Performance of 15 *Exacum affine* Genotypes in a Low-irradiance Environment

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Abstract. Fifteen cultivated genotypes of *Exacum affine* Balf. were evaluated for flower development and for flower and leaf color at 0 days (marketable stage, $\approx 25\%$ of plant canopy covered with flowers), and after 14 and 28 days of maintenance in a low-irradiance environment ($\approx 1 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ photosynthetically active radiation from cool-white fluorescent lights for 12 hours daily). Flowering and flower color development were reduced, but leaf color improved during maintenance under low irradiance. Variability was observed among the 15 genotypes for flower bud and flower color development in a low-irradiance environment.

Consumers desire flowering potted plants that maintain their showiness after being transported, displayed under retail conditions, and placed in the home or office environment (Shafer and Kelly, 1986). Both the plant species and cultivar can affect interior performance (Nell and Barrett, 1986).

Exacum affine (Persian violet) has a long postharvest life (Irwin, 1979; Larson, 1981). Harbaugh and Waters (1979) evaluated 53 cultivars representing 21 genera of flowering potted plants under simulated home or office conditions (23 to 26C, 1.2 to 1.5 klx from cool-white tubes with a 12-h photoperiod). They reported that the performance of three *E. affine* cultivars during the first 4 weeks in simulated home conditions was as good as or better than that of *Sinningia* and *Dendranthema grandiflora* Tzvelev. (*Chrysanthemum morifolium* Ramat.) 'Puritan' plants used for comparison. However, flower color faded from violet to gray after 4 to 6 weeks. The postharvest performance of the three cultivars was similar.

Harbaugh and Waters (1982) showed that controlled-release fertilizer level at planting affected postharvest quality of *E. affine* 'Elf-in' under simulated home conditions. An increase in fertilizer rate generally resulted in

less chlorosis, although it also resulted in a deterioration in floral display after 4 weeks under simulated home conditions.

Flower bud development in *E. affine* appears to depend on high irradiance levels (Irwin, 1984; Larson, 1981; Williams et al., 1983). We found no reports on the existence of genotypic variability for postharvest quality characteristics in cultivated *E. affine* germplasm. Therefore, this study was conducted to examine the effects of maintenance in a low-irradiance environment on *E. affine* flower development and new flower and leaf color and to determine if genotypic variability for these characteristics exists among a sample of cultivars and breeding lines.

Seedlings of 15 cultivars and breeding lines of *E. affine* (Table 1) were planted, one per 1.05-liter pot, in a soilless medium (Pro-mix BX, Premier Brands, Stamford, Conn.) supplemented with Micromax at $80 \text{ g}\cdot\text{m}^{-3}$ (fritted micronutrient mixture) and with 2 g of Osmocote 14N-6.1P-11.6K (controlled-release fertilizer) per pot. Pots were arranged in a randomized complete-block design with three blocks (glasshouses) and eight plants of each genotype per block. At the full bloom stage [$\approx 25\%$ of the plant canopy covered with flowers (L.T. Irwin, 1990, personal communication)], four plants of each genotype from each block were moved to a growth room maintained at $22.0 \pm 0.1\text{C}$, 80% to 90% relative humidity, and $\approx 1 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ of photosynthetically active radiation (PAR) at plant level from Sylvania 60-W cool-white fluorescent lights for 12 h daily. The other

Table 1. *Exacum affine* genotypes and flower colors.

Genotype	Flower color ²
Petite	Violet (92A)
CE	Violet (92A)
Michigan White	White (155D)
3057A	Violet (93C)
42E	Violet (93C)
3033	Violet (93C)
Royal Blue	Violet (93B)
4002A	White/rose (84C/155B) ¹
Best Rosa	Rose (84C)
White Champion	White (155B)
Blue Champion	Violet (93C)
Little Champ	Violet (93C)
42Y	Violet (93C)
505	Violet (93C)
Blue Chip	Violet (93C)

¹Codes in parentheses are from the Royal Horticultural Society Colour Chart (1986).

²Genotype 4002A segregated for white and rose flower colors.

four plants were maintained during Apr. and May 1990 under natural irradiance ($>5 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ PAR) in the glasshouse at $22.0 \pm 2.0\text{C}$. Plants were watered when the soil was dry on the surface, at ≈ 3 -day intervals in the growth room and ≈ 2 -day intervals in the glasshouse. In both environments, the number of open flowers was counted at 0, 14, and 28 days, and color intensity was determined on two freshly opened flowers (with anthers just beginning to dehisce) and two fully expanded leaves by comparing them to the Royal Horticultural Society Colour Chart (1986). The color ratings were subsequently converted to a numerical scale by assigning values to panels of the color chart based on color intensity (1 = low intensity and 5 = high intensity). Flower color was not evaluated for the genotypes with white flowers.

Flower count increased during maintenance in the growth room and glasshouse (Table 2). The response to days was significantly ($P < 0.01$) linear in both environments, although the response in the growth room was also nonlinear (Table 3). Therefore, the low-irradiance environment did not promote flower development. This result is consistent with Harbaugh and Waters (1982), whose report indicated a tendency for deterioration in floral display of plants maintained for 4 weeks under simulated home conditions for plants receiving overhead irrigation and similar rates of fertilizer application as in this study.

Flower color rating did not change during maintenance in the glasshouse but decreased in the growth room (Tables 2 and 3). The response to days of maintenance in the growth

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Table 2. Mean values over genotypes and SD for three characteristics of *Exacum affine* for three intervals in the growth room (low irradiance) and glasshouse (high irradiance).

Characteristic ²	Time in growth room (days)			Time in glasshouse (days)		
	0	14	28	0	14	28
Flower count	44 $\pm$ 15	128 $\pm$ 38	148 $\pm$ 44	48 $\pm$ 22	134 $\pm$ 45	231 $\pm$ 73
Flower color	3.6 $\pm$ 0.8	3.0 $\pm$ 0.6	2.7 $\pm$ 0.8	3.7 $\pm$ 0.8	3.8 $\pm$ 0.7	3.7 $\pm$ 0.7
Leaf color	2.6 $\pm$ 0.7	4.1 $\pm$ 0.5	4.8 $\pm$ 0.4	2.7 $\pm$ 0.7	2.7 $\pm$ 0.7	2.3 $\pm$ 0.6

¹Color rated on a 1-5 scale derived from the Royal Horticultural Society Colour Chart; 1 = low, 5 = high color intensity.

Table 3. Mean squares for the analysis of variance of three characteristics of *Exacum affine*.

Source of variation	Growth room			Glasshouse		
	Flower		Leaf color	Flower		Leaf color
	Count	Color		Count	Color	
Block	24,173**	1.8 ^{NS}	1.9 ^{NS}	2,886 ^{NS}	2.9 ^{NS}	1.6 ^{NS}
Genotype	16,185**	9.6**	1.6 ^{NS}	28,982**	10.1**	3.2 ^{NS}
Day	548,860**	30.6**	230**	1,506,459**	0.7 ^{NS}	8.9*
Linear	972,504**	58.7**	440**	3,009,437**	0.1 ^{NS}	11.7*
Lack of fit	125,216**	2.4 ^{NS}	20.3**	3,481 ^{NS}	1.3 ^{NS}	6.1 ^{NS}
Genotype × day	2,049 ^{NS}	0.5 ^{NS}	0.3 ^{NS}	5,733 ^{NS}	0.5 ^{NS}	0.8 ^{NS}
Experimental error	4,284	1.2	1.6	12,028	1.3	2.1
Sampling error	548	0.2	0.2	1,467	0.3	0.3

^{NS}***Nonsignificant or significant at $P = 0.5$, or 0.01 , respectively.

Table 4. Mean percentage change for three characteristics of 15 genotypes of *Exacum affine* after 28 days of maintenance in the growth room or glasshouse.

Genotype	Growth room			Glasshouse		
	Flower count	Color ^y		Flower count	Color ^y	
		Flower	Leaf		Flower	Leaf
		Change (%)				
Petite	251	−30	46	606	4	−12
CE	293	−13	100	464	0	−4
Michigan White	261	---	81	562	---	−33
3057A	190	−33	102	398	−5	−19
42E	196	−25	102	382	6	0
3033	196	−17	92	348	0	−18
Royal Blue	262	−37	99	398	−15	21
4002A	252	---	110	354	---	−19
Best Rosa	327	−8	80	563	6	−22
White Champion	233	---	112	370	---	−11
Blue Champion	323	−23	111	377	9	−6
Little Champ	242	−15	115	514	9	−8
42Y	281	−23	108	387	−4	−8
505	218	−40	79	322	−1	25
Blue Chip	247	−27	104	339	4	−10
LSD (0.05)	92	15	43	158	18	25

Percentage change = [(value day 28 - value day 0/value day 0) × 100].

^yRated on a 1 to 5 scale derived from the Royal Horticultural Society Colour Chart (1986); 1 = low color intensity, 5 = high color intensity.

room was linear (Table 3). Koes et al. (1989) reported that the expression of genes coding for chalcone synthase enzymes in the flavonoid biosynthetic pathway of *Petunia hybrida* Vilm. are red-light dependent. Further research is needed to determine if a light dependency is responsible for the reduction of color intensity of new flowers when *E. affine* plants are maintained under low irradiance from cool-white fluorescent tubes.

Leaf color improved in the growth room and tended to deteriorate in the glasshouse (Table 2). Most of the increased intensity in leaf color occurred during the first 2 weeks in the low-irradiance environment, which was reflected in a lack of fit to a linear model

(Table 3). Shade leaves with more chlorophyll (Salisbury and Ross, 1978) likely developed in the growth room environment but not in the glasshouse.

Significant variation among genotypes was observed for flower count and color rating but not for leaf color rating (Table 3). In addition, the genotypes did not respond differentially to days in the growth room or glasshouse for the characteristics evaluated, as was reflected in the nonsignificant genotype × day interaction (Table 3).

The differences among means for percentage change from 0 to 28 days of maintenance under low irradiance were significant for some genotype comparisons (Table 4),

although further research is necessary to determine the genetic basis for the observed differences. In the glasshouse, CE was the only genotype that was among the five highest ranking genotypes for all three characteristics (increase in flower count, flower color development, leaf color development). After 28 days in the low-irradiance growth room, 'Blue Champion' and 42Y were among the five highest ranking genotypes for all three characteristics. CE, 'Best Rose', and 'Little Champ' each ranked among the best five genotypes for two of the three characteristics evaluated. Variability for flower bud and flower color development in a low-irradiance environment is present in cultivated *E. affine* germplasm and may permit breeding for improved performance for these characteristics.

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