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IR-4 Ornamental Horticulture Program PGR Effect on Branching of Woody Ornamentals

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Abstract

Nurserymen have found that a well-branched woody ornamental offers superior plant architecture and produces more blooms, thus is more desirable in the marketplace. Many woody plant species do not branch adequately in a container nursery production system. In order to produce a well branched plant that meets desired size specifications, plants are usually pruned frequently, though some still do not branch as much as desired. Developing plant growth regulators (PGR) that could increase branching is important to provide ornamental nursery growers an additional tool that they can use to produce more desirable plants. Consequently, identifying a plant growth regulator treatment that effectively improves the architecture of woody ornamentals became a research priority for the IR-4 Ornamental Horticulture Program. From 2006 to 2011, eleven products representing seven different active ingredients were tested for enhanced branching on several container grown woody ornamental species. Some products were already registered for use as plant growth regulators on food crops but were not yet registered with the EPA for use on ornamentals. Seven container grown ornamental species were tested including arrowwood, azalea, holly, hydrangea, Indian hawthorn, rose, and sourwood. Sufficient data was generated to recommend registration for use of one or more product(s) on two species. Tiberon 2.8SC (cvclanilide) and MaxCel, (6-benzyladenine) provided significant increase of branching in azalea. Augeo (dikegulac sodium) demonstrated efficacy improving branching on both florist and landscape types of hydrangea. This research shows promise for identifying plant growth regulator treatments to meet the demand for improved branching on species important to the ornamental horticulture industry.

Introduction

Many woody plant species do not branch adequately when small plants are being grown in a container nursery production system. In order to produce a well branched plant that meets desired size specifications, plants are usually pruned frequently, though some still do not branch as much as desired. Developing plant growth regulators that could increase branching is important to provide ornamental nursery growers an additional tool that they can use to produce more desirable plants. Screening products to enhance branching pattern of container grown ornamentals became one of the high priority projects for the IR-4 Project Ornamental Horticulture Program. The following research was conducted between 2006 and 2011 in response to this need among specialty crop growers.

Materials and Methods

During 2006 and 2008 nine PGR's were tested to evaluate their plant growth and branching effects on various cultivars of azalea, holly, hydrangea, Indian hawthorn, rose and sourwood. However, not all products were tested on all plant species. All products were applied as foliar spray. Typically, products were applied twice except for Gibberellins $A_{4+}A_7$ (Provide or Novagib 10L) which was applied once and Cyclanilide (Tiberon 2.8SC) which was applied once or twice. A minimum of ten plants (replicates treatments) were required with some researchers exceeding this minimum. Shoot counts, plant height, diameter, and phytotoxicity (with 0 being no phytotoxicity and 10 being plant death) were recorded.

In 2011, both floral type cultivars (*H. macrophylla* 'Merritt's Supreme') and landscape varieties (*H. macrophylla* 'Nikko Blue', *H. paniculata* 'Limelight') were evaluated for crop injury and branching response to Augeo, Configure and Florel. A minimum of ten pots per treatment were used. Cuttings were planted into soilless media in high density liner trays. Rooted cuttings received a pinch in the liner tray except where noted. After rooting for approximately 6 to 8 weeks plants were potted into 5" or 1 gallon containers. Treatments were sprayed over the top to wetness. Configure was applied twice although some researchers deviated from the protocol with only one application. Treatments included a pinched untreated control for comparison. Crop safety evaluations were taken at 2 and 6 weeks after application (WAT). Plant quality was rated on a subjective scale from 1 to 7 (1 = significantly worse than untreated, 4 = no difference from untreated, 7 = significantly better than untreated) when 50% of the plants developed buds. Number of breaks (lateral shoots) were counted at bud set when stems swelled. Height and width measurements were collected.

Please visit http://ir4.rutgers.edu/ornamental/OrnamentalDrafts.cfm to view and download these protocols.

Products were supplied to researchers (See list of researchers in Appendix 2) by their respective manufacturers.

Product	Active	Manufacturer	Rates	# Sprays	# Trials
	Ingredient(s)				
Atrimmec	Dikegulac sodium	PBI Gordon	3100 or 3900	2	1
			50 ppm	Drench	_
Augeo	Dikegulac sodium	800 & 1600	OHP	1	6
Configure	6-Benzyladenine	Fine Americas, Inc.	300, 500, 600	2	7
			ppm		
Exilis Plus	6-Benzyladenine	Fine Americas, Inc.	500 ppm	2	2
Fascination	6-Benzyladenine +	Valent USA Corp.	500 ppm	2	7
	Gibberellins A _{4 +} A ₇				
Floral	athanhan	500 & 1000	Monterey	1	6
110101	emephon	500 & 1000	AgResources		
Fresco	6-Benzyladenine +	Fine Americas, Inc.	500 ppm	2	1
	Gibberellins A _{4 +} A ₇				
MaxCel	6-Benzyladenine	Valent USA Corp.	500 ppm	2	5
Novagib 10L	Gibberellins A _{4 +} A ₇	Fine Americas, Inc.	500 ppm		1
Provide	Gibberellins A _{4 +} A ₇	Valent USA Corp.	500 ppm	1	4
Tiberon 2.8SC	Cyclanilide	Bayer Environmental	112 ppm	1 or 2	8
		Sciences			

 Table 1.
 List of Products and Rates Tested in 2006 to 2011.

Results and Discussion

Azalea (Rhododendron spp.)

In 2006 and 2007, five researchers examined the effect of five PGR's on branching and growth of 8 different azalea cultivars. Three cultivars (Chen, Lieth and Pemberton trials) were pinched before initial application. The products tested included Fascination, Fresco, MaxCel, and Novagib 10L at 500 ppm applied twice, Provide at 500 ppm applied once and Tiberon 2.8SC at 112 ppm applied once or twice. All treatments were applied as foliar sprays typically 4 weeks apart when applied twice. In these experiments, the assessment typically made was number of shoots, plant height, width and phytotoxicity taken for several weeks after foliar spray.

Although not positive in all cultivars, Tiberon and MaxCel were the only products that showed promising results for increased branching of azalea in the seven experiments conducted over 10 cultivars. In the Pemberton and Lieth trials where no increased branching was observed, plants were pinched before initial application. In general, Tiberon applied twice showed advantage over one application and over MaxCel applied twice. The 6-BA + GA_{4+7} products Fascination and Fresco showed no effect in 8 of 10 cultivars. The gibberellin products Novagib and Provide showed no effect on all cultivars tested. Overall treatments provided no growth effects except for Fascination and Provide increasing growth in one trial (Pemberton 2006); this was attributed to the effect of GA_{4+7} in these products. Also in a Lieth 2006 trial, Tiberon applied twice resulted in decreased branching and plant growth but provided more flower buds. Treatments resulted in no phytotoxicity except in one trial (Keever 2007) where Tiberon applied twice caused reddening along the margins of the leaves, clustering of buds at terminal growing points, twisting of leaves, and mild chlorosis. See the individual reports below for more information.

	Chen 2006	Keever 2006	Lieth 2006	Pemberton 2006		Keever 2007			Czarnot 2007	a	Lieth 2007
Turation	Amelia Rose	Korean Stardust	Rememb rance	Redwing	Conver sation	Hallie	Iveryana	Hallie	Red Ruffles	Watchet	Scarlet
Treatments					Piece						
Fascination (6-	-	-	-	-	-	+	-				-
$BA + GA_{4+7}$											
Fresco (6-BA +								-	-	-	
$GA_{4+7)}$											
MaxCel (6-BA)	-	+	-	-	+	+	+	-	-	-	
Novagib 10L	-							-	-	-	
(GA_{4+7})											
Provide (GA ₄₊₇₎		-	-	-	-	-	-				
Tiberon 2.8SC	+	-	-	-	++	++	+	-	-	-	-
(cyclanilide) – 1											
applic.											
Tiberon 2.8SC	+	+	-	-	++	++	+	-	-	-	-
(cyclanilide) - 2											
applic.											

 Table 2.
 Summary of Effect on Branching of Azalea (Rhododendron spp.) cultivars.

¹Rating Scale: ++ = clearly statistically increased branching compared to untreated; + = increased branching but not consistent over time; - = branching statistically equivalent to or less than Untreated. ²Weeks after initial treatment

Chen 2006

Novagib 10L (GA_{4+7})

- 1 applic.

- 2 applic.

Tiberon 2.8SC (cyclanilide)

Tiberon 2.8SC (cyclanilide)

In 2006, Chen conducted an experiment to determine effect of four products on branching of 'Amelia Rose' azalea. 'Amelia Rose' is a variety with attractive double-petaled flowers with a less ideal growth habit. After spring bloom, plants branch 2-3 new stems only from the top of previous year's growth. No branch is formed after the spring growth and no branch comes out along the growing stems. Two groups of plants were used: one group was pruned one week before treatment by cutting back about 3 inches of main stems after spring blooming. The other group was not pruned before treatments. The purpose was to test how PGR and removing topic growth dominant will improve branching. The treatments were Fascination and MaxCel at 500 ppm applied twice 4 weeks apart, Novagib 10L at 500 ppm applied once and Tiberon at 112 ppm applied once or twice 2 weeks apart. Total number of shoots per plant was recorded at weeks 8, 11, and 20. Data were subjected to statistical analysis (LSD test, p= 0.05).

Tiberon 2.8SC applied once or twice provided significant increase in branching of 'Amelia Rose' azalea in 8 weeks after initial treatment when combined with pruning (Table 3). However, the number of shoots was not different from the Untreated Check by 11 weeks after initial treatment. Without pruning, Tiberon applied once, but not twice, provided significantly higher shoot numbers compared to the Untreated. Fascination, Maxcel and Novagib 10L showed no significant effect on branching (Table 4). No phytotoxicity was observed.

Chen 2006.								
Treatment	Total 1	Number of Sho	ots Per Plant Tr	eated After P	runing ^z			
	Week 0 ^y	Week 8	Week 0-8	Week 11	Week 20			
Fascination $(6-BA + GA_{4+7})$	31.7 a	38.9 a	7.1 ab	40.0 a	35.4 a			
MaxCel (6-BA)	28.9 a	32.6 b	3.7 b	32.3 c	30.3 a			

36.6 ab

39.9 a

40.3 a

6.7 ab

11.9 a

10.8 a

33.0 bc

37.7 ab

37.7 ab

33.8 a

33.4 a

35.1 a

35.1 a

Table 3. Effect of several PGR's on Branching of Azalea (Rhododendron sp.), 'Amelia Rose',Chen 2006.

Untreated 31.8 a 36.0 ab 4.2 b 35.1 abc ^z Means in the same column followed by the same letter are not significantly different, (LSD test, P = 0.05,).

29.9 a

28.0 a

29.5 a

^y Week 0 is 1 week before treatment when plants showed visible new growth. Plants were then pruned back.3 inches and treated with PGR's.

Treatment	Total Number of	f Shoots Per Plant	Treated Without	Initial Pruning ^z
	Week 0 ^y	Week 8	Week 11	Week 20
Fascination $(6-BA + GA_{4+7})$	33.4 a	32.5 a	32.0 b	30.6 b
MaxCel (6-BA)	33.6 a	34.9 a	34.2 ab	33.8 ab
Novagib 10L (GA _{4 + 7)}	32.2 a	29.0 a	27.0 b	28.6 b
Tiberon 2.8SC (cyclanilide)	36.1 a	39.6 a	40.4 a	40.3 a
– 1 applic.				
Tiberon 2.8SC (cyclanilide)	30.1 a	34.8 a	35.4 ab	35.6 ab
– 2 applic.				
Untreated	29.2 a	31.2 a	30 0 b	30 b

Table 4.Effect of several PGR's on Branching of Azalea (Rhododendron sp.), 'Amelia Rose',
Chen 2006.

^z Means in the same column followed by the same letter are not significantly different, (LSD test, P = 0.05,).

^y Week 0 is 1 week before treatment when plants showed visible new growth.

Keever 2006

Keever conducted a trial to determine the effect of four products on branching and growth of Korean Stardust' azalea. Fascination and MaxCel at 500 ppm were applied twice 4 weeks apart, Provide at 500 ppm applied once and Tiberon at 112 ppm applied once or twice 2-3 weeks apart. Treatments were replicated 10 times. Data on plant height and width, growth index [GI = (height + width)/2], and phytotoxicity (0=none, 10 = dead) were taken 4, 7 and 12 weeks after initial treatment (WAIT), and new shoots were counted at 7 and 12 WAIT. Data were subjected to statistical analysis (Duncan's Multiple Range test, p=0.05).

By 12 WAIT, Maxcel and Tiberon applied twice provided higher new shoot counts compared to Untreated (Table 5). No phytotoxicity or PGR effects on plant height, width of growth index was observed for the 12-week duration of the experiment (Table 6). In general, 2 applications of MaxCel or Tiberon were the most effective in promoting branching without any visible injury.

Table 5.	Effect of several PGR's on Branching and Phytotoxicity of Azalea (Rhododendron
poukhane	nse), 'Korean Stardust', Keever 2006.

Treatment	New Shoot Counts ^z		Phytotoxicity at
	7 WAIT ^y	12 WAIT	4-12 WAIT
Fascination (6-BA +	0.7 a	7.5 abc	0 a
GA _{4 + 7)}			
MaxCel (6-BA)	1.4 ab	10.0 a	0 a
Provide (GA _{4 + 7)}	1.3 ab	4.8 bc	0 a
Tiberon 2.8SC	2.3 a	6.7 abc	0 a
(cyclanilide) – 1 applic.			
Tiberon 2.8SC	2.3 a	8.6 ab	0 a
(cyclanilide) – 2 applic.			
Untreated	1.6 ab	4.2 c	0 a

 $\frac{1}{2}$ Means in the same column followed by the same letter are not significantly different, (P = 0.05, Duncan's

Multiple Range test).

^y Week after first application.

Treatment		Height ^z			Width		G	rowth Ind	ex
	4	7	12	4	7	12	4	7	12
	WAT1 ^y	WAT1	WAIT	WAT1	WAT1	WAT1	WAT1	WAT1	WAT1
Fascination	22.8 a	22.4 a	25.0 a	18.0 a	18.1 a	20.9 a	20.40 a	20.25 a	22.95 a
(6-BA +									
$GA_{4+7)}$									
MaxCel (6-	22.4 a	21.8 a	24.6 a	17.8 a	17.1 a	18.9 a	20.10 a	19.45 a	21.75 a
BA)									
Provide	22.0 a	21.4 a	22.8 a	17.0 a	17.5 a	18.0 a	19.50 a	19.45 a	20.40 a
(GA _{4 + 7)}									
Tiberon	22.1 a	21.4 a	22.8 a	15.1 a	17.9 a	20.4 a	18.60 a	19.65 a	21.60 a
(cyclanilide)									
- 1 applic.									
Tiberon	22.8 a	22.4 a	24.2 a	15.4 a	17.7 a	19.1 a	19.10 a	20.05 a	21.65 a
(cyclanilide)									
-2 applic.									
Untreated	21.9 a	21.3 a	22.4 a	18.0 a	17.5 a	18.2	19.95 a	19.40 a	20.30 a

Table 6.Effect of several PGR's on Plant Growth of Azalea (*Rhododendron poukhanense*),'Korean Stardust', Keever 2006.

^z Means in the same column followed by the same letter are not significantly different, (P = 0.05, Duncan's

Multiple Range test).

^y Week after first application.

Keever 2007

In this trial, Keever determined the effect of four products on branching and growth of 3 azalea cultivars ('Conversation Piece', Hallie and 'Iveryana') pruned before first application. Fascination and MaxCel at 500 ppm were applied twice 4 weeks apart, Provide at 500 ppm applied once and Tiberon at 112 ppm applied once or twice. The second applications were made ~4 weeks after the first, which was 1 or 2 weeks later than called for in the protocol for Tiberon. MaxCel applied twice and Tiberon applied once or twice provided significantly higher new shoot counts compared to Untreated in the 3 cultivars tested (Table 7). Fascination provided significant increase in new shoot only with 'Hallie' cultivar at 45 DAT but had lower number of new shoots vs. Untreated at 90 DAT for "Iveryana' cultivar. Provide did not significantly increase new shoot counts on the 3 varieties. With few exceptions new shoot counts of plants treated with Tiberon were higher than those treated with the other PGR's.

Plant height and growth index were minimally affected by any treatment, and differences were not deemed of horticultural importance (Tables 8 and 9). Injury was observed only on plants treated with 2 Tiberon applications. Of the 3 cultivars, 'Hallie' exhibited the most pronounced effect with reddening along the margins of the leaves, clustering of buds at terminal growing points, twisting of leaves, and mild chlorosis. Plants were also treated for Phytophthora root rot, and 5 'Iveryana' plants were removed from testing (1 from control and 4 from Tiberon applied once. Flower buds were present on plants in all treatments in December ('Conversation Piece' were blooming) with Tiberon-treated plants appearing to have less mature, but more flower buds than controls, possibly due to increased branching.

Treatment				New	Shoot Cou	ints ^z			
	'Con	versation l	Piece'		'Hallie'			'Iveryana	,
	6 July	23 Aug	8 Oct	6 July	23 Aug	8 Oct	6 July	23 Aug	8 Oct
	0 DAT ^y	45 DAT	90 DAT	0 DAT	45 DAT	90 DAT	0 DAT	45 DAT	90 DAT
Fascination	24.7 a	51.6 c	60.0 c	26.9 a	88.7 a	44.6 d	24.0 a	40.4 c	54.2 d
(6-BA +									
$GA_{4+7)}$									
MaxCel (6-	23.2 a	59.4 b	66.0 bc	26.1 a	53.4 b	54.9 c	24.0 a	42.5 bc	87.0 a
BA)									
Provide	24.3 a	46.7 c	59.3 c	26.7 a	40.7 c	39.1 d	24.1 a	39.1 c	67.1 c
(GA _{4 + 7)}									
Tiberon	23.8 a	68.4 a	68.8 b	27.0 a	79.5 a	72.3 b	23.8 a	49.9 ab	78.7 ab*
(cyclanilide)									
– 1 applic.									
Tiberon	24.1 a	71.1 a	82.3 a	26.5 a	88.7 a	87.3 a	24.3 a	53.3 a	74.4 bc
(cyclanilide)									
-2 applic.									
Untreated	24.7 a	51.9 c	59.8 c	26.7 a	46.2 bc	45.2 d	24.3 a	37.7 c	67.6 bc*

Table 7. Effect of several PGR's on Branching of Three Azalea (*Rhododendron sp.*) Cultivars'Conversation Piece', 'Hallie' and 'Iveryana', Keever 2007.

² Means in the same column followed by the same letter are not significantly different, (P = 0.05, LSD test). ⁹ Week 0 is 1 week before treatment when plants showed visible new growth. Plants were then pruned.

* Some plants removed due to *Divisorial and Division infection*

* Some plants removed due to Phytophthora and Pythium infection.

Table 8. Effect of several PGR's on Height of 3 Azalea (*Rhododendron sp.*) Cultivars'Conversation Piece', 'Hallie' and 'Iveryana', Keever 2007.

Treatment				P	lant Heigh	lt ^z			
	'Con	versation l	Piece'		'Hallie'			'Iveryana	,
	6 July	23 Aug	8 Oct	6 July	23 Aug	8 Oct	6 July	23 Aug	8 Oct
	0 DAT ^y	45 DAT	90 DAT	0 DAT	45 DAT	90 DAT	0 DAT	45 DAT	90 DAT
Fascination	26.5 a	32.4 a	37.5 a	23.3 a	25.0 a	28.1 a	22.9 a	28.4 a	30.7 a
(6-BA +									
$GA_{4+7)}$									
MaxCel (6-	27.3 a	30.2 a	35.2 a	22.1 a	24.4 a	24.5 b	22.8 a	26.5 ab	29.3 ab
BA)									
Provide	28.1 a	32.6 a	34.1 a	21.6 a	24.4 a	25.7 ab	22.1 a	25.9 ab	30.5 a
(GA_{4+7})									
Tiberon	27.3 a	30.9 a	32.8 a	21.1 a	24.5 a	25.7 ab	21.4 a	24.6 b	26.3 b*
(cyclanilide)									
– 1 applic.									
Tiberon	29.0 a	32.8 a	35.9 a	22.6 a	25.0 a	27.5 a	23.1 a	23.6 b	28.6 ab
(cyclanilide)									
– 2 applic.									
Untreated	27.5 a	30.2 a	32.4 a	21.7 a	23.8	25.6 ab	23.9 a	26.1 ab	26.9 b*

^z Means in the same column followed by the same letter are not significantly different, (P = 0.05, LSD test).

^y Week 0 is 1 week before treatment when plants showed visible new growth. Plants were then pruned.

* Some plants removed due to Phytophthora and Pythium infection.

Treatment		Growth	Index [(he	eight + wi	idest widt	h + perpe	ndicular	width)/3]	
	'Con	versation I	Piece'		'Hallie'			'Iveryana	,
	6 July	23 Aug	8 Oct	6 July	23 Aug	8 Oct	6 July	23 Aug	8 Oct
	0 DAT ^y	45 DAT	90 DAT	0 DAT	45 DAT	90 DAT	0 DAT	45 DAT	90 DAT
Fascination	23.9 ab	36.5 a	45.5 a	18.0 a	19.9 a	22.7 a	23.1 a	32.0 a	34.9 a
(6-BA +									
$GA_{4+7)}$									
MaxCel (6-	24.8 ab	31.7 b	41.6 ab	17.4 a	21.0 a	20.9 a	21.9 a	29.1 ab	33.8 ab
BA)									
Provide	34.4 ab	34.4 ab	42.0 ab	17.4 a	20.0 a	21.5 a	22.2 a	29.1 ab	34.7 a
(GA _{4 + 7)}									
Tiberon	23.8 b	31.9 b	41.4 ab	16.8 a	20.6 a	21.2 a	21.5 a	28.2 b	30.6 b*
(cyclanilide)									
– 1 applic.									
Tiberon	24.4 ab	31.9 b	44.8 a	18.2 a	19.9 a	21.8 a	22.2 a	27.2 b	33.6 ab
(cyclanilide)									
-2 applic.									
Untreated	265a	31.9 h	395h	174a	196a	21 8 a	22.9 a	29 5 ab	32.6 ab*

Table 9. Effect of several PGR's on Growth Index of 3 Azalea (*Rhododendron sp.*) Cultivars'Conversation Piece', 'Hallie' and 'Iveryana', Keever 2007.

^z Means in the same column followed by the same letter are not significantly different, (P = 0.05, LSD test).

^y Week 0 is 1 week before treatment when plants showed visible new growth. Plants were then pruned.

* Some plants removed due to Phytophthora and Pythium infection.

Lieth 2006

In 2006, Lieth conducted an experiment to determine effect of four products on branching and growth of 'Remembrance' azalea pinched 4 weeks before spray application. The treatments were Fascination and MaxCel at 500 ppm applied twice 4 weeks apart, Tiberon 2.8SC at 112 ppm + Latron applied once or twice 3 weeks apart and Provide at 500 ppm applied once. The number of shoots, flower buds, height and width, as well as phytotoxicity (0 = no damage, 10 = complete kill) were recorded at various times after treatment. Canopy volume index was calculated as H*W1*W2, where H is the height and W1 and W2 are two width measurements. Data were subjected to statistical analysis (t-test, P=0.05).

Tiberon applied once resulted in no increase in number of shoots, flower buds or plant growth. Tiberon applied twice resulted in decreased branching and plant growth but provided more flower buds (Table 10). Thus Tiberon is, in fact, a very useful tool on azalea since while it does not result in higher number of vegetative branches, it can be used to increase the number of flowers on the plant. Fascination, Maxcel and Provide resulted in no increase in number of shoots or flower buds and generally had no effect on plant growth except Provide which increased height (Table 12). No treatment resulted in any significant injury (Tables 11 and 13).

Treatment	Height I	ncrease ^z	Ave.V	Width	Volume	Index	Increas	e in No.	Flower
	(cm) By	Increase	e (cm) By	Increa	se By	of Sho	ots By	Bud No.
	8	15	8	15	8	15	8	15	15
	WAIT	WAIT	WAIT	WAIT	WAIT	WAIT	WAIT	WAIT	WAIT
Tiberon	4.33 a	5.72 a	4.47 a	5.83 ab	1966.4 a	2863.0	1.00 ab	4.89 ab	17.8 b
(cyclanilide)						ab			
+Latron -1									
applic.									
Tiberon	3.17 a	3.39 b	4.17 a	5.64 b	1735.7 a	2388.5	0.67 ab	2.00 b	29.6 a
(cyclanilide)						b			
+Latron -2									
applic.									
Latron	4.61 a	6.17 a	4.83 a	8.72 a	2097.9 a	4554.3	0.33 b	5.78 a	16.7 b
						а			
Untreated	4.44 a	5.39 a	4.58 a	7.94 ab	2296.1 a	4544.7	1.56 a	7.67 a	18.3 b
						а			

Table 10. Effect of Tiberon on Branching and Growth of Azalea (*Rhododendron sp.*),'Remembrance', Lieth 2006.

^{*z*} Means in the same column followed by the same letter are not significantly different, (t-test, P < 0.05); number of shoots at 8 WAIT significantly different at P = 0.10.

^y Week after first application.

 Table 11. Effect of Tiberon on Phytotoxicity to Azalea (*Rhododendron sp.*), 'Remembrance', Lieth 2006.

Treatment	In	crease in Phytote	oxicity Index ^z fro	om Trial Start U	ntil
	2 WAIT ^y	4 WAIT	6 WAIT	8 WAIT	15 WAIT
Tiberon 2.8SC	0.00 a	0.22 a	-0.11 a	0.56 a	0.67 ab
(cyclanilide) +					
Latron – 1 applic.					
Tiberon 2.8SC	0.00 a	0.33 a	0.11 a	0.56 a	1.00 b
(cyclanilide) +					
Latron – 2 applic.					
Latron	0.00 a	-0.11 a	-0.11 a	-0.22 a	-0.22 a
Untreated	0.00 a	0.11 a	0.22 a	0.11 a	-0.22 a

^z Means in the same column followed by the same letter are not significantly different, (t-test, P < 0.05).

^y Week after first application.

Treatment	Height I	ncrease ^z	Ave.	Ave. Width		Index	Increase in No.		Flower Bud No
	(cm) Бу	Increase (ciii) by		Increase By		OI SHOOLS BY		Bua No.
	8	15	8	15	8	15	8	15	15
	WAIT	WAIT	WAIT	WAIT	WAIT	WAIT	WAIT	WAIT	WAIT
Fascination	4.11 b	5.22 b	4.19 a	6.22 a	2029.7 a	3207.2	0.00 b	5.78 ab	20.8 a
(6-BA +						а			
$GA_{4+7)}$									
MaxCel (6-	4.83 ab	4.61 b	4.56 a	5.97 a	2231.6 a	2919.0	0.56 b	2.67 b	19.3 a
BA)						а			
Provide	6.33 a`	6.78 a	4.94 a	6.58 a	2463.4 a	3451.1	0.67 b	4.44 ab	18.6 a
(GA _{4 + 7)}						а			
Untreated	4.44 b	5.39 b	4.58 a	7.94 a	2296.1 a	4544.7	1.56 a	7.67 a	18.3 a
						9			

 Table 12. Effect of several PGR's on Branching and Growth of Azalea (*Rhododendron sp.*),

 'Remembrance', Lieth 2006.

^z Means in the same column followed by the same letter are not significantly different, (t-test, P < 0.05); height at 8 WAIT

significantly different at P = 0.10.

^y Week after first application.

Table 13. Effect of several PGR's on Phytotoxicity to Azalea (*Rhododendron sp.*), 'Remembrance',Lieth 2006.

Treatment	Increase in Phytotoxicity Index ^z from Trial Start Until									
	2 WAT ^y	4 WAT	6 WAT	8 WAT	15 WAT					
Fascination (6-BA	0.00 a	0.56 a	0.67 a	0.67 a	0.89 a					
$+ GA_{4+7}$										
MaxCel (6-BA)	0.00 a	0.11 a	0.11 a	0.22 a	0.78 a					
Provide (GA_{4+7})	0.00 a	0.11 a	-0.22 a	-0.22 a	0.33 a					
Untreated	0.00 a	0.11 a	0.22 a	0.11 a	-0.22 a					

^z Means in the same column followed by the same letter are not significantly different, (t-test P < 0.05).

^y Week after first application.

Lieth 2007

In this trial, Lieth determined the effect of Fascination and Tiberon on branching and growth of 'Scarlet' azalea pinched 25 days before first application. Fascination at 500 ppm was applied twice and Tiberon at 112 ppm applied once or twice. The second applications were made approximately 4 weeks after the first which was 1 to 2 weeks later than called for in the protocol for Tiberon. Fascination and Tiberon provided no significant effect on branching and growth of 'Scarlet' azalea (Tables 14 and 15). No phytotoxicity was observed from these treatments.

Treatment	Increase i	n Number of S Week 0	hoots From	Phytotoxicity Index (0-10) ^y				
	Week 4 ^z	Week 8	Week 10	Week 4	Week 8	Week 10		
Fascination	0.58 a	0.67 a	3.8 ab	0.33 b	0.33 a	0.42 a		
$(6-BA + GA_{4+})$								
7)								
Tiberon 2.8SC	0.67 a	0.83 a	5.0 a	0.00 a	0.00 a	0.00 ab		
(cyclanilide) –								
1 applic.								
Tiberon 2.8SC	0.17 a	0.58 a	1.4 b	0.00 a	0.17 a	0.00 b		
(cyclanilide) –								
2 applic.								
Untreated	0.00 a	0.50 a	3.6 ab	0.00 a	0.00 a	0.00 b		

 Table 14. Effect of several PGR's on Branching and Phytotoxicity of Azalea (*Rhododendron sp.*),

 'Scarlet', Lieth 2007.

² Different letters within a column indicate significant differences between treatments (P < 0.05).

^y Phytotoxicity Index: 0 = no injury, 10 = complete kill.

Tabla 15	Effect of several PCR's on	Growth of Azəlea	(Rhadadandran sn)	Scarlet' Lieth 2007
Table 15.	Effect of several FGK S off	Growin of Azalea	(M uuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuuu	Scarlet, Lieth 2007.

Treatment	Incr Fi	Increase in Height From Week 0			ase in Av 1 From W	rerage Veek 0	Increase in Volume Index From Week 0			
	Week	Week	Week	Week	Week	Week	Week	Week	Week	
	4 ^z	8	10	4	8	10	4	8	10	
Fascination	7.17 a	14.12 a	14.96	7.33 a	16.52	21.46	3324 a	13849	21407	
$(6-BA + GA_4)$			ab		ab	а		а	а	
+ 7)										
Tiberon	7.08 a	13.58 a	14.54	7.27 a	17.81	21.04	3397 a	15719	20792	
(cyclanilide)			b		ab	а		а	а	
– 1 applic.										
Tiberon	6.71 a	14.38 a	16.92	7.58 a	18.58	22.19	3530 a	17087	24896	
(cyclanilide)			а		а	а		а	а	
-2 applic.										
Untreated	7.54 a	13.83 a	14.54	7.19 a	16.00	20.00	3675 a	13962	20103	
			b		b	а		а	а	

^z Different letters within a column indicate significant differences between treatments (P < 0.05).

Pemberton 2006

In 2006, Pemberton conducted an experiment to determine effect of four products on branching and growth of 'Redwing' azalea. Plants were potted and pinched 26 June, one month before first application on 26 July 2006. The treatments were Fascination, MaxCel and Provide at 500 ppm applied twice 4 weeks apart and Tiberon 2.8SC at 112 ppm applied once or twice 2 weeks apart. Initial measurements plant height and width (plant volume was calculated) and total shoot number were taken on 25 July 2006. Final data was taken on 20 December 2006. These data included plant height and width, number of shoots from the base of the plant, number of shoots breaking above the base of the plant, and the total of these. Other parameters were calculated.

Branching of azalea was not affected by the PGR treatments (Table 16), but Fascination and ProVide increased plant growth in comparison to the control as measured by plant volume (Table 17). Both of these products contain GA_{4+7} so that the growth stimulation was not surprising. The plant volume was presumably due to an increase in shoot length, number of leaves, and increase in leaf size, or a combination of these factors which were not measured individually.

Table 16. Effect of several PGR's on Branching of Azalea (*Rhododendron sp.*), 'Redwing',Pemberton 2006.

Treatment	Initial Shoot No. ^z	Final # of Bottom	Final # of Top	Final Total # of Bottom and Top	Final # of Top Shoots	Final # of Bottom Shoots/Ini	Final Total # of Shoots/Ini	Total Shoot # Increase
		Shoots	Shoot	Shoots	/Initial	tial Shoot	tial Shoot	
			S		Shoot	#	#	
					No.			
Fascination (6-	7.9	2.1	27.8	29.9	3.5	0.26	3.8	22.0
$BA + GA_{4+7}$								
MaxCel (6-BA)	7.4	3.1	21.6	24.7	3.0	0.46	3.5	17.3
Provide (GA ₄₊₇₎	9.1	2.3	26.3	28.6	3.0	0.26	3.2	19.5
Tiberon 2.8SC	7.5	2.4	26.8	29.2	3.7	0.33	4.0	21.7
(cyclanilide) – 1								
applic.								
Tiberon 2.8SC	8.0	2.6	26.4	29.0	3.3	0.34	3.6	21.0
(cyclanilide) – 2								
applic.								
Untreated	8.7	2.5	25.7	28.2	3.0	0.30	3.3	19.5
ANOVA	NS	NS	NS	NS	NS	NS	NS	NS

^z Means followed by the same letter are not significantly different, P > 0.05

Table 17.	Effect of several PGR's on Growth of Azalea (Rhododendron sp.), 'Redwing', Pemberton
2006.	

Treatment	Initial Plant Height	Initial Plant Volume (cm ³)	Final Plant Height (cm)	Final Plant Volume (cm ³)	Plant Volume Increase (cm ³)	
	(cm) ^z	~ /	8 ()	× ,		
Fascination (6-	19.3	7638.4	22.3	14956.9 a	7318.5 a	
$BA + GA_{4+7}$						
MaxCel (6-BA)	20.0	6955.4	20.9	12156.5 bc	5201.1 b	
Provide (GA _{4 + 7)}	19.0	6849.9	21.4	14789.0 ab	7939.1 a	
Tiberon 2.8SC	19.0	7241.0	20.4	11627.1 c	4386.1 b	
(cyclanilide) – 1						
applic.						
Tiberon 2.8SC	19.1	7753.5	20.2	12288.4 abc	4534.9 b	
(cyclanilide) – 2						
applic.						
Untreated	19.8	7464.6	20.1	11591.1 c	4126.5 b	
ANOVA	NS	NS	NS	*	**	

^z Means followed by the same letter are not significantly different, P > 0.05

Czarnota 2007

Czarnota conducted a trial to determine the effect of four products on growth of 3 azalea cultivars ('Hallie', 'Red Ruffles' and 'Watchet'). Fresco, MaxCel and NovaGib at 500 ppm were applied twice 4 weeks and Tiberon at 112 ppm applied once or twice. The second applications were made ~4 weeks after the first, which was 1 or 2 weeks later than called for in the protocol for Tiberon. Data for plant growth (height, number of buds and width) were taken 4, 8, and 12 weeks after second treatment (WAT). Damage ratings were taken only at 4 WAT and discontinued as no damage was seen on any of the cultivars. No treatment affected plant growth of the cultivars 'Hallie and 'Red Ruffles' (Tables 18 and 19). For 'Watchet' only Tiberon applied once or twice had an effect, reducing height and number of buds (Table 20).

Treatment		Height ^z		Nu	mber of	Buds	Width	Phytotoxicity
	4	8	12	4	8	12	4	4 WAT
	WAT	WAT	WAT	WAT	WAT	WAT	WAT	
Fresco $(6-BA + GA_{4+7})$	24 a	29 a	28 a	10 a	11 ab	12 a	17 ab	0 a
Maxcel (6-BA)	29 a	30 a	31 a	9 a	8 b	10 a	13 b	0 a
NovaGib (GA _{4 + 7)}	27 a	29 a	31 a	8 a	9 b	10 a	15 ab	0 a
Tiberon 2.8SC	29 a	33 a	33 a	11 a	13 a	13 a	20 a	0 a
(cyclanilide) – 1 applic.								
Tiberon 2.8SC	27 a	31 a	33 a	11 a	13 a	13 a	20 a	0 a
(cyclanilide) - 2 applic.								
Untreated	29 a	31 a	29 a	8 a	11 ab	11 a	14 b	0 a

Table 18. Effect of PGR's on Branching and Growth of Azalea (*Rhododendron sp.*) 'Hallie', Czarnota 2007.

^z means followed by the same letter are not significantly different (LSD, P= 0.05).

Table 19. Effect of PGR's on Branching and Growth of Azalea (*Rhododendron sp.*), 'Red Ruffles', Czarnota 2007.

Treatment	Height			Nu	mber of l	Buds	Width	Phytotoxicity
	4	8	12	4	8	12	4	4 WAT
	WAT	WAT	WAT	WAT	WAT	WAT	WAT	
Fresco $(6-BA + GA_{4+7})$	22 ab	24 a	47 a	25 a	26 a	28 a	31 a	0 a
Maxcel (6-BA)	22 ab	24 a	25 ab	22 a	25 a	26 a	29 ab	0 a
NovaGib (GA _{4 + 7)}	32 a	23 a	26 ab	21 a	24 a	24 a	24 bc	0 a
Tiberon 2.8SC	20 b	22 a	21 b	20 a	25 a	24 a	21 c	0 a
(cyclanilide) – 1 applic.								
Tiberon 2.8SC	21 ab	24 a	22 b	20 a	23 a	24 a	23 bc	0 a
(cyclanilide) - 2 applic.								
Untreated	22 ab	24 a	26 ab	22 a	24 a	25 a	26 abc	0 a

^z means followed by the same letter are not significantly different (LSD, P= 0.05).

Treatment		Height		Nun	nber of 1	Buds	Width	Phytotoxicity
	4	8	12	4	8	12	4 WAT	4 WAT
	WAT	WAT	WAT	WAT	WAT	WAT		
Fresco (6-BA	19 ab	20 abc	20 ab	12 ab	12 ab	13 ab	12 a	0 a
$+ GA_{4+7}$								
Maxcel (6-	20 a	22 ab	22 a	14 a	13 a	15 a	13 a	0 a
BA)								
NovaGib	20 a	21 ab	21 a	13 ab	14 a	13 ab	15 a	0 a
(GA_{4+7})								
Tiberon 2.8SC	15 b	16 c	14 c	7 c	8 b	10 b	22 a	0 a
(cyclanilide) –								
1 applic.								
Tiberon 2.8SC	16 ab	19 bc	17 bc	9 bc	12 ab	13 ab	15 a	0 a
(cyclanilide) –								
2 applic.								
Untreated	20 a	23 a	22 a	12 ab	13 a	12 ab	16 a	0 a

Table 20. Effect of PGR's on Branching and Growth of Azalea (*Rhododendron sp.*), 'Watchet', Czarnota 2007.

^z means followed by the same letter are not significantly different (LSD, P= 0.05).

Holly (*llex* spp.)

From 2006 to 2008, five experiments were conducted to determine effect on branching and growth of holly. The products tested included Atrimmec, Exilis Plus, Fascination, Fresco, MaxCel, and Provide typically at 500 ppm applied twice and Tiberon 2.8SC typically at 112 ppm applied once or twice. All treatments were applied as foliar sprays typically 4 weeks apart when applied twice. Atrimmec was sprayed twice at 3900 ppm and also applied once as drench at 50 ppm. In these experiments, the assessment typically made was number of shoots, plant height, width and phytotoxicity taken for several weeks after treatment.

Overall, the five experiments conducted by Czarnota, Fulcher and Keever showed variable results on branching and plant growth. In 2006, Keever showed MaxCel and Tiberon applied twice provided increase in branching of 'Sky Pencil' holly with no phytotoxicity. Fascination and Provide showed significantly higher plant height and growth index. In 2008, Keever showed that Atrimmec, Fascination, Maxcel and Tiberon sprayed twice increased shoot numbers in both unpruned and pruned 'Sky Pencil' holly. Atrimmec applied as drench provided no increase in shoot numbers. All treatments generally had no effect on plant growth and treated plants showed no injury except those sprayed with Atrimmec and Maxcel which were stunted and leaves were elongated and keeled with an unattractive chlorosis. In 2007, Fulcher showed that Exilis Plus and Tiberon were not effective in increasing branching, and provided no effect on plant growth of holly cultivars 'Helen Hahn and 'Sadyr Hill'. In both trials, products caused no phytotoxicity. In 2008 Fulcher again showed that Tiberon sprayed twice did not increase branching of unpruned and pruned 'Winter Red' holly. Atrimmec increased branching in both pruned and unpruned plants without affecting growth, but phytotoxicity experienced with Atrimmec may limit its utility. Unpruned plants are generally bigger and had more berries than pruned plants and Fulcher suggested that pruning should be avoided on 'Red Winter' holly. In 2006, Czarnota showed that Exilis Plus at 9500 ppm, Fresco at 5550 ppm and MaxCel at 20000 ppm applied once, and Tiberon at 39 ppm applied once or twice did not affect internode length but Maxcel and Tiberon decreased canopy width. Note that these

rates are dramatically different from those suggested in the protocol. See the individual reports below for more information.

Czarnota 2006

Czarnota conducted a trial to determine the effect of four products on growth of 'Cardinal' holly. Exilis Plus at 9500 ppm, Fresco at 5550 ppm and MaxCel at 20000 ppm were applied once, and Tiberon at 39 ppm applied once or twice. Note that these rates are dramatically different from those suggested in the protocol. Data for plant growth (internode length and canopy width) were taken 6 and 30 weeks after treatment (WAT). No treatment affected internode length but Maxcel at 20000 ppm applied once and Tiberon at 39 ppm applied twice decreased canopy width (Table 21).

Treatment	Internode	Length ^z (cm)	Canopy Width (cm)		
	6 WAT	30 WAT	30 WAT		
Exilis Plus (6-BA)	1.7 b	1.5 a	10.6 a		
Fresco $(6-BA + GA_{4+7})$	2.3 a	1.4 a	9.6 ab		
Maxcel (6-BA)	1.6 b	1.5 a	6.1 c		
Tiberon 2.8SC (cyclanilide) – 1 applic.	2.0 ab	1.3 a	11.3 a		
Tiberon 2.8SC (cyclanilide) – 1 applic.	1.9 ab	1.5 a	9.2 ab		
Tiberon 2.8SC (cyclanilide) – 2 applic.	1.7 b	1.4 a	8.1 bc		
Untreated	1.9 ab	1.4 a	11.2 a		

Table 21. Effect of several PGR's on Growth of Holly (Ilex sp.), 'Cardinal' Czarnota 2006.

^z means followed by the same letter were not significantly different (LSD, P= 0.05).

Keever 2006

Keever conducted a trial to determine the effect of four products on branching and growth of 'Sky Pencil' holly. Fascination and MaxCel at 500 ppm were applied twice 4 weeks apart, Provide at 500 ppm applied once and Tiberon at 112 ppm applied once or twice 2-3 weeks apart. Treatments were replicated 10 times. Data on plant height and width, growth index [GI = (height + width)/2], and phytotoxicity (0=none, 10 = dead) were taken 4, 7 and 12 weeks after initial treatment(WAIT), and new shoots were counted at 7 and 12 WAIT. Data were subjected to statistical analysis (Duncan's Multiple Range test, p=0.05).

At 7 WAIT, Maxcel and Tiberon applied twice provided significantly higher new shoot counts compared to untreated control (Table 22). However, no significant increase in shoot counts was observed by 12 WAIT although Tiberon applied twice had the highest new shoot count. Tiberon applied once, Fascination and Provide had no significant effect on branching. At 12 WAIT plants treated with Fascination and Provide showed significantly higher plant height and growth index compared to untreated control (Table 23). Both of these products contain GA_{4+7} which may produce growth stimulation. No phytotoxicity was observed during the 12-week evaluation.

Treatment	New Shoo	Phytotoxicity at	
	7 WAIT	12 WAIT	4-12 WAIT
Fascination (6-BA + GA_{4+7})	5.0 bc	7.44 ab	0 a
MaxCel (6-BA)	8.3 a	5.00 b	0 a
Provide (GA_{4+7})	3.5 cd	6.56 ab	0 a
Tiberon 2.8SC (cyclanilide) – 1 applic.	1.0 d	6.25 ab	0 a
Tiberon 2.8SC (cyclanilide) – 2 applic.	7.5 ab	8.30 a	0 a
Untreated	4.2 cd	6.00 ab	0 a

Table 22. Effect of several PGR's on Branching and Phytotoxicity of Holly (*Ilex crenata*), 'Sky Pencil', Keever 2006.

² Means in the same column followed by the same letter are not significantly different, (P = 0.05, Duncan's Multiple Range test).

Treatment		Height ^z			Width		(Growth Index		
	4	7	12	4	7	12	4	7	12	
	WAIT	WAIT	WAIT	WAIT	WAIT	WAIT	WAIT	WAIT	WAIT	
Fascination	12.8 ab	16.3 a	26.4 a	5.60 a	5.40 ab	6.67 a	9.18 ab	10.85 a	16.56 a	
$(6-BA + GA_4)$										
+ 7)										
MaxCel (6-	12.7 ab	14.6 a	21.8 ab	4.55 c	5.25 ab	5.90 a	8.62	9.25 ab	13.85 ab	
BA)							abc			
Provide (GA ₄	13.4 a	16.7 a	25.4 a	5.30 ab	5.44 ab	6.78 a	9.35 a	11.06 a	16.11 a	
+ 7)										
Tiberon	11.3 b	11.4 b	17.4 b	5.00 bc	5.9 a	6.38 a	8.15 bc	8.65 bc	11.88 b	
(cyclanilide)										
– 1 applic.										
Tiberon	10.8 b	10.7 b	16.7 b	5.00 bc	4.9 b	6.00 a	7.88 c	7.80 c	11.35 b	
(cyclanilide)										
-2 applic.										
Untreated	12.6 ab	13.5 ab	17.7 b	5.40 ab	5.4 ab	5.89 a	9.00 ab	9.45 abc	11.78 b	

 Table 23. Effect of several PGR's on Growth of Holly (*Ilex crenata*), 'Sky Pencil', Keever 2006.

^z Means in the same column followed by the same letter are not significantly different, (P = 0.05, Duncan's Multiple Range test).

Keever 2008

In this trial, Keever evaluated four products on unpruned (Unpruned) and pruned (P) 'Sky Pencil' holly. Atrimmec at 3900 ppm, Fascination at 1000 ppm, MaxCel at 500 ppm and Tiberon at 100 ppm were applied twice 4 weeks apart. Atrimmec was also applied once as drench at 50 ppm. Overall, all foliar treatments increased shoot numbers in both unpruned and pruned holly, with Fascination and Maxcel providing the highest, and Tiberon the lowest increase (Table 24). Atrimmec applied as drench at 50 ppm provided no increase in shoot numbers. Pruned treatments formed fewer shoots than unpruned plants suggesting pruning 2 weeks after the second spray application does not increase the efficacy of PGR treatment on 'Sky Pencil' holly. All spray treatments generally decreased height in both unpruned and pruned plants; increased width in unpruned and no effect on pruned plants and had no effect on growth index (Table 25). Atrimmec drench had no effect on height, width and growth index of both unpruned and pruned plants at 210 DAT. Growth indices between unpruned and pruned plants were similar for all

treatments except for Atrimmec drench at this observation date. Plants sprayed with Atrimmec and Maxcel were stunted and leaves were elongated and keeled with an unattractive chlorosis.

Treatment	New Shoo	ot Counts ^z	Phytotoxicity		
	60-90 DAT	210 DAT	60-90 DAT	120 DAT	
Atrimmec (dikegulac sodium) -	52.2 b	51.5 a	2.4 a	2.3 a	
Unpruned					
Fascination (6-BA + GA_{4+7}) -	57.5 a	48.2 a	1.2 b	1.7 bc	
Unpruned					
MaxCel (6-BA) - Unpruned	57.7 a	48.5 a	1.3 b	2.0 ab	
Tiberon 2.8SC (cyclanilide) –	34.5 de	46.8 ab	1.3 b	1.4 c	
Unpruned					
Atrimmec Drench - Unpruned	21.9 f	25.5 e	1.0 b	1.2 c	
Untreated - Unpruned	25.3 f	28.6 de	1.0 b	1.2 c	
Atrimmec (dikegulac sodium) -	50.9 b	37.4 c	2.6 a	1.7 bc	
Pruned					
Fascination (6-BA + GA_{4+7}) -	42.8 c	38.9 c	1.0 b	1.5 c	
Pruned					
MaxCel (6-BA) - Pruned	45.9 c	42.2 bc	1.2 b	2.1 ab	
Tiberon 2.8SC (cyclanilide) – P	37.8 d	37.8 c	1.0 b	1.5 c	
Atrimmec Drench - Pruned	31.5 e	27.2 de	1.1 b	1.2 c	
Untreated - Pruned	33.9 de	31.4 d	1.0 b	1.2 c	

 Table 24. Effect of several PGR's on Branching and Phytotoxicity of Holly (*Ilex crenata*), 'Sky Pencil', Keever 2008.

^{*z*} Means in the same column followed by the same letter are not significantly different, (P = 0.05, Duncan's Multiple Range test).

Treatment	Hei	ght ^z	Wi	dth	Growt	Growth Index		
	60-90	210	60-90	210	60-90	210		
	DAT	DAT	DAT	DAT	DAT	DAT		
Atrimmec (dikegulac sodium) - Unpruned	29.1 c	38.4 bc	13.1 a	16.1 ab	18.4 b	23.5 abc		
Fascination (6-BA + GA_{4+7}) - Unpruned	27.8 c	38.1 bc	10.1 b	15.8 ab	16.0 c	23.2 abc		
MaxCel (6-BA) - Unpruned	21.3 d	36.4 bcd	13.9 a	16.2 a	16.4 c	22.9 a-d		
Tiberon 2.8SC (cyclanilide) – Unpruned	21.3 d	37.8 bc	10.4 b	16.1 ab	14.0 d	23.3 abc		
Atrimmec Drench - Unpruned	38.4 a	42.8 a	13.1 a	15.2 bc	21.5 a	24.4 a		
Untreated - Unpruned	33.3 b	42.8 a	10.9 b	14.9 c	18.4 b	24.2 ab		
Atrimmec (dikegulac sodium) - Pruned	27.0 c	35.4 cd	13.6 a	15.8 ab	18.0 b	22.3 cd		
Fascination (6-BA + GA_{4+7}) - Pruned	22.5 d	35.9 cd	13.2 a	15.9 ab	16.3 c	22.5 cd		
MaxCel (6-BA) - Pruned	21.3 d	33.4 d	13.3 a	15.8 ab	16.0 c	21.6 d		
Tiberon 2.8SC (cyclanilide) – P	22.4 d	36.3 bcd	13.0 a	15.5 abc	16.1 c	22.4 cd		
Atrimmec Drench - Pruned	26.9 c	37.5 bcd	13.8 a	15.4 abc	18.1 b	22.8 bcd		
Untreated - Pruned	23.2 d	40.3 ab	13.4 a	16.0 ab	16.6 c	24.1 ab		

Table 25. Effect of several PGR's on Growth of Holly (Ilex crenata), 'Sky Pencil', Keever 2008.

^z Means in the same column followed by the same letter are not significantly different, (P = 0.05, Duncan's Multiple Range test).

Fulcher 2007

Fulcher conducted a trial to determine the effect of Exilis Plus and Tiberon on branching and growth of holly cultivars 'Helen Hahn and 'Sadyr Hill'. 'Helen Hahn' is cold hardy, and a fast grower, but retains the open, loose branch habit of orchard holly species which once dominated the American holly trade. An increase in branch number would increase the canopy density for 'Helen Hahn' and increase its desirability for landscapes. 'Sadyr Hill' represents an American Holly that is in high demand with an inherently dense canopy and, therefore, was included in the study for comparison. Exilis Plus at 500 ppm was applied twice 4 weeks apart and Cyclanilide at 112 ppm applied once or twice 2-3 weeks apart. A surfactant Latron B was applied with the treatments at 2.34 ml per gallon. Treatments were replicated 5 times for 'Helen Hahn' and 8 times for 'Sadyr Hill' cultivars. Branch number, plant height and width were recorded at initiation and termination of the experiment. A growth index was calculated as (Height + Width A + Width B)/3 where Width A = the widest point of the canopy and Width B = the width perpendicular to the widest part of the canopy. Phytotoxicity (0=no injury, 10=plant death) was assessed one week after first application and for the duration of the experiment. Data were subjected to statistical analyses, (SAS Institute, Inc., Cary, NC) at alpha = 0.05.

There were no significant differences for branch number, height, width, or growth index due to PGR treatments for holly cultivars 'Helen Hahn' and 'Sadyr Hill' (Table 26). There were no visible signs of phytotoxicity from any of the treatments (data not shown).

Treatment		'Heler	ı Hahn'			'Sady	r Hill'	
	Branch	Height	Width	Growth	Branch	Height	Width	Growth
	No. ^z	(cm)	(cm)	Index	No.	(cm)	(cm)	Index
Exilis Plus (6-BA)	5.00 a	34.4 a	29.0 a	25.2 a	5.8 a	30.3 a	22.3 a	22.3 a
Tiberon 2.8SC	4.80 a	43.6 a	35.2 a	33.4 a	6.0 a	37.4 a	24.0 a	25.8 a
(cyclanilide) – 1								
applic.								
Tiberon 2.8SC	-	-	-	-	5.5 a	35.8 a	21.3 a	22.8 a
(cyclanilide) – 2								
applic.								
Untreated	3.75 a	37.0 a	21.0 a	23.0 a	5.8 a	32.4 a	20.5 a	22.3 a

Table 26. Effect of PGR's on Branching and Growth of Holly (*Ilex opaca*) Cultivars'Helen Hahn' and 'Sadyr Hill', Fulcher 2007.

^z means followed by the same letter were not significantly different (Tukey's HSD, $\alpha = 0.05$).

Fulcher 2008

In this trial, Fulcher evaluated Atrimmec at 3800 ppm and Tiberon at 100 ppm applied twice on holly (*I. verticillata*) 'Winter Red' cultivar. This cultivar was selected because it was identified by members of the Kentucky nursery industry as difficult to produce efficiently, due to a lack of branching. In addition, to sell at a young age, Winter Red® hollies need an abundance of branches with berries. A typical industry practice is to prune to induce branching. Pruning could remove fruiting wood that might have had berries, so the problem of stimulating branching is compounded for hollies. There was no difference initially in the branch number, height or width for the treatments (Table 27). Unpruned plants are generally bigger and had more berries than pruned plants (Tables 27 and 28). Atrimmec increased branching in both pruned and unpruned plants without affecting growth, but phytotoxicity experienced with Atrimmec may limit its utility (Table 29). Reducing the Atrimmec rate may reduce phytotoxicity. Growers may be able to apply this product in the season before sale or early in the season of sale, as time did diminish the phytotoxic effects. Tiberon did not increase branching and had no effect on plant growth. Pruning was ineffective and reduced the number of berries, therefore, woody cut stem growers, in particular, may want to avoid using pruning techniques to induce branching.

Treatment		6/23/08		9/9/08					
	Initial Measurement			4 We	4 Weeks After Last Application				
	Branch	Height	Width	Branch	Height	Width	Growth		
	No. ^z	(cm)	(cm)	No.	(cm)	(cm)	Index		
Atrimmec (dikegulac	11.42 a	91.25 a	35.25 a	23.33 a	97.25 a	38.00 ab	67.63 a		
sodium) - Unpruned									
Tiberon 2.8SC	11.58 a	92.00 a	33.75 a	18.92 ab	98.92 a	44.33 a	71.63 a		
(cyclanilide) – Unpruned									
Untreated - Unpruned	11.33 a	90.42 a	31.67 a	16.75 bc	95.42 a	41.25 a	68.33 a		
Atrimmec (dikegulac	11.67 a	85.67 a	36.92 a	18.58 ab	63.33 b	29.75 b	46.54 b		
sodium) - Pruned									
Tiberon 2.8SC	11.58 a	89.17 a	38.08 a	11.42 c	68.00 b	37.92 ab	52.96 b		
(cyclanilide) – Pruned									
Untreated - Pruned	11.67 a	82.75 a	30.58 a	12.25 c	65.42 b	35.25 ab	50.33 b		

 Table 27. Effect of PGR's on Branching and Growth of Holly (*Ilex verticillata*) 'Winter Red', Fulcher 2008.

^{*z*} Means followed by the same letter were not significantly different (Tukey's HSD, $\alpha = 0.05$)

Total Branch	Number of Long	% of Long	Height (cm)	Width (cm)	Number	Growth Index
Number ^z	Branches	Branches	(0111)	(011)	Berries	Inden
25.42 a	15.33 a	60.98	98.83 a	43.92 ab	144.00 a	57.72 a
18.75 bc	15.00 a	80.27	99.29 a	53.46 a	183.17 a	63.35 a
16.17 cd	12.25 ab	76.81	94.79 a	51.25 a	165.00 a	60.83 a
23.25 ab	12.75 ab	55.43	65.75 b	34.71 b	38.25 b	42.47 b
12.58 d	9.42 b	77.20	70.25 b	45.21 ab	34.00 b	48.61 b
13.92 cd	9.67 b	70.51	66.71 b	44.75 ab	33.67 b	46.86 b
	Total Branch Number ^z 25.42 a 18.75 bc 16.17 cd 23.25 ab 12.58 d 13.92 cd	Total Branch Number of Long Number ^z Branches 25.42 a 15.33 a 18.75 bc 15.00 a 16.17 cd 12.25 ab 23.25 ab 12.75 ab 12.58 d 9.42 b 13.92 cd 9.67 b	Total Branch Number of Long % of Long Number ^z Branches Branches 25.42 a 15.33 a 60.98 18.75 bc 15.00 a 80.27 16.17 cd 12.25 ab 76.81 23.25 ab 12.75 ab 55.43 12.58 d 9.42 b 77.20 13.92 cd 9.67 b 70.51	Total Branch Number ^z Number of Long Branches % of Long Branches Height (cm) Number ^z Branches Branches (cm) 25.42 a 15.33 a 60.98 98.83 a 18.75 bc 15.00 a 80.27 99.29 a 16.17 cd 12.25 ab 76.81 94.79 a 23.25 ab 12.75 ab 55.43 65.75 b 12.58 d 9.42 b 77.20 70.25 b 13.92 cd 9.67 b 70.51 66.71 b	Total Branch Number ^z Number of Long Branches % of Long Branches Height (cm) Width (cm) 25.42 a 15.33 a 60.98 98.83 a 43.92 ab 18.75 bc 15.00 a 80.27 99.29 a 53.46 a 16.17 cd 12.25 ab 76.81 94.79 a 51.25 a 23.25 ab 12.75 ab 55.43 65.75 b 34.71 b 12.58 d 9.42 b 77.20 70.25 b 45.21 ab 13.92 cd 9.67 b 70.51 66.71 b 44.75 ab	Total Branch Number ^z Number of Long Branches % of Long Branches Height (cm) Width (cm) Number of Berries 25.42 a 15.33 a 60.98 98.83 a 43.92 ab 144.00 a 18.75 bc 15.00 a 80.27 99.29 a 53.46 a 183.17 a 16.17 cd 12.25 ab 76.81 94.79 a 51.25 a 165.00 a 23.25 ab 12.75 ab 55.43 65.75 b 34.71 b 38.25 b 12.58 d 9.42 b 77.20 70.25 b 45.21 ab 34.00 b 13.92 cd 9.67 b 70.51 66.71 b 44.75 ab 33.67 b

Table 28. Effect of PGR's on Branching and Growth of Holly (*Ilex verticillata*) 'Winter Red' 12weeks after last application (November 6, 2008).

^z Means followed by the same letter were not significantly different (Tukey's HSD = 0.05)

Table 29.	Effect of PGR's on Phytotoxicity and Quality on Holly (Ilex verticillata) 'Winter
Red', Fulcher	2008.

Treatment		Quality Rating (1-5)			
	7/18/08	8/1/08	8/21/08	9/26/08	10/2/08
		3 WATT	1 WA12	0 WA12	
Atrimmec (dikegulac	1.17 a	3.25 a	6.33 a	2.83 a	2.00 ab
sodium) - Unpruned					
Tiberon 2.8SC	1.17 a	1.17 b	1.17 b	0.92 b	2.54 ab
(cyclanilide) – Unpruned					
Untreated - Unpruned	0.42 a	0.75 b	0.50 b	0.50 b	3.21 a
Atrimmec (dikegulac	1.17 a	3.58 a	6.75 a	3.00 a	1.75 b
sodium) - Pruned					
Tiberon 2.8SC	0.83 a	0.58 b	1.25 b	0.75 b	2.92 ab
(cyclanilide) – Pruned					
Untreated - Pruned	0.50 a	0.92 b	0.00 b	0.50 b	3.33 a

^z Means followed by the same letter were not significantly different (Tukey's HSD alpha $\alpha = 0.05$)

^yWeeks after application

Hydrangea (Hydrangea spp.)

Ornamental hydrangeas are an economically important crop in both the floral and landscape industries. The value of landscape hydrangea sales was considered to be \$73 million in the 2009 USDA survey¹. This is a threefold increase from 1997. Products to produce a well branched hydrangea plant holds a value to ornamental. Six products including Exilis plus, Fascination, Fresco, MaxCel, Provide and Tiberon

2.8SC were tested between 2006 to 2008 in four experiments (Tables 30-36). All treatments were applied as foliar sprays typically 4 weeks apart when applied twice In 2011, six researchers evaluated Augeo, Configure and Florel for branching on both florist and nursery types of hydrangeas (Tables 37-46). The four experiments conducted by Fulcher, Gibson and Lieth between 2006 and 2008 showed that Tiberon was the only treatment that significantly increased branching; however it caused phytotoxicity symptoms that may limit its use. In 2006, Gibson showed that Tiberon sprayed twice was the only treatment that significantly increased branching; however, it caused reduced plant diameter and visual quality. In 2006, Lieth showed that Tiberon, as well as, Maxcel and Provide, had no effect on branching or growth of hydrangea pinched 4 weeks before spray application. Fascination dramatically increased stem elongation which may represent a powerful tool for cut-flower hydrangea growers despite the phytotoxicity, perhaps at lower rates of application. In 2007 and 2008, Fulcher conducted trials to determine the effect of Exilis Plus and Tiberon on branching and growth of 'Alice' hydrangea produced from cutting or tissue culture. In the 2007 trial, only cutting-produced plants responded to the PGR treatments, with Tiberon applied twice the only treatment that significantly increased branching without affecting growth or causing injury. Similarly in the 2008 trial, Tiberon applied twice was the only PGR treatment that increased 6" or longer branches only for cutting propagated plants. However, this treatment resulted in substantial phytotoxicity (bright yellow chlorosis) rendering plants unmarketable in a short time. Overall plant growth was not affected by PGR treatments. Based on her data, Fulcher suggested that pruning is an effective method to increase long branches and quality if growing cutting-propagated plants and sales are to occur soon after potting up liners. If sales are to occur 12 or more weeks after treatment, pruning or two applications of Tiberon could increase the number of long branches and quality for cutting-propagated plants.

Tiberon was sold as a branching agent on fruit trees in nursery production but is not currently commercialized due to too few customers (Capital Press, Jan. 2012, Western innovator: Researcher Delivers Smaller Trees by Dan Wheat. Western innovator: Researcher delivers smaller trees capitalpress.com). Efforts were made to evaluate three additional products for their impact on hydrangea branching. Augeo, Configure and Florel were selected for screening in six experiments on either florist or nursery type hydrangea varieties. Three trials involved Hydrangea macrophylla 'Merrit's Supreme', two of *H. macrophylla* 'Nikko Blue', and one with *H. paniculata* 'Limelight'. Hydrangea plants treated with Augeo at 800 or 1600 ppm developed significantly more lateral shoots than the pinched untreated in five of six experiments. In these experiments, Augeo treated plants had quality ratings equal to (Table 40 &Table 41) or greater than (Table 43 &Table 45) the pinched control. Branch counts were higher for Augeo treated pots compared to the pinched untreated in five out of six trials. One researcher noted that by 16WAT some of the shoots appeared to have arrested growth (Whipker) and bud necrosis was noted in one experiment (Figure 9). A second researcher observed fewer blooms. Branch count was not increased with Florel treatments. Branching was greater for Hydrangea paniculata 'Limelight' treated with 1000 ppm Florel (37.2) than the pruned control (26.7) but with no statistical difference (Table 40). In this trial only the pruned control was pruned, whereas, in the other experiments all treated plants received a pinch/pruning. Configure (300 and 600 ppm) did not appear to improve branching. In one trial, plants treated with Configure and Florel had fewer branches (Table 41) than the pinched control. In a single trial, 'Merritt's Supreme' plants treated with Florel were described as full and glossy with quality ratings exceeding the control (Table 43Error! Reference source not found.).

Injury to hydrangea was evaluated at 2WAT and 6WAT on a scale of 0-10 (0 = no injury and 10 =death). Averages of the initial evaluations show unacceptable (\geq 3) injury with 1600 ppm Augeo at 2WAT (Figure 4). This type of injury was characterized most often as chlorosis to new growth (see Figure 7). Also at 2WAT Augeo at 800 ppm, as well as, both rates of Configure (300 and 600 ppm) and Florel at 1000 ppm caused slight crop injury compared to the untreated. By 6WAT all pots recovered from treatment and were rated within the acceptable range.

Overall, results demonstrated that treatments with Augeo at 800 or 1600 ppm will provide a well branched full growth habit on hydrangea comparable to the pinched control. Initial phytotoxicity was observed but plants were of acceptable quality by 6WAT. A follow-up application of growth regulator such as GA+BA may help lateral branches to resume apical dominance and is worth consideration. Fine tuning the application(s) may increase the likelihood of this amendment being adopted as a commercial practice.



Figure 1. Augeo Impact on Lateral Branch Count on Hydrangea sp.



Figure 2. Configure Impact on Lateral Branch Count of Hydrangea Sp.

*Significance letters compare treatments by researcher.



Figure 3. Florel Impact on Lateral Branch Count on Hydrangea sp.

Figure 4. Augeo, Configure and Florel Crop Injury on Hydrangea sp.

Gibson 2006

Gibson conducted a trial to determine the effect of three products on branching and growth of oakleaf hydrangea. Exilis Plus and Fresco at 100 ppm were applied twice 4 weeks apart and Tiberon at 100 ppm applied once or twice 2 weeks apart. Data for shoots (greater than 1 cm) before spray or after spray, visual quality (0 to 5 scale; 0=dead to 5 =outstanding), plant height (measured from the container rim to the highest growing point), and plant diameter (measured at the widest point and then turned 90°) were recorded on 19 December.

Tiberon sprayed twice was the only treatment that significantly increased branching (Table 30). However, this treatment reduced plant diameter, and a visual quality rating of 2.8 compared to a 4.3 for all other treatments demonstrated that Tiberon affects plant appearance negatively. Products caused no phytotoxicity (data not shown). There appears to be no benefit to treating oakleaf hydrangea with Tiberon at 100 ppm because of similar shoot numbers to the untreated control when sprayed once or producing a poor visual quality when applied twice. The other PGR's did not increase branching nor improve visual quality.

Treatment	Branch Number ^z		Diameter	Visual
	2 Nov	19 Dec	(cm)	Quality
	Pretreatment	7WAT	19 Dec.	19 Dec.
Exilis Plus (6-BA)	1.0 a	2.8 a	44.6 b	4.2 a
Fresco $(6-BA + GA_{4+7})$	1.2 a	5.0 ab	52.8 c	4.2 a
Tiberon 2.8SC (cyclanilide) – 1 applic.	1.4 a	8.4 b	37.7 a	3.6 ab
Tiberon 2.8SC (cyclanilide) – 2 applic.	2.2 a	12.2 c	40.6 ab	2.8 b
Untreated	1.6 a	6.2 ab	54.1 c	4.4 a

 Table 30. Effect of several PGR's on Branching and Growth of Oakleaf Hydrangea (Hydrangea quercifolia), Gibson 2006.

^z means followed by the same letter are not significantly different (LSD, $P \le 0.05$).

Lieth 2006

In 2006, Lieth conducted an experiment to determine effect of four products on branching and growth of 'Angel Robe' hydrangea pinched 4 weeks before spray application. The treatments were Fascination and MaxCel at 500 ppm applied twice 4 weeks apart, Tiberon 2.8SC at 112 ppm + Latron applied once or twice 2 weeks apart and Provide at 500 ppm applied once. Treatments were replicated 9 times. The number of shoots, flower buds, height and width, as well as phytotoxicity (0 = no damage, 10 = complete kill) were recorded at various times after treatment. Canopy volume index was calculated as H*W1*W2, where H is the height and W1 and W2 are two width measurements. Data were subjected to statistical analysis (t-test, P=0.05).

Tiberon applied once or twice and Provide were not phytotoxic but did not increase branching and provided no effect on plant growth (Table 31). Fascination and Maxcel caused unacceptable injury (Table 32). Fascination dramatically increased stem elongation which may represent a powerful tool for cut-flower hydrangea growers perhaps at lower rates of application. Research should be done to see if lower concentrations will result in reduced phytotoxicity, while retaining the effect of stretching the stem length. Maxcel provided no effect on branching or plant growth.

Table 31. Effect of Tiberon on Branching and Growth of Hydrangea (Hydrangea macrophylla),'Angel Robe', Lieth 2006.

Treatment	Height Increase ^z	Ave. Width Increase	Volume Index	Increase in No. of	Incre Phytotoxici	ase in ty Index ^z by
	(cm) by 8	(cm) by 8	Increase By S WAT	Shoots by	4 WAIT	8 WAIT
Tiberon	20.94 a	22.42 a	62459 a	1.78 a	1.67 a	0.89 a
Latron – 1 applic.						
Tiberon (cyclanilide) + Latron – 2 applic.	20.17 a	20.58 a	52378 a	0.33 b	1.78 a	1.22 a
Latron	13.11 a	15.97 a	37266 a	1.11 ab	2.22 a	1.56 a
Untreated	23.00 a	21.56 a	64027 a	0.56 ab	1.78 a	1.33 a

² Means in the same column followed by the same letter are not significantly different, (t-test, P < 0.05); number of shoots significantly different at P = 0.10.

^y Week after first application.

Table 32. Effect of several PGR's on Branching and Growth of Hydrangea (*Hydrangea macrophylla*), 'Angel Robe', Lieth 2006.

Treatment	Height Increase ^z	Ave. Width Increase	Volume Index	Increase in No. of	Incre Phytotoxici	ase in ty Index ^z by
	(cm) by 8 WAT	(cm) by 8 WAT	Increase By 8 WAT	Shoots by 8 WAT	4 WAIT	8 WAIT
Fascination (6- BA + GA_{4+7})	39.67 a	14.86 b	61010 a	2.56 a	3.33 a	3.89 a
MaxCel (6-BA)	14.11 c	17.28 ab	31597 b	0.44 a	2.78 ab	2.89 a
Provide (GA_{4+7})	23.06 b	23.25 a	70322 a	0.67a	1.89 b	1.67 b
Untreated	23.00 b	21.56 a	64027 a	0.56 a	1.78 b	1.33 b

^z Means in the same column followed by the same letter are not significantly different, (t-test, P < 0.05); width and number of shoots significantly different at P = 0.10.

^y Week after first application.

Fulcher 2007

Fulcher conducted a trial to determine the effect of Exilis Plus and Tiberon on branching and growth of 'Alice' hydrangea. In production, *Hydrangea quercifolia* often grows a single long branch which exhibits apical dominance and causes uneven canopy development. 'Alice' hydrangea from both conventional cuttings and tissue culture – grown cuttings were selected with the goal of examining the effect of habituation to plant hormones used in tissue culture on plant response to PGR application during production and mediation of the undesirable single branch growth habit. Exilis Plus at 500 ppm was applied twice 4 weeks apart and Tiberon at 112 ppm applied once or twice 2-3 weeks apart. A surfactant Latron B was applied with the treatments at 2.34 ml per gallon. Treatments were replicated 8 times. Branch number, plant height and width were recorded at initiation and termination of the experiment. A growth index was calculated as (Height + Width A + Width B)/3 where Width A = the widest point of the canopy and Width B = the width perpendicular to the widest part of the canopy. Phytotoxicity (0=no injury, 10=plant death) was assessed one week after first application and for the duration of the experiment. Data were subjected to statistical analyses, (SAS Institute, Inc., Cary, NC) at alpha = 0.05.

To analyze the data, a multivariate ANOVA was conducted to look at the propagation technique by PGR treatment interaction. The results showed that propagation technique by PGR treatment interactions for individual response variables were not significant. The PGR treatments were significant only for branch number of cutting-produced plants, with Tiberon sprayed twice significantly increasing branching (Table 33). Propagation technique of the cuttings was significant for branch number, height, width, and growth index. The cutting-produced plants were significantly taller and wider than the tissue culture produced plants used in this experiment (Table 34). As a result, it is difficult to determine if differences in branch number recorded at the end of the season are due to the initial size or the treatments imposed. It is possible that the tissue culture - produced plants may not have had sufficient photosynthetically active tissue and/or sufficient root mass to support the additional growth PGRs would normally induce. Growers who are propagating or purchasing *Hydrangea quercifolia* 'Alice' propagated by cuttings may be able to increase branch number with two applications of Tiberon, while those purchasing tissue culture-produced plants may not.

Table 33.Effect of PGR's on Branching and Growth of Hydrangea (Hydrangea quercifolia)'Alice' grown from two propagation techniques, Fulcher 2007.

Propagation	Treatment	Branch	Height	Width	Growth
Technique		No.	(cm)	(cm)	Index
Cutting	Tiberon 2.8SC (cyclanilide) – 1 applic.	4.6 ab	56.2	58.9	52.9
	Tiberon 2.8SC (cyclanilide) – 2 applic.	6.3 a	56.4	55.2	52.2
	Exilis Plus (6-BA)	3.8 b	59.1	56.8	54.0
	Untreated	4.0 b	56.3	59.2	52.5
Tissue Culture	Tiberon 2.8SC (cyclanilide) – 1 applic.	3.3 A	55.3	41.6	42.6
	Tiberon 2.8SC (cyclanilide) – 2 applic.	3.7 A	51.2	48.2	45.5
	Exilis Plus (6-BA)	3.4 A	55.3	47.8	47.1
	Untreated	3.4 A	51.8	46.8	45.2

Source	DF	F	F	F	F
		Statistic	Statistic	Statistic	Statistic
Propagation	1	11.85**	4.82*	30.58**	43.19**
Technique					
PGR	3	3.72*	0.99 ^{ns}	0.30 ^{ns}	0.86 ^{ns}
Treatment					
Prop. Tech. x	3	2.36 ^{ns}	0.30 ^{ns}	1.15 ^{ns}	0.48 ^{ns}
PGR					

^z means followed by the same letter were not significantly different (Tukey's HSD, $\alpha = 0.05$).

Propagation Technique	Height (cm)	Width (cm)
Cutting	11.8 a	9.7 a
Tissue Culture	7.2 b	6.1 b
ANOVA P value	0.0001	0.0001

Table 34. Initial Height and Width of Hydrangea (*Hydrangea quercifolia*) 'Alice' grown from two propagation techniques, Fulcher 2007.

^z means followed by the same letter were not significantly different (Bonferroni, $\alpha = 0.05$).

Fulcher 2008

In this trial, Fulcher compared the effect of Exilis Plus and Tiberon on branching and growth of 'Alice' hydrangea produced from both conventional cuttings and tissue culture. Exilis Plus at 500 ppm was applied twice 4 weeks apart and Tiberon at 100 ppm applied once or twice 4 weeks apart. Plants propagated by tissue culture had significantly greater number of branches 6 inches and longer than those propagated by cuttings (Tables 35 and 36). Tiberon applied twice was the only PGR treatment that provided significant increase in long branches but only for cutting propagated plants; however this treatment resulted in substantial phytotoxicity (bright vellow chlorosis) rendering plants unmarketable at this time (data not shown). The effect of Tiberon and Exilis Plus on total branch number and phytotoxicity of cutting produced plants is consistent with results of Gibson (Table 30). Overall plant growth was not affected by PGR treatments. Growers may need to conduct a cost analysis to determine the most cost-effective solution to increasing branching of 'Alice' oakleaf hydrangea. Based on this study, tissue culture-propagated plants have a greater number of branches and higher quality than cuttingpropagated plants but are more expensive. These qualities persisted to six months after potting up rooted cuttings. Tiberon applied twice may be effective at increasing the more noticeable, long branches in the season following application, but was phytotoxic the season of application. Pruning is an effective method to increase long branches and quality, if growing cutting-propagated plants and sales are to occur soon after potting up liners. If sales are to occur 12 or more weeks after treatment, pruning or two applications of Tiberon could increase the number of long branches and quality for cutting-propagated plants.
Propagation	Treatment	6"+	Total	Height	Width	Growth	Quality
Technique		Branch ^z	Branch	(in)	(in)	Index	
Cutting	Water	3.7b ^z	10.9b	19.8	29.1	23.0	2.3b
	Exilis Plus (6- BA)	5.3b	13.3b	18.0	28.0	22.3	2.4b
	Tiberon 2.8SC (cyclanilide) – 1 applic.	4.8b	16.3ab	17.0	30.0	21.4	2.4b
	Tiberon 2.8SC (cyclanilide) – 2 applic.	5.2b	21.3a	17.5	30.1	21.3	2.4b
	Prune	7.6a	11.0b	22.1	25.8	22.4	3.9a
Tissue							
Culture	Water	6.3ab	15.0ab	22.1	26.7ab	23.6	3.1ab
	Exilis Plus (6- BA)	5.0b	12.1b	20.3	28.7a	23.1	2.3b
	Tiberon 2.8SC (cyclanilide) – 1 applic.	6.4ab	17.9a	20.9	28.1a	22.3	3.3ab
	Tiberon 2.8SC (cyclanilide) – 2 applic.	5.8ab	18.3a	20.6	27.3a	22.6	2.7b
	Prune	7.4a	11.5b	22.5	22.8b	21.5	3.94a

Table 35. Effect of PGR's on Branching and Growth of Hydrangea (*Hydrangea quercifolia*) 'Alice' grown from two propagation techniques 4 weeks after last application, Fulcher 2008.

Source	DF	F statistic	F	F	F	F	F
			statistic	statistic	statistic	statistic	statistic
Prop.Tech.	1	5.92**	0.00 ^{ns}	8.14**	4.97*	1.42 ^{ns}	4.43*
Branch Trt.	4	6.73***	8.93***	1.90 ^{ns}	4.68**	0.68 ^{ns}	9.02***
Water Control ^y	-	25.27***	-	-	-	-	-
Prop. Tech.	4	2.83*	0.95 ^{ns}	0.51 ^{ns}	0.80 ^{ns}	0.54 ^{ns}	1.11 ^{ns}
x PGR							

^zmeans followed by the same letter within a column within a propagation technique were not significantly different (Tukey's HSD $\alpha = 0.05$)

^ypairwise comparison of water controls of cutting and tissue culture propagated plants

Propagation	Treatment	6"+	Total	Height	Width	Growth	Ouality
Technique		Branch ^z	Branch	(in)	(in)	Index	Q =====5
Cutting	Water	5.3b ^z	12.3b	23.5a	32.3	23.8	2.2c
	Exilis Plus (6- BA)	6.9ab	14.7ab	17.9b	32.5	24.1	2.8bc
	Tiberon 2.8SC (cyclanilide) – 1 applic.	7.0ab	16.0ab	17.8b	32.5	23.2	2.9bc
	Tiberon 2.8SC (cyclanilide) – 2 applic.	7.9a	19.9a	19.9ab	34.6	25.0	3.3ab
	Prune	7.9a	11.7b	18.7ab	31.7	26.2	3.9a
Tissue							
Culture	Water	10.2a	13.5b	24.5	29.7	25.0	3.5ab
	Exilis Plus (6- BA)	6.6b	12.5b	21.3	32.6	25.4	2.9b
	Tiberon 2.8SC (cyclanilide) – 1 applic.	6.8b	15.1ab	22.3	29.5	24.0	3.1b
	Tiberon 2.8SC (cyclanilide) – 2 applic.	8.3ab	19.6a	21.0	29.2	23.3	3.2b
	Prune	7.3ab	11.6b	24.6	30.7	25.7	4.0a

Table 36. Effect of PGR's on Branching and Growth of Hydrangea (*Hydrangea quercifolia*) 'Alice' grown from two propagation techniques 12 weeks after last application, Fulcher 2008.

Source	DF	F	F	F	F	F	F
		statistic	statistic	statistic	statistic	statistic	statistic
Prop.Tech.	1	4.09*	0.23 ^{ns}	13.52** *	6.42*	0.17 ^{ns}	5.51*
Branch Trt.	4	4.53 ^{ns}	8.58***	3.46*	0.42 ^{ns}	2.06 ^{ns}	8.93***
Water Control ^y	-	18.05***	-	-	-	-	19.92** *
Prop. Tech. x PGR	4	6.12***	0.33 ^{ns}	1.16 ^{ns}	0.99 ^{ns}	1.13 ^{ns}	3.51*

²means followed by the same letter within a column within a propagation technique were not significantly different (Tukey's HSD $\alpha = 0.05$)

^ypairwise comparison of water controls of cutting and tissue culture propagated plants

<u>Bi 2011</u>

Bi evaluated Augeo, Configure and Florel on container grown 'Merritt Supreme' hydrangea for effects on improved branching. Y cuttings were established in 6" pots and grown outdoors under shadecloth with drip irrigation.

Phytotoxicity: At 2 WAT, plants treated with Augeo, Configure and Florel at all rates tested exhibited some foliar necrosis. Plants treated with Augeo at 800 ppm and 1600 ppm had significantly higher phytotoxicity ratings than plants treated with Configure and Florel. At 6WAT, some of the foliar necrosis diminished as plants grew bigger except for plants treated

with 1600 ppm Augeo. Plants treated with 1600 ppm Augeo showed significantly higher phytotoxicity ratings compared to plants in all other treatments.

Efficacy: The total number of stems per plant was counted before putting plants into the cooler for chilling treatment. Augeo at 800 ppm and 1600 ppm significantly increased plant branching. There was no difference on the number of stems between plants treated with Augeo 800 ppm and Augeo 1600 ppm. Plants treated with Configure (300 and 600 ppm, two applications) and Florel (500 and 1000 ppm) had similar number of stems as untreated pinched control. Untreated non-pinched controls had significantly lower number of stems than plants in other treatments.

		Phytotoxicity I	Rating (0-10)	Shoot Count
Product	Rate (ppm)	2 WAT	6 WAT	Shoot Count
	800	$0.63 a^2$	0.42 b	5.9 a
Mugeo	1600	0.67 a	1.50 a	5.7 a
Configural	300	0.25 b	0.08 b	4.0 b
Configure	600	0.29 b	0.17 b	3.8 b
Floral	500	0.13 bc	0.08 b	3.9 b
FIOLEI	1000	0.33 b	0.13 b	3.9 b
Pinched check	water	0 c	0 b	3.9 b
Unpinched check	water	0 c	0 b	2.6 c

 Table 37. Phytotoxicity and branching effect of Augeo, Configure and Florel on 'Merritt's

 Supreme' hydrangea. G. Bi

¹Two applications were made one week apart.

²Means in the same column followed by the same letter are not significantly different (LSD test, P = 0.05).

Czarnota 2011

Czarnota evaluated the effects of Augeo, Configure and Florel on branching of *Hydrangea macrophylla* 'Nikko Blue'. Plants were grown in one gallon containers. Treatments were applied at a lower volume (20 gallons per acre) delivering the recommended ppm rate.

Phytotoxicity: No difference among treatments was observed.

Efficacy: All of the products worked as well if not better than the unpinched check at all rating dates, as no significant differences were seen in bud #, width, and height between the treatments and pinched check. Significant decreases were seen in height with high rates of Augeo and Florel at 2 WAT, and at 10 WAT with the high rate or Florel when compared to the pinched check.

Fulcher 2011

Fulcher evaluated the effects of Augeo, Configure and Florel on the landscape variety *Hydrangea paniculata* 'Limelight'. Plants were grown in 3 gallon containers on container pad. Note: Only the pruned control was pruned; all other treatments remained unpruned.

Phytotoxicity: At 2WAT plants treated with both rates of Augeo and Configure had greater phytotoxicity than water controls, pruned and Florel treated plants. By 6WAT there was no difference in phytotoxicity.

Efficacy: None of the plants exhibited significantly different quality ratings than water. However, pruned plants had a higher quality than Configure-treated plants at either rate. At the end of the season, *H. paniculata* 'Limelight' treated with Augeo at the low and high rates had more branches than all other treatments, 101.1 and 103.4, respectively. All other treatments had 25.1 to 37.2 branches and were not different from one another. Pruned plants were shorter than all other treatments except both concentrations of Florel (500 and 1000 ppm). There was no difference in average width. Panicle number ranged from 0.4 to 4.0 per plant. Plants that were pruned had fewer blooms than all other treatments except those treated with Augeo 1600 ppm. Panicle size varied with treatments. Augeo at 800 and 1600 ppm had smaller flowers than all other treatments except pruned plants.

Treatment	Rate (ppm)	Phytoxicity Rating		Shoot Count		
		6WAT	2WAT	4WAT	6WAT	10WAT
Augeo	800	0 a	7 a	8 a	9 a	8 a
Augeo	1600	0 a	7 a	7 a	8 a	8 a
Configure ¹	300	0 a	7 a	8 a	8 a	8 a
Configure ¹	600	0 a	6 a	7 a	8 a	8 a
Florel	500	0 a	7 a	7 a	8 a	7 a
Florel	1000	0 a	7 a	8 a	9 a	8 a
Pinched check		0 a	8 a	9 a	9 a	9 a
Unpinched check		0 a	2 b	4 b	4 b	4 b
	LSD (P=0.05)	0.0	1.9	2.5	2.2	1.9

Table 38. Phytotoxicity and branching effect of Augeo, Configure and Florel on *Hydrangea macrophylla* 'Nikko Blue'. Czarnota, 2011.

¹Two applications were made one week apart.

Table 39.	Effect of Augeo,	Configure and Flore	l on hydrangea	height and width,	, Czarnota, 2011
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Treatment	Rate (ppm)		Plant Height (cm)				Plant Dia	meter (cn	n)
		2WAT	4WAT	6WAT	10WAT	2WAT	4WAT	6WAT	10WAT
Augeo	800	29 bc	36 b	36 bc	36 bc	38 b	38 b	42 b	44 b
Augeo	1600	27 c	35 b	33 c	34 bc	35 b	40 b	40 b	39 b
Configure ¹	300	32 b	37 b	40 b	37 bc	41 b	40 b	44 b	41 b
Configure ¹	600	29 bc	36 b	34 c	36 bc	40 b	39 b	41 b	42 b
Florel	500	29 bc	35 b	34 c	36 bc	37 b	37 b	39 b	41 b
Florel	1000	27 c	34 b	34 c	32 c	34 b	38 b	42 b	42 b
Pinched check	0	32 b	38 b	38 bc	41 b	37 b	40 b	43 b	42 b
Unpinched		48 a	51 a	50 a	52 a	53 a	52 a	53 a	51 a
LSD ((P=0.05)	4.5	4.2	5.4	6.8	7.3	4.6	5.8	5.9

¹Two applications were made one week apart.

Treatment.	Rate	Phyto	oxicity	Quality	Branch	Height (cm)	Width	Panicle	Panicle
	(ppm)				Count		(cm)	Count	Size(cm)
		2WAT	6WAT	15WAT	15WAT	15WAT	18WAT	20WAT	20WAT
Augeo	800	2.9ab	1.2a	4.7ab	101.1a	49.3abc	68.8ab	2.6ab	8.4c
Augeo	1600	3.5a	1.1a	4.6ab	103.4a	48.0abc	65.0ab	1.2bc	8.0c
Configure	300	3.1a	0.6a	2.9c	33.5b	54.4ab	3.1ab	3.1ab	16.0a
Configure	600	3.3a	1.1a	3.1bc	31.6b	47.8abc	2.8ab	2.8ab	13.8ab
Florel	500	0.8c	1.1a	4.0abc	25.1b	45.2bc	4.0a	4.0a	16.1a
Florel	1000	1.2c	1.5a	4.5abc	37.2b	43.2c	2.7ab	2.7ab	14.1ab
Pruned	-	1.6bc	1.9a	5.3a	26.7b	55.1a	63.8 b	0.4c	11.0bc
check									
Water		1.4c	1.3a	3.8abc	25.4b	47.0abc	70.6ab	2.5ab	15.7a
	P value	0.0001	0.7454	0.7454	0.0003	0.0018	0.3283	0.0001	0.0001

Table 40. Evaluation of Augeo, Configure, and Florel on Hydrangea paniculata 'Limelight' growth and branching, Fulcher, 2011.



Figure 5. Chlorosis 2WAT on *Hydrangea paniculata* 'Limelight' following Augeo (800 ppm) application, Fulcher, 2011.

Keever 2011

Keever tested Augeo, Configure and Florel as branching agents on *Hydrangea macrophylla* 'Nikko Blue'. Terminal cuttings were rooted, cut back to 2" when 8-12" and grown in one gallon pots in an open sided shadehouse.

Phytotoxicity: At 2 WAT plants treated with the low rates of Configure or Florel, as well as, the pinched and unpinched controls exhibited slight yellowing of the foliage. Foliage of plants receiving the high rates of Configure or Florel was moderately yellow at 2 WAT. Plants treated with 800 ppm Augeo exhibited severe interveinal foliar yellowing, while foliage of plants receiving 1600 ppm Augeo was severely yellowed with slight necrosis. By 6 WAT phytotoxic symptoms were no longer evident (data not included).

Efficacy: At 12 WAT shoot counts were highest on pinched controls (23 shoots) and plants treated with 1600 ppm Augeo (22). All other treatments had significantly fewer shoots with Configure treated plants having the least amount of branching (9 shoots). Numerous buds broke following pruning of all plants on 6/8/11, prior to the application of treatments. This extensive bud break may have reduced the effect of the treatments and contributed to the relatively high shoot counts and quality of the unpruned control plants at the end of the test. See Figure 6.

There were relatively minor differences among treatments in plant height, width, and growth index (GI), but visually the plants with the most shoots appeared more compact and shorter, and had shoots that were more slender than plants with fewer shoots. The quality rating was highest for plants treated with 1600 ppm Augeo and pinched, and similar for all other treatments.

Treatment	Rate	Crop Injury ^a	Crop Injury	Shoot Number	Quality Rating	
	(ppm)	2WAT	6WAT	12WAT	25WAT	
Augeo	800	3	0	13b* ^{bc}	4b	
Augeo	1600	4	0	22ab	5.5a	
Configure ^d	300	1	0	9c*	4b	
Configure ^d	600	2	0	9c*	4b	
Florel	500	1	0	9c*	3.5b	
Florel	1000	2	0	13bc*	4b	
Pinched check		1	0	23a	5.5ab	
Unpinched check		1	0	13bc*		

 Table 41. Effect of branching agents, Augeo, Configure, and Florel crop injury, shoot number and quality for *Hydrangea macrophylla* 'Nikko Blue'. Keever.

^a Due to no variability within treatments for phytotoxicity evaluation there is no error term and thus no analysis can be performed. ^bTukey's means comparison, P=0.05. Means within a column followed by the same letter are similar.

^cDunnett's comparison to Pinched. Means within a column followed by an * differ from the pinched treatment.

^dTwo applications applied one wee apart.

Treatment	Rate (ppm)	Heigl	nt	Width		Growth Index	
1 reatment		1DAT	12WAT	1DAT	12WAT	1DAT	12WAT
Augeo	800	13.9ns	37.9 c	23.1ns	52.9 ab	20.0ns	47.9ab
Augeo	1600	14.8	39.1 bc	22.6	51.5 b	20.0	47.4b
Configure	300	14.1	43.8 ab*	23.5	58.3 ab	20.4	53.5ab
Configure	600	14.2	46.6 a*	22.3	60.5 a	19.6	54.5a
Florel	500	14.9	44.6 ab*	24.5	57.1 ab	21.3	53.0ab
Florel	1000	15.4*	40.9 bc	24.4	55.9 ab	21.4	50.9ab
Pinch		12.6	36.7 c	22.9ns	55.0 ab ns	19.5ns	49.0abns
Unpinched		13.0	42.2 abc	21.0	56 ab	18.4	51.4ab

 Table 42. Effect of branching agents, Augeo, Configure, and Florel on Hydrangea macrophylla

 'Nikko Blue' on height, width and growth index. Keever.

^aTukey's means comparison, P=0.05. Means within a column followed by the same letter are similar.

^bDunnett's comparison to Pinched. Means within a column followed by an * differ from the pinched treatment.



Figure 6. Heavy bud break prior to application may have reduced pgr effects compared to untreated control, Keever, 2011.

Lieth 2011

Lieth evaluated Augeo, Configure and Florel effects on growth of '*Merritt's Supreme*' hydrangea. Terminal cuttings were rooted in liner trays then pinched to 1-2 buds to create Y cuttings which were potted into 5" pots and grown in the greenhouse.

Phytotoxicity: Plants treated with Augeo (800 and 1600 ppm) had the greatest crop injury of all the treatments compared to the controls (Table 44). Severe chlorosis on the new growth was observed (Figure 7). Chlorotic symptoms persisted through 13WAT. Necrosis on axillary buds was noted on Augeo treated plants (Table 9). Little to no injury to hydrangea was observed for Configure or Florel.

Efficacy: Plant quality of Augeo treated plants was moderately worse compared to the control (Table 43). Both application rates of Augeo produced smaller plants with mediocre plant quality and high phytotoxicity symptoms. Configure plants were similar in quality to the control while Florel treated plants had a higher plant quality rating than the control because of larger plant volume and deeper green foliage (Figure 8). Augeo (1600 ppm) treated plants had the highest number of lateral breaks compared to all other treatments. Only Configure at 300 ppm and Florel 500 ppm were similar to the control in average number of breaks. All other treatments (Augeo 800 ppm, Configure 600 ppm, Florel 1000 ppm) had a greater number of lateral breaks compared to the control. Terminal bud count was not affected by any growth regulator treatment.

 Table 43. Plant quality rating, number of lateral breaks and terminal buds of *Hydrangea macrophylla* 'Merritt Supreme' 13 weeks after plant growth regulator application, Lieth, 2011.

Treatment	Concentration (ppm)	Mean Plant Quality (Rated 1-7)		Mean # o Breaks	f	Mean # of Terminal Buds		
Control	N/A	4.0 ± 0.0	а	3.4 ± 0.6	а	4.1 ± 0.3	а	
Augoo	800	2.2 ± 0.2	b	8.3 ± 0.5	b	4.1 ± 0.3	а	
Augeo	1600	1.8 ± 0.4	b	12.0 ± 0.5	с	3.8 ± 0.5	а	
Configure	300	3.7 ± 0.3	а	5.8 ± 0.6	ab	4.6 ± 0.3	a	
	600	3.8 ± 0.4	а	7.3 ± 0.9	b	4.3 ± 0.8	a	
Florel	500	5.2 ± 0.4	с	6.3 ± 0.8	ab	4.8 ± 0.8	а	
	1000	6.0 ± 0.4	с	6.8 ± 1.0	b	4.2 ± 0.8	а	
mean \pm S.E.								

			Mean Change in Phytotoxicity from week 0 (Rated 1-10)										
Product	Rate ppm	Week 0		Week 1		Week 2	Veek 2 Week 4		Week 6		ō	Week 13	
A.u.co.o	800	0.7 ± 0.2	a	0.3 ± 0.4	с	3.6 ± 0.6	с	4.3 ± 0.5	с	3.7 ± 0.5	с	2.4 ± 0.4	b
Augeo	1600	0.6 ± 0.2	a	0.3 ± 0.3	с	4.2 ± 0.2	с	4.5 ± 0.2	с	4.3 ± 0.3	с	4.0 ± 0.9	с
Configure	300	0.8 ± 0.2	a	-0.6 ± 0.2	a	-0.2 ± 0.3	a	-0.4 ± 0.2	а	-0.3 ± 0.2	а	0.2 ± 0.4	а
_	600	0.5 ± 0.3	a	0.2 ± 0.2	bc	0.4 ± 0.3	ab	0.1 ± 0.2	ab	0.6 ± 0.4	b	0.6 ± 0.3	а
Florel	500	0.5 ± 0.2	a	-0.1 ± 0.2	ab c	0.5 ± 0.2	ab	-0.1 ± 0.2	ab	0.0 ± 0.3	ab	0.3 ± 0.3	а
	1000	0.5 ± 0.2	а	0.2 ± 0.3	bc	0.8 ± 0.4	b	0.4 ± 0.3	b	-0.3 ± 0.2	ab	-0.1 ± 0.3	а
Control	N/A	0.8 ± 0.1	a	-0.4 ± 0.2	ab	0.2 ± 0.4	ab	0.0 ± 0.3	ab	0.1 ± 0.3	ab	0.0 ± 0.2	а
mean \pm S.E													

Table 44. Average phytotoxicity ratings for *Hydrangea macrophylla* 'Merritt Supreme' at 0, 1, 2, 4, 6, and 13 weeks after various plant growth regulator applications, Lieth, 2011.



Figure 7. Chlorosis 6WAT with Augeo 1600ppm. Lieth.



Figure 8. Control (left) compared to Florel 1000ppm (right). Treated shows darker glossy leaves. Lieth.



Figure 9. Terminal bud necrosis followed by axillary branching with Augeo 1600ppm at 13 WAT. Lieth.

Whipker 2011

Whipker evaluated three plant growth regulators (Augeo, Configure, Florel) as potential branching enhancers for hydrangeas. Y cuttings of *Hydrangea macrophylla* 'Merritt's Supreme' were potted into five inch pots and grown in the greenhouse.

Phytotoxicity: Phytotoxicity occurred with both Augeo applications at weeks 2 and 6 but new leaves covered it up and it was not noticeable at the end of the experiment (week 16). **Error! Reference source not found.**Efficacy: Only Augeo provided enhancement of the number of lateral (axillary) breaks as compared to the untreated control (4.1) with the number increasing with rate (7.2 with 800 ppm and 10.4 with 1600 ppm). While the number of axillary shoots was significantly increased with Augeo, it should be noted that by 16WAT not all of the shoots had grown but appeared to have stalled, allowing fewer shoots to regain apical dominance. This stall has been observed with other species when treated with Augeo. A follow up application of GA+BA may be beneficial to achieve the full potential of all the axillary shoots.

Table 45. Crop injury and effect on branching and quality from Augeo, Configure, and Florel on *Hydrangea macrophylla* 'Merritt's Supreme', Whipker, 2011.

Treatment	Rate	Crop Injury		Shoot Number	Quality Rating		
	(ppm)	2WAT	6WAT	16WAT	16WAT	6WAT	16WAT
Augeo	800	3.3 b	2.9 b	0.0 a	7.7 b	2.4b	6.0 b
Augeo	1600	6.8 a	6.8 a	0.0 a	10.9 a	1.3c	7.0 a
Configure	300	0.0 c	0.0 c	0.0 a	4.4 c	4.0a	4.0 c
Configure	600	0.5 c	0.0 c	0.0 a	4.6 c	4.0a	4.0 c
Florel	500	0.0 c	0.0 c	0.0 a	4.2 c	4.0a	3.5 d
Florel	1000	0.1 c	0.0 c	0.0 a	4.2 c	4.0a	3.2 e
Pinched		0.0 c	0.0 c	0.0 a	4.8 c	4.0a	4.0 c
control							
	P Value	0.0001	0.0001	NS	0.0001	0.0001	0.0001

Table 46.	Effect of Augeo, Confi	gure, Florel on h	eight and diameter	of Hydrangea	macrophylla
'Merritt's	Supreme', Whipker, 2	011.			

Treatment	Rate (ppm)	Plant Height (cm)		Plant Dia	ameter (cm)
		6WAT	16WAT	6WAT	16WAT
Augeo	800	18.2 c	24.1 ab	22.7 d	27.7 d
Augeo	1600	12.0 d	21.1 bc	18.1 e	29.9 cd
Configure	300	17.6 c	20.6 c	27.6 c	29.5 cd
Configure	600	18.4 bc	21.0 c	28.9 abc	31.5 bc
Florel	500	20.4 ab	23.4 abc	30.0 ab	33.8 ab
Florel	1000	21.3 a	25.1 a	30.5 a	35.7 a
Pinched Control	0	18.5 ab	20.6 c	27.7 bc	29.9 cd
	P value	0.0001	0.009	0.0001	0.0001



NC STATE UNIVERSITY

Two Weeks After Treatment (7 July)







Untreated

Augeo @ 800 ppm Augeo @ 1600 ppm

Phytotoxicity with Augeo, which new leaves covered later

IR4 Protocol #11-001



16 Weeks After Treatment (11 October)



Untreated Augeo @ 800 ppm Augeo @ 1600 ppm

Top growth, showing breaks

Figure 10. Phytoxicity 2WAT vs. 16WAT with Augeo 1600ppm on *H. macrophylla* 'Merritt's Supreme' compared to pinched control, Whipker, 2011.

Indian Hawthorn (*Rhaphiolepis indica*)

Keever 2008

Keever conducted a trial to determine the effect of four products on branching and growth of unpruned (Unpruned) and pruned (P) 'Snow White' Indian hawthorn. Atrimmec at 3100 ppm, Fascination at 1000 ppm, MaxCel at 500 ppm and Tiberon at 100 ppm were applied twice 4 weeks apart. Atrimmec was also applied once as drench at 50 ppm. Treatments were replicated 10 times. Data on number of new shoots, plant height and width, growth index [GI = (height + width)/2], and phytotoxicity (0=none, 10 = dead) were taken 60-90 and 210 DAT. Data were subjected to statistical analysis (Duncan's Multiple Range test, p=0.05). Tiberon increased number of new shoots in unpruned and pruned Indian hawthorn while Atrimmec spray increased number only in pruned plants and all other treatments provided no increase (Table 37). Unpruned plants treated with Tiberon also formed more new shoots than pruned controls. Unpruned and pruned controls showed no significant difference in number of new shoots. Except for increased height in unpruned plants from Fascination at 60-90 DAT, all treatments provided no increase in height, width and growth index in both unpruned and pruned Indian hawthorn (Table 38). Spray applications of Atrimmec, Fascination and Tiberon caused significant injury (chlorosis, reddening and keeling or twisting of leaves) at 60-90 DAT. By 210 DAT, phytotoxicity ratings were similar to their respective controls.

Treatment	New Shoo	ot Counts ^z	Phytotoxicity		
	60-90	210 DAT	60-90	120	
	DAT		DAT	DAT	
Atrimmec (dikegulac sodium) - Unpruned	8.3 fg	28.6 bcd	2.4 ab	1.7 ab	
Fascination (6-BA + GA_{4+7}) - Unpruned	7.4 g	25.7 cd	2.1 b	1.5 ab	
MaxCel (6-BA) - Unpruned	11.9 c-f	33.7 a-d	1.6 c	1.5 ab	
Tiberon 2.8SC (cyclanilide) – Unpruned	18.3 a	43.6 a	2.7 a	1.6 ab	
Atrimmec Drench - Unpruned	9.6 efg	26.2 cd	1.2 c	1.8 ab	
Untreated - Unpruned	9.9 d-g	29.7 bcd	1.2 c	1.3 b	
Atrimmec (dikegulac sodium) - Pruned	15.1 abc	38.4 ab	1.3 c	1.7 ab	
Fascination $(6-BA + GA_{4+7})$ - Pruned	10.2 d-g	32.5 a-d	1.4 c	1.5 ab	
MaxCel (6-BA) - Pruned	13.5 bcd	23.7 d	1.4 c	1.7 ab	
Tiberon 2.8SC (cyclanilide) – P	16.7 ab	36.8 abc	2.6 ab	2.1 a	
Atrimmec Drench - Pruned	11.8 c-f	28.8 bcd	1.2 c	2.1 a	
Untreated - Pruned	13.2 b-e	24.1 d	1.1 c	1.4 ab	

Table 47. Effect of several PGR's on Branching and Phytotoxicity of Indian Hawthorn (*Rhaphiolepis indica*), 'Snow White', Keever 2008.

² Means in the same column followed by the same letter are not significantly different, (P = 0.05, Duncan's Multiple Range test).

Treatment	Height ^z		Width		Growth Index	
	60-90	210	60-90	210	60-90	210
	DAT	DAT	DAT	DAT	DAT	DAT
Atrimmec (dikegulac sodium) - Unpruned	18.7 bc	28.2 ab	22.9 ab	35.2 a-d	21.5 ab	32.9 abc
Fascination (6-BA + GA_{4+7}) - Unpruned	22.0 a	29.9 a	25.8 a	36.1 a-d	24.6 a	34.0 ab
MaxCel (6-BA) - Unpruned	16.9 bc	25.8 a-d	22.3 ab	36.8 a-d	20.5 b	33.1 abc
Tiberon 2.8SC (cyclanilide) – Unpruned	16.1 c	22.8 cde	22.6 ab	37.8 abc	20.4 b	32.8 abc
Atrimmec Drench - Unpruned	17.8 bc	26 a-d	21.9 ab	40.5 a	20.5 b	35.7 a
Untreated - Unpruned	17.8 bc	26.8 abc	24.5 ab	39.8 ab	22.3 ab	35.5 a
Atrimmec (dikegulac sodium) - Pruned	18.2 bc	25.4 bcd	23.9 ab	36.4 a-d	22.0 ab	32.7 abc
Fascination (6-BA + GA_{4+7}) - Pruned	20.0 ab	23.8 cde	21.4 ab	34.2 bcd	20.9 ab	30.7 bcd
MaxCel (6-BA) - Pruned	19.1 abc	24.8 b-e	21.5 ab	33.6 cd	20.7 b	30.7 bcd
Tiberon 2.8SC (cyclanilide) – P	17.0 bc	20.8 e	21.0 b	31.9 d	19.6 b	28.2 d
Atrimmec Drench - Pruned	18.8 bc	22.3 de	25.1 ab	32.4 cd	23.0 ab	29.0 cd
Untreated - Pruned	18.0 bc	24.7 b-e	20.5 b	33.5 cd	23.0 ab	30.6 bcd

Table 48. Effect of several PGR's on Growth of Indian Hawthorn (*Rhaphiolepis indica*), 'Snow White', Keever 2008.

² Means in the same column followed by the same letter are not significantly different, (P = 0.05, Duncan's Multiple Range test).

Rose (Rosa spp.)

In 2006 and 2007, three experiments were conducted to determine effect on branching and growth of rose. The products tested included Configure, Fascination, MaxCel, and Provide typically at 500 ppm applied twice and Tiberon 2.8SC typically at 112 ppm applied once or twice. All treatments were applied as foliar sprays typically 4 weeks apart when applied twice. In these experiments, the assessment typically made was number of shoots, plant height, width and phytotoxicity taken for several weeks after treatment.

Results of the three experiments conducted by Lieth, Pemberton and Runkle showed that the 6-BA products Configure and Maxcel were the only treatments that increased branching but Maxcel reduced growth and caused phytotoxicity (growth malformations, distortion and necrosis of emerging leaves). In 2006, Lieth showed that Maxcel was the only treatment that increased branching of 'Kardinal' rose pruned before initial application but was also phytotoxic. In 2006, Pemberton showed that Fascination, MaxCel, Provide and Tiberon did not increase branching of 'Chuckles' rose pinched before initial application. Growth malformation and smaller plant size resulted from MaxCel treatment. In 2007, Runkle showed Configure increased branching of 'Alicante' rose at 500 and 1000 ppm when applied at second pinch but not at first pinch. The treatment caused no phytotoxicity. The other treatments did not affect plant growth and caused no injury. See the individual reports below for more information.

Lieth 2006

In 2006, Lieth conducted an experiment to determine effect of four products on branching and growth of 'Kardinal' rose pruned 2 weeks before spray application. The treatments were Fascination and MaxCel at 500 ppm applied twice 4 weeks apart, Tiberon 2.8SC at 112 ppm + Latron applied once or twice 2 weeks apart and Provide at 500 ppm applied once. Treatments were replicated 9 times. The number of shoots, flower buds, height and width, as well as phytotoxicity (0 = no damage, 10 = complete kill) were recorded at various times after treatment. Data were subjected to statistical analysis (t-test, P=0.05).

Tiberon applied once or twice, Fascination and Provide were not phytotoxic but provided no effect on branching or plant growth (Tables 39 to 42). Maxcel dramatically increased the number of shoots but this gain in branching did not result in greater flower productivity. Plants exposed to MaxCel also tended to be much shorter and showed significant phytotoxicity (distortion and necrosis of emerging leaves). Maxcel should be tested at lower rates and with larger plants that can support increased branching to increase flower production.

Treatment	Height Increase ^z (cm) By		Ave.Width Increase (cm) By		Volume Increa	e Index se By	Increase in No. of Shoots By		No. of Blind Shoots
	4	10	4	10	4	10	4	10	10
	WAIT	WAIT	WAIT	WAIT	WAIT	WAIT	WAIT	WAIT	WAIT
Tiberon	63.89 a	69.50 a	20.44 a	22.22 a	322210 ab	339425 a	-2.00 a	4.67 a	4.8 a
(cyclanilide)									
+ Latron -1									
applic.									
Tiberon	49.50 b	72.22 a	17.61 a	24.28 a	200846 b	366388 a	-2.11 a	4.44 a	4.6 a
(cyclanilide)									
+Latron -2									
applic.									
Latron	68.78 a	75.67 a	21.97 a	21.58 a	357516 a	366677 a	-2.56 a	2.44 a	4.9 a
Untreated	70.78 a	70.72 a	14.94 a	19.06 a	271827 ab	318697 a	-1.33 a	3.00 a	3.0 a

Table 47. Effect of Therein of Dranching and Orowin of Rose (Rosa sp.), Raruman, Effett 200	Table 49.	Effect of Tiberon	on Branching and	l Growth of Rose	(Rosa sp.).	, 'Kardinal', Lieth 200
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^z Means in the same column followed by the same letter are not significantly different, (t-test, P < 0.05).

^y Week after first application.

Table 50.	Effect of Tiberon on	Phytotoxicity	to Rose (Rosa sp.)	. 'Kardinal'. J	Lieth 2006.
)	

Treatment	Increase in Phytotoxicity Index ^z from Trial Start Until			
	4 WAIT ^y	10 WAIT		
Tiberon 2.8SC (cyclanilide) + Latron – 1 applic.	0.89 a	2.22 ab		
Tiberon 2.8SC (cyclanilide) + Latron – 2 applic.	1.44 a	1.89 ab		
Latron	0.78 a	2.44 a		
Untreated	1.11 a	1.78 b		

^z Means in the same column followed by the same letter are not significantly different, (t-test, P < 0.05).

^y Week after first application.

 Table 51. Effect of several PGR's on Branching and Growth of Rose (*Rosa sp.*), 'Kardinal', Lieth 2006.

Treatment	Height Increase ^z (cm) By		Ave.Width Increase (cm) By		Volume Index Increase By		Increase in No. of Shoots By		No. of Blind Shoots
	4	10	4	10	4	10	4	10	10
	WAIT	WAIT	WAIT	WAIT	WAIT	WAIT	WAIT	WAIT	WAIT
Fascination	61.83 a	60.17 b	20.31 a	20.36 a	274117 ab	266819 a	-4.33 b	5.00 b	6.2 b
(6-BA +									
$GA_{4+7)}$									
MaxCel (6-	48.83 b	48.11 c	17.14 a	23.53 a	202255 b	259663 a	-1.89 a	13.22 a	14.8 a
BA)									
Provide	63.72 a	72.50 a	22.14 a	17.25 a	323641 a	297909 a	-1.78 a	2.56 b	4.3 b
(GA_{4+7})									
Untreated	70.78 a	70.72 a	14.94 a	19.06 a	271827 ab	318697 a	-1.33 a	3.00 b	3.0 b

^z Means in the same column followed by the same letter are not significantly different, (t-test, P < 0.05); volume index at 10

WAIT significantly different at P = 0.10.

^y Week after first application.

Treatment	Increase in Phytotoxicity Index ^z from					
	Trial Start Until					
	4 WAIT ^y	10 WAIT				
Fascination $(6-BA + GA_{4+7})$	1.11 b	2.22 ab				
MaxCel (6-BA)	2.89 a	2.78 a				
Provide (GA _{4 + 7)}	1.00 b	2.33 ab				
Untreated	1.11 b	1.78 b				

^z Means in the same column followed by the same letter are not significantly different, (t-test, P < 0.05);); phytotoxicity index at 10 WAIT significantly different at P = 0.10.

^y Week after first application.

Pemberton 2006

In 2006, Pemberton conducted an experiment to determine effect of four products on branching and growth of 'Chuckles' rose. Plants were potted in early June, pinched 10 July and first application applied 26 July 2006. The treatments were Fascination, MaxCel and Provide at 500 ppm applied twice and Tiberon 2.8SC at 112 ppm applied once or twice. Initial measurements of plant height and width (plant volume was calculated) and total shoot number were taken on 25 July 2006. The number of flowering shoots was counted on 9 August 2006, and the growth malformation rating was determined on 1 September 2006 (Rating scale: 1=Normal growth, 3=one fourth of the terminals had slight leaf wrinkling or mottling, 5=most of the terminals slightly affected, 7=most of the terminals strongly affected, some wilting despite adequate moisture 10=Entire plant affected with die-back symptoms. Final data was taken on 9 October 2006 and included height and width (volume was calculated), number of flowering shoots, and number of new basal flowering shoots. Other parameters were calculated. Total shoots data refer to the addition of the flowering and new basal flowering shoots.

PGR treatments provided no significant increase in branching of pinched 'Chuckles' rose (Table 43). After the second application of the products, some growth malformations were noted and rated (Table 44). Wilting that was not water stress related and leaf mottling was noted on plants treated with MaxCel. In addition to the symptoms seen on MaxCel treated plants, stretching of the peduncles and internodes was noted on the plants treated with Fascination. These symptoms were noted only slightly on the ProVide treated plants (only a slight stretching of the peduncles was noted), so that the effects appear to be mainly due to the 6-BA contained in the MaxCel and Fascination products. At the end of the season, MaxCel treated plants were shorter and smaller (as measured by volume) than the Untreated, and had the lowest increase in plant volume over the season than all the other treatments.

Treatment	Initial	August #	Final # of	Final # of	Final	Final	Final Basal	Final Total
	Shoot	of	Flowering	Basal	Total	Flowering	Shoot/Initial	# of
	#	Flowering	Shoots	Shoots	Shoot #	Shoot/Initial	Shoot #	Shoots/Init
		Shoots			Increase	Shoot #		ial Shoot #
Fascination $(6-BA + GA_{4+7})$	4.2	3.5 bc	21.7	1.7	19.2	5.3	0.4	5.7
MaxCel (6-BA)	4.4	4.7 ab	18.2	0.8	14.6	4.3	0.2	4.5
Provide (GA_{4+7})	4.2	3.0 c	18.8	1.2	15.8	4.7	0.2	5.0
Tiberon 2.8SC (cyclanilide) – 1 applic.	5.2	4.8 ab	22.0	1.6	18.4	4.2	0.3	4.5
Tiberon 2.8SC (cyclanilide) – 2 applic.	4.3	5.2 a	20.6	1.7	18.0	4.8	0.4	5.2
Untreated	4.3	4.4 ab	18.2	2.1	16.0	4.3	0.4	4.8
ANOVA	NS	*	NS	NS	NS	NS	NS	NS

Table 53. Effect of several PGR's on Branching of Rose (Rosa sp.), 'Chuckles', Pemberton 2006.

Table 54. Effect of several PGR's on Growth of Rose (Rosa sp.), 'Chuckles', Pemberton 2006.

Treatment	Initial	Initial	September	Final	Final Plant	Plant Volume	Plant
	Plant	Plant	Growth	Plant	Volume (cm ³)	Increase (cm ³)	Height
	Height	Volume	Malformation	Height			Increase
	(cm)	(cm ³)	Rating ^z	(cm)			(cm)
Fascination $(6-BA + GA_{4+7})$	24.2	10545.8 ab	3.6 b	47.5 a	383349.2 a	372803.4 ab	23.3 a
MaxCel (6-BA)	22.6	10328.1 ab	5.4 a	34.1 c	147072.4 b	136509.1 c	10.8 bc
Provide (GA ₄₊₇₎	21.0	8640.4 b	1.5 c	40.5 abc	397032.7 a	388392.3 a	19.5 abc
Tiberon 2.8SC (cyclanilide) – 1 applic.	24.4	13083.0 a	1.0 c	37.2 bc	286679.2 a	273596.2 b	13.2 c
Tiberon 2.8SC (cyclanilide) – 2 applic.	24.0	12837.0 a	1.0 c	37.9 bc	314559.6 a	301722.6 ab	13.9 bc
Untreated	22.4	8482.7 b	1.0 c	44.1 ab	348307.7 a	339825.0 ab	21.7 ab
ANOVA	NS	*	**	*	*	**	*

² Rating scale: 1=Normal growth, 3=one fourth of the terminals had slight leaf wrinkling or mottling, 5=most of the terminals slightly affected, 7=most of the terminals strongly affected, some wilting despite adequate moisture 10=Entire plant affected with die-back symptoms.

Runkle 2007

In 2007, Runkle conducted an experiment to determine effect of Configure on branching of 'Alicante' rose. Configure at 250, 500 and 1000 ppm was applied once at first pinch or second pinch. Treatments were replicated 10 times. Number of branches and flower buds, and time in days to first open flower were recorded at flowering.

Overall, Configure application at first pinch did not increase number of lateral branches observed at flowering; application at second pinch typically increased lateral branching (Table 45). With increasing concentrations of Configure applied at second pinch, more lateral branches were produced. The Configure spray at 1000 ppm at second pinch increased the number of lateral branches by about 50% compared to Untreated. No phytotoxicity was observed following sprays up to 1000 ppm (data not shown).

Treatment	Application Timing	Rate (ppm)	Mean No. Branches ± SE ^z	Mean Time to First Open Flower (Days) ± SE	Mean No. Flower Buds ± SE
Configure (6-BA)	First Pinch	250	19.0±1.0	78.0±1.1	4.0±0.6
		500	20.0±1.3	76.9±1.5	4.0±0.5
		1000	17.1±0.5	77.1±1.4	4.1±0.6
Configure (6-BA)	Second Pinch	250	22.1±1.7	76.0±1.2	3.4±0.4
		500	25.0±1.5	79.3±1.8	2.4±0.2
		1000	31.0±1.7	82.2±1.8	3.0±0.4
Untreated	-	-	20.3±1.2	74.9±2.1	3.5±0.6

Table 55. Effect of Configure (6-BA) on Branching of Rose (Rosa sp.), 'Alicante', Runkle 2006.

^z Standard error of means of 10 replicates.

Sourwood (Oxydendrum arboreum)

Fulcher 2007

Fulcher conducted a trial to determine the effect of Exilis Plus and Tiberon on branching and growth of sourwood. Sourwood was selected because it is a native plant with increasing popularity in landscapes and previous preliminary branch architecture research has been completed on sourwood. Examining the effect of some PGR's on this species would further add to the knowledge base of canopy management. Exilis Plus at 500 ppm was applied twice 4 weeks apart and Tiberon at 112 ppm applied once or twice 2-3 weeks apart. A surfactant Latron B was applied with the treatments at 2.34 ml per gallon. Treatments were replicated 10 times. Branch number, plant height and width were recorded at initiation and termination of the experiment. A growth index was calculated as (Height + Width A + Width B)/3 where Width A = the widest point of the canopy and Width B = the width perpendicular to the widest part of the canopy. Phytotoxicity (0=no injury, 10=plant death) was assessed one week after first application and for the duration of the experiment. Data were subjected to statistical analyses, (SAS Institute, Inc., Cary, NC) at alpha = 0.05.

There were no significant differences for branch number, height, width, or growth index due to PGR treatments for sourwood (Table 46). There were no visible signs of phytotoxicity from any of the treatments (data not shown).

Treatment	Branch	Height	Width	Growth
	Number ^z	(cm)	(cm)	Index
Exilis Plus (6-BA)	5.7 a	47.6 a	35.3 a	35.0 a
Tiberon 2.8SC (cyclanilide) – 1 applic.	6.6 a	47.4 a	30.4 a	32.6 a
Tiberon 2.8SC (cyclanilide) – 2 applic.	5.7 a	43.0 a	28.3 a	30.3 a
Untreated	5.5 a	46.4 a	31.4 a	31.9 a

Table 56. Effect of PGR's on Branching and Growth of Sourwood (Oxydendrum arboreum),Fulcher 2007.

^z means followed by the same letter were not significantly different (Tukey's HSD, $\alpha = 0.05$).

Arrowwood (Viburnum dilatatum)

Czarnota 2006

Czarnota conducted a trial to determine the effect of four products on growth of arrowwood. Exilis Plus at 9500 ppm, Fresco at 5550 ppm and MaxCel at 20000 ppm were applied once, and Tiberon at 39 ppm applied once or twice. Note that these rates are dramatically different from those suggested in the protocol. Data for plant growth (internode length and canopy width) were taken 6 and 30 weeks after treatment (WAT). No treatment affected plant growth (Table 47

Treatment	Internode	Length ^z (cm)	Canopy Width (cm)
	6 WAT	30 WAT	30 WAT
Exilis Plus (6-BA)	6.6 a	2.5 a	5.1 a
Fresco $(6-BA + GA_{4+7})$	5.3 a	2.0 b	4.4 a
Maxcel (6-BA)	6.1 a	2.0 ab	4.3 a
Tiberon 2.8SC	5.5 a	2.0 ab	5.1 a
(cyclanilide) – 1 applic.			
Tiberon 2.8SC	5.5 a	2.1 ab	4.9 a
(cyclanilide) – 1 applic.			
Tiberon 2.8SC	5.2 a	2.0 ab	4.3 a
(cyclanilide) – 2 applic.			
Untreated	6.2 a	2.4 ab	5.1 a

Table 57. Effect of several PGR's on Growth of Arrowwood (Viburnum dilatatum), Czarnota 2006.

^z means followed by the same letter were not significantly different (LSD, P = 0.05).

Plant Impact by Product

Augeo (Dikegulac sodium)

Augeo applied at 800 and 1600 ppm to hydrangea liners increased lateral branching with increasing rate. Some delay in branching growth and flowering was noted in two experiments. Significant but transient chlorosis was observed. Further testing with treatments to counteract the stalling of branch growth is merited.

Atrimmec (Dikegulac sodium)

Atrimmec sprayed once or twice at 3900 ppm on holly and at 3100 ppm on Indian hawthorn increased branching in two holly and one Indian hawthorn trials. However it caused injury in all trials which may limit its utility. This warrants further exploration, perhaps at lower rates. Atrimmec applied as drench at 50 ppm had no effect.

Configure/Exilis Plus/MaxCel (6-Benzyladenine)

MaxCel increased branching on 4 of 9 azalea cultivars and of a holly cultivar in two trials but Exilis Plus had no effect on 2 cultivars in another holly trial. Maxcel and Exilis Plus did not increase branching in 3 hydrangea trials. Configure applied at 300 ppm and 600 ppm was not effective in improving branching on hydrangea in six experiments .Also Maxcel had no effect in one Indian hawthorn trial. Results of three experiments on roses pruned before application showed that the 6-BA products Configure and Maxcel were the only treatments that increased branching but Maxcel reduced growth and caused phytotoxicity (growth malformations, distortion and necrosis of emerging leaves. Exilis Plus did not increase branching on sourwood in one trial. Maxcel at 20,000 ppm had no effect on plant growth of arrowwood. Maxcel caused stunting and chlorosis in holly, hydrangea and rose trials.

Fascination/Fresco (6-Benzyladenine + Gibberellins A_{4 +} A₇)

Except for one positive effect in 1 of 9 azalea cultivars, these 6-Benzyladenine + Gibberellins $A_{4+}A7$ – based products did not increase branching on azalea, hydrangea, Indian hawthorn and rose. Fascination at 1000 ppm increased branching in one holly trial; in two other trials, it had no effect at 500 ppm. Fascination did not increase branching in 2 rose trials where plants were pinched before initial application. No growth effects were observed except for Fascination increasing growth in one of nine azalea trials, one of three holly trials and one of two hydrangea trials. Fascination caused injury in hydrangea and Indian hawthorn.

Florel (ethephon)

Florel (ethephon) at 500 and 1000 ppm was not effective in improving branching on hydrangea except for a single trial with '*Merritt's Supreme*' (Table 43) where quality was improved.

Novagib 10L/Provide (Gibberellins A4 + A7)

These Gibberellins $A_{4+}A7$ – based products did not increase branching on 9 azalea cultivars and in one holly and one hydrangea trial. Provide did not increase branching in 2 rose trials where plants were pinched before initial application. No growth effects were observed except for Provide increasing growth in one azalea and one holly trial. Provide caused no injury.

Tiberon 2.8SC (Cyclanilide)

Tiberon sprayed once or twice increased branching on 5 of 10 azalea cultivars. Tiberon sprayed twice increased branching of 'Sky Pencil' holly cultivar in two trials but no effect on 3 other cultivars in two other trials. Tiberon sprayed twice was the only treatment that significantly increased branching in 3 of 4 hydrangea trials. However in two of these trials, it reduced plant diameter and caused phytotoxicity symptoms that may limit its use. It increased branching in Indian hawthorn but not in 2 rose trials where plants were pinched before initial application. Also no effect was observed on sourwood. In general,

Tiberon applied twice showed some advantage over one application. Overall, Tiberon did not affect plant growth of azalea, holly, Indian hawthorn, rose and arrowwood. Tiberon caused significant injury on Indian hawthorn at 60-90 DAT with plants recovering by 210 DAT. It also caused phytotoxicity in one azalea trial.

Phytotoxicity

Treatments in azalea resulted in no phytotoxicity except in one trial (Keever 2007) where Tiberon applied twice caused reddening along the margins of the leaves, clustering of buds at terminal growing points, twisting of leaves, and mild chlorosis. Atrimmec and Maxcel caused phytotoxicity on holly, and Fascination, Maxcel and Tiberon, on hydrangea. Configure and Florel caused little to no crop injury on hydrangea. Hydrangea treated with Augeo had significant but transient phytotoxicity (chlorosis). Atrimmec, Fascination and Tiberon caused injury to Indian hawthorn at 60-90 DAT, with plants recovering by 210 DAT. Maxcel caused injury to rose. No treatment caused injury to sourwood and arrowwood.

Table 58. Summary of Effect By Product – Branching.

PR#	Product	Crop N	lame	Site	Researcher	Year	Application	Results	Data Link
		Latin	Common				Туре		
27871	Atrimmec (Dikegulac sodium)	Ilex sp. I. verticillata 'Winter Red' - pruned	Holly	Field Container	Fulcher	2008	Foliar	Pruned: Increased branching at 3800 ppm applied twice; did not increase plant growth or number of berries; moderate injury, reduced plant quality.	20090319f.pdf
27871	Atrimmec (Dikegulac sodium)	Ilex sp. I. verticillata 'Winter Red' - unpruned	Holly	Field Container	Fulcher	2008	Foliar	Unpruned: Increased branching at 3800 ppm applied twice; did not increase plant growth or number of berries; moderate injury, reduced plant quality.	20090319f.pdf
27871	Atrimmec (Dikegulac sodium)	Ilex sp. I. crenata 'Sky Pencil'	Holly	Field Container	Keever	2008	Spray or Drench	Increased shoot counts in pruned and unpruned plants at 3900 ppm applied twice as spray, not at 50 ppm applied as drench; generally no effect on growth index; significant injury.	20090218e.pdf
27872	Atrimmec (Dikegulac sodium)	Raphiolepis indica 'Snow White'	Indian Hawthorn	Field Container	Keever	2008	Spray or Drench	Increased shoot counts only in pruned plants 210 DAT at 3100 ppm applied twice; did not increase growth index; significant injury.	20090218e.pdf
27876	Atrimmec (Dikegulac sodium)	Rhododendron sp. 'Katherine Allison'	Azalea	Field Container	Bi	2009		At 8 and 20WAT1 pruned plants treated with 2 applications at 3100 ppm had significantly more branching than the unpruned treated with one applicatioin. By 30WAT1 no difference among treatments. No crop injury.	20110202a.pdf
27876	Atrimmec (Dikegulac sodium)	Rhododendron sp. 'Midnight Flare'	Azalea	Field Container	Bi	2009	Foliar	3100 ppm applied once or twice showed increase in branching 8WAT1 and no differences by 20 and 30 WAT1.	20110202a.pdf

Note: Table entries are sorted by crop Latin name. Only those trials received by 2/20/2012 are included in the table below.

PR#	Product	Crop N	ame	Site	Researcher	Year	Application	Results	Data Link
		Latin	Common				Туре		
27876	Atrimmec (Dikegulac sodium)	Rhododendron sp. 'Pink Ruffles'	Azalea	Field Container	Czarnota	2008		No effect on branching and plant growth at 3900 ppm applied once	20090724b.pdf
27876	Atrimmec (Dikegulac sodium)	Rhododendron sp. 'Formosa'	Azalea	Field Container	Czarnota	2008	Foliar	No effect on branching and plant growth at 3900 ppm applied once	20090724b.pdf
29974	Atrimmec (Dikegulac sodium)	Rhododendron sp. 'Remembrance'	Azalea, & Rhododendron	Greenhouse	Lieth	2008	Foliar	Fewer shoots than control at 14 WAT; Phytotoxicity at 7 WAT; smaller plant height and width at all timings.	20100922a.pdf
27876	Atrimmec (Dikegulac sodium)	Rhododendron sp. 'glandulosa' 'Rosea'	Azalea	Field Container	Schreiber	1977	Foliar	No injury	
29260	Atrimmec (Dikegulac sodium)	Rosa sp. 'Knockout'	Rose	Field Container	Czarnota	2008	Foliar	Significantly increased branching, no effect on plant growth at 3900 ppm applied once	20090724b.pdf
30269	Augeo (Dikegulac sodium)	Hydrangea macrophylla H. 'Merritt's Supreme'	Hydrangea, French	Greenhouse	Bi	2011	Spray to wet	Significantly higher crop injury (minor) at 2WAT and significant increase in number of stems and for plants treated with 800 or 1600 ppm compared to pinched and non- pinched control.	20111208a.pdf
30269	Augeo (Dikegulac sodium)	Hydrangea macrophylla H. 'Nikko Blue'	Hydrangea, French	Greenhouse	Czarnota	2011	Spray to wet	Pots treated with 800 or 1600 ppm were not different in shoot number, height or width compared to pinched control but significantly improved compared to unpinched control at 2, 4, 6, 10WAT. No crop injury observed at 6WAT.	20120106a.pdf
30269	Augeo (Dikegulac sodium)	Hydrangea macrophylla H. paniculata 'Limelight'	Hydrangea, French	Greenhouse	Fulcher	2011	Spray to wet	Dramatic increase in branching with 800 and 1600 ppm with significant chlorosis decreasing with time and smaller flowers compared to control. No difference in quality or width.	20120104a.pdf

PR#	Product	Crop N	Name	Site	Researcher	Year	Application	Results	Data Link
		Latin	Common				Туре		
30269	Augeo (Dikegulac sodium)	Hydrangea macrophylla H. 'Nikko Blue'	Hydrangea, French	Greenhouse	Keever	2011	Spray to wet	Severe chlorosis with 800 and 1600 ppm at 2WAT diminishing by 6WAT. Growth index and quality rating for hi rate was comparable to the pinched check.	20120113c.pdf
30269	Augeo (Dikegulac sodium)	Hydrangea macrophylla H. macrophylla 'Merritt Supreme'	Hydrangea, French	Greenhouse	Lieth	2011	Spray to wet	Significant increase in branching with 800 and 1600 ppm compared to pinched control but decrease in quality due to significant phyto (chlorosis and bud necrosis) 13WAT.	20120209c.pdf
30269	Augeo (Dikegulac sodium)	Hydrangea macrophylla H. 'Merritt's Supreme'	Hydrangea, French	Greenhouse	Whipker	2011	Sprench	Significant increase in number of breaks increasing rate (800 and 1600 ppm) although shoots appeared to have stalled by 16WAT. Significantly differences in crop injury but acceptable with 800, unacceptable with 1600 ppm decreasing with time. Quality at 16WAT.	20111103a.pdf
30268	Configure (6- benzyladenine)	Hydrangea macrophylla H. 'Merritt's Supreme'	Hydrangea, French	Greenhouse	Bi	2011	Spray to wet	Minor but significantly different crop injury at 2WAT with two applications at 300 or 600 ppm and significantly greater number of stems compared to non-pinched control.	20111208a.pdf
30268	Configure (6- benzyladenine)	Hydrangea macrophylla H. 'Nikko Blue'	Hydrangea, French	Greenhouse	Czarnota	2011	Spray to wet	Pots treated with a single application at 300 or 600 ppm were not different in shoot number, height or width compared to pinched control but significantly improved compared to unpinched control at 2, 4, 6, 10WAT. No crop injury observed at 6WAT.	20120106a.pdf

PR#	Product	Crop N	lame	Site	Researcher	Year	ar Application	Results	Data Link
		Latin	Common				Туре		
30268	Configure (6- benzyladenine)	Hydrangea macrophylla H. paniculata 'Limelight'	Hydrangea, French	Greenhouse	Fulcher	2011	Spray to wet	No differences in branching, quality, flowering, height or width with 300 or 600 ppm. Minor to moderate injury at 2WAT, no injury at 6WAT.	20120104a.pdf
30268	Configure (6- benzyladenine)	Hydrangea macrophylla H. 'Nikko Blue'	Hydrangea, French	Greenhouse	Keever	2011	Spray to wet	Slight chlorosis with 300 and 600 ppm at 2WAT diminishing by 6WAT. Fewer shoots than pinched or unpinched control and quality index slightly less than the pinched control.	20120113c.pdf
30268	Configure (6- benzyladenine)	Hydrangea macrophylla H. 'Merritt Supreme'	Hydrangea, French	Greenhouse	Lieth	2011	Spray to wet	Significantly more branching with 600 ppm but no difference in quality for 300 or 600 ppm treated plants compared to pinched control. Little to no crop injury.	20120209c.pdf
30268	Configure (6- benzyladenine)	Hydrangea macrophylla H. 'Merritt's Supreme'	Hydrangea, French	Greenhouse	Whipker	2011	Sprench	Slight decrease in height at 6WAT with 300 ppm but no other differences in crop injury, breaks, or quality throughout the evaluation compared to the untreated.	20111103a.pdf
25890	Exilis Plus (6- Benzyladenine)	Hydrangea sp. H. quercifolia 'Alice'	Hydrangea	Greenhouse	Fulcher	2007	Foliar	No significant effect on branch number, height, width or growth index at 26.5 ml/liter (500 ppm) applied twice	20071220f.pdf
25890	Exilis Plus (6- Benzyladenine)	Hydrangea sp. H. quercifolia 'Alice'	Hydrangea	Greenhouse	Fulcher	2008	Foliar	No significant effect on branch number, growth index or plant quality for both cutting- and tissue culture- propagated plants at 500 ppm applied twice	20090316b.pdf
25890	Exilis Plus (6- Benzyladenine)	Hydrangea sp.	Hydrangea	Greenhouse	Gibson	2006	Foliar	Did not increase shoot number and visual quality, decreased plant size at 100 ppm applied twice	20080116p.pdf
25897	Exilis Plus (6- Benzyladenine)	Ilex sp. I. X 'Cardinal'	Holly	Greenhouse	Czarnota	2006	Foliar	No effect on plant growth at 9500 ppm applied once	20070409a.pdf
25897	Exilis Plus (6- Benzyladenine)	llex sp. I. opaca 'Sadyr Hill'	Holly	Greenhouse	Fulcher	2007	Foliar	No significant effect on branch number, height, width or growth index at 26.5 ml/liter (500 ppm) applied twice	20071220f.pdf

PR# Product		Crop N	Crop Name		Researcher	Year	· Application	Results	Data Link
		Latin	Common	-			Туре		
25897	Exilis Plus (6- Benzyladenine)	llex sp. I. opaca 'Helen Hunt'	Holly	Greenhouse	Fulcher	2007	Foliar	No significant effect on branch number, height, width or growth index at 26.5 ml/liter (500 ppm) applied twice	20071220f.pdf
26860	Exilis Plus (6- Benzyladenine)	Oxydendrum arboreum	Sourwood, Sorrel Tree	Field Container	Fulcher	2007	Foliar	No significant effect on branch number, height, width or growth index at 26.5 ml/liter (500 ppm) applied twice	20071220f.pdf
25883	Exilis Plus (6- Benzyladenine)	Rhododendron sp. 'Red Ruffles'	Azalea, & Rhododendron	Greenhouse	Czarnota	2007	Foliar	No effect on branching and plant growth at 500 ppm applied twice	20080625a.pdf
25883	Exilis Plus (6- Benzyladenine)	Rhododendron sp. 'Watchet'	Azalea, & Rhododendron	Greenhouse	Czarnota	2007	Foliar	No effect on branching and plant growth at 500 ppm applied twice	20080625a.pdf
25883	Exilis Plus (6- Benzyladenine)	Rhododendron sp. 'Hallie'	Azalea, & Rhododendron	Greenhouse	Czarnota	2007	Foliar	No effect on branching and plant growth at 500 ppm applied twice	20080625a.pdf
25904	Exilis Plus (6- Benzyladenine)	Rosa sp. 'Alicante'	Rose	Greenhouse	Runkle	2007	Foliar	Experiment 1: 250, 500 and 1000 ppm applied once; no effect applied at 1st pinch; increased branching applied at 2nd pinch	200801160.pdf
25904	Exilis Plus (6- Benzyladenine)	Rosa sp. 'Alicante'	Rose	Greenhouse	Runkle	2007	Foliar	Experiment 2: Did not decrease leaf abscission nor improve visual quality at 25, 50 and 100 ppm	200801160.pdf
27729	Exilis Plus (6- Benzyladenine)	Viburnum sp. V. dilatatum	Arrowwood	Field Container	Czarnota	2006	Foliar	No effect on plant growth at 9500 ppm applied once	20070409a.pdf
25888	Fascination (6- Benzyladenine + Gibberellic Acid)	Hydrangea sp. H. macrophylla 'Angel Robe'	Hydrangea	Greenhouse	Lieth	2006	Foliar	Significant injury but increased height, may increase branching at 500 ppm; should test a lower rate	20070717e.pdf
25895	Fascination (6- Benzyladenine + Gibberellic Acid)	Ilex sp. I. crenata 'Sky Pencil'	Holly	Greenhouse	Keever	2006		Did not increase shoot counts at 500 ppm applied twice; no injury; generally no significant effect on plant height, width and GI	20060912a.pdf
25895	Fascination (6- Benzyladenine + Gibberellic Acid)	Ilex sp. 'Sky Pencil'	Holly	Greenhouse	Keever	2008	Foliar	Increased shoot counts in pruned and unpruned plants at 1000 ppm applied twice; did not increase growth index	20090218e.pdf

PR#	Product	Crop N	ame	Site Resea	Researcher	Year	Application	Results	Data Link
		Latin	Common				Туре		
27873	Fascination (6- Benzyladenine + Gibberellic Acid)	Raphiolepis indica 'Snow White'	Indian Hawthorn	Field Container	Keever	2008	Foliar	Did not increase shoot counts or growth index in pruned and unpruned plants at 1000 ppm applied twice; some injury	20090218e.pdf
25881	Fascination (6- Benzyladenine + Gibberellic Acid)	Rhododendron sp. Azalea 'Amelia Rose'	Azalea, & Rhododendron	Greenhouse	Chen	2006	Foliar	No effect on branching at 500 ppm applied twice	20070110f.pdf
27014	Fascination (6- Benzyladenine + Gibberellic Acid)	Rhododendron sp. 'Formosa'	Azalea, & Rhododendron	Field Container	Czarnota	2008	Foliar	No effect on branching and plant growth at 1000 ppm applied once	20090724b.pdf
27014	Fascination (6- Benzyladenine + Gibberellic Acid)	Rhododendron sp. 'Pink Ruffles'	Azalea, & Rhododendron	Field Container	Czarnota	2008	Foliar	No effect on branching and plant growth at 1000 ppm applied once	20090724b.pdf
25881	Fascination (6- Benzyladenine + Gibberellic Acid)	Rhododendron sp. R. roukhanense 'Korean Stardust'	Azalea, & Rhododendron	Greenhouse	Keever	2006		Did not significantly increase shoot counts at 500 ppm applied twice; no injury and no effect on plant height, width and GI	20060912a.pdf
25881	Fascination (6- Benzyladenine + Gibberellic Acid)	Rhododendron sp. Azalea 'Iveryana'	Azalea, & Rhododendron	Greenhouse	Keever	2007		Decreased new shoot count not, plant growth at 500 ppm applied twice	20080116n.pdf
25881	Fascination (6- Benzyladenine + Gibberellic Acid)	Rhododendron sp. Azalea 'Conversation Piece'	Azalea, & Rhododendron	Greenhouse	Keever	2007		No effect on new shoot count and plant growth at 500 ppm applied twice	20080116n.pdf
25881	Fascination (6- Benzyladenine + Gibberellic Acid)	Rhododendron sp. Azalea 'Hallie'	Azalea, & Rhododendron	Greenhouse	Keever	2007		No effect on new shoot count and plant growth at 500 ppm applied twice	20080116n.pdf
25881	Fascination (6- Benzyladenine + Gibberellic Acid)	Rhododendron sp. 'Remembrance'	Azalea, & Rhododendron	Greenhouse	Lieth	2006	Foliar	Decreased branching at 500 ppm; no injury, no effect on growth and flowering	20070717j.pdf
27014	Fascination (6- Benzyladenine + Gibberellic Acid)	Rhododendron sp. x Girard's Hot Shot	Azalea, & Rhododendron	Field Container	Lieth	2007		No effect on branching and plant growth at 500 ppm applied twice.	20080116g.pdf
25881	Fascination (6- Benzyladenine + Gibberellic Acid)	Rhododendron sp. 'Scarlet'	Azalea, & Rhododendron	Greenhouse	Lieth	2007	Foliar	No effect on branching and plant growth at 500 ppm applied twice.	20080116g.pdf
25881	Fascination (6- Benzyladenine + Gibberellic Acid)	Rhododendron sp. 'Remembrance'	Azalea, & Rhododendron	Greenhouse	Lieth	2008	Foliar	Fewer shoots than the control at 14 WAT, phytotoxicity at 4 WAT, smaller plant height and width than control at 14 and 24 WAT.	20100922a.pdf

PR#	Product	Crop N	lame	Site	Researcher	Year	Application	Results	Data Link
		Latin	Common				Туре		
27014	Fascination (6- Benzyladenine + Gibberellic Acid)	Rhododendron sp. 'Redwing'	Azalea, & Rhododendron	Field Container	Pemberton	2006	Foliar	No effect on branching at 500 ppm applied twice; increased plant growth	20080116m.pdf
27701	Fascination (6- Benzyladenine + Gibberellic Acid)	Rosa sp. 'Knockout'	Rose	Field Container	Czarnota	2008	Foliar	No effect on branching and plant growth at 1000 ppm applied once	20090724b.pdf
25902	Fascination (6- Benzyladenine + Gibberellic Acid)	Rosa sp. 'Kardinal'	Rose	Greenhouse	Lieth	2006	Foliar	No increase in branching and growth, no injury at 500 ppm	20070717k.pdf
27701	Fascination (6- Benzyladenine + Gibberellic Acid)	Rosa sp. 'Chuckles'	Rose	Field Container	Pemberton	2006	Foliar	No effect on branching at 500 ppm applied twice; significant leaf wrinkling/mottling	20080116m.pdf
25902	Fascination (6- Benzyladenine + Gibberellic Acid)	Rosa sp. 'Alicante'	Rose	Greenhouse	Runkle	2007	Foliar	No effect on leaf abscission or visual quality at 5, 10 and 25 ppm	200801160.pdf
30267	Florel (Ethephon)	Hydrangea sp. H. 'Merrit's Supreme'	Hydrangea	Greenhouse	Bi	2011	Spray to wet	Minor but significantly higher crop injury at 2WAT with 1000 ppm and significantly greater number of stems with 500 or 1000 ppm compared to non- pinched control.	20111208a.pdf
30267	Florel (Ethephon)	Hydrangea sp. H. 'Nikko Blue'	Hydrangea	Greenhouse	Czarnota	2011	Spray to wet	Pots treated with a single application at 300 or 600 ppm were not different in shoot number, or width compared to pinched control but significantly improved compared to unpinched control at 2, 4, 6, 10WAT. No crop injury observed at 6WAT. Height for	20120106a.pdf
30267	Florel (Ethephon)	Hydrangea sp. H. paniculata 'Limelight'	Hydrangea	Greenhouse	Fulcher	2011	Spray to wet	Decreased height with 500 or 1000 ppm compared to untreated pruned pots. No crop injury or difference in quality, flower number, or branching compared to control.	20120104a.pdf

PR#	Product	Crop N	ame	Site	Researcher	Year	Application	Results	Data Link
		Latin	Common				Туре		
30267	Florel (Ethephon)	Hydrangea sp. H. 'Nikko Blue'	Hydrangea	Greenhouse	Keever	2011	Spray to wet	Slight chlorosis with 500 and 1000 ppm at 2WAT diminishing by 6WAT. Fewer shoots than pinched or unpinched control and quality index slightly less than the pinched control.	20120113c.pdf
30267	Florel (Ethephon)	Hydrangea sp. H. 'Merritt Supreme'	Hydrangea	Greenhouse	Lieth	2011	Spray to wet	Significantly higher quality (lg. and glossy foliage) with 500 and 1000 ppm and more branching with hi rate compared to pinched control. Little to no crop injury.	20120209c.pdf
30267	Florel (Ethephon)	Hydrangea sp. H. 'Merritt's Supreme'	Hydrangea	Greenhouse	Whipker	2011	Sprench	No difference in crop injury or breaks with 500 or 1000 ppm but greater plant height and diameter with decreased quality rating at 16WAT.	20111103a.pdf
25889	Fresco (Gibberellic Acid + 6- Benzyladenine)	Hydrangea sp.	Hydrangea	Greenhouse	Gibson	2006	Foliar	No increase in shoot number, plant size and visual quality at 100 ppm applied twice	20080116p.pdf
25896	Fresco (Gibberellic Acid + 6- Benzyladenine)	Ilex sp. I. X 'Cardinal'	Holly	Greenhouse	Czarnota	2006	Foliar	No effect on plant growth at 5550 ppm applied once	20070409a.pdf
25882	Fresco (Gibberellic Acid + 6- Benzyladenine)	Rhododendron sp. 'Red Ruffles'	Azalea, & Rhododendron	Greenhouse	Czarnota	2007	Foliar	No effect on branching and plant growth at 500 ppm applied twice	20080625a.pdf
25882	Fresco (Gibberellic Acid + 6- Benzyladenine)	Rhododendron sp. 'Watchet'	Azalea, & Rhododendron	Greenhouse	Czarnota	2007	Foliar	No effect on branching and plant growth at 500 ppm applied twice	20080625a.pdf
25882	Fresco (Gibberellic Acid + 6- Benzyladenine)	Rhododendron sp. 'Hallie'	Azalea, & Rhododendron	Greenhouse	Czarnota	2007	Foliar	No effect on branching and plant growth at 500 ppm applied twice	20080625a.pdf
27728	Fresco (Gibberellic Acid + 6- Benzyladenine)	Viburnum sp. V. dilatatum	Arrowwood	Field Container	Czarnota	2006	Foliar	No effect on plant growth at 5550 ppm applied once	20070409a.pdf
25891	MaxCel (6- Benzyladenine)	Hydrangea sp. H. macrophylla 'Angel Robe'	Hydrangea	Greenhouse	Lieth	2006	Foliar	No increase in branching at 500 ppm; unacceptable injury	20070717e.pdf
25898	MaxCel (6- Benzyladenine)	Ilex sp. I. X 'Cardinal'	Holly	Greenhouse	Czarnota	2006	Foliar	Reduced internode length at 20,000 ppm applied once	20070409a.pdf

PR#	Product	Crop Name		Site	Researcher	Year	Application	Results	Data Link
		Latin	Common				Туре		
25898	MaxCel (6- Benzyladenine)	Ilex sp. I. crenata 'Sky Pencil'	Holly	Greenhouse	Keever	2006		Increase shoot counts at 7, but not at 12 WAT at 500 ppm applied twice; no injury; generally no significant effect on plant height, width and GI	20060912a.pdf
25898	MaxCel (6- Benzyladenine)	Ilex sp. I. crenata 'Sky Pencil'	Holly	Greenhouse	Keever	2008	Foliar	Increased shoot counts in pruned and unpruned plants at 500 ppm applied twice; did not increase growth index; significant injury	20090218e.pdf
27874	MaxCel (6- Benzyladenine)	Raphiolepis indica 'Snow White'	Indian Hawthorn	Field Container	Keever	2008	Foliar	Did not increase shoot counts or growth index in pruned and unpruned plants at 500 ppm applied twice	20090218e.pdf
21495	MaxCel (6- Benzyladenine)	Rhododendron sp. Azalea 'Amelia Rose'	Azalea, & Rhododendron	Greenhouse	Chen	2006	Foliar	No effect on branching at 500 ppm applied twice	20070110f.pdf
21496	MaxCel (6- Benzyladenine)	Rhododendron sp. 'Formosa'	Azalea, & Rhododendron	Field Container	Czarnota	2008	Foliar	No effect on branching and plant growth at 500 ppm applied once	20090724b.pdf
21496	MaxCel (6- Benzyladenine)	Rhododendron sp. 'Pink Ruffles'	Azalea, & Rhododendron	Field Container	Czarnota	2008	Foliar	No effect on branching and plant growth at 500 ppm applied once	20090724b.pdf
21496	MaxCel (6- Benzyladenine)	Rhododendron sp. 'Elsie Lee' (azalea)	Azalea, & Rhododendron	Field Container	Keever	2003	Foliar	No effect on growth parameters at 1250, 2500, 3750 and 5000 ppm; no injury.	19750101r.pdf
21495	MaxCel (6- Benzyladenine)	Rhododendron sp. 'English Roseum'	Azalea, & Rhododendron	Greenhouse	Keever	2003	Foliar	Only plant height decreased as rate increased (1250, 2500, 3750, 5000 ppm); no injury.	19750101r.pdf
21495	MaxCel (6- Benzyladenine)	Rhododendron sp. R. roukhanense 'Korean Stardust'	Azalea, & Rhododendron	Greenhouse	Keever	2006		Increased shoot counts with no injury at 500 ppm applied twice; no effect on plant height, width and GI	20060912a.pdf
21495	MaxCel (6- Benzyladenine)	Rhododendron sp. Azalea 'Iveryana'	Azalea, & Rhododendron	Greenhouse	Keever	2007	Foliar	Increased new shoot count, not plant growth at 500 ppm applied twice	20080116n.pdf
21495	MaxCel (6- Benzyladenine)	Rhododendron sp. Azalea 'Hallie'	Azalea, & Rhododendron	Greenhouse	Keever	2007	Foliar	Increased new shoot count, not plant growth at 500 ppm applied twice	20080116n.pdf

PR#	Product	Crop Name		Site	Researcher	Year	Application	Results	Data Link
		Latin	Common				Туре		
21495	MaxCel (6- Benzyladenine)	Rhododendron sp. Azalea 'Conversation Piece'	Azalea, & Rhododendron	Greenhouse	Keever	2007	Foliar	No effect on new shoot count and plant growth at 500 ppm applied twice	20080116n.pdf
21495	MaxCel (6- Benzyladenine)	Rhododendron sp. 'Remembrance'	Azalea, & Rhododendron	Greenhouse	Lieth	2006	Foliar	Decreased branching at 500 ppm; no injury, no effect on growth and flowering	20070717j.pdf
21495	MaxCel (6- Benzyladenine)	Rhododendron sp. 'Remembrance'	Azalea, & Rhododendron	Greenhouse	Lieth	2008	Foliar	No crop injury and no significant differences from control.	20100922a.pdf
21496	MaxCel (6- Benzyladenine)	Rhododendron sp. 'Redwing'	Azalea, & Rhododendron	Field Container	Pemberton	2006	Foliar	No effect on branching and plant growth at 500 ppm applied twice	20080116m.pdf
27702	MaxCel (6- Benzyladenine)	Rosa sp. 'Knockout'	Rose	Field Container	Czarnota	2008	Foliar	No effect on branching and plant growth at 500 ppm applied once	20090724b.pdf
25905	MaxCel (6- Benzyladenine)	Rosa sp. 'Kardinal'	Rose	Greenhouse	Lieth	2006		Increase in branching but significant injury at 500 ppm; should test lower rates	20070717k.pdf
27702	MaxCel (6- Benzyladenine)	Rosa sp. 'Chuckles'	Rose	Field Container	Pemberton	2006	Foliar	No effect on branching at 500 ppm applied twice; significant leaf wrinkling/mottling	20080116m.pdf
27726	MaxCel (6- Benzyladenine)	Viburnum sp. V. dilatatum	Arrowwood	Field Container	Czarnota	2006	Foliar	No effect on plant growth at 20,000 ppm applied once	20070409a.pdf
25885	NovaGib (GA4+7)	Rhododendron sp. Azalea 'Amelia Rose'	Azalea, & Rhododendron	Greenhouse	Chen	2006	Foliar	No effect on branching at 500 ppm applied once	20070110f.pdf
25885	NovaGib (GA4+7)	Rhododendron sp. 'Red Ruffles	Azalea, & Rhododendron	Greenhouse	Czarnota	2007	Foliar	No effect on branching and plant growth at 500 ppm applied twice	20080625a.pdf
25885	NovaGib (GA4+7)	Rhododendron sp. 'Watchet'	Azalea, & Rhododendron	Greenhouse	Czarnota	2007	Foliar	No effect on branching and plant growth at 500 ppm applied twice	20080625a.pdf
25885	NovaGib (GA4+7)	Rhododendron sp. 'Hallie'	Azalea, & Rhododendron	Greenhouse	Czarnota	2007	Foliar	No effect on branching and plant growth at 500 ppm applied twice	20080625a.pdf
25893	ProVide (GA4+7)	Hydrangea sp. H. macrophylla 'Angel Robe'	Hydrangea	Greenhouse	Lieth	2006	Foliar	No increase in branching at 500 ppm; no injury	20070717e.pdf

PR#	Product	Crop Name		Site	Researcher	Year	ar Application	n Results	Data Link
		Latin	Common				Туре		
25900	ProVide (GA4+7)	Ilex sp. I. crenata 'Sky Pencil'	Holly	Greenhouse	Keever	2006		Did not increase shoot counts at 500 ppm applied once; no injury; generally no significant effect on plant height, width and GI	20060912a.pdf
25886	ProVide (GA4+7)	Rhododendron sp. R. roukhanense 'Korean Stardust'	Azalea, & Rhododendron	Greenhouse	Keever	2006		Did not increase shoot counts at 500 ppm applied once; no injury and no effect on plant height, width and GI	20060912a.pdf
25886	ProVide (GA4+7)	Rhododendron sp. Azalea 'Iveryana'	Azalea, & Rhododendron	Greenhouse	Keever	2007	Foliar	No effect on new shoot count and plant growth at 500 ppm applied once	20080116n.pdf
25886	ProVide (GA4+7)	Rhododendron sp. Azalea 'Conversation Piece'	Azalea, & Rhododendron	Greenhouse	Keever	2007	Foliar	No effect on new shoot count and plant growth at 500 ppm applied once	20080116n.pdf
25886	ProVide (GA4+7)	Rhododendron sp. Azalea 'Hallie'	Azalea, & Rhododendron	Greenhouse	Keever	2007	Foliar	No effect on new shoot count and plant growth at 500 ppm applied once	20080116n.pdf
25886	ProVide (GA4+7)	Rhododendron sp. 'Remembrance'	Azalea, & Rhododendron	Greenhouse	Lieth	2006	Foliar	Decreased branching at 500 ppm; no injury, no effect on growth and flowering	20070717j.pdf
25886	ProVide (GA4+7)	Rhododendron sp. 'Redwing'	Azalea, & Rhododendron	Greenhouse	Pemberton	2006	Foliar	No effect on branching at 500 ppm applied twice; increased plant growth	20080116m.pdf
25907	ProVide (GA4+7)	Rosa sp. 'Kardinal'	Rose	Greenhouse	Lieth	2006	Foliar	No increase in branching and growth, no injury at 500 ppm	20070717k.pdf
25907	ProVide (GA4+7)	Rosa sp. 'Chuckles'	Rose	Greenhouse	Pemberton	2006	Foliar	No effect on branching and plant growth at 500 ppm applied twice	20080116m.pdf
25887	Tiberon 2.8 SC (Cyclanilide)	Hydrangea sp. H. quercifolia 'Alice'	Hydrangea	Greenhouse	Fulcher	2007	Foliar	Two applications at 0.5 oz per 100 gal (112 ppm) increased branch number for plants produced by cutting but not by tissue culture; one application had no effect	20071220f.pdf
25887	Tiberon 2.8 SC (Cyclanilide)	Hydrangea sp. H. quercifolia 'Alice'	Hydrangea	Greenhouse	Fulcher	2008	Foliar	Two applications at 100 ppm increased branching but was phytotoxic for both cutting- and tissue culture- propagated plants; one application generally had no effect	20090316b.pdf

PR#	Product	Crop Name		Site	Researcher	Year	Application	Results	Data Link
		Latin	Common				Туре		
25887	Tiberon 2.8 SC (Cyclanilide)	Hydrangea sp.	Hydrangea	Greenhouse	Gibson	2006	Foliar	100 ppm; 1 application did not increase shoot number and visual quality, decreased plant size; 2 applications increased shoot number but decreased plant size and visual quality	20080116p.pdf
25887	Tiberon 2.8 SC (Cyclanilide)	Hydrangea sp. H. macrophylla 'Angel Robe'	Hydrangea	Greenhouse	Lieth	2006	Foliar	No increase in branching and growth, no injury at 112 ppm + Latron; 1 application looked better	20070717e.pdf
25894	Tiberon 2.8 SC (Cyclanilide)	Ilex sp. I. X 'Cardinal'	Holly	Greenhouse	Czarnota	2006	Foliar	Reduced internode length at 39 ppm applied twice, not when applied once	20070409a.pdf
25894	Tiberon 2.8 SC (Cyclanilide)	Ilex sp. I. opaca 'Helen Hahn'	Holly	Greenhouse	Fulcher	2007	Foliar	No significant effect on branch number, height, width or growth index at 0.5 oz per 100 gal (112 ppm) applied once or twice	20071220f.pdf
25894	Tiberon 2.8 SC (Cyclanilide)	Ilex sp. I. opaca 'Sadyr Hill'	Holly	Greenhouse	Fulcher	2007	Foliar	No significant effect on branch number, height, width or growth index at 0.5 oz per 100 gal (112 ppm) applied once or twice	20071220f.pdf
25894	Tiberon 2.8 SC (Cyclanilide)	Ilex sp. I. verticillata 'Winter Red' - pruned	Holly	Greenhouse	Fulcher	2008	Foliar	Pruned: No significant effect on branch number, growth index or number of berries at 100 ppm applied twice	20090319f.pdf
25894	Tiberon 2.8 SC (Cyclanilide)	Ilex sp. I. verticillata 'Winter Red' - unpruned	Holly	Greenhouse	Fulcher	2008	Foliar	Unpruned: No significant effect on branch number, growth index or number of berries at 100 ppm applied twice	20090319f.pdf
25894	Tiberon 2.8 SC (Cyclanilide)	Ilex sp. I. crenata 'Sky Pencil'	Holly	Greenhouse	Keever	2006	Foliar	Two applications at 112 ppm increased shoot counts with no injury; generally no effect on plant height, width and GI	20060912a.pdf
25894	Tiberon 2.8 SC (Cyclanilide)	Ilex sp. I. crenata 'Sky Pencil'	Holly	Greenhouse	Keever	2008	Foliar	Increased shoot counts in pruned and unpruned plants at 100 ppm + Buffer X applied twice; did not increase growth index	20090218e.pdf

PR#	Product	Crop Name		Site	Researcher	Year	Application	Results	Data Link
		Latin	Common]			Туре		
26859	Tiberon 2.8 SC (Cyclanilide)	Oxydendrum arboreum	Sourwood, Sorrel Tree	Field Container	Fulcher	2007	Foliar	No significant effect on branch number, height, width or growth index at 0.5 oz per 100 gal (112 ppm) applied once or twice	20071220f.pdf
26150	Tiberon 2.8 SC (Cyclanilide)	Raphiolepis indica 'Snow White'	Indian Hawthorn	Field Container	Keever	2008	Foliar	Increased shoot counts in pruned and unpruned plants at 100 ppm + Buffer X applied twice; did not increase growth index; significant injury	20090218e.pdf
27012	Tiberon 2.8 SC (Cyclanilide)	Rhododendron sp.	Azalea, & Rhododendron	Field Container	Bi	2009		Unpruned plants treated with 200 ppm had fewer branches than the pruned or unpruned controls and the pruned treated (200ppm) at 30WAT1. No difference among other treatments at 30WAT.	20110202a.pdf
25880	Tiberon 2.8 SC (Cyclanilide)	Rhododendron sp. Azalea 'Amelia Rose'	Azalea, & Rhododendron	Greenhouse	Chen	2006	Foliar	Marginal increase in branching at 112 ppm applied once or twice	20070110f.pdf
25880	Tiberon 2.8 SC (Cyclanilide)	Rhododendron sp. 'Amelia Rose' - unpruned	Azalea, & Rhododendron	Greenhouse	Chen	2007	Foliar	Marginal increase in branching at 112 ppm applied once or twice	20070110f.pdf
25880	Tiberon 2.8 SC (Cyclanilide)	Rhododendron sp. 'Amelia Rose' - pruned	Azalea, & Rhododendron	Greenhouse	Chen	2007	Foliar	Marginal increase in branching at 112 ppm applied once or twice	20070110f.pdf
25880	Tiberon 2.8 SC (Cyclanilide)	Rhododendron sp. 'Red Ruffles'	Azalea, & Rhododendron	Greenhouse	Czarnota	2007	Foliar	No effect on branching and plant growth at 112 ppm applied once or twice	20080625a.pdf
25880	Tiberon 2.8 SC (Cyclanilide)	Rhododendron sp. 'Hallie'	Azalea, & Rhododendron	Greenhouse	Czarnota	2007	Foliar	No effect on branching and plant growth at 112 ppm applied once or twice	20080625a.pdf
25880	Tiberon 2.8 SC (Cyclanilide)	Rhododendron sp. 'Watchet'	Azalea, & Rhododendron	Greenhouse	Czarnota	2007	Foliar	Significantly reduced plant height and number of buds at 112 ppm applied once or twice	20080625a.pdf
27012	Tiberon 2.8 SC (Cyclanilide)	Rhododendron sp. 'Formosa'	Azalea, & Rhododendron	Field Container	Czarnota	2008	Foliar	No effect on branching and plant growth at 100 ppm applied once	20090724b.pdf
27012	Tiberon 2.8 SC (Cyclanilide)	Rhododendron sp. 'Pink Ruffles'	Azalea, & Rhododendron	Field Container	Czarnota	2008	Foliar	No effect on branching and plant growth at 100 ppm applied once	20090724b.pdf

PR#	Product	Crop N	ame	Site	Researcher	Year	Application	Results	Data Link
		Latin	Common				Туре		
25880	Tiberon 2.8 SC (Cyclanilide)	Rhododendron sp. R. roukhanense 'Korean Stardust'	Azalea, & Rhododendron	Greenhouse	Keever	2006		Increased shoot counts with no injury at 112 ppm applied once or twice; no effect on plant height, width and GI; 2 applications more effective	20060912a.pdf
25880	Tiberon 2.8 SC (Cyclanilide)	Rhododendron sp. Azalea 'Conversation Piece'	Azalea, & Rhododendron	Greenhouse	Keever	2007	Foliar	Increased new shoot count, not plant growth at 112 ppm applied once or twice; some injury with 2 applications	20080116n.pdf
25880	Tiberon 2.8 SC (Cyclanilide)	Rhododendron sp. Azalea 'Hallie'	Azalea, & Rhododendron	Greenhouse	Keever	2007	Foliar	Increased new shoot count, not plant growth at 112 ppm applied once or twice; some injury with 2 applications	20080116n.pdf
25880	Tiberon 2.8 SC (Cyclanilide)	Rhododendron sp. Azalea 'Iveryana'	Azalea, & Rhododendron	Greenhouse	Keever	2007	Foliar	No significant increase in new shoot count and plant growth at 112 ppm applied once or twice; some injury with 2 applications	20080116n.pdf
25880	Tiberon 2.8 SC (Cyclanilide)	Rhododendron sp. 'Remembrance'	Azalea, & Rhododendron	Greenhouse	Lieth	2006	Foliar	Two applications at 112 ppm + Latron reduced branching and growth but increased flowering; no injury	20070717j.pdf
27012	Tiberon 2.8 SC (Cyclanilide)	Rhododendron sp. x Girard's Hot Shot	Azalea, & Rhododendron	Field Container	Lieth	2007		Increased branching with 112 ppm applied twice, but not once.	20080116g.pdf
25880	Tiberon 2.8 SC (Cyclanilide)	Rhododendron sp. 'Scarlet'	Azalea, & Rhododendron	Greenhouse	Lieth	2007	Foliar	No effect on branching and plant growth at 112 ppm applied once or twice.	20080116g.pdf
25880	Tiberon 2.8 SC (Cyclanilide)	Rhododendron sp. 'Remembrance'	Azalea, & Rhododendron	Greenhouse	Lieth	2008	Foliar	More shoots than control at 2 WAT2nd but no sig. difference b/ treatments at 7 WAT2.	20100922a.pdf
27012	Tiberon 2.8 SC (Cyclanilide)	Rhododendron sp. 'Redwing'	Azalea, & Rhododendron	Field Container	Pemberton	2006	Foliar	No effect on branching and plant growth at 112 ppm applied once or twice	20080116m.pdf
27700	Tiberon 2.8 SC (Cyclanilide)	Rosa sp. 'Knockout'	Rose	Field Container	Czarnota	2008	Foliar	No effect on branching and plant growth at 100 ppm applied once	20090724b.pdf
25901	Tiberon 2.8 SC (Cyclanilide)	Rosa sp. 'Kardinal'	Rose	Greenhouse	Lieth	2006	Foliar	No increase in branching and growth, no injury at 112 ppm + Latron	20070717k.pdf
27700	Tiberon 2.8 SC (Cyclanilide)	Rosa sp. 'Chuckles'	Rose	Field Container	Pemberton	2006	Foliar	No effect on branching and plant growth at 112 ppm applied once or twice	20080116m.pdf
PR#	Product	Crop Name		Site	Researcher	Year	Application	Results	Data Link
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		Latin	Common				Туре		
27727	Tiberon 2.8 SC	Viburnum sp. V.	Arrowwood	Field	Czarnota	2006	Foliar	No effect on plant growth at 39	20070409a.pdf
	(Cyclanilide)	dilatatum		Container				ppm applied once or twice	

Label Suggestions

Based upon data accumulated through the IR-4 research program in 2006 to 2008, we suggest that registrants consider labeling Tiberon 2.8SC and MaxCel for increased branching in container grown azalea. Data are not adequate at this time to consider registration of on other species.

Based on data generated in 2011 the following label suggestions are for postemergence greenhouse, hoop house or shadehouse use for container grown hydrangea: Augeo applied at 800 ppm in liner stage to rooted cuttings is recommended for branching.

Appendix 1: Contributing Researchers

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Appendix 2: Submitted Data Reports

The reports in this Appendix cover multiple PR numbers and are arranged alphabetically by researcher and year the experiments were conducted.

These reports can also be found at <u>www.rutgers.ir4.edu</u> by searching under the woody ornamental branching project.