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EFFECT OF GROWTH REGULATORS ON LEAF DEVELOPMENT OF CALADIUM

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Abstract. **Growth regulators N^6-benzyladenine (BA), tetrahydropyranylbenzyladenine (PBA), dikegulac, and thidiazuron (TDZ) were evaluated to ascertain their ability to negate apical dominance of the terminal buds of caladium tubers and to stimulate the development of lateral eyes. BA and PBA, at concentrations of 0, 12.5, 25, or 50 ppm applied as a 15 min tuber soak on intact or de-eyed caladium 'Candidum' and 'Postman Joyner', had no effect on number of leaves, leaf length, time to marketability, and plant height. BA, at concentrations of 0, 50, 100, 250, or 500 ppm on 'Elise', had no effect on leaf development and number. Dikegulac (concentrations of 0, 100, 200, or 400 ppm) and thidiazuron (concentrations 0, 0.5, or 1 ppm) were applied as a 24-hr tuber soak on 'Candidum' and 'Postman Joyner'. No differences were measured with dikegulac but thidiazuron retarded plant height and inhibited leaf development. Chemicals used: (1-methylethylidene)-a-L-xylo-2-hexulofuranoionic acid, N^6-benzyladenine, 6-benzylamino-9-(tetrahydropyran-2-yl), and N-phenyl-N^1-1,2,3-thiadiazol-5-ylurea.**

Caladiums (*Caladium* × *Hortulanum* Birdsey) are an important, attractive tropical foliage plant produced from a tuber (Harbaugh and Tjia, 1985). They are grown as single or multiple units in containers ranging from 4 to 24 inches in diameter (Black and Tjia, 1979). Each tuber has a minimum of one dominant eye, which if allowed to grow unaltered, will produce a single large leaf. This growth type yields a tall plant and reduces the plant's marketability. A preplant process known as "de-eying," which excises the dominant eye, allows the lateral eyes to develop and produce more leaves (Harbaugh and Tjia, 1985). Unfortunately de-eying is a very time consuming process and requires many hours of manual labor to do a large quantity of tubers.

Several foliage plants have been treated successfully with growth regulators to induce basal and lateral shoot development. The most commonly used chemicals are N^6-benzyladenine (BA) and 6-benzylamino-9-(tetrahydiapyran 2-yl)-9H-purine (PBA) (Henny, 1990). BA has been shown to increase the number of axillary shoots of *Hylocereus* (a rootstock used for many of the colorful grafted cactus) (Shimomura and Fujihara, 1980), to increase the number of basal shoots of *Anthurium* (Henny and Fooshee, 1989), to increase the number of lateral shoots of *Dieffenbachia* (Wilson and Nell, 1983), and to increase the number of phylloclades and flowers of *Schlumbergera* (Heins et al., 1981). PBA increased the number of lateral shoots of *Anthurium* (Higaki & Rasmussen, 1979), increased the number of cuttings produced from *Dracaena* (Criley, 1980), and increased the number of lateral shoots of *Pellionia* (Henley and Poole, 1974) and *Pilea* (Henley and Poole, 1974). Thidiazuron (TDZ), used to defoliate mature green leaves in cotton, has been used to stimulate *in vitro* shoot formation in apple (van Niewkerk et al., 1986). Henny and Fooshee (1990) showed that a TDZ drench at the base of *Alocasia* plants increased the number of elongated buds but reduced root growth. Similar TBZ treatments of *Syngonium* yielded numerous elongated basal buds which failed to develop and produce new leaves (Henny and Fooshee, 1991). Dikegulac has been shown to promote lateral branching on herbaceous plants such as salvia and verbena (Anon., 1970) and has been used as a chemical pinching agent on azaleas (Heursel, 1975; Larson, 1978). Carter and Mahotiere (1991) reported that dikegulac increased shoot number, decreased plant height, and had no effect on leaf area in "scooped" and intact caladium tubers. The objective of this research was to evaluate the effect of four growth regulators when applied as a tuber soak on development of caladium leaves.

Materials and Methods

Caladium tubers were planted in 6-inch diameter pots (1.6 qt) which were spaced on 10-inch centers on a raised bench in a glass greenhouse. The glass was shaded to exclude 40% of ambient light. One jumbo tuber (2.5-3.5 inches diameter) was placed in each container and covered with a medium of Florida sedge peat, coarse white builder's sand, coarse vermiculite, and perlite (5:3:3:1, v/v) amended (per yd^3) with dolomite limestone (7.5 lb), hydrated lime (3 lb), granular calcium carbonate (7.5 lb), single superphosphate (5 lb), and Nutricote® 13N-5.7P-10.8K) (6 lb). Medium pH was initially 6.0. Pots were arranged on the bench in a randomized split plot design with three replications per treatment and three pots per replication. Main plots were tuber type (intact vs. de-eyed) and subplots were chemical and concentration. Each cultivar was analyzed separately using ANOVA through the SAS program.

Expt. 1. Tubers of 'Candidum' and 'Postman Joyner' were either left intact or were de-eyed on 12 June 1991. After de-eying, tubers were immersed for 15 min in BA or PBA at concentrations of 0, 12.5, 25, or 50 ppm on 13 June and allowed to dry for 24 hr at 75°F. On 14 June, all tubers were planted and placed in the glass greenhouse. The plants were observed daily and the date when the first leaf was fully expanded was recorded. The number of mature leaves in each pot was counted weekly, starting on 28 June and finishing on 31 July. Date of marketability, defined as 10 mature leaves per pot, was recorded daily. On 31 July and 1 August, the plants were measured for the following parameters: maximum height, length of the four

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longest petioles per pot, length of the largest leaf blade, and total foliage weight.

Expt. 2. Tubers of 'Elise' were left intact or de-eyed on 18 Aug., 1991. They were soaked for 30 min in BA at concentrations of 0, 50, 100, 250, or 500 ppm on 19 Aug., allowed to dry at 75°F for 24 hr, and were planted on 20 Aug. Data were collected on 20 October and the parameters recorded were: number of leaves per pot, maximum plant height, and length and width of the largest four leaf blades.

Expt. 3. Tubers of 'Candidum' and 'Postman Joyner' were de-eyed or left intact on 15 June 1992. They were soaked for 24 hr in solutions of dikegulac (0, 100, 200, or 400 ppm) or TDZ (0, 0.5, or 1.0 ppm) and allowed to dry for 24 hr. Tubers were planted on 18 June and placed in the greenhouse. Plants were observed each day and the date was recorded when the first leaf matured and when the unit was marketable. Number of mature leaves per pot was recorded weekly starting on 3 July and continuing through 7 Aug. On 8 Aug. the plants were measured for total leaves per pot, maximum height, length of the four longest petioles per pot, and the weight of the total foliage.

Results and Discussion

Expt. 1. BA and PBA had no significant effect on the number of leaves or any of the other parameters measured (Table 1, 2). The only significant differences found were between the intact and de-eyed treatments (Table 3). Tubers of 'Postman Joyner' treated with either BA or PBA and left intact produced the first mature leaf 6.5 days earlier than from de-eyed tubers. 'Candidum' intact tubers produced the first leaves only 2.4 days earlier than de-eyed tubers. Tubers of both cultivars which had been de-eyed produced marketable plants 4 days earlier than those left intact (Table 3). The plants from intact tubers were taller and had fewer leaves at the termination of the experiment than those from de-eyed tubers. Results illustrate the value of de-eying caladium tubers prior to planting to produce shorter plants with more leaves in a shorter period of time.

Expt. 2. The concentrations of BA used had no effect on plant height or number of leaves at the termination of the experiment (Table 4). As with the first experiment, the de-eyed tubers produced more leaves but no differences were evident in plant height. 'Elise' produces shorter petioles than 'Candidum' or 'Postman Joyner' and this inherent short habit probably was responsible for the comparable height of the plants from the different tuber types. These data are in contrast to that of Carter and Mahotiere (1991) who reported that BA reduced shoot number and plant height. However, they also reported a reduction in shoot number by scooping the tubers, which is contrary to normal expectations.

Table 1. Effect of BA and PBA preplant tuber soak on leaf development of caladium 'Candidum' (1991).

Tuber type	Chemical	Conc. (ppm)	No. days to first leaf	No. days to market	Total leaves	Plant height (inches)
De-Eyed	BA	0	20.3	34.9	18.2	24.2
		12.5	18.6	32.8	20.8	24.2
		25	19.1	34.8	23.7	22.1
		50	20.6	31.3	16.4	24.2
Intact	BA	0	16.9	37.0	13.9	25.2
		12.5	18	38.7	11.8	27.8
		25	17.5	41.6	11.0	26.4
		50	17.5	40.7	11.1	26.5
De-Eyed	PBA	0	20.6	33.8	17.4	23.4
		12.5	21.8	33.0	19.3	22.9
		25	21.6	41.6	12.7	22.7
		50	20.9	34.7	17.4	20.4
Intact	PBA	0	18.7	40.7	13.3	24.2
		12.5	20.1	35.8	14.9	25.2
		25	18.2	37.0	16.4	24.4
		50	19.8	39.6	15.3	25.8
LSD (∝=0.05)			2.6	3.0	3.1	1.6

Table 2. Effect of BA and PBA preplant tuber soak on leaf development of caladium 'Postman Joyner' (1991).

Tuber type	Chemical	Conc. (ppm)	No. days to first leaf	No. days to market	Total leaves	Plant height (inches)
De-Eyed	BA	0	19.1	28.7	22.4	19.2
		12.5	19.8	31.4	24.2	18.8
		25	18.8	29.0	24.1	18.8
		50	20.0	31.0	22.4	20.4
Intact	BA	0	12.1	34.7	14.7	21.6
		12.5	13.8	34.8	12.1	22.4
		25	11.5	29.0	19.6	20.7
		50	11.4	34.0	16.2	21.1
De-Eyed	PBA	0	21.9	32.9	21.2	20.0
		12.5	18.9	31.1	26.2	20.0
		25	19.7	30.3	27.1	19.9
		50	19.6	30.8	24.1	20.9
Intact	PBA	0	13.4	34.8	13.9	21.7
		12.5	15.6	36.9	11.6	20.8
		25	13.6	38.6	11.8	20.4
		50	13.8	35.2	12.0	21.9
LSD (∝=0.05)			2.7	2.9	3.8	1.2

Table 3. Composite effect of BA and PBA preplant tuber soak on caladium leaf development (1991).

Cultivar	Tuber type	No. days to first leaf	No. days to market	Total leaves	Plant height (inches)
Candidum	De-Eyed	20.4	34.6	17.8	23.3
	Intact	18.0	38.8	13.4	25.7
LSD (∝=0.05)		1.8	3.1	2.6	1.2
Postman Joyner	De-Eyed	19.7	30.6	24.0	19.8
	Intact	13.2	34.8	14.0	21.4
LSD (∝=0.05)		2.2	3.4	4.8	1.3

Table 4. Effect of BA tuber soak on leaf development of caladium 'Elise' (1991).

Tuber type	Conc. (ppm)	No. leaves	Plant height (inches)
De-Eyed	0	28.2	17.2
	50	30.0	17.4
	100	31.2	16.8
	250	32.7	16.3
	500	27.2	16.8
Intact	0	21.4	16.7
	50	22.4	16.9
	100	23.2	17.9
	250	20.2	16.3
	500	23.9	17.5
LSD (∝=0.05)		3.6	2.1

Table 5. Effect of dikegulac and thidiazuron tuber soak on leaf development of caladium 'Postman Joyner' (1992).

Tuber type	Chemical	Conc. (ppm)	No. days to first leaf	No. days to market	Total leaves	Plant height (inches)
Intact	Dikegulac	0	12.8	31.4	15.2	22.0
		100	13.5	30.2	14.6	22.2
		200	12.6	28.2	16.5	20.2
		400	12.8	30.8	16.8	20.6
	Thidiazuron	0.5	13.7	34.9	14.2	20.2
		1.0	13.2	33.2	14.8	22.2
De-Eyed	Dikegulac	0	21.0	30.3	27.0	18.3
		100	22.9	31.4	23.0	17.9
		200	20.5	32.3	25.7	19.7
		400	18.2	31.3	23.4	20.3
	Thidiazuron	0.5	23.0	32.8	23.9	18.3
		1.0	18.6	35.6	12.3	18.1
LSD ($\alpha = 0.05$)			4.2	3.7	4.1	2.3

Table 6. Effect of dikegulac and thidiazuron tuber soak on leaf development of caladium 'Candidum' (1992).

Tuber type	Chemical	Conc. (ppm)	No. days to first leaf	No. days to market	Total leaves	Plant height (inches)
Intact	Dikegulac	0	11.4	24.2	21.3	22.4
		100	11.8	24.9	18.2	25.7
		200	12.0	24.7	20.4	23.8
		400	10.5	23.3	23.3	23.6
	Thidiazuron	0.5	12.0	26.6	26.6	21.0
		1.0	14.9	39.9	16.1	17.9
De-Eyed	Dikegulac	0	15.0	23.4	34.0	22.8
		100	16.0	23.8	34.5	23.7
		200	15.6	23.8	33.8	22.4
		400	14.8	24.2	38.3	23.0
	Thidiazuron	0.5	18.6	35.0	20.1	18.8
		1.0	18.0	43.9	14.2	14.8
LSD ($\alpha = 0.05$)			2.7	4.2	4.7	2.4

Expt. 3. When applied to intact or de-eyed tubers of 'Candidum' and 'Postman Joyner', dikegulac had no effect on number of days to development of the first leaf, number of days to marketability, total number of leaves, or plant height (Table 5, 6). Thidiazuron had no effect on 'Postman Joyner' as to number of days to first leaf, days to marketability, and plant height but inhibited the development of leaves at a concentration of 1.0 ppm (Table 5). 'Candidum' tubers treated with thidiazuron at 1.0 ppm produced both initial leaves and total leaves later than plants soaked in water, inhibited the total production of leaves, and retarded plant height (Table 6). A concentration of 0.5 ppm on de-eyed tubers also delayed leaf development, inhibited leaf number, and retarded plant growth. At termination of the experiment, the tubers were examined and the 'Candidum' tubers soaked in thidiazuron at 1.0 ppm had numerous small elongated buds which did not penetrate the media surface. The tubers dug were soft and pliable with a very limited root system. This shoot formation was similar to that reported on *Alocasia* (Henny and Fooshee, 1990) and *Syngonium*(Henny and Fooshee, 1991).

Results of these experiments demonstrate that BA, PBA, and dikegulac at the concentrations used had no effect on stimulating leaf development from intact or de-eyed caladium tubers, contrary to the results reported by Carter and Mahotiere (1991). Thidiazuron reduced the number of leaves visible above the media surface but produced numerous elongated buds on the tuber. Further studies that would use this chemical in conjunction with gibberellic acid might be worthwhile to stimulate leaf development.

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SHADING AND POT COLOR INFLUENCE GROWTH AND FLOWERING OF STRAWBERRY FIRETAILS

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Abstract. **Experiments were conducted to study the influence of shading and pot color on shoot growth of strawberry firetails (*Acalypha hispaniolae* Urb.). Four rooted liners with at least 13 cm stem length were potted in either green or white 20-cm hanging baskets filled with Pro-Mix BX™. Ten days after potting, shoot tips were pinched leaving six nodes on each plant, and plants were fertilized with 12 g SierraBlen™ 18N-2.6P-10K as a topdressing. Plants were grown under 60 or 80% shading with daily irrigation for 10 weeks. Flowers developing on stem tips were removed by hand once a week for 6 weeks following pinching. Stems of plants grown under 80% shade were 8, 9, and 12% longer 4, 6, and 10 weeks after pinching, respectively, compared to plants grown under 60% shade. Six weeks after pinching, stem lengths were 9% longer in plants grown in green pots compared to white pots. After 10 weeks growth, plants grown in green pots under 60% shading had 10% longer shoots, 10% more shoot dry weight and 23% larger flowers compared to plants grown in white pots under 60% shading. Strawberry firetails had 22% more shoot weight and 48% larger flowers when grown under 60% shading compared to 80% shading. Production using less than 60% shading may be beneficial, but light penetration through white pots may reduce growth and flowering with less shading.**

Acalypha hispaniolae (Euphorbiaceae), a native of the island of Hispaniola, has been given a variety of common names including: strawberry firetails (Walter, 1992), dwarf chenille plant (Herwig, 1987), pendulous chenille plant, and summer love (Macaboy, 1988). Strawberry firetails are often mistakenly sold as chenille plants (*Acalypha hispida* Burm. f.). The species is not listed in Hortus Third (1976) or the New Royal Horticultural Society Dictionary of Gardening (Huxley et al., 1992). Commercially, botanical names used have included: *A. pendula* (Herwig, 1987; Walter, 1992), *A. pendula* 'Firetails,' *A. hispida* 'Pendula,' *A. reptans* (Macaboy, 1988), and *A. repens*. Related plants include chenille plant and copperleaf (*Acalypha wilkesiana* Mull. Agr.). Unlike most ornamental acalypha which have a more upright, shrub-like growth habit and produce flowers from their leaf axils, strawberry firetails is an herbaceous, spreading, tropical perennial that produces showy, red terminal catkins or racemes. Computer and hand literature searches found no previously published research on strawberry firetails.

Commercial growers generally propagate strawberry firetails by sticking four to eight, 10 to 15 cm long cuttings directly into 20 or 25 cm hanging baskets. Alternatively, rooted liners are available for purchase year-round. Several growers have described the occurrence of foliar chlorosis during and immediately following propagation, and again from 3 to 6 weeks after propagation. Previous studies (Svenson, unpublished) have shown that proper fertilization of stock plants, and fertilization during propagation, prevents foliar chlorosis during and immediately following propagation. Growers who described chlorosis during production used white pots, while growers who did not report chlorosis used dark-colored (usually green) pots. The objective of this study was to determine if pot color would influence the growth, flowering, or development of foliar chlorosis of strawberry firetails.

Materials and Methods

Four rooted liners of *A. hispaniolae* with at least 13 cm stem length were potted in either green or white 20 cm diameter hanging baskets filled with Pro-Mix BX™. Plants were fertilized immediately after potting, and then once every 4 weeks, with a solution containing a 20N-8.6P-16K liquid fertilizer at 200 mg N/liter, and 10 mg Fe/liter from Sequestrene™ 138Fe. Ten days after potting (25 July 1992), shoot tips were pinched leaving six nodes on each plant, and plants were fertilized with 12 g SierraBlen™ 18N-2.6P-10K as a topdressing. Plants were grown under 60 or 80% shading with daily irrigation for 10 weeks. Temperatures averaged 35/26 C (maximum/minimum). Unshaded full sun at solar noon averaged 2050 μmol $m^{-2}s^{-1}$ of photosynthetically active radiation (400-700 nm) as meas-

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