become leggy, narrow, and open near their bases. Nurseries may shear or prune the plants to improve proportions and stimulate branching, but this adds labor costs and can delay plant finishing. Plant growth regulators have been used to reduce plant height, increase branching, and increase flower set. The objectives of this research were to determine if plant growth regulators could be used to develop fuller, more compact plants in spaced or unspaced situations, without additional pruning . This could provide high quality plants that finish faster than by conventional methods, and that would be easier to ship.

In this experiment growth regulator treatments were applied to three species of woody shrubs in spaced and unspaced blocks. Plants used included *Buddleia davidii* 'Nanho Blue', *Spiraea japonica* 'Anthony Waterer', and *Ilex glabra* 'Shamrock'. All plants were grown in 3 gal. pots using a 3:1 pine bark:sand medium. Plants were fertilized with slow release Osmocote 18-6-12 supplemented with liquid fertilizer supplied through the irrigation system. Plants were sheared to shape two days before treatments were applied. On July 8, 2001, the following treatments were applied: Atrimmec at concentrations of 1200 and 2400 ppm; Sumagic at 45 and 90 ppm; Florel at 500, 1000 and 2000 ppm, and a water control. All treatments were prepared with distilled water and applied with a CO2-pressurized sprayer. A split-plot design was utilized with spaced and unspaced plots randomly assigned as main plots, and the eight PGR treatments randomly assigned as sub-plots within each of the two main plots. Eight replicates were used for the Buddleia, and four replicates were used for the Ilex and the Spiraea. Each species was evaluated as a separate experiment. Height and width measurements were taken three and six weeks after treatment application (WAT). Data were subject to analysis of variance procedures, with mean separations by LSD (P=0.05). All experiments were conducted at Lancaster Farms Wholesale Nursery in Suffolk, VA, with plant material provided by the nursery and grown under regular nursery practices.

Results and Discussion: *Buddleia davidii*: There were no spacing by PGR interactions, but spaced plants were significantly wider than unspaced plants at 3 and 6 WAT, averaged over all PGR treatments (Table 1). At 6 WAT, mean height of unspaced plants was greater than that of spaced plants, but this difference was not significant at P=0.05. None of the PGR treatments had a significant effect on plant width but all of the PGR treatments resulted in plants that were significantly shorter than the controls averaged over both spaced and unspaced plants (Table 2). Atrimmec at 1200 ppm provided a desirable reduction in height but caused severe stunting of the leaves and flowers, resulting in plants considered unsaleable. Atrimmec at 2400ppm also controlled height and promoted shoot breaks but caused even more stunting of leaves and flowers than the 1200 ppm treatment. Florel at 500 ppm had the least effect in reducing plant height but the treated plants were shorter than the control plants. The mean width of buddleia treated with 500 ppm Florel was greater than that of the other PGR treatments, providing fuller-appearing plants, although the width differences were not significant. These plants also had good flower and leaf size, with no apparent delay in flowering. Florel at 1000 and 2000 ppm provided greater height control but, in general, the plants were not as full and flowering was delayed compared to 500 ppm Florel. Sumagic at both 45 and 90 ppm reduced height with no significant effect on plant width of the spaced plants. The plants were well proportioned in terms of height to width ratio, and there was no stunting of flowers or delay in flowering.

Spiraea japonica: There were significant differences in both height and width due to spacing but there was no spacing by PGR interaction. Spaced plants were shorter and wider than unspaced plants averaged over all PGR treatments (Table 1) The PGR treatments were not as effective as with the buddleia. At 3 WAT, 1200 and 2400 ppm Atrimmec, and 90 ppm Sumagic provided significant height control. But by 6 WAT, only Atrimmec at 2400 ppm resulted in plants that had heights and widths that were significantly less than the controls (Table 3).Visually the quality was acceptable but most of the plants with this treatment were delayed and had not reached a saleable grade by time the experiment had ended. Florel and Sumagic had no significant effect on plant height or width, and the plants appeared uneven in growth.

Ilex glabra: These plants were significantly wider due to spacing as compared with unspaced plants over all PGR treatments, but by 6 WAT, there was little difference in height due to spacing (Table 1). There was no spacing by PGR interaction effect. Atrimmec at 2400ppm was very effective at reducing height, with little effect on width for spaced and unspaced plants. Visually these plants had more breaks than any other PGR treatment and were very uniform in growth habit but the height suppression was somewhat excessive. Florel did not control plant height but the 2000 ppm Florel-treated plants were slightly wider than the control plants. Sumagic at 45ppm resulted in Ilex plants that were shorter than with any other treatment, including the 90 ppm Sumagic treatment. Plants of this treatment were considered to be excessively short. These plants, along with those treated with Sumagic at 90 ppm also appeared to have fewer shoot breaks than those of other treatments.

Significance to the Industry: Generally, the results of this research verify the practice of spacing plants at the proper time to produce fuller, generally wider plants. There is also a trend toward shorter plants due to spacing. PGR treatments such as Atrimmec or Florel can help reduce the height of unspaced plants and there is some indication that increased breaks from these treatments may help increase the fullness of unspaced plants over time, but Atrimmec caused excessive leaf and flower stunting of buddleia and excessive height reduction of *Ilex glabra*. Florel at higher concentrations caused a delay in flowering of Buddleia. Further research is needed to determine if PGR applications can improve quality of plants when spacing has been delayed.

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Table 1. Influence of plant spacing on plant heights and widths. Values averaged over several PGR treatments. Plants were measured (in cm) 3 and 6 weeks after PGR and spacing treatments were initiated.

		3 WAT		**6 WAT**	
Species	**Spacing**	**height**	**width**	**height**	**width**
Buddleia	yes	70	46a[z]	82	56a
	no	70	42b	86	46b
		NS		NS	
Spiraea	yes	31	39a	35b	48a
	no	31	34b	42a	36b
		NS			
Ilex	yes	44b	39a	56	44a
	no	46a	35b	57	34b
				NS	

[z] Mean separation by LSD, P (0.05. NS = not significantly different at P = 0.05.

Table 2. Effect of PGR treatments on height and width of Buddleia davidii 3 and 6 weeks after treatment (WAT). Values (in cm) are averaged over spaced and unspaced plant treatments.

Treatment	conc. (ppm)	3 WAT height	3 WAT width	6 WAT height	6 WAT width
Control	--	77a[z]	47	100a	55
Atrimmec	1200	67d	45	81cd	50
	2400	59e	43	68e	51
Florel	500	74ab	45	90b	53
	1000	71bc	45	86bc	49
	2000	69cd	42	79d	51
Sumagic	45	72b	44	82cd	50
	90	72b	45	83cd	51
			NS		NS

[z] Mean separations by LSD, P (0.05. NS = not significantly different at P = 0.05.

Table 3. Effect of PGR treatments on height and width of Spiraea japonica 3 and 6 weeks after treatment (WAT). Values (in cm) are averaged over spaced and unspaced plant treatments.

Treatment	conc. (ppm)	3 WAT height	3 WAT width	6 WAT height	6 WAT width
Control	--	32a[z]	36bc	38bc	43ab
Atrimmec	1200	28b	36bc	37c	42ab
	2400	27b	32d	33d	36c
Florel	500	33a	41a	42a	45a
	1000	33a	39ab	43a	44a
	2000	33a	35cd	41ab	42ab
Sumagic	45	32a	38abc	38bc	43ab
	90	28b	36bc	37c	40bc

[z] Mean separations by LSD, P (0.05. NS = not significantly different at P = 0.05.

Table 4. Effect of PGR treatments on height and width of Ilex glabra 3 and 6 weeks after treatment (WAT). Values (in cm) are averaged over spaced and unspaced plant treatments.

	conc.	**3 WAT**		**6 WAT**	
Treatment	**(ppm)**	**height**	**width**	**height**	**width**
Control	--	46bc[z]	35b	58ab	37
Atrimmec	1200	46bc	36ab	56bc	37
	2400	44c	37ab	52d	39
Florel	500	47ab	37ab	59a	39
	1000	49a	36ab	60a	40
	2000	44c	40a	56bc	41
Sumagic	45	44c	40a	51d	41
	90	46c	37ab	56c	39
					NS

[z] Mean separations by LSD, P (0.05. NS = not significantly different at P = 0.05.