SECTION 7
GROWTH REGULATORS

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Effects of Sumagic on 'Prize' Azalea Dependent on Shoot Apex Stage of Development

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Nature of Work: Growth retardants (GRs) are applied to forcing azaleas primarily to promote compact form and hasten flower bud initiation and secondarily to suppress bypass shoot development. Plant response to GRs is dependent upon time of application, among other factors. It is recommended that uniconazole (Sumagic), a triazole GR labeled for forcing azaleas, be applied 4 to 6 weeks after final pinch. However, even when applied according to labeling, the desired response may not always occur, due to cultivar differences or variations in light, temperature or cultural conditions. Application of GRs at the appropriate stage of shoot apex development (SOD) may eliminate much of the unpredictability encountered by growers.

'Prize' azaleas in 6 1/2 inch azalea pots of amended 3 milled pine bark:1 peat moss were obtained from Blackwell Nurseries, Semmes, Ala. and were pruned for uniformity in December 1991. Sumagic was foliarly applied at 15 or 30 ppm at 4 stages of shoot apex development; a nontreated control also was included. Stage of development (SOD) and date of Sumagic application included: SOD 0 (vegetative), January 10, 1992; SOD 1 (apex broadened), February 10; SOD 2-3 (sepal and petal initiation), March 17; and SOD 4 (stamen initiation), March 31. On April 28, plants were placed in the dark at 38°F. After 6 weeks plants were moved to a double polyethylene greenhouse and forced at a minimum temperature of 65°F. When 50% of the flowers on each plant were fully opened the following data were collected: plant height, growth index [(height + $width_1$ + $width_2$)÷3; $width_2$ was perpendicular to $width_l$], bypass shoot number and length, time to flower, and flower number and diameter.

Results and Discussion: Plant height and growth index increased when Sumagic was applied at a later stage of development (SOD); control plants were the largest. These effects were expected since earlier application of Sumagic should result in a more pronounced response to the retardant. Plant height and growth index decreased with increasing rate, except for height at SOD 4 (NS). Treated plants were compact and uniform, while control plants tended to be loose, open and irregular. Bypass shoot number (BSN) and length (BSL) were not influenced by SOD. BSN decreased at the 30 ppm rate to zero but was similar to the control at 15 ppm. There were insufficient data to determine rate effects on BSL.

Time to flower (TTF) and flower number (FN) varied with SOD. Plants treated at SOD 0 or l flowered earlier and with more blooms than control plants. Plants treated with 15 ppm Sumagic at SOD 2-3 flowered at the same time as control plants, and FN's were similar. Plants treated with 30 ppm Sumagic at SOD 2-3 or at SOD 4 flowered after control plants with fewer blooms.

The response of TTF and FN to Sumagic rate varied with SOD. SOD O and l: TTF decreased quadratically and FN increased quadratically (SOD O) or linearly (SOD l) with increasing rate. SOD 2-3 and 4: TTF increased linearly and FN decreased linearly with increasing rate.

Flower diameters (FD) of plants treated at SOD 0 and 1 were similar to those of control plants and greater than those of plants treated at SOD 2-3 (30 ppm) or 4. Sumagic rate did not affect FD at SOD 0 and l but decreased FD at SOD 2-3 and 4.

Flowering of plants that received the following treatments was very late and inconsistent (a few blooms opened at a time with no pronounced peak); these plants were considered unmarketable:

SOD	Sumaqic (ppm)	No. of unmarketable plants
2-3	30	7 of 8
4	15	2 of 7
4	30	8 of 8
—	o	2 of 8

Significance to Industry: Based upon results of this test with 'Prize', it is best to treat plants at SOD 0 with 15 ppm Sumagic. These plants flowered 16 days earlier, had twice as many blooms and were more compact and uniform than control plants.

The Response of Buffalograss to Primo

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Texas

Nature of Work: Interest in buffalograss *[Buchloe dactyloides* (Nutt.) Engelm.] has increased because of it's low maintenance requirements and tolerance to drought. It exists throughout the Great Plains and can thrive in diverse environments. Buffalograss is therefore a good lawn grass for the semi-arid conditions of the Plains. Some observers who find that the male flower, which is borne above the surface of the turf, detracts from the appearance of buffalograss lawns have initiated breeding programs. The buffalograss selection 'Prairie' contains only female plants which bear flowers closer to the ground than the male plants (3).

Plant growth regulators are being used on many turf grasses to reduce the time and costs incurred in mowing. Newer plant growth regulators last for longer periods of time and cause less damage than their predecessors (2), and on large turf areas have shown the ability to both retard growth and reduce seed head production in some grasses (4). We applied the plant growth regulator Primo (Trinexapac-ethyl, Ciba-Geigy) to determine its effect on seed head production and its ability to control the growth habit of buffalograss turf. A stand of common buffalograss in Abernathy, Texas was used for the test plots.

Plots in this study measured 5 x 20 feet and were replicated four times in a randomized block design. One end of each plot was fertilized with a drop spreader and these fertilized halves constituted a sub-plot factor. Applications of Primo were made with a hand-held boom sprayer at the application rates recommended for bermudagrass (1). The rates used were .5, 1, and 2 oz./1000 sq. ft. and a zero-rate control with nothing applied to it. We fertilized with 16N-8P_2O_5-8K_2O at a rate of 10 lbs./1000 sq. ft. The measurements taken during the study period included seed head counts, plot height, and clipping weights. Seed head counts were taken within a one meter square quadrat (10.8 sq. ft.) that was placed randomly inside the subplot areas. Two applications of Primo were made to determine if there was any benefit to a second application after the grass was mowed, and to determine any effect of carry-over. Six weeks after the first application, the grass was mowed and the clippings were weighed. One half of the plots were then treated a second time.

Results and Discussion: The reduction of growth in the plots that were fertilized was as great as 74% when measured by clipping weight (Fig. 1). This was a significant change at the highest use rate. There was an 86% difference in seed head production when plots were treated at the highest rate (Fig 2.). The reduction in seed heads was statistically different at all rates of Primo that were applied. There was also a 42% change in plot height between the control and the 2 oz. treatment level (Fig. 3) which was also statistically significant. Comparisons for significance were made among fertilized sub-plots and among unfertilized sub-plots. There was no evidence that Primo had the ability to carry-over and affect the growth of the turf after it was mowed (data not shown). This was true at all application rates and would indicate the need for a second application to control the growth of buffalograss turf after being mowed, especially several weeks after the initial treatment.

The most marked effect on buffalograss growth was made by the application of fertilizer. Fertilizer allowed the buffalograss to grow quite quickly in a short period of time, while the unfertilized areas grew much slower. Sub-plots that were not fertilized therefore, showed little or no response to Primo during the test period. It is likely that a lawn grown at a residence would be fertilized in order to produce a high-quality dark green turf. However, low maintenance areas that are not fertilized are likely to show a similar lack of response.

Significance to Industry: Plant growth regulators like Primo may provide an opportunity to improve the appearance and at the same time reduce the mowing frequency required to maintain lawns made of buffalograss. Results indicate that only fertilized buffalograss will respond to Primo.

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1. Anonymous. Information supplied by Ciba-Geigy Chemical Co. on Primo.

2. Dipaola, J. M. 1992. Regulating turfgrass growth. Grounds Maintenance. 10: 29-32.

3. Engelke, M. C. and V. G. Lehman. 1990. Registration of Prairie buffalograss. Crop Sci. 30: 1360.

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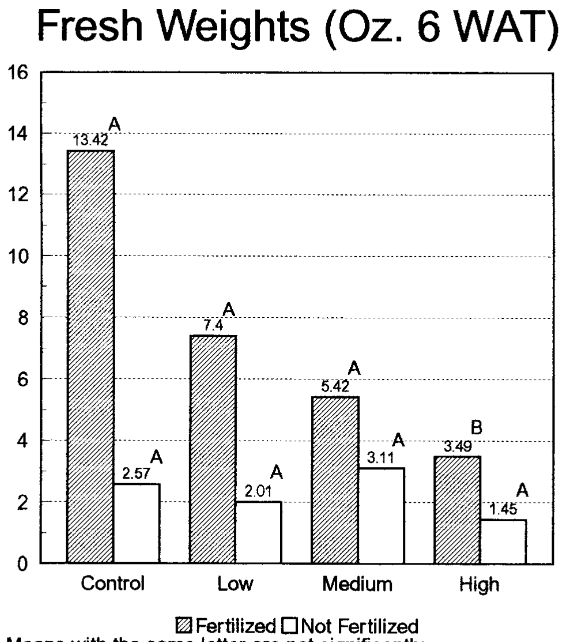
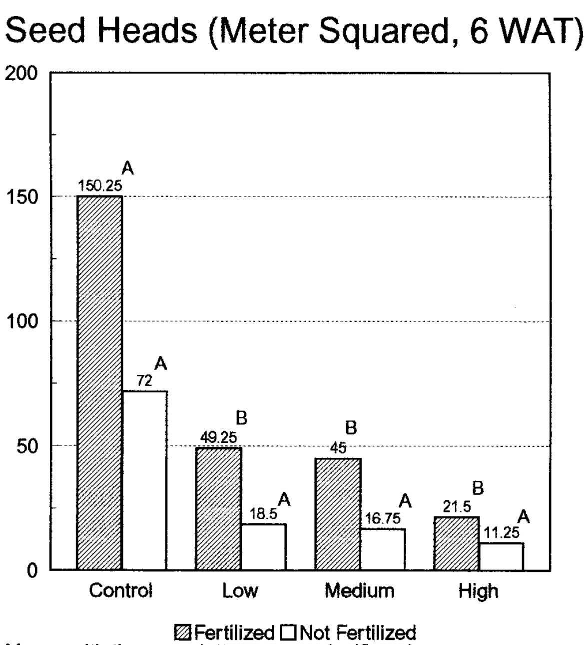


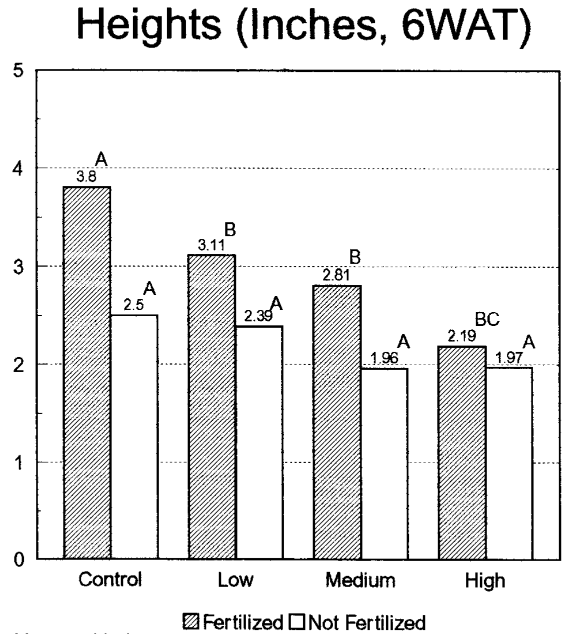
Means with the same letter are not significantly different, P>.05 LSD.

Fig. 1.



Means with the same letter are not significantly different, P>.05 LSD.

Fig. 2



Means with the same letter are not significantly different, P>.05 LSD.

Fig. 3

Pine Bark and Peat Based Media Influence the Effects of Paclobutrazol (Bonzi) Spikes on 'Celebrate 2' Poinsettias

Jesse R. Quarrels, Jeffrey S. Tant, and Steven E. Newman
Mississippi

Nature of Work: The poinsettia, *Euphorbia pulcherrima,* is the number one flowering pot plant in the United States (Ecke et al.,1990). Current cultivars are longer lasting, have shorter growth habits, and are easier to grow, but height control is still the major problem in growing poinsettias. Most cultivars would not meet the height or size requirements without cultural practices that regulate growth (Hartley, 1992). Growers pinch poinsettias to control final height, but this alone will not always have the desired height control effect, therefore, most growers rely on chemical plant growth regulators to control the height of poinsettias (Hartley, 1992). Paclobutrazol, a fairly new plant growth regulator, requires substantially lower application rates than other labeled regulators, while still yielding the desired height control effect (Davis et al., 1988). Paclobutrazol (Bonzi) has been shown to be effective either as a spray or drench, but it is difficult to apply small amounts of the chemical with precision (Barrett, 1982). In an effort to offset the application difficulty, a spike has been developed to provide a more precise slow release method of application. Previous studies involving paclobutrazol have shown that the base organic material of the media influences the activity of the growth regulator (Barrett, 1982; Lamont, 1986). The objective of this study was to determine the influence of eight commercial media, four pine bark-based and four peat-based, on the effect of paclobutrazol spikes applied to ‘Eckespoint Celebrate 2’ poinsettias.

Rooted cuttings of ‘Eckespoint Celebrate 2’ poinsettias were potted in 6 inch (15 cm) azalea pots on August 20, 1992. The four pine bark-based media were Metro 360 (M360), Metro 366 (M366), Metro 700 (M700), and Metro 702 (M702). The peat-based media were Baccto Growers Mix (BG), Baccto High Porosity Professional Mix (HP), Baccto High Porosity Professional Mix with Bacctite (HPB), and Baccto Rockwool Mix (RW). A constant liquid feed fertility program using 15N-2.2P-12.5K (Peters Excel 15-5-15 Cal/Mag, Grace/Sierra) was applied at 300 mg N/liter (200 ppm) from the beginning of the study and terminated three weeks prior to the end of production. All plants were pinched to 5 to 7 nodes on September 3, 1992. The plants were grown in a double polyethylene greenhouse with a minimum night temperature of 68°F (20°C) and a maximum day temperature of 82°F (28°C).

An 8x2x10 factorial split plot completely randomized design was used to test the influence of the eight media on the effect of paclobutrazol on poinsettias. There were 10 treatments, eight spike treatments and two drench treatments. The concentrations of paclobutrazol spikes were 0.001,0.005, or 0.020 oz. a.i./spike (0.0625, 0.25, or 1 mg a.i./spike) The number of spikes applied to each pot were 1, 2, 4, 6 or 8. The treatment rates were 0, 0.005, 0.010, 0.015, 0.020 or 0.040 oz. a.i./pot (0.125, 0.250,0.375,0.500 or 1.00 mg a.i./pot). The spikes were inserted into the media 1 inch (2.5 cm) from the stem of the plant. In all treatments requiring more than one spike, the spikes were placed equidistant from each other around the stem of the plant. The two drench treatments were applied two weeks after pinch at rates of 0.01 and 0.02 oz. a.i./pot in 8 oz. tap water (0.25 and 0.50 mg a.i./pot in 250 ml tap water). There were five single plant observations per treatment. Stem length (length of shoots when excised at the original break) was recorded at harvest, as well as bract dry weights.

Results and Discussion: Paclobutrazol spike and drench treatments reduced shoot length of ‘Eckespoint Celebrate 2’ poinsettias in all treatments (Table 1). Overall, the spikes were more effective than the drench treatments at reducing shoot length. All paclobutrazol treatments were less effective in the pine bark-based media. Bract dry weight of ‘Eckespoint Celebrate 2’ was influenced by all treatments. All plants receiving spike treatments had lower bract dry weight than plants receiving drench treatments (Table 1). Plants grown in the peat-based media were more sensitive to paclobutrazol than those grown in pine bark-based media.

There were some noticeable differences within both the peat-based and the pine bark-based media. RW grew plants with longer stems and greater bract dry weight than the other peat-based media. Within the pine bark-based media, M360 and M366 were the most sensitive to the spike and drench treatments, with M366 the more sensitive. These two media have a larger proportion of sphagnum peat moss and a lower proportion of pine bark than the other two pine bark-based media (M700 and M702).

Significance to the Industry: Paclobutrazol is an effective plant growth retardant when applied to poinsettias as either a spike or drench. Its effectiveness is modified by the base components of the growth media. The spikes were more active than the drench and should be used at lower rates. Plants grown in peat-based media are more sensitive to these products than when grown in pine bark-based media, therefore, the base components must be considered when determining the level of plant growth requlator to be used. The introduction of a spike to the industry as a means of accurate plant growth retardant delivery will be useful to greenhouse and nursery growers.

Literature Cited:

1. Barrett, J.E. 1982. Chrysanthemum height control by ancymidol, PP333, and EL-500 dependent on medium composition. Hortscience 17: 737-738.

2. Davis, T.D., G.L. Steffens, and N. Sankhla. 1988. Triazole plant growth regulators. Horticultural Reviews. 10:63-105

3. Ecke, P. Jr., O.A. Martin, and D.E. Hartley. 1990. The Poinsettia Manual. Encinitas, CA. Paul Ecke Poinsettias .

4. Hartley, D.E. 1992. Poinsettias. In: Roy A. Larson (Ed.), Introduction to Floriculture (pp. 306-331). Academic Press, Inc., San Diego, CA.

5. Lamont, G.P. 1986. Evaluation of growth retardants for controlling height of Geraldton wax flowers *(Chamelaucium uncinatum* Schauer.). Scientia Hort. 29:363-371.

Table 1. Shoot length and bract dry weight of 'Eckespoint Celebrate 2' poinsettias as influenced by paclobutrazol applied as a drench or spike and media.

	Paclobutrazol Rate (mg a.i./pot) and Application Method					
	0.25 ma			0.50 ma		
Media	Drench	Spike[z]	Pr>F	Drench	Spike[y]	Pr>F
	- - - - - - - - - - - - - - - - shoot length (cm) - - - - - - - - - - - - - - - - -					
Peat Moss-Based						
Baccto Grower's Mix	9.6	7.6	**	8.7	6.4	**
Baccto High Porosity	10.9	7.4	***	8.1	5.2	**
Baccto High Porosity with Bacctite	11.0	8.1	*	9.6	6.5	*
Baccto Rockwool	10.3	9.5	NS	8.1	7.8	NS
Pine Bark-Based						
Metro-Mix 360	13.6	10.0	****	10.0	6.5	****
Metro-Mix 366	13.4	8.9	* * * *	11.3	6.4	* * * *
Metro-Mix 700	13.6	10.6	*	11.7	9.2	NS
Metro-Mix 702	13.5	12.1	NS	12.8	10.3	NS
L-S-D-(∝ =0 06) = 2 2[x]						
	- - - - - - - - - - - - - — bract dry weight (g) - - - - - - - - - - - - - - - -					
Peat Moss-Based						
Baccto Grower's Mix	4.74	4.33	NS	3.90	3.78	NS
Baccto Hiah Porosity	6.79	4.66	**	6.16	2.78	***
Baccto High Porosity with Bacctite	4.79	3.54	NS	3.89	2.74	NS
Baccto Rockwool	6.25	5.57	NS	4.79	4.74	NS
Pine Bark-Based						
Metro-Mix 360	9.28	6.14	**	7.77	3.93	****
Metro-Mix 366	4.71	3.53	NS	5.16	3.29	**
Metro-Mix 700	8.23	5.38	**	6.74	4.72	*
Metro-Mix 702	6.34	5.83	*	6.21	4.85	NS
L.S.D.(∝ =006,= 1.63[x]						

NS Not Significant.
* Significant at the 0.05 level.
** Significant at the 0.01 level.
*** Significant at the 0.001 level.
* * * * Significant at the 0.0001 level.
[z] Average of treatment having one spike and treatment having four spikes.
[y] Average of treatment having two spikes and treatment having eight spikes.
[x] L.S.D. = Least Significant Difference.

Pine Bark and Peat-based Media Influence the Effects of Paclobutrazol (Bonzi) and Uniconazole (Sumagic) Drench on 'Gutbier V-14 Glory' Poinsettias

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Mississippi

Nature of Work: Poinsettias today are longer lasting, have shorter growth habits, and are easier to grow. Despite the development of shorter-growing cultivars, the control of plant height is still one of the most important tasks in the production of high-quality poinsettias. Most cultivars would not meet the prescribed height or size requirements without cultural practices that regulate growth (Hartley, 1992). Pinching is done by most growers to help control the final height of poinsettias, but this alone will not always produce a marketable plant. More growers than not use chemical growth regulators to retard the growth of poinsettias (Hartley, 1992). Two new growth regulators, paclobutrazol and uniconazole, are labelled for use on poinsettias; uniconazole, however, is currently labelled for poinsettia drench applications in the state of Florida, yet may be applied as a spray elsewhere. These two chemical compounds are triazoles and require substantially lower rates than traditional growth regulators, while yielding the desired height control without exhibiting phytotoxic effects (Davis et al., 1988). Previous research with paclobutrazol and uniconazole has shown that the base organic material of the media influences the activity of the growth regulator (Barrett, 1982; Lamont,1986). Because of the wide variety of container media used by greenhouse growers, and their effect on plant growth regulator activity, more research is needed in this area. The objective of this study was to determine the influence of eight commercial media, four pine bark-based and four peat-based, on the effects of paclobutrazol (Bonzi) and uniconazole (Sumagic) drenches applied to 'Gutbier V-14 Glory' poinsettias.

Rooted cuttings of 'Gutbier V-14 Glory' poinsettias were potted in 6 inch (15 cm) azalea pots on August 20, 1992. The four pine bark-based media were Metro 360 (M360), Metro 366 (M366), Metro 700 (M700), and Metro 702 (M702). The peat-based media were Baccto Growers Mix (BG), Baccto High Porosity Professional Mix (HP), Baccto High Porosity Professional Mix with Bacctite (HPB), and Baccto Rockwool Mix (RW). A constant liquid feed fertility program using 15N-2.2P-12.5K (Peters Excel 15-5-15 Cal/Mag, Grace/Sierra) was applied at 300 mg N/liter (300 ppm) from the beginning of the study and terminated three weeks prior to the end of production. All plants were pinched to 5 to 7 nodes on September 3, 1992. The plants were grown in a double polyethylene greenhouse with a minimum night temperature of 68°F (20°C) and a maximum day temperature of 82°F (28°C).

An 8x2x5 factorial split plot completely randomized design was used to test the influence of the eight media on the effect of paclobutrazol and uniconazole on poinsettias. The drench treatments were applied two weeks after pinch at rates of 0, 0.125, 0.250, 0.375 and 0.500 mg a.i./pot in 250 ml tap water (0, 0.005, 0.010, 0.015, 0.020 oz a.i./pot in 8 oz tap water). There were five single plant observations per treatment. All plants were harvested at anthesis. Stem length (length of stems when excised at the original break) was recorded at harvest, as well as bract dry weights.

Results and Discussion: Paclobutrazol and uniconazole drench applications reduced shoot length of ‘Gutbier V-14 Glory’ poinsettias in all treatments (Table 1). Uniconazole drench treatments were more effective at reducing shoot length than were paclobutrazol drench treatments. All treatments were less effective in the pine bark-based media than in the peat-based media. Of the four pine bark media receiving paclobutrazol drench applications, plants grown in M360 and M366 were the least affected overall, regarding shoot length. Plants grown in M700 and M702 were the most sensitive to paclobutrazol drenches. Of the four peat mixes, plants grown in HP were the most sensitive to paclobutrazol, and plants grown in RW were, on average, the least sensitive to paclobutrazol in regard to shoot length. For plants treated with uniconazole drenches, those grown in M702 were the most sensitive of the pine bark-based media, and those grown in M366 were the least sensitive.

Bract dry weight of poinsettias grown in RW, M700, and M702 media was reduced by paclobutrazol drench treatments and bract dry weight was reduced by uniconazole drench treatments in RW, M360, M366, and M700 media (Table 2). Generally, plants grown in the peat-based media had a lower bract dry weight than those grown in pine bark-based media in both the paclobutrazol and uniconazole treatments except at 0.375 mg a.i./pot or greater.

Both paclobutrazol and uniconazole were shown in this study to be effective in controlling plant height of poinsettia. The uniconazole drenches were more effective than the paclobutrazol drenches in controlling plant height. This suggests that lower rates of uniconazole may be used to achieve the same height control as a given rate of paclobutrazol. All treatments in this study were influenced by the media composition. Plants grown in the four peat-based media were more sensitive to all paclobutrazol and uniconazole treatments than were plants grown in the four pine bark-based media. All control plants grown in the peat-based mixes, with the exception of RW, were generally shorter with lower bract dry weights than control plants grown in the pine bark-based mixes. This indicated that peat-based media would require fewer growth regulator applications than a pine bark-based media.

Significance to the Industry: Paclobutrazol and uniconazole are effective plant growth retardants when applied to poinsettias as a drench. There effectiveness is modified by the base components of the growth media. Uniconazole is more active than paclobutrazol and should be used at lower rates. Plants grown in peat-based media are more sensitive to these products than when grown in pine bark-based media, therefore, the base components must be considered when determining the level of plant growth regulator to be used.

Literature Cited:

1. Barrett, J.E. 1982. Chrysanthemum height control by ancymidol, PP333, and EL-500 dependent on medium composition. Hortscience 17: 737-738.

2. Davis, T.D., G.L. Steffens, and N. Sankhla. 1988. Triazole plant growth regulators. Horticultural Reviews. 10:63-105

3. Hartley, D.E. 1992. Poinsettias. In: Roy A. Larson (Ed.), Introduction to Floriculture (pp. 306-331). Academic Press, Inc., San Diego, CA.

4. Lamont, G.P. 1986. Evaluation of growth retardants for controlling height of Geraldton wax flowers *(Chamelaucium uncinatum* Schauer.). Scientia Hort. 29:363-371.

Table 1. Stem length of 'Gutbier V-14 Glory' poinsettias as influenced by paclobutrazol and uniconazole drenches.

	Media							
	Peat Moss-Based				Pine Bark-Based			
Rates	BG[z]	HP[Y]	HPB[X]	RW[W]	M360[V]	M366[U]	M700[t]	M702[s]
	- - - stem length (cm) - - -							
	Paclobutrazol							
0.000	19.4	18.4	18.0	20.7	28.5	31.2	23.0	24.5
0.125	11.9	11.8	14.7	14.9	19.9	17.5	16.7	16.7
0.250	11.4	10.3	16.4	10.4	15.6	17.0	14.0	15.7
0.375	9.8	8.5	15.2	9.4	13.2	15.8	13.6	13.5
0.500	9.6	7.9	11.2	9.5	12.0	12.0	12.9	12.9
Linear	****	****	**	****	****	****	****	****
Quadratic	****	****	*	****	****	****	****	****
Cubic	****	****	*	****	****	****	****	****
L.S.D. $_{(\alpha=0.05)}$=2.10[r]								
	Uniconazole							
0.000	19.9	18.0	21.4	28.9	29.1	29.5	28.1	18.9
0.125	9.4	8.4	9.7	8.7	13.5	12.8	12.3	10.1
0.250	8.8	6.3	10.1	8.2	10.2	9.7	8.9	8.0
0.375	7.6	6.2	7.9	7.6	9.8	9.8	9.7	9.2
0.500	8.2	6.1	6.5	7.2	8.8	9.4	9.7	8.4
Linear	****	****	****	****	****	****	****	****
Quadratic	****	****	****	****	****	****	****	****
Cubic	****	****	****	****	****	****	****	****
L.S.D. $_{(\alpha=0.05)}$ = 2.10[r]								

NS Not Significant
* Significant at the 0.05 level
** Significant at the 0.01 level
*** Significant at the 0.001 level
* * * * Significant at the 0.0001 level
z Baccto Grower's Mix
y Baccto High Porosity Professional Mix
x Baccto High Porosity Professional Mix with Bacctite
w Baccto Rockwool Mix
v Metro-Mix 360
u Metro-Mix 366
t Metro-Mix 700
s Metro-Mix 702
r L.S.D. = Least Significant Difference

Table 2. Bract dry weight of 'Gutbier V-14 Glory' poinsettias as influenced by paclobutrazol anduniconazole drenches.

	Media							
	Peat Moss-Based				Pine Bark-Based			
Rates	BG[z]	HP[y]	HPB[x]	RW[w]	M360[v]	M366[u]	M700[t]	M70[s]
	---------------------- bract weight (cm) ----------------------							
	Paclobutrazol							
0.000	8.4	6.5	6.2	17.9	17.4	20.5	10.7	9.6
0.125	7.1	6.2	6.1	9.7	11.5	11.9	10.1	8.9
0.250	7.5	5.8	6.2	7.8	9.5	10.0	8.8	8.4
0.375	6.4	4.6	6.0	9.3	9.1	9.7	8.1	7.7
0.500	7.1	4.6	5.0	8.8	8.8	8.7	9.3	6.5
Linear	NS	*	NS	NS	***	****	NS	**
Quadratic	NS	NS	NS	NS	* * * *	* * * *	NS	*
Cubic	NS	NS	NS	NS	* * *	* * * *	NS	NS
L.S.D. $_{(\alpha = 0.05)}$ = 2.45[r]								
	Uniconazole							
0.000	9.04	8.91	9.00	18.78	18.65	20.68	19.25	8.66
0.125	5.35	5.54	5.78	6.80	11.09	9.37	8.85	6.43
0.250	6.62	4.29	6.45	7.76	7.65	8.63	6.89	8.41
0.375	4.82	4.72	6.50	7.34	7.99	6.89	7.95	7.31
0.500	6.22	6.05	5.32	5.97	5.98	8.33	8.77	7.04
Linear	*	*	**	***	****	**	**	NS
Quadratic	**	****	**	****	****	****	****	NS
Cubic	*	****	***	****	****	***	****	NS
L.S.D. $_{(\alpha = 0.05)}$ = 2.45[r]								

NS Not Significant
* Significant at the 0.05 level
** Significant at the 0.01 level
*** SignificantattheO.001 level
* * * * Significant at the 0.0001 leve
[z] Baccto Grower's Mix
[y] Baccto High Porosity Professional Mix
[x] Baccto High Porosity Professional Mix with Bacctite
[w] Baccto Rockwool Mix
[v] Metro-Mix 360
[u] Metro-Mix 366
[t] Metro-Mix 700
[s] Metro-Mix 702
[r] L.S.D. = Least Significant Difference

Royal Slo-Gro Eliminates Pruning of Container-Grown Juniperus chinensis 'Pfitzeriana'

Jeffrey G. Norcini and James H. Aldrich
Florida

Nature of Work: Several plant growth regulators (PGRs) can be utilized for reducing the amount or frequency of pruning during production of woody landscape plants. Atrimmec (dikegulac) is registered for use on a broad range of species while Royal Slo-Gro (maleic hydrazide) and Retard (maleic hydrazide) are registered for use on a much narrower range of species. Recently developed PGRs such as Cutless (flurprimidol), Sumagic (uniconazole), and Bonzi (paclobutrazol) have shown potential for use in production of woody landscape plants (1, 2, 3, 4). The purpose of this study was to assess the effect of PGRs on the frequency and amount of pruning (utilizing grower pruning practices) required during container production of Pfitzer juniper.

The experiment was set up to accurately reflect local grower conditions and practices. Rooted liners of Juniperus chinensis L. 'Pfitzeriana' were obtained from a local nursery. On March 3, 1990, plants were potted into 1-gal containers filled with a medium consisting of pine bark, Canadian sphagnum peat, and sand (3:1:1 by vol.); initial pH was 5.6. One cubic yard of medium was amended with 10.4 lb dolomite, 5.2 lb superphosphate, 1.6 lb Micromax, and 10.4 lb Osmocote 18-612. A top dressing of 0.5 oz per pot Osmocote 18-6-12 was applied on March 4 and June 1, 1990. The experiment was conducted under full sun. An average of 0.21 inches water was applied daily via overhead irrigation.

On March 19, 1990 all plants were pruned to obtain uniform shape and size and were then sprayed to wet with Atrimmec (PBI/Gordon, Kansas City, Missouri), Cutless 10WP (DowElanco, Indianapolis, Ind.), or Royal Slo-Gro (Uniroyal, Middlebury, Conn.) as listed in Table 1. Height (H), width at the widest point (W1), and width perpendicular to the widest point (W2) were measured biweekly (until December 12, 1990) and used to calculate a growth index (GI = [H+((W1 +W2)/2)]/2). When half or more of the plants within a treatment required additional pruning (based on local grower recommendations), plants were pruned and the PGRs were reapplied. Clippings were collected, dried, and weighed. Final plant growth habit was visually assessed by the authors in mid-December 1990.

Results and Discussion: Royal Slo-Gro at 7200 ppm (2X label recommendation) eliminated the need for additional pruning of Juniperus during the growing season. Furthermore, this rate of Royal Slo-Gro did not detrimentally affect final size or growth habit as compared to the controls (Table 1). At 4200 ppm (1.5X label recommendation), Royal Slo-Gro delayed additional pruning about a month; however, reapplication significantly inhibited growth resulting in excessively small plants. Although this growth inhibition was excessive for production, it might have been useful in a landscape situation. Neither Atrimmec or Cutless eliminated pruning of Juniperus. None of the PGRs reduced clippings dry weight of Juniperus that received additional pruning (Table 1).

Significance to the Industry: Royal Slo-Gro at the 2X label rate applied to liners of Pfitzer juniper immediately after pruning eliminated the need for additional pruning during the growing season. Treated plants were similar in size and growth habit to plants that had received additional pruning during the growing season but were not treated with any PGR.

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Table 1. Effect of plant growth regulators on pruning and total growth of Juniperus chinenesis 'Pfitzeriana' grown in 1-gal containers.

Growth Regulator	Rate (ppm)	Pruning date[z]	Clippings dry wt (oz)	Increase in GI (in)[y]
Control	——	6/21	0.29	16.3
Atrimmec	600	6/21	0.25	16.9
Cutless	15	6/21	0.35	16.1
Cutless	45	6/21	0.29	14.6
Cutless	75	6/21	0.38	15.1
Royal Slo-Gro	3600	6/21	0.28	8.0
Royal Slo-Gro	5400	7/16	0.38	4.6
Royal Slo-Gro	7200	NR[x]	—	15.8
LSD 5 % (Protected)			—	3.4
Significance			NS	* * *

[z] All plants within a treatment were pruned when 50% or more of the plants within that treatment required pruning.

[Y] GI (Growth Index) = (Height + ([W1 + W2]/2))/2, where W1 width at the widest point and W2 =width perpendicular to W1.

[x] NR = Pruning not required. NS, Nonsignificant or significant at P = 0.001, respectively.

Response of Catharanthus roseus (Vinca) to Shearing and Application of Uniconazole (Sumagic)

Thomas J. Banko and Marcia A. Stefani
Virginia

Nature of Work: An experiment was conducted during commercial production of Catharanthus roseus (Periwinkle, Vinca) to compare shearing, applications of Sumagic (uniconazole), and combinations of the two for maintaining compact growth. Plants of the cvs. ‘Peppermint Cooler’ and ‘Grape Cooler’ were grown in 6x5 in. containers in a ventilated, poly-covered house by a wholesale grower in Suffolk, Virginia, during the spring of 1993. Plants in the experiment were maintained by the grower in the same manner as the rest of the crop*. On 7 May, the plants were sheared as part of the grower’s normal procedure for keeping them from getting too leggy. Some of the treatment plants were left unsheared, however. At that time, the unsheared plants had reached a height of about 6 inches (15 cm). The plants were sheared to about 3.5 inches (9 cm) in height. Two days or nine days later, Sumagic sprays of 0, 5, or 10 ppm were applied to the sheared and unsheared plants. The experimental design was completely randomized with 4 replications per treatment. Each experimental unit consisted of a group of 9 plants but only the center 3 plants of each unit were evaluated. The remaining 6 plants were considered border plants. Each cv. was treated as a separate experiment. On 20 May the plants were measured and evaluated for appearance. The majority of the grower’s Vinca crop was being shipped at this time. Internode lengths (the most recently fully-elongated internode on each of 3 main shoots) were measured on 24 May.

Results and Discussion: Previous work has shown that Sumagic is very effective in inhibiting growth of Vinca (1). However, the grower wants to produce a plant that is a good size for the retail market, fills the pot, but is not leggy or floppy during shipping. Shearing the plants without a Sumagic treatment produced fuller plants than leaving them unsheared, but they still had a somewhat leggy appearance. Treating with Sumagic 2 days after shearing produced very compact plants (Tables 1 and 2) but they were somewhat small. Treating 9 days after shearing was too late for growth control prior to shipping. The treated plants showed little difference in size or appearance from the controls. The plants that most consistently received the highest grower ratings were the unsheared plants that were treated with 5 or 10 ppm Sumagic 2 days after the plants would normally be sheared (about 6 inches in height). These plants were large enough to fill the pots, full, with large, dark green leaves, and sturdy stems with short internodes.

Significance to Industry: Sumagic was very effective in controlling growth of Vinca. Application to sheared and unsheared plants was compared. The treatments that received the highest grower ratings were 5 or 10 ppm Sumagic sprays applied to unsheared plants at the time the grower would normally shear the plants. These treatments would also save the grower the time and expense of shearing.

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*We would like to thank Lancaster Farms, Inc. for supplying the plants and research space for this study, and Mr. Sam Saunders for his help in setting up the experiment and evaluating it.

Table 1. Effects of Sumagic applied to Catharanthus roseus 'Peppermint Cooler' unsheared and 2 and 9 days after shearing.

Sumagic Application					
Day after shearinq	Conc. (ppm)	Height (cm)	Width (cm)	Internode ln. (cm)	Visual rating[z]
Not sheared	0	22.8a[y]	26.5a	4.7ab	l.0e
	5	17.5b	22.0bc	2.3c	4.5ab
	10	16.3b	20.5c	l.9c	4.8a
2	0	17.3b	25.0ab	5.4a	2.5d
	5	10.5c	17.3d	1.5c	3.5bcd
	10	10.8c	19.3cd	1.5c	4.0abc
9	0	17.5b	24.5ab	4.7ab	3.3cd
	5	17.3b	22.0bc	4.Ob	2.8d
	10	16.8b	24.0ab	4.5ab	3.3cd

[z] Visual rating provided by the grower for preferred size and form at time of shipping. 5=most desirable; l=least desirable.

[y] Mean separations within columns by LSD, 5% level.

Table 2. Effects of Sumagic applied to Catharanthus roseus 'Grape Cooler' unsheared and 2 and 9 days after shearing.

Sumaqic Application					
Day after shearing	Conc. (ppm)	Height (cm)	Width (cm)	Internode In. (cm)	Visual rating[z]
Not sheared	0	24.0a[y]	22.8a	4.8a	l.0c
	5	17.5b	18.3cd	2.lde	3.3b
	10	17.5b	l9.0bcd	1.7e	4.5a
2	0	l9.0b	20.8abc	4.lab	2.3b
	5	11.5d	l9.0bcd	1.6e	4.5a
	10	13.5cd	18.0d	2.2de	3.3b
9	0	16.8bc	20.3abcd	3.1c	2.3b
	5	17.0bc	20.3abcd	2.9cd	3.3b
	10	18.3b	21.3ab	3.2bc	2.3b

[z] Visual rating provided by the grower for preferred size and form at time of shipping. 5=most desirable; l=least desirable.

[y] Mean separations within columns by LSD, 5% level.

Chemical Growth Regulation of Established Landscape Shrubs

Thomas J. Banko and Marcia A. Stefani
Virginia

Nature of Work: Frequent pruning or shearing is often required to maintain desired size and shape of shrubs in the landscape. Growth regulators may be used to reduce the labor and expense of mechanical growth control. Atrimmec (dikegulac) and Trim-Cut (mefluidide) are two growth regulators that are labelled for use on many woody shrubs. Cutless (flurprimidol) is a turf growth regulator that has shown promise in controlling growth of woody plants in containers (1,2,3). However, little has been published on its effectiveness for shrubs established in the landscape. This study evaluates several rates of Cutless applied to four different landscape shrubs, and compares them to label rates of Atrimmec and Trim-Cut.

Plants utilized were well-established plantings of Euonymus kiautschovicus (Spreading Euonymus), Ilex crenata 'Convexa', Eleagnus pungens (Thorny Eleagnus), and Ilex vomitoria (Yaupon holly). They were sheared to uniform heights by species, and spray treatments applied to runoff in the spring of 1992 as follows:

Ilex 'Convexa'- sheared to 5 ft. on 8 April, treated 28 April;
Euonymus - sheared to 3 ft. on 23 April, treated 27 April;
Eleagnus - sheared to 5 ft. on 29 April, treated 30 April;
Ilex vomitoria - sheared to 10 ft. on 2 June, treated 3 June.

Plants were evaluated twice during the growing season by measuring the shoot growth above the point of shearing (Table 1). Shoot weights and numbers of new shoots were also obtained for this study but these data are not presented here. A randomized complete block experimental design was used with 3 single plant replicates for the Eleagnus and the Yaupon Hollies, and 5 replicates for the Ilex 'Convexa' and the Euonymus.

Results and Discussion: Euonymus - the Cutless treatments were very effective in reducing shoot elongation on this plant, with increasing rates providing a significant linear reduction in shoot length both 6 weeks and 14 weeks after treatment. Atrimmec was effective in reducing shoot elongation during the first 6 weeks, however, after 14 weeks, shoot lengths were similar to the those of the controls. Trim-Cut had no significant effect on shoot length. **Ilex 'Convexa'** - The 5000 ppm Cutless produced noticeably shorter shoots than the controls but a further reduction in growth would be desirable. The 5000 ppm Atrimmec was the most effective treatment for this Ilex in terms of reduced shoot elongation. Atrimmec also promoted significantly more shoot production on this plant (data not shown). However, Atrimmec caused a temporary yellowing of the leaves beginning about 2 weeks following application. **Eleagnus-** Cutless provided control of shoot growth during the first six weeks after treatment application, but rapid growth soon resumed and, by 14 weeks after treatment, shoot length had caught up with the controls. Atrimmec was by far the most effective treatment for controlling shoot growth of this plant. Shoot growth was essentially stopped during the first 6 weeks, and shoots remained much shorter than those from the other treatments during the remaining 8 weeks. Atrimmec also stimulated increased numbers of new shoots during this period (data not shown). Trim-Cut provided control at 6 weeks but there was little effect at 14 weeks. **Yaupon Holly** - There was a linear response to increasing rates of Cutless, with 5000 ppm being the most effective Cutless treatment. Atrimmec was a little more effective, however.

Significance to Industry: Cutless was the most effective material in controlling growth of Euonymus kiautschovicus, and the least effective with Eleagnus pungens. Atrimmec, however, was very effective on the Eleagnus but not very effective on the Euonymus. Trim-Cut was generally not effective, except moderately on Eleagnus.

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Table 1. Shoot growth response (cm) of Euonymus kiautschovicus, Ilex crenata 'Convexa', Ilex vomitoria, and Eleagnus pungens to foliar application of Cutless, Atrimmec, or Trim-Cut.

Treatment	ppm	Euonymus	Ilex c.	Ilex v.	Eleagnus
		6 weeks after treatment			
Control	0	9.7a[z]	7.0a	7.5a	17.7a
Cutless	1000	7.3b	4.8c	7.0a	8.2bc
	2000	-	4.6cd	5.9ab	10.3bc
	3000	3.6c	4.8cd	4.3b	10.7bc
	4000	-	4.2cd	5.0ab	7.5bc
	5000	2.9c	3.9d	3.6bc	6.7bcd
Regression Analysis[y]		L	L	L	L
Atrimmec	5000	4.5c	2.3e	l.0c	2.3d
Trim-Cut	1600	8.lab	5.8b	5.0ab	5.9cd
		14 weeks after treatment			
Control	0	19.3a	16.7a	10.7b	53.0a
Cutless	1000	12.Ob	13.8bc	15.0a	46.9a
	2000	-	11.6cd	lO.lbc	47.7a
	3000	6.9c	12.4bcd	9.3bc	47.3a
	4000	-	11.7bcd	9.9bd	52.6a
	5000	4.3c	11.3d	6.6cd	49.6a
Regression analysis L			L	L	L
Atrimmec	5000	16.6a	7.2e	4.5d	4.6b
Trim-Cut	1600	16.0a	14.0b	l0.0bc	38.2a

[z] Mean separation within columns by LSD, P=0.05.

[y] Significance at P<0.05: L=linear, Q=quadratic, NS=not significant; control included in regression.

The Effect of Paclobutrazol (Bonsi) on Shoot Elongation and Flower Bud Set of Container Grown 'Roseum Elegans' Rhododendron

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North Carolina

Nature of Work: Hybrid evergreen rhododendrons are most salable to retail customers as compact, well branched plants flowering in a springtime garden center. Achieving uniform branching plus compaction and abundant flower bud set requires timely pruning as well as skillful manipulation of fertilizer and irrigation. If a chemical treatment could be found that reduces labor as well as the skills required to produce a salable crop, hybrid rhododendrons might be produced less expensively and marketed to a broader segment of the general public. Plant growth regulators have shown promise in reducing growth of woody plants (Keever, et. al. 1989, 1990) but have only shown limited commercial use (Finney and Witte, 1988).

All research was conducted at MHCREC, Fletcher. Quart container grown liners were obtained from Appalachian Nurseries, Waynesboro, PA in April 1992. They were potted into Lerio 300 (trade gallon) containers in a growing medium of 5 parts pine bark and one part Canadian sphagnum peat (v:v) to which 7 lbs of dolomitic limestone per cubic yard had been added and thoroughly mixed prior to potting. Plants were placed outdoors under 50% lath shade for one week to acclimate prior to being placed in full sun on a crushed rock container pad. Irrigation was applied on an as needed basis via Roberts Irrigation spray stakes below the leaf canopy of the plants. No herbicide was applied during this test. Fertilizer used was ProKote Intermediate 22-3-10 from O.M. Scott at 13 grams per pot.

An initial growth index (GI) was determined for each plant by measuring the height and greatest width. The sum of these two figures was divided by two to provide the starting growth index.

Treatments were applied on June 15, 1992 following the first growth flush. Formulations and rates are shown in Tables 1 and 2. Spray was applied with a Polyspray 1 liter pump-up sprayer to the point of run-off without run-off occurring. Twenty-six ounces of spray were applied to 12 plants for each treatment. Drench applications were applied at the rate of 12 ounces of solution per pot. Weather was partly cloudy/overcast with no rain all day. Air temperature at time of treatment was 72°F. Medium temperature was 84°F. Twelve complete blocks were established with treatments randomized within each block utilizing single plant replicates.

Results and Discussion: In October 1992, when they could be differentiated from vegetative buds, flower buds were counted. Bonzi .128% L applied as a soil drench at 10 ppm increased the number of flower buds per plant over the control and all treatments except the 200 ppm Bonzi .128% foliar treatment (Table 1). Flower bud response was statistically the same as the other Bonzi .128% L drench treatments except the 20 ppm treatment. The 20 ppm Bonzi .128% L drench treatment resulted in more buds than all other treatments.

A growth index was determined in October when leaf and stem growth had ceased for the 1992 growing season. The final growth index was determined by measuring the height and greatest width of plants, dividing their sum by two. This final growth index was subtracted from the initial growth index to obtain a growth index for the 1992 growing season. The plants treated with 10 and 20 ppm Bonzi .128% L drench had a lower growth index compared to the control, Bonzi .128% 50 ppm foliar treatment and the Bonzi .4% SC 2.5 ppm drench treatment but they were not significantly less than any of the other treatments (Table 2.)

Since the growth index is a reflection of total growth and the growth regulator treatments were not applied until just before the last flush of growth during the 1992 season, an additional growth measurement was taken. The length of growth from the last node to the terminal of the three longest shoots was measured for each plant. Their average is reported as terminal growth in Table 2.

Terminal growth was less on the Bonzi .128% L 10 ppm and 20 ppm drench treated plants than for any other treatment. The next lower concentration for this treatment, Bonzi .128% L at 5 ppm, had shorter terminals than the control, both Bonzi .4% SC treatments, and the two lowest rates of the Bonzi .128% L foliar treatments.

Significance to Industry: Bonzi .128% L as a 10 and 20 ppm drench resulted in the greatest reduction in plant growth as well as the greatest number of flower buds with no visual symptoms of phytotoxicity. This suggests promise in the commercial use of this product to regulate shoot growth and increase flower bud numbers in hybrid evergreen rhododendrons.

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Table 1. Mean number of flower buds per plant on container grown *Rhododendron cv. '* Roseum Elegans'

Treatment	ppm	Number of Flower buds*
Control	0.0	3.33 c
Bonzi .128% L Foliar	50.0	2.33 c
Bonzi .128% L Foliar	100.0	2.67 c
Bonzi .128% L Foliar	200.0	4.25 bc
Bonzi .4% SC Foliar	50.0	3.17 c
B-Nine 85% SP Foliar	2500.0	2.67 c
Bonzi .128% L Drench	2.5	4.50 bc
Bonzi .128% L Drench	5.0	4.42 bc
Bonzi .128% L Drench	10.0	5.58 b
Bonzi .128% L Drench	20.0	8.89 a
Bonzi .4% SC Drench	2.5	3.08 c

Rp05 Duncan's New Multiple Range Test

Table 2. Growth Index (in.) and average length of terminal growth flush on *Rhododendron cv . '* Roseum Elegans'.

Treatment	ppm	Growth Index*	Terminal Growth*
Control	0.0	15.06 a	2.95 ab
Bonzi .128% L Foliar	50.0	14.77 a	2.88 abc
Bonzi .128% L Foliar	100.0	13.43 ab	2 . . 69 abc
Bonzi .128% L Foliar	200.0	14.27 ab	2.21 cd
Bonzi .4% SC Foliar	50.0	14.53 ab	3.17 a
B-Nine 85% SP Foliar	2500.0	14.46 ab	2.47 bcd
Bonzi .128% L Drench	2.5	14.42 ab	2.53 abcd
Bonzi .128% L Drench	5.0	14.23 ab	2.02 d
Bonzi .128% L Drench	10.0	12.64 b	1.40 e
Bonzi .128% L Drench	20.0	12.58 b	0.98 e
Bonzi .4% SC Drench	2.5	15.06 a	2.71 abc

Rp05 Duncan's New Multiple Range Test

Influence of Growth Regulators on Container-Grown *Salvia farinacea x longispicata* 'Indigo Spires'

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Texas

Nature of Work: 'Indigo Spires' salvia *(Salvia farinacea x longispicata* 'Indigo Spires') is an attractive fast-growing herbaceous perennial recently released by the Huntington Botanical Garden in California. The plant produces intense blue-purple flower spikes (8-12 inches long) throughout the growing season and is considered to have excellent potential as a landscape plant for southern climates (Welch, 1989). Because 'Indigo Spires' salvia is relatively new, no published information exists regarding cultural practices needed to optimize plant production. One serious problem encountered during production is very rapid vegetative growth which results in plants that quickly become too large for their container. This makes it difficult to keep the plants adequately watered and dramatically reduces post-production quality and shelf-life. Furthermore, overgrown plants in containers are easily toppled by wind or mechanical disturbance. For these reasons, a more compact growth habit would be highly desirable during production. The purpose of this study was to evaluate various growth retardants (Bonzi=paclobutrazol, Sumagic=uniconazole, and BNine=daminozide) and application methods (cutting dips, foliar sprays) for their ability to regulate shoot growth of 'Indigo Spires' salvia during container production in a nursery.

The study was conducted in its entirety under standard production practices at Greenleaf Nursery in El Campo, Texas. Cuttings were taken on 15 June and removed from mist on 3 July. Plants were transplanted from 2-inch pots to 1 gallon containers on 20 July. The growth retardants were applied at several rates as indicated in Table 1 using four application methods: 1) soaking- cuttings taken on 15 June were immediately placed in growth retardant solution (20 cuttings per 100 ml of solution) for 24 hours before placement into the 2-inch pots—during soaking the cuttings were held at 24 ° C in a room with fluorescent lighting; 2) quick-dip- the basal 0.5-1 inch of cuttings taken on 15 June was dipped in growth retardant solution for 3 seconds before placement into the 2-inch pots; 3) single foliar spray- on 4 July, rooted cuttings were each sprayed with 7.5 ml of growth retardant solution; 4) double foliar spray- rooted cuttings were each sprayed on 4 July with 7.5 ml of growth retardant solution and again on 22 July with 15 ml of growth retardant solution. Control plants were left untreated. Height of plants from all treatments was measured on 20 July (at the time of transplanting to the 1 gallon containers) and 11 August. In addition, the number of flower spikes per plant and flower spike length were measured on 11 August.

Results and Discussion: Untreated control plants grew rapidly and reached a height of 18 inches at the time of transplanting to the 1 gallon containers (Table 1). Soaking the unrooted cuttings in the growth retardant solutions for 24 hours reduced plant height at transplanting. Sumagic reduced height more than Bonzi or B-Nine. This is in agreement with previous studies with other species where Sumagic was more active than Bonzi in inhibiting shoot growth (Davis et al., 1988). With the soak treatments, the greatest reduction in height occurred with 50 ppm Sumagic where plants were about 8 inches tall at transplanting (Table 1).

Compared to the 24 hour soak treatments, the quick-dip treatments tended to be less effective in reducing plant height at transplanting (Table 1). The greatest reductions in height occurred with the highest concentrations of Sumagic and B-Nine but plant height was at least 15 inches in all quick-dip treatments. Thus these treatments, at least at the dosages used, are probably not suitable for commercial production of ‘Indigo Spires’ salvia, perhaps because of insufficient uptake of the growth retardants.

All of the single foliar sprays applied on 4 July were effective in reducing height at transplanting (Table 1). As with the soaking method, foliar sprays with Sumagic resulted in the greatest reduction in height where plants were just under 12 inches tall. As with other herbaceous species, foliar growth regulator sprays appear to yield adequate short-term height control with ‘Indigo Spires’ salvia.

Following transplanting to the 1 gallon containers, the untreated control plants increased in height by about 8 inches during the subsequent 3 weeks (Table 1). This rapid growth is typical for ‘Indigo Spires’ salvia. In general, plants from the soak, quick-dip (with the exception of the high rates of Sumagic), and single foliar spray treatments grew as much or more than the untreated controls following transplanting (Table 1- compare heights at transplanting vs. final heights). This indicates that the growth-retarding effects of these treatments had subsided. Despite the lack of growth inhibition following transplanting, many of the treated plants were still shorter than the controls on 11 August as a result of the initial period of growth inhibition (Table 1) (e.g. Sumagic and B-Nine soaks and foliar sprays, Sumagic quick-dips, Bonzi foliar sprays at high rates). The shortest plants on 11 August were those treated with 50 ppm Sumagic as a 24 hour soak or foliar spray.

With the double foliar spray treatments, only Sumagic was effective in retarding growth following transplanting to the 1 gallon containers (Table 1). At the highest concentration used (50 ppm), the double foliar spray of Sumagic reduced growth following transplanting to about only 3/4 inch. Foliar application of Bonzi or B-Nine to well-established plants, at least at the dosages administered in this study, is apparently ineffective for controlling shoot growth.

Untreated controls had about 8 flower spikes per plant by 11 August. The growth retardant treatments (with the exception of the 1500 ppm B-Nine foliar sprays or 24 hour soak) tended to decrease the number of flower spikes per plant compared to the control (data not shown). Thus, reduced flower spike number appears to be an inevitable consequence of shoot growth control with 'Indigo Spires' salvia. In contrast, triazole-type growth regulators (i.e. Bonzi and Sumagic) have increased flowering in a variety of woody species while at the same time reducing shoot growth (Davis, 1991). Although the growth retardant treatments tended to reduce flower spike number in the present study, all plants had at least 5 spikes and, in our judgement, would certainly be commercially acceptable especially because they were relatively compact. Most of the growth retardant treatments did not influence mean flower spike length (data not shown). Exceptions were that the Sumagic 24 hour soak treatments consistently caused a slight (1-1.5 inches) reduction in flower spike length and the double foliar sprays of Sumagic at 25 or 50 ppm reduced flower spike length by about 4 inches.

Significance to Industry: The results of this investigation indicate that growth retardants can be effective in reducing excessive shoot growth during the production of 'Indigo Spires' salvia. Sumagic was generally more effective than Bonzi or B-Nine in reducing height of this species. Even with Sumagic, which is generally quite persistent (Davis et al.,1988), the growth-retarding effects were relatively short-lived (less than three weeks) which suggests that post-production growth should not be adversely affected. If longer term growth inhibition is needed, multiple foliar sprays of Sumagic would likely be the most effective. The 24 hour soak and foliar spray application methods were both effective in controlling height but quick-dip treatments were less consistent.

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Table 1. Effects of growth retardants applied at several rates and application methods on height of 'Indigo Spires' salvia plants on two different dates. ±values indicate standard error of the mean (n=20.)

Application Method	Chemical	Concentration (ppm)	Height attransplanting Julv 20 (in.)	Final height Aua. 11 (in.)
Control	untreated	—	18.1±0.4	25.9±0.2
Soak	Bonzi	10	17.1 ±0.6	26.5±0.3
		25	16.2±0.5	28.3±0.4
		50	16.7±0.5	28.1±0.4
	Sumagic	10	14.3±0.7	20.9±0.4
		25	10.9±0.6	19.8±0.4
		50	8.3±0.6	16.8±0.6
	B-Nine	1500	16.2±0.7	24.3±0.5
		3000	15.4±0.6	21.5±0.4
		4500	12.3±0.4	21.8±0.4
Quick-dip	Bonzi	30	17.6±0.5	28.4±0.4
		100	18.0±0.5	26.9±0.4
		500	17.4±0.6	26.1±0.4
	Sumagic	30	16.9±0.6	23.7±0.5
		100	17.1 ±0.4	22.3±0.4
		500	15.9±0.5	21.1±0.3
	B-Nine	1500	17.1±0.4	26.6±0.3
		3000	17.0±0.4	26.3±0.3
		4500	16.0±0.6	26.2±0.3
Single spray	Bonzi	10	14.3±0.4	26.0±0.3
		25	13.9±0.3	24.9±0.5
		50	13.8±0.3	22.2±0.3
	Sumagic	10	11.8±0.2	23.2±0.3
		25	11.5±0.2	21.5±0.2
		50	11.7±0.2	19.1±0.4
	B-Nine	1500	13.7±0.2	22.8±0.2
		3000	12.9±0.2	22.0±0.3
		4500	12.6±0.2	22.8±0.5
Two sprays	Bonzi	10	14.3±0.4	25.3±0.2
		25	13.9±0.3	25.6±0.1
		50	13.8±0.3	22.6±0.2
	Sumagic	10	11.8±0.2	18.7±0.5
		25	11.5±0.2	13.5±0.4

	50	11.7±0.2	12.5±0.3
B-Nine	1500	13.7±0.2	23.1±0.2
	3000	12.9±0.2	22.3±0.3
	4500	12.6±0.2	23.6±0.2
L.S.D.$_{0.5}$		1.3	1.0

Spectral Filtering Liquid Shading Compounds Regulate Growth of Pepper and Polka-Dot Seedlings

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Nature of Work: Morphological growth responses to altered light quality of canopy-shading are similar to growth responses to reduce ligllt quantity including: including elollgated stem internodes and leaf petioles, less branching, and reduced flowering. In contrast, plants grown under artificial shading that provided high red relative to far-red light (high R:FR ratio) or high blue relative to red or far-red light (high B:R and B:FR ratios) had shorter stem internodes and leaf petioles, and increased branching (2, 5). Recently, research has focused on developing artificial shading environments which selectively filter light to a quality that produces plants of a desired morphological form. Most of the techniques being studied require artificial lighting, replacing existing greenhouse glazing, or reconstruction of production facilities to accomodate new types of greenhouse covers (1, 2, 3, 4, 5).

If spectral filtering shading compounds can be correctly developed, they could be used with existing greenhouse growing facilities, with little or no alteration of existing growing structures. Shading compounds have been shown to be effective spectral filters (3).

The objective of this study was to determine if newly formulated liquid shading compounds altered shoot morphological growth of ‘Cayenne’ pepper and ‘White Splash’ and ‘Pink Splash’ Hypoestes in a way different from the white shading compound normally used in commercial production.

Twelve-foot long quonset-type greenhouse structures covered with standard 6-mil clear polyethylene plastic were painted with five different liquid shading compounds: KoolRay White, KoolRay Cobalt Blue, KoolRay Bright Golden, KoolRay Thallo Green, or KoolRay Orange (The Continental Products Company, Euclid, OH). Two-inch tall seedlings of Capsicum annuum ‘Cayenne,’ Hypoestes phyllostachya ‘Pink Splash’ (Pink Polka Dot) and H. phyllostachya ‘White Splash’ (White Polka Dot) were transplanted into round quart pots (4.5 inch top diameter), were pinched once, and placed under the greenhouses for about 50 days. At the end of the growing period, plant height and shoot dry weight was recorded. Irrigation was supplied as needed. Plants were grown in a completely randomized design. Data were analyzed using analysis of variance.

Light quantity transmittance in each structure was measured at solar noon with an LI-19ISA line quantum sensor connected to a LI-185B photometer (LI-COR, Inc., Lincoln, NE). Light quality was measured as blue (400 to 500 nm) red (600 to 700 nm) and far-red light (700 to 800 nm) with an ILI400 photometer connected to silicon detectors designed to measured in photon flux (International Light, Newburyport, MA).

Results and Discussion: 'Cayenne' peppers and 'White Splash' Hypoestes were taller and had more shoot dry weight when grown under Orange shading compared to all other shading compounds tested. Peppers grown under Cobalt Blue or Thallo Green shading were taller than those grown under White or Bright Golden shading, but did not have more shoot dry weight than plants grown under standard White shading. Peppers grown under Bright Golden shading were shorter and had less shoot dry weight than those grown under all other compounds tested. Peppers grown under Orange or Thallo Green shading were visibly darker green in color. The apparent higher chlorophyll concentrations may have contributed to the faster growth under the Orange and Thallo Green shading compounds.

'White Splash' Hypoestes under Bright Golden and Thallo Green shading were taller than those under White or Cobalt Blue shading, but did not have more shoot dry weight. 'Pink Splash' grown under Thallo Green shading were taller than plants grown under all other compounds except Orange, and had more shoot dry weight than plants grown under White or Bright Golden shading. 'White Splash' plants were taller than 'Pink Splash' under Bright Golden shading, but were shorter under Orange shading. 'White Splash' had more shoot dry weight than 'Pink Splash' under all shading compounds. Both cultivars had darker green leaves when grown under Orange or Thallo Green shading (dark green leaf color, contrasting with smaller colored "dots") compared to plants grown under other shading compounds.

The most consistent response was the large size of p]ants grown under Orange shading. KoolRay Orange deserves further research with traditional crops of more commercial value. Responses may be more pronounced under different greenhouse structures, since the "quonset-type" structures used in this study did allow for some unfiltered light to reach the plants by reflection off of gray-white gravel (no measureable affect on light quality).
Based on similar light intensities, growth under Orange, White and Bright

Golden shading was not expected to differ. However, plants grown under Orange shading were consistantly taller and had more shoot mass, demonstrating the growth response to differences in light quality. Under Orange shading, the R:FR was 1.5, the B:R was 0.5, and the B:FR was 0.4. The R:FR for Bright Golden and White was 1.2, the B:R was 0.4 and 0.3, and the B:FR was 0.5 and 0.6 for Bright Golden and White shading, respectively.

Significance to Industry: Spectral filtering shading compounds can be used to regulate shoot morphology without chemical growth regulators. Regimes for growing plants using spectral-filtered shading need to be established. Formulations which slow growth could be useful to ornamental plant "plug" growers who use chemcial growth retardants to slow the growth of plants to prolong the "sales window" of the crop. Use of these retardants may slow growth of the plugs after transplanting. Formulations which increase the
chlorophyll content of crops could enhance the post-harvest life of pot and cut flowers, bedding plants, and foliage crops. The "active-life" of each shading compound needs to be determined, since the ability to alter light quality may change as the shading compound ages or washes-off the greenhouse surface. Possible changes in light quality as shading compounds are diluted with water (to provide less shading) need to be investigated.

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Growth response of Hypoestes varieties to DCPTA

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Nature of Work: The tertiary amine bioregulator, DCPTA, was originally synthesized in 1958 (5). The influence of DCPTA on non-ornamental crop production has received considerable study (1). Recently, applications of 30
(10 ppm) DCPTA to seeds, cuttings, or seedlings of ornamental species have been shown to increase seedling survival and long-term vegetative plant growth, and to accelerate flowering when compared to controls (2, 4). With few exceptions (3, 4), the studies on ornamental crops have been performed by a single research team, sometimes using growing environments that do not simulate standard commercial production (1). Additional research is needed to fully determine if DCPTA has potential to enhance commercial production of ornamental crops. The objective of this study was to evaluate the growth response of Hypoestes phyllostachya (Polka Dot Plant) seedling varieties treated with DCPTA.

Twenty seedlings of 'White,' 'Red,' 'Carmine Rose,' and 'Burgandy' Hypoestes (Daehnfeldt, Albany, OR) were sprayed to drip 40 days after sowing) with a solution containing 10 ppm DCPTA and 0.1% Tween 80. Twenty seedlings of each variety were treated 0.1% Tween 80 (controls). Seedlings were grown in pint (0.55 liter) pots filled with a 5 pine bark:4 Florida sedge peat:l sand growing medium. Pots were top-dressed with 9 grams of Osmocote 18N-2.6P-l0K (Grace/Sierra, Milpitas, CA), and watered as needed. Seedlings were grown in a single layered polycarbonate greenhouse with Kool-Ray SuperStik™ (Continental Products, Inc., Euclid, OH) to provide 80% shade. Seven weeks after DCPTA application, seedling shoot height was measured, and shoots were weighed after drying for 5 days at 65°C (150°F). A completely randomized design was used, and data were analyzed with analysis of variance and Duncan's multiple range test.

Results and Discussion: DCPTA did not influence shoot height or weight of Hypoestes seedlings under the conditions of this study. 'White' Hypoestes had more shoot weight than the red varieties, and there was no significant difference in shoot height among varieties (Table 1). The larger leaf size of 'White' seedlings may explain the higher shoot dry weights and the more compact appearance of this variety.

There have been other studies where DCPTA has not influenced plant growth (2, 3). Studies with red pine (3) and blue spruce (2) indicated that DCPTA application is progressively less effective with increasing plant age, suggesting that a seed treatment of Hypoestes needs to be tested. The light quantity used in this study may have limited response to DCPTA, as maximal exposure to sunlight has been suggested for DCPTA-treated plants (1). Since high light will cause marginal leaf curl, use of higher light on DCPTA-treated plants may not be an aesthetically pleasing option for Hypoestes production.

Significance to Industry: DCPTA treatments have enhanced biomass production, number of flowers, and maturity of many ornamental plants (2, 4). Potential of DCPTA application to increase production of ornamental crops needs additional study. Researchers need to determine if growing environments that enhance production when DCPTA is used can produce the same quality product as plants grown using optimal production environments without DCPTA. Other tertiary amine bioregulators that are similar to DCPTA should also be studied.

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Table 1. Plant height and shoot dry weight of Hypoestes phyllostachya seedlings after treatment with DCPTA.

Treatment	Variety	Shoot height	Shoot weight
		(cm)	(g)
DCPTA and Tween 80	White	27.0 a	1.87 a[z]
	Red	26.9 a	1.21 bc
	Carmine Rose	30.3 a	1.38 bc
	Burgandy	29.3 a	1.52 b
Tween 80	White	28.8 a	1.94 a
	Red	27.3 a	1.42 b
	Carmine Rose	28.5 a	1.06 c
	Burgandy	30.6 a	1.56 b

[z] Means within columns followed by the same letter are not different (P<0.05) according to Duncan's multiple range test; n=20. There were no DCPTA X variety interactions. 28.35 grams = one ounce; 2.54 cm = 1 inch.

Medium Volume and Noisture Stress Influence Shoot Growth of 'Rutgers' Tomato Transplants

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Nature of Work: When marketing tomato transplants, producers prefer short, compact plants due to consumer preference. In the past, tomato transplants exhibiting this growth habit were usually produced with the chemical growth regulator daminozide (B-Nine SP). Label changes in 1989 prohibited the use of daminozide on vegetable transplants, forcing producers to consider alternative height control methods. Reduced medium volume and moisture stress are proven non-chemical height control methods available to vegetable transplant producers (1,2). However, information is limited on the influence these factors may have on tomato transplant growth if used in various combinations during greenhouse production. The objective of this study was to determine the influence of 3 cell pack medium volumes and 2 irrigation regimes on shoot growth of 'Rutgers' tomato transplants during greenhouse production. Seeds of 'Rutgers' tomato *(Lycopersicon esculentum 'Rutgers')* were directly sown into cell packs with cell volumes of 4.1, 8.0, and 12.0 in3 (72, 48, and 32 cells per flat, respectively). Each flat contained the commercial growing medium Fafard #3 (Conrad Fafard, Inc., Springfield, MA). Flats were placed in a double walled, polyethylene greenhouse under natural light with average temperatures of 95/72 F (day/night) during germination and production.

Irrigation regimes were initiated when transplants reached the 3 true-leaf stage. Plants from each cell volume received one of 2 irrigation regimes: moisture stress (MS), which involved allowing plants to reach visible wilt (Ψ_L = -l.1 to -1.4 MPa), before rehydration: and a well-watered control. For MS transplants, time between the first visible symptoms of wilt and rehydration varied from 12 to 30 hours depending on the cell volume and environmental conditions. Well-watered controls were watered by applying small amounts of tap water as needed to maintain a moist medium surface. For each cell volume treatment, 8 hours after MS plants were rehydrated all transplants of that cell size received 300 ppm N from a water soluble 20-10-20 fertilizer (Sierra Chemical Company, Milpitas, CA).

The experimental design was a 3 (container volume) by 2 (irrigation regime) factorial arranged in 4 randomized complete blocks consisting of 1 flat of transplants per treatment per block. Twenty-one days after irrigation treatment initiation, 8 transplants per block, container cell size, and irrigation regime were harvested at soil level to determine shoot height, total leaf area, and average internode length (shoot height/node number).

Results and Discussion: Container cell volume and irrigation regime had an interactive influence on shoot height, total leaf area, and average internode length (Table 1). Shoot height and average internode length were greatest for well-watered controls compared to MS transplants regardless of medium volume. Differences in height and average internode length between MS and control transplants increased as container cell volume decreased. Total leaf area was also greatest for well-watered control transplants for all cell sizes, but as medium volume decreased, differences decreased between MS and control transplants.

MS in conjunction with the 2 smallest medium volumes resulted in transplants with greatly reduced shoot height and average internode length, while reducing total leaf area to a lesser extent when compared to MS transplants in the large medium volume. For this reason, transplant canopies in the 2 smallest medium volumes appeared fuller than those in the large medium volume for MS treated transplants or well-watered controls in similar medium volumes. This synergistic effect of decreasing medium volume and MS for control of tomato transplant height was probably due to decreased water reserves in the smaller cell sizes causing wilt cycles to occur more often (transplants in 4.1 and 8.0 in3 cells had 5 wilt cycles while transplants in 12.0 in3 cells had 4 wilt cycles).

Significance to Industry: Results from this work show that decreasing medium volume and MS utilized together produce shorter, more compact tomato transplants than either height control method used alone. However, when using these height control methods caution must be emphasized so that excessive wilting, which can lead to foliage damage or transplant death, does not occur.

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Table 1. Effect of container cell volume and irrigation regime on 'Rutgers' tomato transplant shoot height, total leaf area, and average internode length (IL).

Container volume (in^3)	Irrigation regime	Shoot height (in)	IL (in)	Leaf area (in^2)
4.1	Moisture stress	8. Id[z]	1 . 8d	40.3e
8.0	Moisture stress	8.6d	1.7d	58.3d
12.0	Moisture stress	10.4c	I.9c	92.Ib
4.1	Control	15.4b	2.7a	59.9d
8.0	Control	15.2b	2.4b	84.8c
12.0	Control	16.Ia	2.3b	127.2a
Significance[y]				
Container volume (CV)	**	**	**	**
Irrigation regime (IR)	**	**	**	**
CV x IR	**	**	**	**

[z] Means within columns having the same letter are not different (LSD, alpha = 0.05).

[y] ** Significant at the 1% level by F-test.