Uniconazole, paclobutrazol, and ancymidol are viable alternatives to use of daminozide and can be applied as single spray applications to give similar plant heights as achieved with multiple daminozide treatments. Spray volume of 2 quarts/100 ft^2 produced plants of similar height as those provided a directed spray of 0.7 oz/plant. Short and medium height chrysanthemum cultivars needed between 10 and 20 ppm of uniconazole or 100 to 150 ppm of paclobutrazol sprays or a uniconazole solution of 1.7 to 3.3 ppm applied as a medium drench for optimum plant height. Taller cultivars would require multiple uniconazole sprays of 20 ppm or single paclobutrazol sprays of 200 ppm to retard plant height. In future studies time of application and chemical concentration need to be evaluated for the tall cultivars and to determine the optimum concentration for the major potted chrysanthemum cultivars grown in Florida.

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BRANCHING OF VERBENA LINERS IS INFLUENCED BY CYTOKININ APPLICATION DURING CUTTING PROPAGATION

SVEN E. SVENSON
University of Florida
Fort Lauderdale Research and Education Center
3205 College Ave., Fort Lauderdale, FL 33314

Additional key words. Verbena X hybrida, adventitious root formation, benzylaminopurine.

Abstract. **Rooting, growth and subsequent branching of *Verbena* cuttings (*Verbena X hybrida*) were measured to determine response to foliar applied cytokinin (benzylaminopurine—BAP). Rooting was not enhanced or inhibited by BAP application when visible nodal roots were present at the base of the cuttings, or when 30, 100, or 300 mg BAP liter^{-1} was applied to the foliage 48 or 96 hours after cuttings were stuck. Fewer roots were formed when a nodal root was present at the base of the cuttings before being stuck. Rooting-zone dry mass, total cutting dry mass, and root number were increased by 30 mg BAP liter^{-1} applied immediately after excision when there were no visible nodal roots at the base of the cuttings. Foliar application of 10 or 30 mg BAP liter^{-1} during propagation reduced plant height 13% and 22%, respectively, and increased lateral bud elongation 20% and 50%, respectively. Application of BAP during cutting propagation of *Verbena* to enhance branching and compactness of rooted liners did not inhibit rooting.**

Root initiation and root growth are affected differently by the application of cytokinins. Exogenous applications of cytokinins immediately after cutting preparation has generally inhibited rooting, while application after formation of root primordia has little effect on rooting (3). The influence of cytokinins on adventitious root development may depend on the specific stage of initiation (timing of application), concentration and type of cytokinin applied, species, type of cutting, morphological location of application, and stock plant growing environment (6).

Application of cytokinins can enhance lateral bud elongation of shoots of a variety of species (1, 2, 4, 5). If foliar application to cuttings having preformed root initials or visible nodal roots does not inhibit rooting, branching of the subsequently rooted shoot may be enhanced.

The objective of these studies was to determine if foliar applied BAP would inhibit rooting of *Verbena* with or without visible nodal roots at the base of stem cuttings, and to determine if BAP applied before rooting would enhance subsequent lateral bud elongation after rooting.

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Materials and Methods

Experiment 1. Six-cm long stem cuttings of *Verbena X hybrida* 'Texturf Red' were inserted (basal 1 cm) into 6.25 cm diameter pots (150 ml medium volume) filled with a moist perlite:peat moss medium (2:1 v/v). Cuttings were removed from stock plants by clipping just above or below a node, producing cuttings having nodal or internodal bases. A single preformed adventitious root (less than 0.5 cm long) was visible at the base of nodal cuttings.

After cuttings were stuck, foliage was sprayed to run-off with either twice-distilled water, or 30, 100 or 300 mg BAP liter^{-1}. No spray or drip was allowed into the rooting medium. Twenty-five cuttings were randomly assigned to each of the eight treatments (four rates on either nodal or internodal cuttings) in a completely randomized design.

Cuttings were rooted in a growth chamber using the following environmental conditions: 80 ± 10% relative humidity; 24°C constant temperature; 210 μmol m^{-2} s^{-1} photosynthetic photon flux (PPF) for 18 of every 24 hour cycle; 380 ul liter^{-1} ambient CO_2.

Nodal and internodal cuttings were examined upon removal from the stock plant to determine initial rooting-zone (basal 1 cm of stem with or without roots) dry weight, leaf dry weight, total cutting dry weight, and root number. Subsequent harvests were made five and twelve days after sticking. Relative growth rate (cg day^{-1}) was calculated.

Experiment 2. Six-cm long internodal cuttings of *V.* X *hybrida* 'Texturf Red' were stuck and rooted using conditions described above. Cuttings were sprayed with BAP as previously described, at 12, 48 or 96 hours after sticking. Design and measured responses were the same as Experiment 1.

Experiment 3. Unbranched 10-cm long stem tip cuttings of *V.* X *hybrida* 'Blaze' were inserted (basal 2 cm) into 6.25 cm diameter pots filled with a moist perlite:peat moss medium (2:1 v/v). Only three nodes and the stem tip were above the soil-line. After cuttings were stuck, foliage of 30 cuttings (3 cuttings per pot) was sprayed to runoff with either twice distilled water, or with 10 or 30 mg liter^{-1} BA. No spray or drip was allowed to drip into the rooting medium. Plants were placed under intermittent mist (5 seconds of every five minutes) four hours after sprays were applied. A completely randomized design was used, with individual pots functioning as experimental units.

Cuttings were rooted in a fiberglass propagation house using the following environmental conditions: 85 ± 15% relativ humidity; 29 ± 5°C; 330 μmol m^{-2} s^{-1} average PPF with a 16 hour photoperiod; ambient CO_2. After 12 days, cuttings were moved to a growing bench under 60% shade (860 μmol m^{-2} s^{-1} average midday PPF), were irrigated daily, and grown with the following conditions: 65 ± 15% relative humidity and 27 ± 8°C.

Cuttings were observed daily for rooting responses to BAP. Twenty-four days after cuttings were stuck, plants were evaluated for stem length (soil-line to apex), and for percentage of elongated lateral buds per stem.

Results and Discussion

Experiment 1. Foliar applied BAP did not influence any measured characteristics of nodal cuttings at either 5 or 12 days after sticking (Table 1). Internodal cuttings sprayed with 30 mg BAP liter^{-1} immediately after sticking had 83% more roots, 20% more total dry mass, and 47% more rooting-zone dry mass after 12 days compared to the 0 mg BAP liter^{-1} controls. Leaf dry mass and relative growth rate were not influenced by BAP. Nodal cuttings generally developed fewer roots than internodal cuttings. Averaged across treatments, growth rate was 0.72 ± 0.08 (mean ±

Table 1. Dry mass partitioning and rooting of *Verbena* X *hybrida* 'Texturf Red' cuttings as influenced by cutting type and concentration of benzylaminopurine. Data taken 12 days after treatment application. Means and standard errors.

Cutting type	BAP concentration (mg l^{-1})	Rooting-zone dry mass (cg)	Total dry mass (cg)	Root number
Internodal	0	30.2 ± 4.2	147.8 ± 16.2	24.6 ± 5.9
	30	44.4 ± 3.8	178.5 ± 13.2	45.1 ± 2.3
	100	32.2 ± 3.8	156.2 ± 13.3	22.3 ± 2.9
	300	23.5 ± 5.9	151.2 ± 16.9	18.6 ± 5.1
Nodal	0	31.3 ± 2.9	158.9 ± 22.4	15.1 ± 2.7
	30	36.1 ± 3.0	155.1 ± 11.8	15.3 ± 1.9
	100	32.6 ± 1.2	158.8 ± 6.0	15.0 ± 1.1
	300	31.4 ± 4.3	171.7 ± 18.8	14.1 ± 2.4
significance[z]				
Internodal				
Linear		NS	NS	NS
Quadratic		*	*	*
Nodal				
Linear		NS	NS	NS
Quadratic		NS	NS	NS

[z]NS and * are nonsignificant or significant at the 5% level, ANOVA f-test, n = 7. No significant responses were found (PR>F above 5%) five days after sticking.

Table 2. Dry mass partitioning and rooting of *Verbena* X *hybrida* 'Texturf Red' cuttings as influenced by timing of application and concentration of benzylaminopurine. Data taken 12 days after treatment application. Means and standard errors.

Cutting type	BAP concentration (mg l^{-1})	Rooting-zone dry mass (cg)	Total dry mass (cg)	Root number
12	0	30.1 ± 4.0	144.7 ± 14.0	19.8 ± 1.1
	30	45.2 ± 4.1	186.1 ± 16.6	32.3 ± 3.4
	100	34.0 ± 3.7	163.7 ± 10.3	21.3 ± 3.0
	300	23.6 ± 5.9	152.5 ± 16.2	16.7 ± 2.9
48	30	25.0 ± 3.0	168.6 ± 11.9	16.4 ± 4.1
	100	40.7 ± 9.6	181.4 ± 21.2	15.3 ± 3.9
	300	32.6 ± 3.3	158.3 ± 10.8	20.9 ± 1.8
96	30	29.7 ± 3.8	155.1 ± 11.1	17.7 ± 3.4
	100	25.6 ± 2.6	135.6 ± 5.9	16.6 ± 1.8
	300	33.9 ± 3.9	160.2 ± 15.4	23.1 ± 2.4
significance[y]				
After 12 hours				
Linear		NS	NS	NS
Quadratic		*	*	*
After 48 hours				
Linear		NS	NS	NS
Quadratic		NS	NS	NS
After 96 hours				
Linear		NS	NS	NS
Quadratic		NS	NS	NS

[z]Hours after sticking cuttings when benzylaminopurine was applied.
[y]NS and * are nonsignificant or significant at the 5% level, ANOVA F-test, n = 7. No significant differences (PR>F above 5%) were found for data taken after five days.

standard error) and 0.88 ± 0.06 cg day^{-1} for nodal and internodal cuttings, respectively.

Experiment 2. There was no effect of BAP on internodal cuttings 5 or 12 days after sticking if application was delayed 48 hours or longer (Table 2). Internodal cuttings sprayed with 30 mg BAP liter^{-1} after sticking had 63% more roots, 28% more total mass, and 50% more rooting-zone dry mass after 12 days compared to the 0 mg BAP liter^{-1} controls (Table 2). Leaf dry mass and relative growth rate were not influenced by BAP. Averaged across treatments, growth rate was 0.84 ± 0.06 cg day^{-1}.

The 30 mg BAP l^{-1} concentration produced more roots in experiment 1 than in experiment 2, possibly a result of the 12 h rather than 0 h application in experiment 2. All other measured parameters were similar for internodal cuttings between Experiments 1 and 2.

Experiment 3. Visual observations did not indicate any influence of BAP on rooting of 10-cm long cuttings. Percent elongated lateral buds was higher and stem length was shorter, as the concentration of BAP used was increased from 0 to 30 mg liter^{-1} (Table 3).

Development of more roots when low concentrations of BAP are applied immediately after excision of internodal cuttings from the stock plant is consistent with reports that cytokinins have little influence on rooting if applied during the later stages of root formation and development, but may promote rooting when applied at low concentrations (3, 6). Within the concentrations studied, foliar applied BAP did not inhibit rooting of *Verbena*. The combined influence of increased lateral bud elongation and shorter plants produced liners that were more compact, and eventually had more flowers.

Table 3. Percent elongated lateral buds and stem length of *Verbena* X *hybrida* 'Blaze' cuttings in response to benzylaminopurine concentration. Data from 24 days after cuttings were treated. Means and standard errors.

Benzylaminopurine concentration	Percent elongated buds	Stem length (cm)
0	15.8 ± 3.8	17.8 ± 0.5
10	35.8 ± 4.3	15.5 ± 0.4
30	65.0 ± 2.4	14.0 ± 0.3
significance[z]		
Linear	**	**
Quadratic	*	*

[z]* and ** are significant at the 5% and 1% levels, respectively (ANOVA F-test, n = 10). Percent elongated buds was analyzed using inverse sine transformed data; reported means are of non-transformed data.

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EFFECT OF PREPLANT BULB SOAK WITH ANCYMIDOL OR UNICONAZOLE ON GROWTH AND DEVELOPMENT OF EASTER LILY

G. J. WILFRET
Gulf Coast Research and Education Center
University of Florida, IFAS
Bradenton, FL 34203

Additional index words. Sumagic, ancymidol, A-Rest, ornamental plants, *Lilium longiflorum*.

Abstract. **In 1988, Easter lily cv. Nellie White (*Lilium longiflorum* Thunb.) bulbs were soaked in ancymidol solutions of 0, 5, 10, 20, or 40 mg.l-^{1} or uniconazole of 1.25, 2.5, 5, 10, or 20 mg.l-^{1} for 5 min. to prevent excessive internode elongation when grown in a glasshouse. Best plant heights were obtained with 10 and 20 mg.l-^{1} ancymidol. All uniconazole conc. produced plants less than 14 in. tall, which were not marketable. Uniconazole at 10 and 20 mg.l-^{1} delayed flower development. In 1989, cvs. 'Nellie White' and 'Ace' tubers were soaked for 2.5 or 5.0 min. in ancymidol at 20 mg.l-^{1} or uniconazole at 0, 0.625, 1.25, 2.5, or 5.0 mg.l-^{1}. Plants treated with ancymidol were too tall, while best plant heights were achieved with 1.25 and 2.5 mg.l-^{1} uniconazole for 'Nellie White' and 'Ace', respectively. Soak time had no effect on plant height or flower development on both cultivars. In 1990, 'Nellie White' and 'Ace' bulbs were soaked for 1 or 2 min. in ancymidol at 20 mg.l-^{1} or uniconazole at 0, 1.25, 2.5, or 5.0 mg.l-^{1}. Optimum plant heights were observed with both cultivars when treated with either 20 mg.l-^{1} ancymidol or 1.25 mg.l-^{1} uniconazole. Soak time had no effect.**

Production of Easter lilies (*Lilium longiflorum* Thunb.) in Florida is primarily in mesh shade houses or plastic houses that depend upon ambient temperatures during the growth cycle. Variable temperatures, a floating holiday, the narrow market duration, and problems with plant height and uniformity discourage Florida growers from producing this crop. In 1989, only 260,000 containerized Easter lily plants with a wholesale value of $988,000 were produced in Florida, compared to 7.9 million plants grown in the remainder of the United States (1). The two major cultivars grown are 'Nellie White' and 'Ace', with the latter generally taller, later flowering, but producing more flowers per plant (23). Environmental conditions play a signif-

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