

## EFFECT OF PLANT GROWTH REGULATORS ON GROWTH OF 'BARBARA KARST' BOUGAINVILLEA

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**Abstract.** Single rooted cuttings of 'Barbara Karst' bougainvillea (*Bougainvillea* × *buttiana* [*Bougainvillea glabra* Choisy × *Bougainvillea peruviana* Humb. & Bonpl.] 'Barbara Karst') were transplanted to 3.8-liter containers on 6 April 1995. The medium was pine bark: Canadian sphagnum peat: sand, 3:1:1 (by vol.). On 15 May, all plants were pruned to a mean height and width of 23.6 cm and 34.5 cm, respectively. Plant growth regulators (PGRs) were applied on 16 May (0 weeks) as follows: foliar spray (2036 liter·ha<sup>-1</sup>) - uniconazole (10 mg a.i.·liter<sup>-1</sup>), paclobutrazol (50, 100, or 200 mg a.i.·liter<sup>-1</sup>), maleic hydrazide (2808 mg a.i.·liter<sup>-1</sup>), daminozide (5000 mg a.i.·liter<sup>-1</sup>); soil drench (150 ml per pot) - paclobutrazol (5, 10, or 20 mg a.i.·liter<sup>-1</sup>). The two nonPGR-treated controls were 1) pruned at 0 weeks after treatment (WAT), and 2) pruned at 0 and 4 WAT. All daminozide sprays were reapplied on 31 May and 13 June as before. Height, width, flowering, number of structural branches (branches ≥ 15 cm), marketability, and level of bacterial spot infection were evaluated 6, 9, and 12 WAT. Phytotoxicity was evaluated 1, 4, 5, 6, 9, and 12 WAT. No PGR suppressed growth, enhanced flowering, branching, or marketability, or affected the degree of bacterial spot infection. Daminozide-treated plants had fewer structural branches and maleic hydrazide was phytotoxic. There were no differences in any of the measured parameters between the nonPGR-treated plants pruned once or twice.

'Barbara Karst' bougainvillea, one of the most widely sold cultivars in the United States, has a vigorous growth habit like many other bougainvillea and therefore requires frequent pruning during production. Several recent studies have concentrated on developing a protocol for using dikegulac (Atrimec) in production of bougainvillea hanging baskets (Norcini et al., 1992, 1993, 1994). Manually pruning or pinching three rooted bougainvillea liners at transplanting (0 weeks) and again 4 weeks later results in a slightly compact plant with a pendulous form in about 10 weeks (Norcini et al., 1992). Dikegulac applied at 1600 mg a.i.·liter<sup>-1</sup> at 0 and 4 weeks after transplanting eliminates the second pruning and results in a more compact plant with increased flowering (Norcini et al., 1992). However, widespread use of dikegulac may be limited because it causes temporary chlorosis, reduces bract size, and efficacy is cultivar dependent.

Previous studies investigating the use of other PGRs on bougainvillea include two hydrazides (daminozide [B-Nine] and maleic hydrazide [Royal Slo-Gro]) and two triazoles (paclobutrazol [Bonzi] and uniconazole [Sumagic]). Daminozide induced flowering of bougainvillea (Dierking and Sanderson, 1985; Hackett and Sachs, 1967) while reducing vegetative growth (Hackett and Sachs, 1967; Norcini et al., 1990). Applications of maleic hydrazide has inhibited height

and increased branching which resulted in a compact flowering plant (Valmayor et al., 1963). Horowitz (1990) found that paclobutrazol and uniconazole applications resulted in a compact (shortened internodes), dark-green (increased chlorophyll content) plant with clusters of bracts on shortened peduncles. Flowering occurred earlier and was more abundant than on nontreated plants; however, bracts wilted on the most inhibited of treated plants, especially those treated with uniconazole.

This study was undertaken to evaluate if PGRs applied to 'Barbara Karst' bougainvillea grown in 3.8-liter containers could eliminate the need for pruning at 4 weeks after initial pruning and result in a more compact plant with increased and/or earlier flowering.

### Materials and Methods

Single rooted cuttings of 'Barbara Karst' bougainvillea (Wes-Cor Nursery Inc., Sarasota, Fla.; height 13.3 cm ± 1.6, width 12 cm ± 1, 13.9 nodes ± 1.8, and 1.1 branches ± .5) were transplanted to 3.8-liter containers on 6 April 1995. The substrate was pine bark:sand:Canadian sphagnum peat; 3:1:1 (v/v/v), amended (per m<sup>3</sup>) with 6.1 kg dolomite, 1.6 kg triple superphosphate, 0.9 kg controlled release micronutrients (Micromax; The Scotts Co., Marysville, OH), and 6.1 kg controlled release fertilizer (Osmocote 18N-2.6P-8.3K [18-6-12]; The Scotts Co., Marysville, OH). A solution of 236 mg N·liter<sup>-1</sup> (Peters 20N-8.8P-16.6K [20-20-02]; The Scotts Co., Marysville, OH) and metalaxyl (Subdue 2E; Ciba-Geigy, Greensboro, NC) at 37 mg a.i.·liter<sup>-1</sup> was applied as a soil drench on 20 April. Foliar application of 1 g·liter<sup>-1</sup> copper hydroxide (Kocide 101; Griffin Corp., Valdosta, GA) was sprayed to drip weekly from 17 May to 3 August to control bacterial spot (*Pseudomonas andropogonis* (E.F. Sm.) Stapp). A foliar acephate (Orthene 75S; Valent U.S.A. Corp., Walnut Creek, CA) at 4 g a.i.·liter<sup>-1</sup> was applied (foliar spray to wet) on 18 May to control aphids. On 22 May and 19 July, 9 g Osmocote 18N-2.6P-8.3K was top-dressed to each container. A solution of 2.6 ml·liter<sup>-1</sup> 1.5Mg-.75Mn-.75Zn-.006Cu-.35Fe-.16B-.003Mo-4.0S + alpha keto acids (Keyplex 350; Morse Enterprises Limited, Miami, FL) was applied as a foliar spray (to wet) on 22 May.

On 12 May, the mean (± SE) plant height was 25 cm ± 6.1 and the width was 33.2 cm ± 6.3 for a mean growth index [(height + avg. width)/2] of 29.1 cm ± 4.1. All plants were pruned to a mean height of 23.6 cm ± 4.6 and width of 34.5 cm ± 5.1 on 15 May resulting in a mean growth index of 29 cm ± 2.4. On 12 June, the mean plant height of the nonPGR-treated controls to be repruned was 35.4 cm ± 6.8, the width was 64.9 cm ± 7.9, and the growth index was 50.2 ± 6.1. The following day these plants were pruned to a mean height of 30.4 cm ± 4.5 and a mean width of 53.7 cm ± 6.7, resulting in a mean growth index of 42.1 cm ± 4.9.

Plant growth regulator treatments were applied on 16 May (0 weeks) with a compressed air backpack sprayer equipped with a TJ60 8004VS tip that delivered 2036 liter·ha<sup>-1</sup> at 1.76 kg·cm<sup>-2</sup> as follows: foliar sprays of uniconazole (Valent U.S.A. Corp., Walnut Creek, CA) at 10 mg a.i.·liter<sup>-1</sup>), paclobutrazol (Uniroyal Chemical, Middlebury, CT) at 50, 100, or 200 mg

Table 1. Effect plant growth regulators on 3.8-liter 'Barbara Karst' bougainvillea 12 weeks after treatment (WAT) on 16 May 1995 at the North Florida Research and Education Center, Monticello, Florida.

Treatment	mg a.i./liter	Number appl. or prunings	Growth index <sup>1</sup> (cm)	Flowering index <sup>2</sup>	Form index <sup>3</sup>	No. of structural branches <sup>4</sup>	Bacterial spot rating <sup>5</sup>	Marketability index <sup>6</sup>
No PGR <sup>7</sup>	—	1	52.0ab*	4.13a	2.75a	16.5ab	2.3b	2.6ab
No PGR <sup>7</sup>	—	2	46.0c*	3.63a	2.88a	18.4a	2.5ab	2.5abc
<i>Sprays</i>								
Uniconazole	10	1	51.9ab	3.38ab	2.75a	18.0a	2.4ab	2.3bc
Maleic hydrazide	2808	1	33.1c	1.50c	2.50a	13.8bc	2.3b	1.3d
Daminozide <sup>9</sup>	5000	3	49.6b	2.63b	2.25a	12.3c	2.1b	1.9c
Bonzi	50	1	56.6ab	3.75a	2.50a	17.0ab	2.6ab	2.5abc
Bonzi	100	1	61.1a	3.71a	2.86a	19.0a	2.4ab	3.0a
Bonzi	200	1	55.3ab	3.29ab	2.29a	16.4ab	2.3b	2.3bc
<i>Drenches</i>								
Bonzi	5	1	57.5ab	3.43ab	2.71a	17.4a	2.6ab	2.6ab
Bonzi	10	1	56.2ab	3.14ab	2.43a	17.3ab	2.3b	2.4abc
Bonzi	20	1	60.0a	3.14ab	2.43a	16.9ab	3.0a	2.1bc

<sup>1</sup>Growth index = [(height + ((widest width + width perpendicular to widest width)/2))/2]

<sup>2</sup>Flowering index: 1 = no flowers, 2 = slight, 3 = some, 4 = moderate, and 5 = heavy flowering.

<sup>3</sup>Form index: 1 = poor, 2 = fair, 3 = good, and 4 = excellent.

<sup>4</sup>Structural branches  $\geq$  15 cm in length.

<sup>5</sup>Level of bacterial spot infection caused by *Pseudomonas andropogonis*, 1 = none, 2 = slight, 3 = some, 4 = moderate, and 5 = heavy.

<sup>6</sup>Marketability index: 1 = poor, 2 = fair, 3 = good, and 4 = excellent.

<sup>7</sup>NonPGR-treated plants were pruned once (15 May, i.e., 0 WAT) or twice (15 May and 13 June, i.e., 0 and 4 WAT).

<sup>8</sup>Means followed by the same letter, within each column, are not significantly different by Duncan's multiple range test (5% level).

<sup>9</sup>Applied 0, 2 and 4 WAT.

a.i.-liter<sup>-1</sup>, maleic hydrazide (Uniroyal Chemical, Middlebury, CT) at 2808 mg a.i.-liter<sup>-1</sup>, or daminozide (Uniroyal Chemical, Middlebury, CT) at 5000 mg a.i.-liter<sup>-1</sup>; soil drenches (150 ml per pot) of paclobutrazol at 5, 10, or 20 mg a.i.-liter<sup>-1</sup>. The two nonPGR-treated controls were 1) pruned at 0 weeks after treatment (WAT), and 2) pruned at 0 and 4 WAT. All daminozide sprays were reapplied on 31 May (2 WAT) and 13 June (4 WAT) as before.

At 12 WAT the following parameters were recorded: growth index [(height + ((widest width + width perpendicular to widest width)/2))/2], flowering index (rating scale: 1 = none, 2 = slight, 3 = some, 4 = moderate, and 5 = heavy), form index (rating scale: 1 = poor, 2 = fair, 3 = good, and 4 = excellent), number of structural branches  $\geq$  15 cm in length, marketability index (1 = poor, 2 = fair, 3 = good, and 4 = excellent), and level of bacterial spot infection caused by *Pseudomonas andropogonis* (rating scale: 1 = none, 2 = slight, 3 = some, 4 = moderate, and 5 = heavy). Additionally, phytotoxicity was rated (0 = no damage to 100 = plant death; increments of 10) 1, 4, 5, 6, 9, and 12 WAT. The experiment was set up as a completely randomized design with 8 replications per treatment. Means (except phytotoxicity) were separated by Duncan's multiple range test (5% level).

## Results and Discussion

There was no benefit to applying a PGR one day after pruning. 'Barbara Karst' bougainvillea treated with paclobutrazol, uniconazole, or daminozide were generally similar to the nonPGR-treated plants pruned once or twice. The only exceptions were that plants sprayed with B-Nine (3 times, 2 weeks apart) had fewer structural branches and flowers compared to the controls, and nonPGR-treated plants pruned twice were smaller than those pruned once or treated with any PGR except maleic hydrazide (Table 1). Neither paclobutrazol, uniconazole, or daminozide suppressed growth even for 6 weeks (results not shown). No treatment had any effect on level of bacterial spot infection (Table 1).

Maleic hydrazide was the only PGR that caused foliar phytotoxicity (phytotoxicity ratings: 1 WAT - 13.8; 4 WAT - 50, 5 WAT - 67.5, 6 WAT - 67.5, 9 WAT - 31.3, and 12 WAT - 26.3). While the severe phytotoxic effect of maleic hydrazide on 'Barbara Karst' bougainvillea was probably the main cause of the reduced plant size and generally poor quality of these plants, one cannot rule out the possibility that maleic hydrazide also directly inhibited growth and flowering.

It should be noted that other bougainvillea cultivars and species may react differently to these PGRs.

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