Growth Regulators

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Plant Growth Regulator Effects on Canna Lily

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Index Words: Plant Growth Regulator, Bonzi, Cutless, Canna Lily

Nature of Work: Canna lily species and cultivars are characterized by heights of up to five feet and leaves two feet in length and six inches or more wide (1). Canna lilies bloom in mid- to late summer with either orchid or gladiolus-like flowers, the latter being the most popular (1). Canna lilies may become difficult to manage during container production due to their rapid and top-heavy growth habit. These characteristics lead to frequent blow-over during production and later at retail facilities, and increased shipping costs, especially when plants are racked during shipment. Plant growth regulators (PGRs) are effective in suppressing height in numerous species (2, 3, 4, 5, 6) and may offer benefits in the production, shipping, and marketing of canna lilies. PGRs used in production occasionally have residual effects which carryover into the landscape (7). The objective of this study was to determine the effects of several rates of four PGRs on height and flowering of canna lily.

On April 3, 1998, 3.8 liter (four-quart) containers of orchid-flowered canna lilies (*Canna x orchiodes*) were divided into quarters and repotted into 3.8 liter (four-quart) containers. The substrate consisted of a 7:1 pine bark to sand medium amended with 10.7 kilograms (18 lbs.) Polyon 22-4-14, 0.9 kilograms (1 $^1/_2$ lbs.) Micromax, and 3.0 kilograms (5 lbs.) limestone per cubic meter (cubic yard). Plants were placed in full sun under overhead irrigation. On May 6, plants were blocked according to height, initial height measurements taken, and the following PGRs applied as foliar sprays in a volume of 0.2 liters per square meter (2 quarts per 100 square feet).

- B-Nine at 2500, 5000, and 7500 parts per million (ppm);
- Bonzi at 33, 66, and 99 ppm;
- Cutless at 50, 100, and 150 ppm;
- Pistill at 125, 250, 500, 750 and 1000 ppm.

The experimental design was a randomized complete block with ten single-plant replications.

Data collected included time to first flower, inflorescence height, scape length at first flower and vegetative heights (to the top of the uppermost

leaf) at first flower and 30 and 60 days after treatments (DAT). On July 20, five plants each from the control and all Bonzi and Cutless treatments were planted in the landscape and blocked by replication. Vegetative height was measured at 30, 60, and 90 days after planting (DAP). Plants from the B-Nine and Pistill treatments were not transplanted because of a lack of treatment effect on inflorescence height at first bloom and vegetative heights 30 and 60 DAT.

Results and Discussion: In container production, vegetative height 30 and 60 DAT, vegetative and inflorescence heights and scape length at first flower, and vegetative height at 30 DAP in the landscape were reduced by increasing rates of Cutless, while days to flower increased (Table 1). By 60 DAP, vegetative height was similar among Cutless and control treatments. With increased rates of Bonzi, vegetative height at 30 DAT, and vegetative and inflorescence heights at first flower were suppressed. However, days to first flower were not affected. In the landscape, Bonzi effects were not evident 30 or 60 DAP; however, by 90 DAP vegetative height increased with increasing rates of Bonzi. B-Nine or Pistill had no effect on any characteristic measured except B-Nine delayed flowering 3 to 8 days.

Significance to Industry: Results of this experiment show that vegetative and inflorescence heights of canna lilies can be significantly reduced during production using Bonzi or Cutless. Height suppression was more persistent with Cutless than with Bonzi; however, plants treated with either PGR and transplanted into the landscape outgrew treatment effects within two months of planting. Previous research has shown Cutless to be effective in suppressing height of *Buddleia davidii* (8). However, PGR effectiveness is known to vary greatly among plant species.

Literature Cited:

1. Still, S. M. 1994. Manual of Herbaceous Ornamental Plants. Stipes Publishing Company, Champaign, Ill. pg. 161-162.

2. Whipker, B. E. and S. Dasoju. 1998. Potted Sunflower Growth and Flowering Responses to Foliar Applications of Daminozide, Paclobutrazol, and Uniconazole. HortTechnology 8:86-88.

3. Barrett, J. E. 1982. Chrysanthemum Height Control by Ancymidol, PP333, and El-500 Dependent on Medium Composition.

HortScience 17:896-897.

4. Pisarezyk, J. M. and W. E. Splittstoesser. 1979. Controlling Tomato Transplant Height with Chlormequat, Daminozide, and Ethephon. J. of Amer. Hort. Sci. 104:342-344.

5. Cox, D. A. and G. J. Keever. 1988. Pacolbutrazol Inhibits Growth of Zinnia and Geranium. HortScience 23:1029-1030.

6. Latimer, J. G. 1991. Growth Retardants Affect Landscape Performance of Zinnia, Impatiens, and Marigold. HortScience 26:557-560.

7 Keever, G. J. and D. A. Cox. 1989. Growth Inhibition in Marigold Following Drench and Foliar-applied Paclobutrazol. HortScience 24:390.

8 Keever, G. J. and C. H. Gilliam. 1994. Growth and Flowering Response of Butterfly-Bush to Cutless. J. Environ. Hort. 12:16-18.

Table 1. Vegetative and inflorescence heights and scape lengths and days to flower for Canna x orchiodes treated with Bonzi and Cutless.

Plant growth regulator	Rate (ppm)	Days flower	First flower: Vegetative height (cm)	First flower: Inflorescence height (cm)	First flower: Scape length (cm)	Vegetative height (cm): Container production 30 DAT	Vegetative height (cm): Container production 60 DAT	Vegetative height (cm): Landscape 30 DAP	Vegetative height (cm): Landscape 90 DAP
Control	0	42	86.0	93.2	32.4	85.7	86.5	94.6	110.4
Cutless	50	41	52.9	47.3	24.5	50.2	55.1	90.2	109.8
Cutless	100	43	49.1	43.7	21.8	45.9	49.0	78.4	108.8
Cutless	150	48	36.6	30.4	14.0	43.6	46.1	81.2	108.2
Dose Response[z]		L*	Q*	Q**	L**	Q***	Q***	L*	NS
Bonzi	33	43	76.5	94.1	35.0	72.8	92.5	99.4	113.2
Bonzi	66	46	78.2	92.3	37.6	68.2	90.5	93.8	117.0
Bonzi	99	43	64.6	74.8	36.3	61.5	83.4	98.0	124.2
Dose Response		NS	L**	L*	NS	L***	NS	NS	L*

[z]Nonsignificant (NS), Linear (L), or Quadratic (Q) response at the 5% (*), 1%(**), or 0.1% (***) level.

Regulation of Bedding Plant Growth by Photoselective Greenhouse Covers

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Index Words: Plant Growth Regulation, Photomorphogenesis, Spectral Filters, R:FR, Light Quality

Nature of Work: The wholesale value of bedding and garden plants sold in this country is estimated at $1.6 billion (USDA Floriculture Crops Summary, 1997). A compact plant is desirable because it is more efficient to maintain and transport, more aesthetically pleasing, and easier to transplant then a tall, leggy plant. Growers typically control growth by the application of chemical growth regulators. However, increased concerns over health and environmental issues have restricted the use of some chemicals and have increased interest in using non-chemical (or less chemical) alternatives.

Red (R) and blue (B) light have been shown to reduce stem elongation while far-red (FR) light has been shown to stimulate stem elongation (Kadman-Zahavi et al., 1976). Therefore, manipulation of light provides a non-chemical alternative for plant growth regulation. By varying the relative amounts of R and FR light in the greenhouse, plant growth can be controlled without or with minimum chemical applications. Removal of FR light from the greenhouse environment by $CuSO_4$ liquid filters is effective in reducing plant height and internode length similar to those treated with chemical growth regulators (Rajapakse and Kelly, 1992). However, the commercial application of liquid spectral technology is limited due to the difficulties in handling and high initial costs. Plastic greenhouse covering material with FR light removing properties will make greenhouse light manipulation commercially feasible. Clemson University researchers are currently collaborating with Mitsui Chemicals Inc., Japan to develop photoselective greenhouse plastic or shading material. The objective of this research was to evaluate plant response to photoselective plastics with varying concentrations of a FR light intercepting dye and to determine the optimum dye concentration for commercial film development.

Growth chambers (0.9 m x 0.6 m x 0.6 m) were constructed from the photoselective plastic panels that contained varying concentrations of FR light absorbing dyes. The material was identified by the following code names from Mitsui Chemicals, Inc., Tokyo, Japan: BBM-1 (clear control),

YBM-10 #85, YBM-10 #75, YBM-10 #65, and YBM-10 #55. The numbers following the YBM-10 indicate the percentage transmittance of photosynthetic photon flux (PPF) through the panel. Percentage transmission of PPF decreased as dye concentration increased so PPF was adjusted to uniformity among experimental chambers with neutral density filters. The average PPF inside the experimental chambers was 630±112 µmol $m^{-2}s^{-1}$. Light quality was measured using a spectroradiometer. Spectral filters did not affect minimum and maximum air temperatures.

Tomato [*Lycopersicon esculentum* Mill.] 'Mountain Pride' seeds were germinated in plug trays. When plants reached the true leaf stage, seedlings were planted individually into 4" pots and separated into the chambers. Eight plants were grown in each chamber and two replicate chambers were made from each YBM-10 material. Plant height (height from soil level to apex) was recorded weekly for four weeks. Average internode length was calculated as plant height divided by number of leaves. Total leaf area and shoot dry weights were measured at harvest. For dry weight measurements, tissue was oven dried for 48 hr. Growth measurements were analyzed by analysis of variance and compared using calculated LSD values at P=0.05. Growth of pepper [Capsicum annuum L.], watermelon [*Citrullus lanatus* (Thunb). Matsum and Nakai], and chrysanthemum [*Dendranthema x grandiflorum* Ramat. Kitamura] plants were also evaluated inside the chambers but, due to space limitations, we will only present data from tomato.

Results and Discussion: The interception of FR wavelengths increased and percentage transmission of PPF decreased as the dye concentration increased (Table 1). The filters slightly increased the transmission of B light but reduced transmission of R light compared to the control. The R:FR ratio [photon flux ratio between 655-665 nm (R) and 725-735 nm (FR)] increased from 1.3 to 46.6 as the dye concentration increased.

The YBM-10 filters reduced height of tomato after as early as one week of exposure. Final height was reduced up to 33% under the #55 treatment (Table 2). Average internode length followed a pattern similar to height reduction. The light transmitted through the photoselective filters did not significantly affect node number, indicating that the height reduction was mainly caused by the reduction in internode length. Light transmitted through the filters reduced total leaf area and total shoot dry weight.

The results conclude that the filters are effective in reducing the height of plants similar to growth regulators, however, results varied with species tested. Watermelon was the most responsive (≈50% height reduction)

while chrysanthemum was the least responsive (≈20% height reduction). Tomato and pepper had an intermediate response. YBM-10 #75 was able to reduce height effectively and the height reduction with further increase in dye concentration was small. Considering the PPF reduction by increase in dye concentration, a dye concentration that gives a light reduction of 25% or 35% may be optimal for commercial development of photoselective films.

Significance to Industry: Increased public awareness over environmental and health issues have led to increased restrictions on the use of chemicals. These concerns are making it desirable to find alternative methods of plant growth regulation. The commercial development of photoselective greenhouse covers can potentially reduce production costs by eliminating the expense of chemical growth regulators, reduce environmental pollution, and reduce health risks of workers and consumers.

Literature Cited:

1. Kadman-Zahavi, A., E. Alvarez-Vega, and E. Ephrat. 1976. Development of plants in filtered sunlight. I. Spectral composition, light intensity and other experimental conditions. Israel J. Bot. 25:1-10.

2. Rajapakse N.C. and J.W. Kelly. 1992. Regulation of chrysanthemum growth by light quality. J. Amer. Soc. Hort. Sci. 117:481-485.

3. USDA Statistics Reporting Service, Floriculture Crops Summary, 1997.

Table 1. Photosynthetic photon flux (PPF), percentage transmission of different wavelength regions, and R:FR ratios of light transmitted through YBM-10 filters.

Filter	PPF	Blue	Red	Far-red	R:FR[1]
Control	1436	20	28	25	1.3
YBM-10 #85	1197	22	27	20	3.2
YBM-10 #75	1041	24	23	15	19.2
YBM-10 #65	934	25	20	13	42.7
YBM-10 #55	744	25	15	12	46.6

PPF in µmol m^{-2} s^{-1}

Percent transmission of different wavelength regions of total from 400-800 nm.

[1]R:FR ratio based on R= 655-665 nm and FR= 725-735 nm.

Table 2. Influence of YBM-10 filters on height, average internode length, number of nodes, shoot dry weight and leaf area of 'Mountain Pride' tomato.

Filter	Height (cm)	Average internode length(cm)	Number of nodes	Shoot d.w. (g)	Leaf area (cm^2)
Control	35.0 a	4.2 a	9 a	9.4 a	1451 a
YBM-10 #85	32.5 a	3.9 a	8 a	6.1 b	1119 b
YBM-10 #75	23.2 b	2.9 b	8 a	4.6 bc	885 b
YBM-10 #65	23.4 b	2.8 b	9 a	4.7 bc	945 b
YBM-10 #55	23.7 b	2.8 b	9 a	4.4 c	960 b

Means within a column with the same letter are not significantly different, LSD test, *P*= 0.05.

Container Grown Azalea Response to Sumagic Sprays

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Index words: Azalea, Plant Growth Regulator, Sumagic, Uniconizole-P

Nature of Work: Since the 1960's plant growth regulators have become an integral part of the greenhouse azalea forcing industry for year round production of flowering pot plants. Plant growth regulators have been reported as producing more flowers per plant, more compact plants, fewer bypass shoots and improved shelf life of flowering plants (3). However, cultivars and cultural practices regularly used for forcing are not the same as those in the southeastern landscape industry.

Success with increasing flower buds on container grown landscape mountain laurel and hybrid rhododendron (1,2) using Sumagic sprays prompted the authors to evaluate the response of common landscape azalea cultivars growing in wholesale nurseries. Sumagic (Uniconazole-P) is labeled for use on florist azaleas. It was thought that in the highly competitive retail azalea market displaying a plant with a more compact habit with most flowers above rather than beneath the foliage might be a marketing advantage.

All treatments were applied at two nurseries located in the NC Piedmont (USDA Hardiness Zone 7a). Ten individual plant replicates were sprayed for each cultivar in a randomized complete block experimental design. Each cultivar was analyzed as a separate test. In each test, plants were sprayed using a one quart air powered hand sprayer. During the last week of July 1998, solutions containing 0, 5, 10 and 20 ppm Sumagic were applied for thorough coverage of leaves and twigs but not to the point of runoff.

Plant height and width were measured immediately before plants were sprayed. At the end of the growing season plants were again measured. A growth index was determined by dividing the sum of the height and width by two then subtracting the season ending growth index from the growth index obtained just before plant growth regulator application. In February, plants were moved to a cool (night temperature 55°F) greenhouse to force flowering for evaluation of any spray influence on flower quality or delay of flowering.

Two growth characteristics were purposely chosen. One group included actively growing plants in trade gallons. These were the cultivars 'Greeting,' 'Hino Crimson' and 'LaRoche.' Another group included 3 gallon plants that were larger, somewhat pot bound and not growing rapidly. This group included 'Girard Rose,' 'Gable Rosebud' and 'Silver Sword.'

Results and Discussion: No phytotoxicity occurred either on foliage or as distortion of flowers. All flowers opened normally and were not delayed by Sumagic treatment.

No significant difference in growth existed due to treatments for 'Girard Rose,' 'Gable Rosebud' or 'Silver Sword' (data not shown). Differences in growth did occur for the actively growing cultivars 'Greeting,' 'Hino Crimson' and 'LaRoche.' (Table 1.) This reduction in vegetative growth resulted in a more prominent Spring display of flowers.

The cultivar 'LaRoche' produced the most vegetative growth following treatment. A 20 ppm spray was required to significantly reduce growth. Both 'Greeting' and 'Hino Crimson' had growth significantly decreased by 5 ppm Sumagic spray treatment with a further significant reduction in growth by the 20 ppm treatment in 'Hino Crimson.' No significant difference existed in the cultivar 'Greeting' with the 20 ppm spray.

Significance To Industry: 1. Normally growing landscape azalea cultivars had height reduced by Sumagic sprays applied in late July in Piedmont NC nurseries. 2. A differential cultivar response existed such that different rates of Sumagic spray were required to reduce plant growth. 3. Plants with reduced vegetative growth displayed flowers above foliage for spring sales. 4. Azaleas not growing at a normal rate did not respond to Sumagic sprays with reduced growth and did not significantly increase the number of flowers produced above foliage for spring sales.

Table 1. Growth Index (inches) for nursery grown azalea cultivars as influenced by applications of Sumagic.

	CULTIVAR		
ppm Sumagic	'Greeting'*	'Hino Crimson'*	'LaRoche'*
0	3.8 a	3.7 a	5.1 a
5	2.7 b	2.7 b	4.9 a
10	2.1 b	2.4 bc	4.5 a
20	1.6 b	1.7 c	3.4 b

*P≤0.05 Duncan's New Multiple Range Test

Literature Cited:

1. Banko, T. J. and Richard E. Bir. 1999. Use of growth retardants to promote flowering of mountain laurel, *Kalmia latifolia* L., J. Environ. Hort. 17(1)11-17.

2. Bir, Richard E. 1998. Increasing Flowers on Container Grown Hybrid Rhododendrons with Uniconazole Sprays. Proc. IPPS 48:159-160.

3. Larson, R. A. 1992. Introduction to Floriculture, second edition. Academic Press. New York. p. 236-238.

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Growth Regulation of *Salvia leucantha* During Greenhouse and Nursery Production

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Index Words: Plant Growth Regulator, Cutless, Sumagic, Cycocel, B-Nine, Distill, Salvia

Nature of Work: *Salvia leucantha* Cav. (Mexican sage) is a herbaceous perennial with spikes of attractive purple flowers that envelope the plant in the fall when few other plants are in bloom. However, Mexican sage presents a challenge to nurserymen who wish to produce the plant because it can grow up to 3-4 feet in a single growing season (2). Plant growth regulators (PGRs) are effective in controlling growth of numerous horticultural crops, including many herbaceous perennials (4, 5, 6). Most research examining height control of herbaceous perennials has been done under greenhouse conditions with plants in small containers, usually 4 inch or smaller. Latimer (7) reported that PGRs may be used to control growth of Mexican sage in greenhouse production. Personal observation and communications, and general literature on the use of PGRs suggest that the effectiveness of PGRs are likely to be very different in nursery production than in greenhouse production due to differences in plant and pot sizes, physiological stage of development, irrigation rates, weather, and crop nutrition (1, 3, 8, 9). To our knowledge, PGRs have not been evaluated for height control of Mexican sage under nursery conditions. The objective of this study was to determine the growth response of Mexican sage to several PGRs under greenhouse and nursery conditions.

For the greenhouse study, rooted cuttings were transplanted on February 3, 1999 to 4-inch (10 cm) square pots containing Fafard #3 and placed in a double-poly greenhouse. Mexican sage, a quantitative short day plant, received night-break lighting (10:00 p.m. - 2:00 a.m) to simulate long days and maintain vegetative growth beginning on February 9 and ending when treatments were applied. Liquid fertilizer was applied weekly at 150 ppm N with a 20-20-20 soluble fertilizer (Peters). On February 9, plants were sheared to two inches above the pot rims. Treatments were applied as foliar sprays after plants had about one inch (2.54 cm) of new growth (17 days after shearing) using a CO_2 sprayer at 20 psi (1.4 Kg per cm^2) in volumes of 2 qt/100ft^2 (2 L/.929m^2). PGR treatments include: Control, Cutless (Flurprimidol) at 50, 100, or 150 ppm; Sumagic (Uniconazole) at 20, 40, or 60 ppm; B-Nine (Daminozide)/

Cycocel (Chlormequat chloride) tank mixes at 2500/1500, 5000/1500, or 7500/1500 ppm; and Pistill (Ethephon) at 500 or 1000 ppm. Six weeks after treatment (WAT), half of the plants in each treatment were planted in outdoor ground beds to determine the persistence of PGR treatments in a landscape setting. The experimental design was a randomized complete block with 8 single plant replications. Growth index (GI = (height + widest width + width perpendicular) ÷ 3) was collected at two week intervals, starting at 2 WAT, until treatment effects were no longer significant.

In the nursery study, plants were transplanted on March 17 from 4-inch pots (10.16 cm) to full gallon (3.8 L) pots containing a 3 pinebark:1 sand medium amended per yd^3 (.76 m^3) with 6 lbs. (2.7 kg) Polyon 18-6-12, 7 lbs. (3.17 kg) lime, and 2 lbs. (.90 kg) Micromax. Plants were placed outdoors in full sun under overhead irrigation. On May 7, plants were sheared to 8 inches above the pot rim, and treatments were applied on May 18. PGR treatments were the same as those used in the greenhouse study. Treatments were completely randomized and replicated with 9 single plants. Similar data were collected as in the greenhouse study. However, plants were not transplanted into the landscape. Data for both the greenhouse and nursery portions were analyzed using general linear models and regression analysis.

Results and Discussion: For the greenhouse study, all PGRs significantly reduced GI of Mexican sage through 6 WAT in the greenhouse. Cutless suppressed GI 5%, 10%, and 4% at 2, 4, and 6 WAT, respectively compared to controls across all rates. For Sumagic, GI was 15%, 15%, and 8% less than controls at 2, 4, and 6 WAT, respectively. GI was 14%, 28%, and 24% less for B-Nine/Cycocel tank mixes compared to controls at 42, 4, and 6 WAT, respectively. Finally, for Pistill, GI was suppressed by 25%, 22%, and 15% in comparison to non-treated plants. After Mexican sage was transplanted into ground beds, GI of plants treated with Cutless or Sumagic was similar to non-treated plants at two weeks after planting (WAP) while GI of plants treated with Pistill or B-Nine/Cycocel were similar to controls at 4 WAP.

For the nursery study, treatment effects for most of the PGRs appeared to be more transitory than in the greenhouse study. Size control steadily decreased through 4 WAT with no significant growth suppression by 6 WAT. For Cutless, GI was reduced by 11% at both 2 and 4 WAT compared to non-treated plants. Sumagic reduced GI by 10% at 2 WAT, but effects on GI were not significant by 4 WAT. For B-Nine/Cycocel tank mixes, GI was 14% less at 2 WAT and 10% less at 4 WAT. For Pistill, GI

was reduced 25% at 2 WAT, but was non-significant at 4 WAT.
Significance to Industry: This research shows that although PGRs have retarding effects under both greenhouse and nursery conditions, effects may be less pronounced and less persistent under nursery conditions. In a greenhouse setting, all of the PGRs provided excellent size control of Mexican sage for a minimum of 8 weeks. Conversely, all of the PGRs reduced height at 2 WAT in a nursery setting, but two weeks later, growth suppression was much less or non- significant. By 6 WAT, all plants treated with PGRs in a nursery setting were similar in size to non-treated controls. Shorter term growth control under nursery conditions indicates the importance of crop scheduling and market timing with Mexican sage and suggests the need for either higher PGR concentrations or multiple applications.

Literature Cited:

1. Anonymous. 1999. Technical Bulletin: growth regulators in perennial crops. Published by Uniroyal Chemical Co.

2. Armitage, A.M. 1997. Herbaceous perennial plants: a treatise on their identification, culture, and garden attributes. 2nd Edition. Stipes Publishing L.L.C. Champaign, Illinois.

3. Bailey, D. and B. Whipker. 1998. Height control of commercial greenhouse flowers. Horticulture Information Leaflet 528, North Carolina Cooperative Extension Service.

4. Barrett, J. 1998. New developments in the use of growth regulators. Greenhouse Product News. December:16-21

5. Keever, G.J. and C.H. Gilliam. 1994. Growth and flowering response of butterfly-bush to Cutless. J. Environ. Hort. 12(1):16-18.

6. Latimer, J.G., P.A. Thomas, and P. Lewis. 1998. An evaluation of growth control on nine greenhouse-grown perennial bedding plants. Greenhouse Product News. November:30-32.

7. Latimer, J.G. 1999. Personal communication.

8. McAvoy, R.J. 1989. Considerations for the grower when using plant growth regulators. University of Connecticut Cooperative Extension System: Connecticut Greenhouse Newsletter (152).

9. Schoellhorn, R. 1999. Personal communication. Southeast Greenhouse Conference and Trade Show.

Table 1. Effects of PGRs on growth of *Salvia leucantha* in a greenhouse settings.

	Rate (ppm)	2 WAT[z]		4 WAT		6 WAT	
		Growth index	Height	Growth index	Height	Growth index	Height
B-Nine/	2500/1500	17	15	22	20	26	27
Cycocel	5000/1500	18	14	21	17	26	26
	7500/1500	17	15	21	18	25	24
		L***Q*	L*Q*	L***Q***	L***Q***	L***Q***	L***Q***

[z]WAT = weeks after treatment
[y]GI =growth index = ((height + widest width + width perpendicular)÷3)
[x]statistical significance is linear (L) or quadratic (Q) at a .05 (*), .01 (**), or .001 (***) level; non-significant results are labeled NS

The Effect of B-Nine, Bonzi, and Sumagic on the Growth of Ornamental Cabbage and Kale

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Index Words: Ornamental Cabbage and Kale, *Brassica oleracea* var. *acephala*, PGRs, B-Nine, Daminozide, Bonzi, Paclobutrazol, Sumagic, Uniconazole

Nature of Work: Ornamental cabbage and kale plants are attractive landscape additions for the fall and early winter garden. Due to their 10 to 12 week production time during periods of warm temperatures, growers face the challenge of maintaining a short, yet robust plant that will look proportional to the pot size. Plant growth regulators (PGRs) are commonly applied to container grown plants to limit stem elongation and produce a more compact plant (3). Current PGR recommendations are to use multiple B-Nine sprays at 1500 to 3000 ppm (1, 2). Whipker et al. (4) found foliar applications of Sumagic at 5 ppm or B-Nine at 2500 or 5000 ppm had the greatest effect on controlling plant height of two ornamental kale cultivars, and Bonzi had little effect; however, a limited number of rates were used. Determining the optimal Bonzi or Sumagic foliar spray or drench rates would offer other options for controlling ornamental cabbage and kale plant growth.

Ornamental kale and cabbage plugs of cultivars ‘Osaka White’ and ‘Nagoya Red’ were potted into 8 inch round plastic containers on August 20, 1998. The root substrate was Fafard® 4-P (Fafard, Anderson, SC), and the plants were fertilized at each watering with 200 ppm N. Ten PGR drench treatments (in mg a.i./pot) were applied 22 days after potting (using a volume of 300 mL of solution per pot): Bonzi at 1, 2, 4, 8, or 16; and Sumagic at 0.125, 0.25, 0.5, 1, or 2. Thirteen PGR foliar sprays (in ppm) were also applied 22 days after potting (using a volume of 204 $mL.m^{-2}$): Bonzi at 5, 10, 20, 40, or 80; Sumagic at 2, 4, 8, 16 or 32; B-Nine at 2500, 2500 (twice, with the second application occurring 14 days later), or 5000; and an untreated control. The experiment was a completely randomized block design with five single-plant replications of the 24 treatments. On November 1, 1999, total plant height (measured from the pot rim to the top of the foliage) was recorded.

Results and Discussion: ‘Osaka White’ plant height responded linearly to increasing Bonzi substrate drench rates, while ‘Nagoya Red’ had a quadratic response with no additional control being observed at rates ≥4 mg (Fig. 1). ‘Osaka White’ is a more vigorous cultivar with the untreated

control plants being 10% taller than 'Nagoya Red'. Optimal rates of Bonzi substrate drenches would be 4 to 8 mg for vigorous cultivars like 'Osaka White' or 2 to 4 mg for less vigorous cultivars like 'Nagoya Red'.

All doses of the Sumagic substrate drenches significantly controlled plant height of 'Osaka White' and 'Nagoya Red', with both cultivars having a quadratic response as Sumagic rates increased ≥1 mg (Fig. 1). Optimal rates of Sumagic substrate drenches would be 0.25 to 1 mg for aggressive cultivars like 'Osaka White' or 0.25 to 0.5 mg for less aggressive cultivars like 'Nagoya Red'.

Bonzi foliar sprays at concentrations of up to 80 ppm were ineffective in controlling plant height of 'Nagoya Red' (Fig.1). 'Osaka White' exhibited a positive response of greater plant height as the Bonzi foliar spray rate increased.

There was a significant linear relationship between increasing rates of Sumagic foliar sprays and plant height for both 'Osaka White' and 'Nagoya Red' (Fig.1). Optimal rates of Sumagic foliar sprays to produce marketable plants would be 2 to 8 ppm for either 'Osaka White' or 'Nagoya Red'.

B-Nine foliar sprays of 2500, 2500 (applied twice), or 5000 ppm resulted in 'Osaka White' and 'Nagoya Red' plants which were ≥ 12% shorter than the control (data not shown). The B-Nine foliar sprays gave height control comparable to Sumagic foliar sprays of 2 to 8 ppm.

Significance to Industry: Chemical growth regulators are required to control plant height of ornamental cabbage and kale. Sumagic foliar sprays between 2 and 8 ppm were effective in controlling height at a cost of $0.004 and $0.02 respectively. B-Nine at 2500 ppm also provided comparable control in limiting unnecessary stretch, with a cost of $0.004 per pot as a single application or $0.01 when sprayed twice. A B-Nine rate of 5000 ppm is also recommended at a cost of $0.01 per pot. Although effective in controlling height, it is not economically feasible to apply Bonzi or Sumagic as drenches, because the costs are 3 to 6 times that of Sumagic or B-Nine foliar sprays.

Literature Cited:

1. Luczai, R. T. 1992. Flowering cabbage and kale: ideal for use in late fall landscapes. PPGA News. 23(4):2-3.

2. McAvoy, R.J. 1994. Cultural tips for ornamental cabbage and kale. Conn. Greenhouse Nwsltr, No. 180, June/July. p. 13-15.

3. Tayama, H.K., R.A. Larson, P.A. Hammer, and T.J. Rolls (eds.). 1992. Tips on the use of chemical growth regulators on floriculture crops. Ohio Florists'Assn., Columbus, Ohio.

4. Whipker, B.E., R.T. Eddy and P.A. Hammer. 1994. Growth regulator height control of ornamental kale. HortScience 29:329.

Acknowledgements: We would like to thank Ingram McCall for her technical assistance, Uniroyal Chemical Company and the North Carolina Commercial Flower Growers' Association for grant support, Fafard for providing the potting substrate, and Wagner Greenhouses for providing the plugs.

Figure 1. a) The effects of Bonzi substrate drenches, b) Sumagic substrate drenches, c) Bonzi foliar sprays, or d) Sumagic foliar sprays on plant height of 'Osaka White' (OW) and 'Nagoya Red' (NR) ornamental cabbage and kale.

Table 1. Response of 'Red Giant' ornamental mustard to B-Nine or B-Nine + Cycocel foliar sprays.

Chemical	Rate	Plant height (cm)
Untreated Control	0	30.4
B-Nine	2500	22.8
	5000	21.9
	7500	22.7
	10000	23.3
B-Nine + Cycocel	2500 + 1500	26.1
	2500 + 3000	22.3
	5000 + 1500	18.8
	5000 + 3000	22.0
Significance[z]		***
LSD (α 0.05)		3.7

[z]Plant height significant at $P \leq 0.001$ for the B-Nine or B-Nine + Cycocel treatments.

The Effect of B-Nine and B-Nine + Cycocel on the Growth of *Brassica juncea* var. *rugosa* 'Red Giant'

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Index Words: Red Mustard, *Brassica juncea* var. *rugosa,* PGRs, B-Nine, Daminozide, Cycocel, Chlormequat

Nature of Work: *Brassica juncea* var. *rugosa* 'Red Giant' is an increasingly popular landscape item for fall, winter, and spring gardens in the southeastern United States. With its robust bronze foliage and thick white midribs, the mustard provides aesthetic value, offering texture and color to a dormant shrub or perennial garden. Commercial production of the mustard is relatively simple, seeds are either directly sown in pots or are transplanted from plug trays. 'Red Giant' is an aggressive grower and its rapid growth rate can result in a plant which is disproportionate to the pot size. The need for chemical growth regulators (PGRs) is of primary concern for commercial growers, but no studies have been done on *Brassica juncea* var. *rugosa.* B-Nine (daminozide) has been recommended for height control of other ornamental Brassicas (2). Adding Cycocel (chlormequat) with B-Nine as a "tank mix" has also proven to be effective in controlling growth of some bedding plants (1). The purpose of this study was to determine the suitability of B-Nine or B-Nine plus Cycocel for growth control of *Brassica juncea* var. *rugosa*.

Seeds of 'Red Giant' were sown on December 16, 1998 in a 128 cell plug tray. Seedlings were then transplanted into 8-inch (20.3 cm) mum pans on January 9, 1999. Plants were placed in a greenhouse at a final spacing of 17 inches (43.2 cm) between centers. 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 150 ppm N using Peters® 20-10-20 (Scotts, Marysville, Ohio) (20-N-4.4P16 6K). The plants were grown under natural daylength.

PGR foliar sprays were applied on January 24, 1999 using a volume of 204 mL· m^{-2}. Treatments consisted of B-Nine foliar sprays at 0, 2500, 5000, 7500, or 10000 ppm. Four B-Nine plus Cycocel tank mixes were also applied to the mustard plants (B-Nine + Cycocel): 2500 + 1500, 2500 + 3000, 5000 + 1500, or 5000 + 3000 ppm. The experiment was a completely randomized design with five single-plant replications of the nine treatments. On February 15, 1999, total plant height (measured from the pot rim to the top of the foliage) and plant diameter (all diam-

eters measured at the widest dimension and turned 90°, and averaged) were recorded.

Results and Discussion: All growth retardant treatments resulted in decreased shoot height when compared to the control (Table 1). Plant height decreased with the use of B-Nine, however no additional control was observed with B-Nine rates ≥2500 ppm. The addition of Cycocel with B-Nine did not provide additional control of plant height when compared to similar doses of B-Nine foliar sprays. Plants treated with Cycocel rates ≥1500 ppm exhibited phytotoxicity. With an ineffective control of growth and phytotoxicity, the addition of Cycocel was not advantageous for height control of 'Red Giant'.

Plant diameters were unaffected by the PGR applications, with the mean plant diameter being 51.7 cm (data not presented). It was observed two weeks prior to data collection7 but before the plants were of a suitable size to market, differences between the PGR treatments were more pronounced. It appears that the PGR effects wore off, which leads the researchers to speculate that multiple applications of B-Nine could be beneficial.

Significance to Industry: The ornamental mustard is a popular crop among growers who produce other plants besides fall pansies and garden mums. In order to sell and ship the product more efficiently, one needs to control the height and leaf expansion until a market date. B-Nine foliar sprays of 2500 ppm are effective in controlling the height of 'Red Giant' at a cost of $0.004 per pot.

Literature Cited:

1. Tayama, H.K., R.A. Larson, P.A. Hammer, and T.J. Rolls (eds.). 1992. Tips on the use of chemical growth regulators on floriculture crops. Ohio Florists'Assn., Columbus, Ohio.
2. Whipker B.E., J. L. Gibson, R.A. Cloyd, C.R. Cambell, and R. Jones. 1998. Success with ornamental cabbage and kale. NCSU Horticultural information Leaflet No. 507. 9 pp.

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Table 1. Response of 'Red Giant' ornamental mustard to B-Nine or B-Nine + Cycocel foliar sprays.

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B-Nine	2500	22.8
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	7500	22.7
	10000	23.3
B-Nine + Cycocel	2500 + 1500	26.1
	2500 + 3000	22.3
	5000 + 1500	18.8
	5000 + 3000	22.0
Significance*		***
LSD ($\propto$ 0.05)		3.7

*Plant height significant at $P \leq 0.001$ for the B-Nine or B-Nine + Cycocel treatments.

Chemical Regulation Of Growth Of Perennial Plants In Coastal South Georgia

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Index Words: Perennial, High Temperature, Plant Growth Regulation, Landscape Coastal, Phlox, Monarda, Sedum, Buddleia, Veronica

Nature of Work: The objective of this research was to screen containerized perennial bedding plants for response to chemical growth regulators during greenhouse production and to evaluate the subsequent effect of growth regulators on the landscape performance of the perennials grown and maintained under hot, dry coastal South Georgia conditions.

Fall-planted perennial plugs were held in a cold frame over winter and moved into the greenhouse in March 1999. After resumption of growth, the plants were treated with foliar spray applications of 5000 ppm B-Nine (applied every 2 weeks), a tank mix of 5000 ppm B-Nine and 1500 ppm Cycocel applied once, or Sumagic at 0, 15, 30, 45, or 60 ppm applied once. Vegetative plant height was measured at 3 weeks after treatment (3 WAT). Plants were planted in raised landscape beds at the Coastal Gardens in Savannah, Georgia. Plant height, width and quality were determined at 4 weeks after planting (4 WAP) into the landscape beds and then at monthly intervals throughout the summer.

Results and Discussion: Four of the five species tested (*Veronica* 'Sunny Border Blue', *Sedum* 'Autumn Joy', *Monarda didyma* 'Marshall's Delight', and *Phlox paniculata* 'David') were responsive to Sumagic, B-Nine, and the B-Nine/Cycocel applications during greenhouse production (Table 1, Table 2). Maximum observed height reductions at 3 WAT, occurred in plants treated with the higher rate of Sumagic (60 ppm), ranging from a 25% reduction with *P. paniculata* 'David' to 37% with Veronica 'Sunny Border Blue' relative to untreated control.

B-Nine was applied at 2-week intervals, resulting in two applications during greenhouse production, which is a fairly costly treatment. This treatment was often less effective that the B-Nine/Cycocel tank mix applied once. A single application of a tank mix of B-Nine and Cycocel effectively reduced the height of four species by 17% to 31% relative to the untreated control. The B-Nine/Cycocel application shows potential for use by commercial growers wishing to control height in these cultivars.

In the landscape, regrowth is a desirable trait, hopefully ending in normal flower production for the consumer. Excessive application of PGRs can have detrimental effects in the landscape weeks after the plants are purchased (2). Over the next four weeks in the landscape, the response of plant height to Sumagic persisted in *Veronica* and *Sedum*, and the plants grew very slowly. This suggests that although the rates used in the greenhouse had the desired effects, a lower concentration may be needed to avoid a delay in landscape growth.

Growth of *Buddleia davidii* 'Pink Delight' was not affected by the application of the three PGRs (Table 2). Even the highest concentration of Sumagic did not reduce height significantly relative to the untreated control. *Buddleia* has proven to be difficult to control using PGRs, and a re-evaluation of application technique, time of application and concentration is needed to resolve this problem. Similar problems were experienced with *Alcea rosea* (5), a popular perennial hollyhock, where application method greatly affected efficacy of the plant growth regulator. Further studies are underway to approach this issue.

Significance to Industry: In commercial settings, as well as in retail locations, perennials grown in pots tend to stretch and become leggy as the season progresses. This makes the plants less marketable, and harder to maintain. Growers and garden centers owners wish to control the growth of perennials, but little is known about which chemicals work best on the over 3000 perennial varieties that are being grown nationwide today. This lack of information makes the use of chemical growth regulators very difficult. This study provides a continuation of our multi-year effort to evaluate plant response to specific plant growth regulators during greenhouse production, and their post-purchase landscape performance (1,3,4). The height reduction provided by these three growth retardants provides a starting point for growers and researchers wishing to adapt the use of these products to their own production systems.

Literature Cited:

1. Thomas, P. A. and J. G. Latimer. 1992. Evaluation of plant growth regulators on petiole and shoot growth of herbaceous perennials. Proc. Southern Nurserymen's Assn. Research Conf. 37:256-260.

2. Latimer, J. G. and P. A. Thomas. 1995. Persistent effects of triazole growth regulators on herbaceous perennials. Proc. Plant Growth Reg. Soc. Am. 22:223-224.

3. Latimer, J. G. and P. A. Thomas. 1997. Effects of plant growth regulators on growth and landscape performance of perennial bedding plants. Proc. Southern Nurserymen's Assn. Research Conf. 42:283-285.

4. Thomas, P. A., J. G. Latimer, and S. Baden. 1998. Greenhouse and landscape evaluations of perennial bedding plants treated with three plant growth regulators. Proc. Southern Nurserymen's Assn. Research Conf. 43:286-290.

5. Latimer, J. G., R. D. Oetting and P. A. Thomas. 1995. Method of application affects response of hollyhock to paclobutrazol. HortScience 30:626.

Table 1. Plant height of *Veronica* 'Sunny Border Blue' and *Sedum* 'Autumn Joy' at 3 weeks after treatment (WAT) with plant growth regulators in the greenhouse and at 4 weeks after planting (WAP) into the landscape.

Treatment	Rate (ppm)	Plant height (cm) 3 WAT	4 WAP
Veronica 'Sunny Border Blue'			
B-Nine[z]	5000	13.4 b	24.1 bc
B-Nine / Cycocel[y]	5000 / 1500	12.2 bc	24.6 b
Control	*0*	*17.8 a*	*31.1 a*
Sumagic	15	12.1 c	19.2 cd
	30	11.9 c	18.7 d
	45	11.1 c	17.8 d
	60	11.3 c	15.7 d
Significance		***	***
LSD		1.5	2.9
Sedum 'Autumn Joy'			
B-Nine	5000	16.8 b	25.4 ab
B-Nine / Cycocel	5000 / 1500	15.6 bc	25.8 ab
Control	*0*	*19.1 a*	*29.9 a*
Sumagic	15	15.6 bc	25.0 b
	30	14.2 cd	25.6 ab
	45	13.3 d	23.7 b
	60	12.9 d	21.6 b
Significance		***	*
LSD		1.9	4.5

[NS], ***,**,* P > 0.05 or P ≤ 0.001, 0.01, or 0.05, respectively. Mean separation by LSD (P ≤ 0.05) over all PGR treatments.
[z] B-Nine applied twice over treatment period: Day 0 and Day 14.
[y] B-Nine / Cycocel tank mix applied once at Day 0.

Table 2. Plant height of beebalm (*Monarda didyma* 'Marshall's Delight'), tall phlox (*Phlox paniculata* 'David') and butterfly bush (*Buddleia davidii* 'Pink Delight') at 3 weeks after treatment (WAT) with plant growth regulators in the greenhouse.

	Rate	Plant height (cm)		
Treatment	(ppm)	*Monarda*	*Phlox*	*Buddleia*
B-Nine[z]	5000	22.1 b	24.3 bc	36.4
B-Nine / Cycocel[y]	5000 / 1500	21.4 bc	26.8 ab	34.1
Control	*0*	*29.2 a*	*29.2 a*	*37.0*
Sumagic	15	22.6 b	25.1 bc	36.1
	30	21.4 bc	25.7 b	35.2
	45	19.5 c	24.6 bc	34.0
	60	19.1 c	22.0 c	34.9
Significance		***	**	NS
LSD		2.4	3.4	- -

[NS], ***,**,* P > 0.05 or P ≤ 0.001, 0.01, or 0.05, respectively. Mean separation by LSD (P ≤ 0.05) over all PGR treatments.
[z] B-Nine applied twice over treatment period: Day 0 and Day 14.
[y] B-Nine / Cycocel tank mix applied once at Day 0.

Effects of a Sprout Inhibitor on Growth and Sprouting of Four Tree Species

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Index Words: Elm, *Ulmus carpinifolia x parvifolia*, *Ulmus Parvifolia*, *Loropetalum*, Peach, *Prunus chinense*, Sprouting, Sprout Inhibitor

Nature of Work: Trunk and basal sprouts and/or suckers are a common sight weeks after a container tree has been pruned to a standard or after it has been placed in the landscape. Traditionally, these adventitious sprouts are removed manually while growth is succulent or mechanically if mature. This practice may be time consuming and labor intensive. Minimizing subsequent sprout and sucker removal to once a year would benefit the nursery and landscape industry.

On June 10, 1997, a test was conducted at Simpson Nurseries in Monticello, FL to evaluate Tre-Hold RTU (AMVAC Chemical Corporation, 4100 East Washington Blvd., Los Angeles, CA 90023), 1.15% ethyl 1-naphthalene acetate of active ingredient, for trunk sprout inhibition. Tre-Hold was tested on 'Frontier' elm (*Ulmus carpinifolia x parvifolia* 'Frontier'), Lacebark elm 'Allee' (*Ulmus parvifolia* 'Allee'), 'Burgundy' Loropetalum (*Loropetalum chinense* var. *rubrum* 'Burgundy') and on July 1st, Peach (*Prunus persica*). These trees were pruned prior to treatment following standard nursery practice, which included topping and trunk limb pruning. Tree height was recorded following pruning. Five trees of each species were treated with Tre-Hold sprout inhibitor to the main trunk area and five trees of each species were left as untreated controls. The treated area consisted of the trunk surface just below the canopy down to the soil line. The product was applied with a hand-held spray bottle, spraying the trunk surface until wet. The Tre-Hold sprout inhibitor was allowed to dry and then all trees were irrigated.

A second trial was conducted on peaches the following year on May 20th. The number of trees was doubled and treatments remained the same. Trees were observed for up to 117 days for phytotoxicity and scored on a scale of 0-10 where 10 was used to score a dead tree. Trunk branching was recorded and pruned on day 44 and 117 of the 1997 study.

Results and Discussion: Treatment with Tre-Hold significantly reduced growth of *Ulmus* species and *Prunus persica* (Table 1). In contrast, treated *Loropetalum* grew significantly taller than untreated plants

(Figure 1). Loropetalums are typically grown as shrubs. Those in this study were being trained as single-stemmed, standard trees. Considerable branching occurred all along the lower stems of the untreated loropetalums (average of 5 sprouts per tree by day 44 and an additional 3 per tree by day 117). By inhibiting sprouting along the lower stems, Tre-Hold induced the plants to redirect their growth upward.

Tre-Hold effectively inhibited trunk and basal sprouting of *Loropetalum* species for up to 117 days. Sprouting on untreated *Prunus persica* and both *Ulmus* species was insufficient to allow analysis (data not shown).

Peach demonstrated phytotoxic symptoms of severe chlorosis and leaf drop during both studies (Table 2). Of the five treated trees in the 1997 study, three died, one came under attack by peach borers, and one survived. Treated peaches in the 1998 study also exhibited similar phytotoxic symptoms that led to death within 30 days.

The apparent sensitivity of peach to Tre-Hold suggests a less concentrated product should be tested on this species. The growth reduction occurring with treated *Ulmus* species indicates a mild phytotoxic effect from Tre-Hold (Table 1). Growth reductions of this magnitude may be acceptable in some landscape situations but are incompatible with nursery production or landscape situations in which rapid growth is desired.

Significance to Industry: Chemicals inhibiting stem sprouting, or "suckering", could benefit the nursery and landscape industries by reducing labor, pruning, and plant injury resulting from pruning. In this study, Tre-Hold RTU effectively reduced sprouting and increased height growth on *Loropetalum chinense* var. *rubrum* 'Burgundy'. However, treatment suppressed growth of *Ulmus* 'Frontier' and 'Allee' and severely injured *Prunus persica*. Additional studies need to test efficacy on other species and refine concentrations and rates of Tre-Hold to effectively inhibit sprouts without suppressing growth.

Table 1. Mean initial(i) and final (f)* heights (ft.) of trees treated with Tre-Hold RTU Sprout Inhibitor.

	Frontier Elm		Allee Elm		Loropetalum		Peach	
	(i)	(f)	(i)	(f)	(i)	(f)	(i)	(f)
Control	7.99a[z]	9.88a	5.05a	8.38a	3.78a	4.49b	3.67a	6.58a
Treated	7.61a	8.44b	5.45a	6.04b	3.88a	6.88a	3.67a	3.09b

* Final height = 117 days for all trees except Peaches = 97 days.
[z] Mean separation within columns by LSD (P<0.05).

Table 2. Mean of phytotoxicity to Tre-Hold RTU on Peaches, *Prunus persica*, during the summer of 1997 and mid-late spring to early summer of 1998. Phytotoxicity was recorded over a range of 0-10 where 10=death.

				Days After Treatment						
Year	Tree	N	Treatment	7	14	16	23	30	36	43
1997	Peach	5	Control	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a
			Tre-Hold	0.0b	0.6b	1.2b	2.4b	3.6b	5.2b	6.0b
				4	8	15	22	30		
1998	Peach	11	Control	0.0a	0.0a	0.0a	0.0a	0.0a		
			Tre-Hold	3.3b	5.3b	7.6b	9.6b	10.0b		

[z] Mean Separation within columns and years by Duncan=s New Multiple Range Test, alpha=0.05

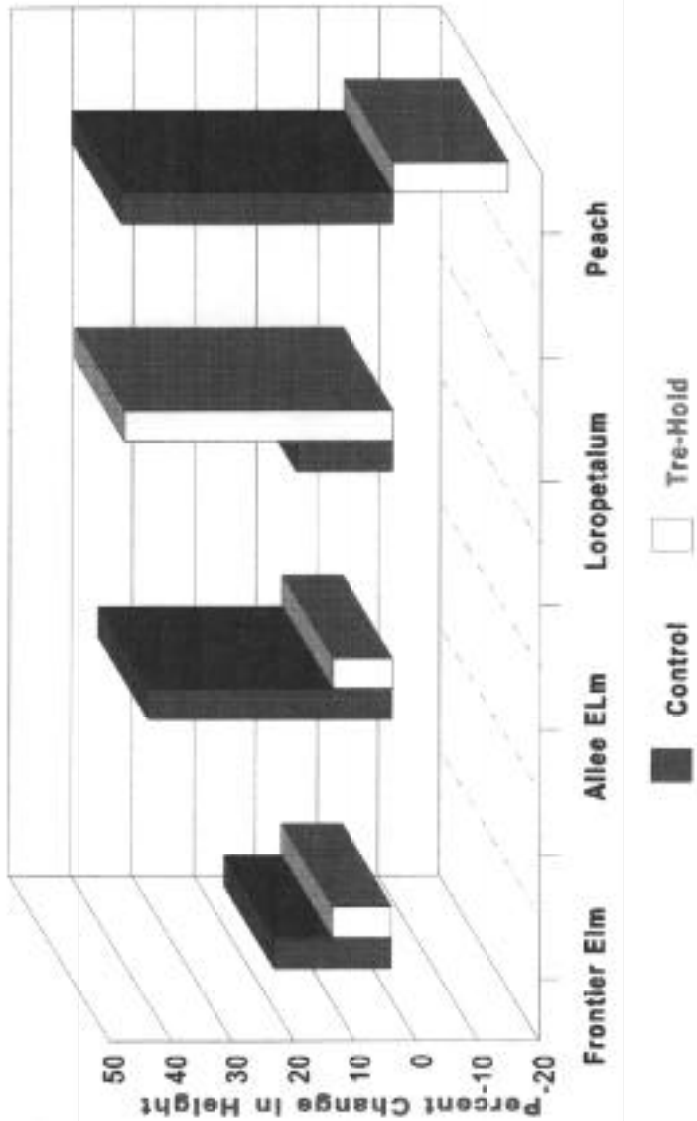

Figure 1. Percentage change in height of untreated and Tre-Hold-treated plants of two Elm species, Loropetalum, and Peach.

Screening Perennials for Response to PGRs under Winter Growing Conditions

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Index words: Perennial Production, Growth Regulation, *Digitalis, Gaura, Scabiosa, Stokesia, Veronica, Achillea, Agastache, Aster, Dianthus,* B-Nine, Cycocel, Sumagic

Nature of Work: The rapid increase in the demand for herbaceous perennials for use in the landscape along with the large number and diversity of species available present production challenges for nursery and greenhouse growers (2,3). Wight Nurseries conservatively estimates pruning costs for overgrown perennials at 3¢ per one gallon pot per pruning event. During a warm winter, fall-planted perennials may require pruning at monthly intervals. Most of this excess growth is in plant width instead of plant height. The objective of this study was to screen commercially grown, containerized perennials from fall-planted plugs for response to plant growth regulators (PGRs) -- over the winter growing period.

Perennial plugs were planted in trade gallon pots filled with Wight Nurseries' perennial media mix amended with Osmocote 17-8-12 in late December 1998. Five species, *Achillea* x 'Paprika', *Agastache* x 'Blue Fortune', *Aster novi-belgii* "Professor Kippenburg', *Dianthus deltoides* 'Brilliant', *Gaura /indheimeri* 'Whirling Butterflies', and *Veronica spicata* 'Red Fox', were grown under outdoor nursery conditions. Five additional species, *Digifalis grandiflora* 'Foxy', *Gaura lindheimeri*'Siskiyou Pink', *Scabiosa caucasica* 'Butterfly Blue', *Stokesia laevis* 'Klaus Jelitto', *Veronica* x 'Goodness Grows' were grown in an unheated polyhouse. On January 19, 1999, plants were treated with a foliar spray of 5000 ppm BNine (at 2-week intervals), a tank mix of 5000 ppm B-Nine plus 1500 ppm Cycocel (applied once), or 0, 15, 30, 45 or 60 ppm Sumagic (applied once). Environmental conditions at time of application were: sunny skies, 75F and 50% RH outdoors, and 85F and 60% RH in the polyhouse. Each plant species was set up as an individual experiment with plants arranged in a randomized complete block design with eight single-plant replications. Plant height and width were measured at 2, 4, 6, and 8 weeks after treatment (WAT). All experiments were conducted at Wight Nurseries, Cairo GA.

Results and Discussion: Of the perennials grown under outdoor conditions, only the *Achillea* and *Agastache* showed significant growth responses to the PGRs. Because of the soft nature of the foliage, PGR effects on plant height of *Achillea* x 'Paprika' were inconsistent, but plant width was significantly reduced by all PGR treatments at 2 and 4 WAT (Table 1). Multiple applications of B-Nine delayed flowering. *Agastache* x 'Blue Fortune' was very sensitive to Sumagic, exhibiting excessive height reductions even 2 WAT, but width reductions were moderate and consistent over the 8 week test (Table 1). It would be necessary to examine this plant for persistent PGR effects in the landscape before treatment rates could be established. B-Nine and the B-Nine/ Cycocel tank mix also gave excellent height and width control. Note: these PGRs are not labeled for use on food crops, including herbs.

Plants grown in the polyhouse had more rapid growth than the plants grown outdoors. Plant height of *Stokesia* was reduced only by multiple applications of B-Nine or less so by the B-Nine/Cycocel tank mix [plant height (cm) at 8 WAT: control 23.2 a, B-Nine 12.9 c, Tank Mix 19.3 b, LSD P ≤0.05]. Plant width was not affected.

Plant width of *Gaura* 'Siskiyou Pink' was reduced by all treatments through 6 WAT with plants treated with B-Nine or the tank mix smaller than the control or Sumagic treated plants at 4 and 6 WAT [plant width (cm) at 6 WAT: control 38.2 a, B-Nine 30.2 c, Tank Mix, 30.0 c, Sumagic (mean all rates) 33.6 b, LSD P ≤0.05]. Plant height of this cultivar showed little increase over the test period. Growth of *Veronica* 'Goodness Grows' was also very slow over the treatment period but all PGR treatments resulted in shorter more compact plants (data not presented).

Even at 8 WAT, plant height and width of *Digitalis* were reduced by Sumagic but the tank mix affected only plant width and B-Nine was not effective in growth regulation (Table 2). Increasing rates of Sumagic affected plant height but had little effect on plant width. *Scabiosa* was also very responsive to Sumagic and to multiple applications of B-Nine but was not responsive to the tank mix (Table 2). Increasing rates of Sumagic resulted in greater reductions in plant height and width. Residual effects of these treatments on landscape performance should be evaluated before these rates are recommended for production.

Significance to Industry: Development of nursery production schedules for herbaceous perennials is complicated by unpredictable weather conditions. Unusually warm, sunny conditions result in excessive growth. The ability to use a PGR to prevent this growth would be of great value in reducing pruning costs. For responsive crops, a single PGR application can be much more cost effective; 5000 ppm B-Nine plus 1500 ppm

Cycocel tank mix costs about 1.5¢ per pot; 15 ppm Sumagic costs ~3¢ per pot (1). The lack of PGR response under environmentally limiting growing conditions prevents excessive retardation of late developing perennials. Attention to PGR effects on plant width will enhance their incorporation into production programs for clump-forming perennials.

Literature Cited:

1. Bailey, D.A. 1999. NCSU PGR calculator. NCSU Floriculture Web page, http:/lwww2. ncsu.edu/unity/lockers/project/floriculture/.

2. Bailey, D.A. and H. Scoggins. 1997. Perennials: Basics of profitable production (Part I). Southeastern Floriculture 7(1):24-27.

3. Behe, B. and V. Allen. 1996. Marketing perennials in the Southeast. Georgia Floriculture 6(1):13-14.

Table 1. Growth of perennials at 2, 4, 6 and 8 weeks after treatment (WAT) with plant growth regulators.

Species Treatment	Rate	2 WAT Height (cm)	2 WAT Width (cm)	4 WAT Height (cm)	4 WAT Width (cm)	6 WAT Height (cm)	6 WAT Width (cm)	8 WAT Height (cm)	8 WAT Width (cm)	8 WAT Flower (%)
***Achillea* 'Paprika'**										
B-Nine	5000 ppm	8.3 c	26.9 b	9.5	30.8 b	9.1 b	28.2 c	9.3	26.3	12 b[z]
B-Nine/ Cycocel	5000 ppm/ 1500 ppm	8.6 bc	26.9 b	11.4	29.9 b	13.3 ab	29.0 bc	9.8	28.1	75 a
Control	0 ppm	10.0 a	30.5 a	13.3	33.5 a	17.2 a	31.9 a	10.2	29.4	88 a
Sumagic	15 ppm	9.2abc	27.0 b	10.9	31.2 b	11.4 b	32.1 a	9.7	28.3	75 a
	30 ppm	8.1 c	26.6 b	11.0	30.3 b	11.8 b	31.5 ab	9.7	29.3	88 a
	45 ppm	9.6 ab	26.9 b	12.4	30.9 b	11.4 b	31.1 ab	10.9	30.1	75 a
	60 ppm	8.2 c	25.9 b	12.1	29.8 b	11.5 b	31.5 ab	10.2	28.9	88 a
Main effect		**	***	NS	**	*	*	NS	NS	**
LSD		1.1	1.4	--	1.8	4.2	2.6	--	--	42
***Agastache* x'Blue Fortune'**										
B-Nine	5000 ppm	13.8 b	22.8 b	14.2 bc	23.1 b	14.2 bc	25.2 b	14.7 bc	25.7 bc	--
B-Nine/ Cycocel	5000 ppm/ 1500 ppm	13.9 b	22.6 b	16.9 b	20.8 d	17.8 b	24.0 bc	19.0 b	25.6 bc	--
Control	0 ppm	19.6 a	26.4 a	22.9 a	26.7 a	25.1 a	30.8 a	29.1 a	32.3 a	--
Sumagic	15 ppm	10.1 bc	22.8 b	11.1 cd	22.8 bc	12.1 cd	24.9 b	14.0 bc	26.1 bc	--
	30 ppm	11.3 bcd	23.1 b	13.2 bc	22.5 bcd	13.5 bc	24.9 b	16.2 b	27.2 b	--
	45 ppm	12.8 bc	21.6 b	13.1 bc	21.2 bcd	14.3 bc	22.2 c	14.9 bc	23.0 c	--
	60 ppm	9.8 d	21.2 b	9.1 d	20.8 cd	8.8 d	21.6 c	9.9 c	23.0 c	--
Main effect		***	***	***	***	***	***	***	***	
LSD		2.6	2.2	4.0	2.0	4.4	2.5	5.1	3.6	

NS, **, *, *** $P > 0.05$ or $P \leq 0.001$, 0.01, or 0.05, respectively. Mean separation by LSD ($P \leq 0.05$) over all PGR treatments.

[z] Bolting, flowers not yet open.

Table 2. Growth of perennials at 2, 4, 6 and 8 weeks after treatment (WAT) with plant growth regulators.

Species Treatment	Rate	2 WAT Height (cm)	2 WAT Width (cm)	4 WAT Height (cm)	4 WAT Width (cm)	6 WAT Height (cm)	6 WAT Width (cm)	8 WAT Height (cm)	8 WAT Width (cm)	Flower (%)
***Digitalis grandiflora* 'Foxy'**										
B-Nine	5000 ppm	19.6 a	45.1	22.4 a	46.4 ab	22.4 ab	47.6 ab	22.7 a	46.0 ab	50
B-Nine/ Cycocel	5000 ppm/ 1500 ppm	16.6 bc	44.5	21.2 ab	41.4 bc	23.0 a	42.6 bc	23.4 a	44.4 bc	38
Control	0 ppm	16.9 ab	47.8	22.3 a	47.9 a	23.7 a	48.9 a	22.6 a	49.9 a	38
Sumagic	15 ppm	16.8 bc	43.1	18.9 bc	38.2 c	21.3 abc	37.4 c	21.9 ab	40.4 cd	50
	30 ppm	16.2 c	43.2	17.4 cd	40.0 c	19.5 bcd	39.3 c	21.6 abc	40.9 cd	12
	45 ppm	15.9 c	44.8	15.2 d	39.3 c	17.1 d	37.5 c	19.2 c	38.1 d	38
	60 ppm	16.6 bc	43.7	15.9 c	41.1 c	18.3 cd	39.0 c	19.8 bc	40.4 cd	38
Main effect		*	NS	***	**	***	***	*	***	NS
LSD		2.6	–	2.7	5.1	3.2	5.7	2.5	4.9	–
***Scabiosa caucasica* 'Butterfly Blue'**										
B-Nine	5000 ppm	8.8 ab	27.2 ab	17.0 bc	30.1 abc	25.0 b	29.4 bc	27.1 b	40.9 b	100
B-Nine/ Cycocel	5000 ppm/ 1500 ppm	8.6 b	26.5 abc	20.1 ab	30.7 ab	30.1 a	30.6 ab	35.9 a	48.8 a	100
Control	0 ppm	10.3 a	28.3 a	24.3 a	31.7 a	31.9 a	31.5 a	35.2 a	51.2 a	100
Sumagic	15 ppm	6.6 c	26.3 abc	13.5 c	28.4 bcd	22.4 b	28.4 cd	26.8 b	40.1 b	75
	30 ppm	5.9 c	24.9 c	14.0 c	26.7 d	20.9 bc	26.1 ef	24.1 bc	36.4 b	100
	45 ppm	6.2 c	26.0 bc	13.8 c	27.9 cd	17.8 cd	26.8 de	21.3 cd	30.3 cd	75
	60 ppm	6.3 c	25.1 bc	11.6 c	26.8 d	15.4 d	24.5 f	18.5 d	28.8 c	100
Main effect		***	*	*	**	***	***	***	***	NS
LSD		1.6	2.0	5.7	2.4	4.2	2.1	4.8	5.1	–

NS, *, **, *** $P > 0.05$ or $P \leq 0.001$, 0.01, or 0.05, respectively. Mean separation by LSD ($P \leq 0.05$) over all PGR treatments.

Using Late Fall Growth Regulator Container Drenches to Control Spring Growth of *Coreopsis lanceolata* 'Sunray'

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Index Words: *Coreopsis lanceolata* 'Sunray', Bonzi, Sumagic, Paclobutrazol, Uniconazole, Growth Regulator, Container Drench

Nature of Work: The number of herbaceous perennials grown in containers is increasing along with their popularity with consumers. A production problem encountered by growers is controlling the growth of these ornamental landscape plants. Typically plant growth regulating compounds are applied in the spring prior to or even during the shipping season (2). At this time of year, nursery personnel are occupied with loading/shipping spring sales. There would be advantages if these growth-regulating compounds could be applied at an alternative time of the year when time constraints would be less. Previous work by the author has shown that container drenches of Bonzi (paclobutrazol) or Sumagic (uniconazole) could be effectively applied in late winter when the herbaceous perennials are still dormant (1). A question that needs to be answered is how early can plant growth regulator container drenches be applied. Also, proper dosing is important as the triazole plant growth regulators can adversely affect flower initiation when concentrations are excessive. The objective of this research was to determine the effectiveness of plant growth regulator container drenches in late fall as the herbaceous perennials are entering dormancy.

Uniform plugs of the herbaceous perennial *Coreopsis lanceolata* 'Sunray' were selected and transplanted into 3.8L (full gallon) containers in 100% pine bark fines. Fertilization and irrigation were applied using best management practices. All plants were uniformly pruned on 1 October 1998. Container drenches of Bonzi (0, 2.0, 4.0, 8.0 mg/container) and Sumagic (0, 0.5, 1.0, 2.0 mg/container) were applied on 1 Nov 1998 using a container drench volume of 500 ml. All containers were placed in a randomized complete block design in cold frames on 1 Dec 1998 for winter protection. All containers were removed from the coldframes on 10 Apr 1999 and topdressed with 16g 14-7-7 granular fertilizer. On 15 Jun 1999 measurements were recorded that included growth index using the (W1+W2+H)/3 method, height, and flower number.

Results and Discussion: The effectiveness of the two growth regulators was significantly different. Increasing drench rates of Sumagic resulted

in greater control of plant height (Table 1). Width and growth index has similar results. All of the Sumagic drench rates provided greater control of plant width and growth index, however there was no difference between the drench treatments. All Sumagic drench rates reduced flower number when compared to the control treatment. Sumagic was effective at all container drench rates examined in controlling the growth of *Coreopsis lanceolata*.

Bonzi at the container drench rates evaluated provided no significant control of any of the parameters examined (Table 2). Possible explanations are the rates were not sufficient or the Bonzi was bound to the pine fine media. A better explanation is based on placing the plants in cold frames for winter protection. The temperatures in the coldframes were moderated to such a degree that the plants did not fully enter dormancy and outgrew the effectiveness of the growth regulator. The results do not preclude late fall Bonzi use to control spring growth, but indicate more study is required of the effects of dormancy and growth regulator efficacy.

Significance to Industry: To maintain the marketability of herbaceous perennials during the spring shipping and sales season, chemical plant growth regulators need to be utilized. Having the management tool of applying these plant growth regulators during a period when the pressures on the labor force is reduced would be advantageous for the nursery grower. Late fall container drenches of herbaceous perennials could be a viable management strategy to use. Much work needs to be done to evaluate the effectiveness of this strategy on the many herbaceous perennials being grown today.

Literature Cited:

1. Bachman, Gary R., Bill Miller, and Ted Whitwell. 1994. Early season drenches of Bonzi and Sumagic for height control of container-grown herbaceous perennials. Proc. SNA Res. Conf. 39:67-70.

2. Thomas, P.A., J.G. Latimer, and S.A. Baden. 1992. Evaluation of plant growth regulators on petiole and shoot growth of herbaceous perennials. . Proc. SNA Res. Conf. 37:256-260.

Table 1. Spring growth response of *Coreopsis lanceolata* 'Sunray' to late fall container drenches of Sumagic.

Sumagic (mg/cont)	Height (cm)	Width (cm) (W1+W2)/2	Growth Index	Flower Number
Control	38.25 a[z]	37.50 a	37.87 a	65.25 a
0.5 mg	33.50 ab	25.00 b	29.25 b	42.75 b
1.0 mg	27.75 bc	24.25 b	26.00 b	41.50 b
2.0 mg	24.25 c	28.00 b	26.12 b	41.00 b

zMean separation within columns by least significant difference (LSD), *P*=0.05.

Table 2. Spring growth response of *Coreopsis lanceolata* 'Sunray' to late fall container drenches of Bonzi.

Bonzi (mg/cont)	Height (cm)	Width (cm) (W1+W2)/2	Growth Index	Flower Number
Control	37.25 a	33.75 a	35.50 a	55.25 a
2.0 mg	38.67 a	34.33 a	36.50 a	78.00 a
4.0 mg	36.33 a	34.50 a	35.42 a	54.67 a
8.0 mg	36.33 a	33.50 a	34.91 a	74.33 a

[z]Mean separation within columns by least significant difference (LSD), *P*=0.05.

Pampas Grass (*Cortaderia argentea*) Response to A-Rest, Bonzi and Sumagic Substrate Drenches

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Index Words: Pampas Grass, Growth Retardant, Ancymidol, Paclobutrazol, Uniconazole

Nature of Work: Ornamental grasses have become increasingly popular as landscape plants. During production, ornamental grasses like pampas grass can become disproportionately large relative to container size when grown in a greenhouse or nursery. This makes the plants less attractive to consumers and makes care more difficult for growers and garden centers. Plant growth retardants (PGRs) are commonly applied to containerized crops when plants are likely to become disproportionately large relative to the container size.

This study was initiated to compare the efficacy of PGR substrate drenches of A-Rest (ancymidol), Bonzi (paclobutrazol), and Sumagic (uniconazole) applied to pampas grass on chemical height control during greenhouse forcing, and to evaluate the residual effects of the PGRs on plant growth in the landscape. Pampas grass plugs were transplanted into six inch pots containing Fafard 4P potting substrate on March 3, 1998. Plants were fertilized at each watering with 150 ppm N from Excel 15-5-15 Cal-Mag, and grown under natural daylight. Greenhouse day/night temperatures were 24/18 C (75/65 F). Plants were treated 17 days after potting using 133 ml (4.5 oz) of solution per pot (in mg a.i.) of A-Rest at 0.25, 0.5, 1, 2 or 4; Bonzi at 1, 2, 4, 8, or 16; and Sumagic at 0.125, 0.25, 0.5, 1, or 2 and an untreated control. The experiment was a completely randomized design with eight replicate plants for each of the 16 treatments. On April 27, total plant height (measured from the pot rim to the top of the inflorescence), basal diameter at the soil line (measured at the widest dimension and turned 90 degrees, and averaged), and plant diameter (measured at the widest dimension and turned 90 degrees, and averaged) were recorded.

Four replications of each treatment were transplanted outdoors in a completely randomized design on May 8 in a sandy-loam soil 4 feet apart

and to a depth corresponding to the pot rim. Data on total plant height and plant diameter were collected on July 8 (15 weeks after the PGR applications) and September 8 (24 weeks after the PGR applications). Data were evaluated by analysis of variance and regression analysis.

Results and Discussion: During greenhouse production, all rates of Sumagic reduced plant height by 56 to 71% compared to the untreated control, whereas A-Rest and Bonzi treatments reduced plant height by 0 to 34% and 14 to 61%, respectively. Severe height retardation was evident at ≥ 2 mg of Sumagic (Table 1).

When the plants were planted in the landscape (week 5), all plants treated with Sumagic, Bonzi rates of 4, 8 or 16 mg and with 4 mg of A-Rest were significantly shorter than the untreated control (Table 1). Plant diameter was significantly less for all plants treated with Sumagic, Bonzi (excluding 1.0 mg rate) and A-Rest rates of 2 and 4 mg at week 5 (Table 1). At the conclusion of the study (week 24), all plants in the landscape exhibited similar heights, except plants treated with Sumagic at 1, 2, or 4 mg which remained significantly shorter than the untreated control. All plants treated with Sumagic also had a significantly smaller plant diameter when compared to the untreated control.

Rates of Bonzi at 1 and 2 mg were considered optimal, with the 1 and 2 mg drench costing $0.03 and $0.06 per pot, respectively. Plant growth was similiar at week 24 among the A-Rest treatments and the untreated control. However, it may not be economical for the commercial grower to use A-Rest on pampas grass because the 1 and 2 mg drench costs $0.26 and $0.52 per pot, respectively. PGR rates of Sumagic used in this study may have been excessive do to the stunting of the pampas grass in the landscape. Using lower rates of Sumagic than were used in this study may provide economical control of pampas grass for the grower, as the 0.125 and 0.25 mg rates cost $0.03 and $0.06 per pot to treat, respectively.

Significance to Industry: These results demonstrate that PGRs can be effectively and economically employed in controlling plant height of pampas grass during greenhouse and nursery forcing and production. The PGRs and rates used resulted in little persistence of growth reduction when planted in the landscape. Greenhouse and nursery growers may apply PGRs to pampas grass during production to prevent plants from becoming disproportionately large relative to the container size. Pampas grass treated with PGRs will be more attractive to consumers and easier to handle and maintain by growers and retail garden centers.

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Table 1. Response of pampas grass (Cortaderia argentea Nees) to drench applications of A-Rest, Bonzi, or Sumagic.

		Plant Height (cm)[1]			Plant Diameter (cm)[2]		
		Weeks			Weeks		
Treatment	Rate	5	15	24	5	15	24
Untreated	0	60.2	111.9	131.3	62.2	96.9	142.1
A-Rest	0.25	56.6	112.7	148.3	61.9	97.4	140.5
	0.5	61.0	113.8	142.8	66.5	97.4	141.6
	1.0	56.2	104.8	132.3	46.0	96.2	127.4
	2.0	49.9	107.8	148.3	44.7	99.9	138.8
	4.0	42.2	99.0	130.5	35.0	97.8	137.5
Bonzi	1.0	56.0	103.9	145.8	58.1	99.8	147.6
	2.0	49.4	104.7	134.0	41.5	98.6	140.6
	4.0	31.8	100.7	122.0	35.0	80.9	125.5
	8.0	25.0	92.3	130.5	35.3	80.9	130.0
	16.0	21.5	77.4	118.3	32.0	79.9	113.5
Sumagic	0.125	26.4	96.7	132.3	37.0	96.6	124.9
	0.25	22.4	84.1	118.1	36.8	76.2	116.1
	0.5	19.7	59.9	98.3	33.7	57.0	105.5
	1.0	17.1	38.4	93.8	36.0	40.6	94.8
	2.0	15.3	27.3	63.0	32.0	34.9	54.3

[1]Plant height was significant for the treatment x week interaction of (P) ≤ 0.001 (LSD at 0.05=16.1 cm).
[2]Plant diameter was significant for the treatment x week interaction of (P) ≤ 0.001 (LSD at 0.05=14.6 cm).

Growth Regulators or Drought Control Growth of Impatiens

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Index Words: Growth Regulators, Bonzi, Sumagic, Florel, Impatiens, Drought Growth Control

Nature of Work: During container production, *Impatiens walleriana* grow rapidly and can soon become leggy, with long, brittle stems. This can make care in the nursery difficult. Compact, uniformly-shaped plants are easier to care for, easier to transport, and are more attractive to customers for a longer period of time. Growth regulators may be used to maintain compact growth but the commonly-used growth regulators, B-Nine and Bonzi, have little effect on *Impatiens*. In this study, we compared the growth regulators Bonzi, Florel, and Sumagic for maintaining compact growth of *Impatiens*. Withholding water is sometimes used to control Impatiens growth. We also compared a limited water treatment with the growth regulator treatments in this study.

Impatiens walleriana 'Dazzler White', transplanted as plugs into 6-inch containers, were treated when they were 3-4 inches in diameter and just beginning to develop flower buds. The treatments were applied once as a spray on April 9, 1998. The spray treatments included Bonzi at 15, 20, or 30 ppm, Sumagic at 10, 15, or 20 ppm, or Florel at 500, 750 or 1000 ppm. A drought treatment consisted of withholding water until the plants visibly wilted. The drought treatment was ongoing through the period of the study. The plants were maintained in a greenhouse with temperatures set at 40F night, 80F day. The plants were watered daily except for the drought-treated plants which were watered only when they began to visibly wilt. There were 12 plants per treatment in a randomized block design. The plants were measured at 8, 15, 21, and 28 days after treatment (DAT).

Results and Discussion: At 8 DAT, the most effective treatments were 750 and 1000 ppm Florel and 20 ppm Sumagic (Table 1). At this time, these higher rates of Florel also caused some yellowing and distortion of young, partially developed leaves. The plants later grew out of these symptoms. At 15 and again at 28 DAT, the most effective growth control was the drought treatment, followed closely by the higher rates of Florel and by 20 ppm Sumagic. The Bonzi treatments provided some growth

control early, but there was very little control 15 to 28 DAT.

Significance to Industry: Withholding water from *Impatiens* until they begin to wilt can be an effective method of controlling excess growth. Alternatively, Florel at about 750 ppm or Sumagic at 20 ppm provide good growth control.

Table 1. Effects of growth regulator sprays and drought treatment on growth of *Impatiens walleriana* 'Dazzler White'.

Treatment/ Conc. (ppm)	8 DAT[z] Plant Diameter (cm)	15 DAT Plant Diameter (cm)	21 DAT Plant Diameter (cm)	21 DAT Plant Height (cm)	28 DAT Plant Diameter (cm)	28 DAT Plant Height (cm)
Control	17.3	19.7	21.7	7.7	26.0	10.3
Sumagic						
10	14.4	18.8	20.8	7.6	25.5	10.6
15	14.4	17.8	19.9	7.1	24.3	10.0
20	13.2	17.4	19.5	6.7	23.5	9.1
Significance[y]	$L^{.0001}$	$L^{.004}$	NS	NS	$L^{.001}$	NS
Bonzi						
15	15.9	19.1	21.3	7.2	24.9	9.5
20	15.7	19.8	21.6	7.8	26.8	10.4
30	15.1	19.3	21.1	7.7	25.1	10.6
Significance	$L^{.001}$	NS	NS	NS	NS	NS
Florel						
500	14.2	18.3	20.3	7.6	25.5	9.7
750	13.1	17.1	19.4	6.7	23.4	9.3
1000	13.3	16.9	18.1	7.2	23.7	10.0
Significance	$L^{.0001}Q^{.003}$	$L^{.0001}$	$L^{.0005}$	NS	$L^{.02}$	NS
Drought	14.9	16.8	20.0	8.0	23.0	10.1
$LSD_{.05}$	1.1	1.2	1.3	NS	1.6	NS

[z] DAT = Days After growth regulator Treatments applied.

[y] Regression response linear (L) or quadratic (Q) at indicated P value, or not significant (NS). Control included in regression. n = 6.

Defoliation of Deciduous Holly for Cut Holly Production

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Index Words: Cut Holly Prodction, Deciduous Holly, Defoliants, Cobra, Dropp, Harvade, Folex, Florel, Finish

Nature of Work: Stems of deciduous holly (*Ilex verticillata*) with berries attached are valued for use in Christmas decorations. Growers cut the stems in October or November and store them in coolers until needed. In eastern Virginia at the time of cutting, however, the leaves have not yet dropped and they must be stripped from the stems by hand. In order to reduce the hand labor needed for this crop, chemical defoliants, normally used to facilitate cotton harvesting, were evaluated.

In the spring of 1996, 6-inch liners of *IIlx verticillata* 'Winter Red' and a pollinator, *I. vertillata* 'Southern Gentleman', were potted into 1 gallon containers and grown through the summer. Berries formed on these plants, and in October of 1996 we did a preliminary experiment evaluating six different defoliants (Cobra, Dropp, Harvade, Folex, Florel and Finish) for promoting leaf drop, without dropping or damaging berries. The container-grown plants were later planted in the field for subsequent experiments.

On November 5, 1997, Dropp 50 WP (thidiazuron) at 100, 200, 400 and 800ppm, and Harvade 5F (dimethipin)at 100, 200, 400, 800, 1600, and 2400 ppm were applied as a foliar spray to runoff, 10 plants per treatment. Combinations of Dropp and Harvade were also compared. On November 26, 1997, the plants were evaluated visually for leaf drop and berry drop.

In October of 1998, one or two applications of Dropp at 800 ppm, and one or two applications of Harvade at 200, 400, or 800 ppm were made. Treatments consisting of two applications were applied at a one week interval. Treatments of Dropp at 1600 ppm, and of Harvade at 1600 ppm were applied once. There were ten plants per treatment in a randomized complete block design. The plants were evaluated visually for leaf drop and berry drop on November 19, 1998. On November 20, one stem containing berries was harvested from each plant and placed in a bucket of water. The berries were counted on each harvested stem, and the stems were placed in a cold room at 45F. Berry counts were made again on Dec. 23, 1998, Jan. 21, 1999, and Feb. 24, 1999, on each of the cut stems.

Results and Discussion: Following the preliminary evaluation in 1996, it was determined that Cobra caused excessive damage to the berries, while Florel and Finish (ethephon products) caused premature berry softening and drop. Although Folex did a good job of promoting leaf abscission without berry drop, we considered the danger label would make this product inappropriate for use with a crop that requires considerable manual handling. The most promising products were Dropp and Harvade (Data not shown).

During the 1997 evaluations of various concentrations of Dropp and Harvade, 1600 or 2400 ppm Harvade gave the best results (approx. 85% leaf drop and < 1% berry drop). Combinations of Dropp and Harvade gave no improvement over equal concentrations of Harvade alone (Data not shown).

The results for the 1998 experiment are presented in Table 1. The best defoliation result was obtained with 2 applications of Harvade at 800 ppm, however, this treatment also promoted excessive berry drop. One application of Harvade at 1600 ppm provided reasonably good defoliation results (71%) with acceptable berry drop levels (1%). There was very little additional berry drop for the cold-stored holly stems over the 3 month storage period and there was no significant difference in berry drop among treatments due to time of storage (data not shown).

Significance to Industry: This study shows that chemical defoliants have the potential for reducing or eliminating hand-defoliation of cut holly stems harvested for use in Christmas decorations.

Table 1. Percent leaf drop and percent berry drop for *Ilex verticillata* 'Winter Red' following defoliant treatments. 1998.

Treatment	Concentration	% Leaf drop	% Berry drop
Control (Latron)[z]	0.15 ml/l	31 c[x]	0.1 de
Control (Latron)	0.15 ml/l (2x)[y]	27 c	0 e
Dropp	800 ppm	30 c	0.1 de
Dropp	800 ppm (2x)	34 c	0.1 de
Dropp	1600 ppm	35 c	0.2 de
Harvade	200 ppm	34 c	0.1 de
Harvade	200 ppm (2x)	36 c	0.2 de
Harvade	400 ppm	32 c	0.1 de
Harvade	400 ppm (2x)	62 b	1.4 b
Harvade	800 ppm	38 c	0.6 cd
Harvade	800 ppm (2x)	89 a	3.9 a
Harvade	1600 ppm	71 b	1.1 bc

[z] Latron B-1956 spreader-sticker included with all treatments at 2 oz/100 gal.

[y] 2x means treatment was applied twice, first on October 7, 1998, and again on October 14, 1998. Otherwise, treatment applied only on October 7.

[x] Means within a column having the same letter are not significantly different at $P \leq 0.05$.

Percent berry drop analysis performed following square root transformation, $(x + 0.5)^{1/2}$.