HORTSCIENCE 27(1):55-57. 1992.

Heritable Differences in Postproduction Quality of *Pelargonium* ×*domesticum*

C. Frederick Deneke[1], Leon J. Glicenstein[2], Kathleen B. Evensen[3], and Richard Craig[4]

Department of Horticulture, The Pennsylvania State University, University Park, PA 16802

Additional index words. breeding, genetics, petal abscission, flowering potted plants, regal pelargonium, Martha Washington geranium

Abstract. **The postproduction quality of 33 cultivars and 178 Pennsylvania State Univ. breeding lines of *Pelargonium* ×*domesticum* L.H. Bailey was evaluated in a simulated consumer environment. Petal abscission was the primary factor that reduced postproduction ratings (PPR). The heterozygosity of some cultivars was indicated by the range of PPR of progeny from self-pollinations. This range of PPR implies that *P.* ×*domesticum* has genetic variation for postproduction quality that can be used in a breeding and selection program. Few progeny with high PPR were produced from either self- or cross-pollinations involving parents with low PPR. Many of the superior progeny resulted from parents with high PPR. Therefore, progeny with improved postproduction quality can be developed by selecting parents with high PPR.**

Postproduction quality of several floricultural crops has been shown to have a strong genetic component. The vase life of 77 hybrid cultivars of tulips ranged from 3 to >6 days (Benschop and DeHertogh, 1969). Harbaugh and Waters (1979) noted differences among cultivars of several species of flowering potted plants for duration of flowering. Petal abscission following mechanical shaking of detached inflorescences of 35 cultivars of seed-propagated zonal geranium (*P.* ×*hortorum* L.H. Bailey) ranged from 10% for 'Ringo Rose' to 39% for 'Sooner Red' (Armitage et al., 1980).

Before selecting for postproduction quality, phenotypic characters must be identified that are good indicators of postproduction quality. For example, van Eijk and Eikelboom (1976) observed that the vase life of cut tulips was strongly correlated with flower longevity on plants grown in the field; therefore, initial selections could be made in the field. Most phenotypic characters responsible for vase life of tulips are additive; therefore, superior progeny could be developed by effective selection of the parents (van Eijk and Eikelboom, 1986). An important consideration in selecting and breeding for improved postproduction quality is the definition of a standard evaluation environment, since postproduction quality is influenced by interactions between a genotype and the environment (de Jong, 1979; Sparnaaij, 1979).

Because of its large showy flowers, *P.* ×*domesticum* (regal pelargonium or Martha Washington geranium) has commercial potential as a flowering potted plant. However, its popularity may be limited by petal abscission following exposure to ethylene (Deneke, 1988) or shipping stress (R. Oglevee, personal communication). In the breeding program at The Pennsylvania State Univ., *P.* ×*domesticum* has been selected for such characteristics as floret color and size, number of inflorescenes, time to anthesis, heat tolerance, and plant form. In addition, enhanced postproduction quality has been used as a selection criterion. Development of cultivars with enhanced postproduction characteristics may increase the marketability of *P.* ×*domesticum.*

Information on the inheritance of horticultural characteristics, particularly postproduction quality, is required for future breeding efforts. Valid inheritance studies require both inbred lines and large populations of progeny. However, *P.* ×*domesticum* displays low seed production in self- and cross-pollinations and is believed to be a polyploid with a complex parentage (Craig, 1982; Hanniford and Holcomb, 1982). In addition, we have observed in-

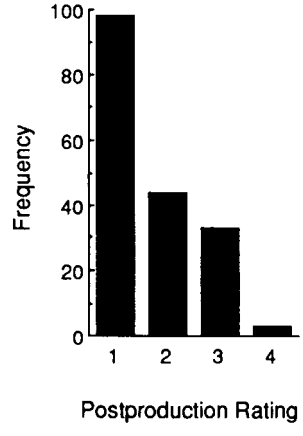

Fig. 1. Distribution of postproduction ratings of 178 *P.* ×*domesticum* progeny from highest (1) to lowest (4) amount of petal abscission after 3 weeks in a simulated consumer environment.

Received for publication 24 Jan. 1991. Accepted for publication 15 Aug. 1991. Contribution no. 170 Dept. of Horticulture. This work was supported in part by the Fred C. Gloeckner Foundation and Oglevee Associates, Inc. Mention of a trademark, proprietary product, or vendor does not imply endorsement by The Pennsylvania State University, nor criticism of similar ones not mentioned. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.

[1]Assistant Professor, Dept. of Horticulture, Auburn Univ., AL 36849-5408.
[2]Present address: Yoder Brothers, Inc., P.O. Box 218, Chualar, CA 93925.
[3]Associate Professor.
[4]Professor.

Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-08-31 via free access

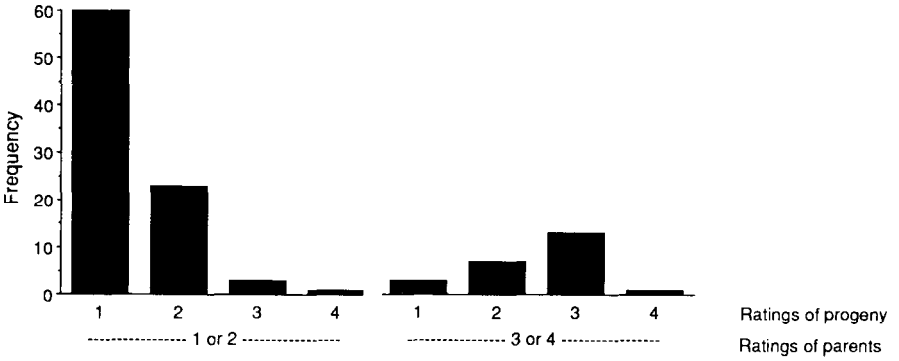

Fig. 2. Distribution of postproduction ratings of 111 *P.* ×*domesticum* progeny from self-pollinations of 18 cultivars and 10 breeding lines with a low (1 or 2) or high (3 or 4) postproduction ratings after 3 weeks in a simulated consumer environment.

Table 1. Mean postproduction ratings (PPR) and SD of 33 *Pelargonium* ×*domesticum* cultivars. Rated from highest (1) to lowest (4) amount of petal abscission after 3 weeks in a simulated consumer environment.

Cultivar	PPR (SD)	Cultivar	PPR (SD)
Carisbrooke	1 (0.5)	Mackensin	1 (0.4)
Clown	2 (0.5)	Mariosa	1 (0.4)
Cotton Candy	1 (0.4)	Marquita	2 (0.8)
Country Girl	4 (0.7)	Melissa	4 (0.2)
Dark Mabel	1 (0.9)	Miss Cherryvale	1 (0.4)
Elsie Hickman	1 (0.5)	Nancy Foss	1 (0.0)
Firedancer	1 (0.0)	Olga	3 (0.9)
Flora Fi	2 (0.7)	Parisienne	2 (1.0)
Granada	2 (1.0)	Pink Bonanza	3 (1.3)
Grandma Fischer	1 (0.5)	Pink Gardeners Joy	1 (0.0)
Grand Slam	4 (0.6)	Purple Firedancer	1 (0.0)
Harvest Moon	2 (1.0)	Rose Hazel	1 (0.0)
Hazel Herald	3 (1.0)	Venedig	1 (0.4)
Inez	2 (0.8)	Virginia	3 (0.7)
Joseph Paul	1 (0.0)	White Country Girl	4 (0.4)
Lavender Grand Slam	4 (0.6)	White Glory	3 (0.8)
Lisa	2 (1.2)		

Table 2. Frequency of postproduction ratings (PPR) of progeny from self- and cross-pollinations of three *Pelargonium* ×*domesticum* cultivars and one breeding line. Rated from highest (1) to lowest (4) amount of petal abscission after 3 weeks in a simulated consumer environment.

Entry (PPR)	Pollination type	Frequency of PPR of progeny 1	2	3	4
Cotton Candy (1)	Self	13	2	0	0
	Cross	0	0	0	0
Elsie Hickman (1)	Self	3	1	0	0
	Cross	6	3	1	1
Virginia (3)	Self	4	5	12	1
	Cross	1	4	2	0
80-31-1 (1)	Self	15	3	0	0
	Cross	8	1	3	0

breeding depression in some breeding lines. For these reasons, a classical genetic study was not feasible. The objectives of this research were to demonstrate that postproduction quality can be used as a selection criterion in breeding *P.* ×*domesticum* and to investigate the heritability of postproduction traits. In six experiments from 1982 to 1985, 33 cultivars and 178 breeding lines were evaluated at least once using four single-plant replicates per experiment.

Cuttings were rooted under intermittent mist in a medium of 1 sphagnum peat : 1 vermiculite (v/v). Rooted cuttings were potted in 1.5-liter azalea pots using the same medium. For floral induction, plants were exposed to supplemental high pressure sodium lighting of 110 $\mu mol \cdot m^{-2} \cdot s^{-1}$ in a glasshouse from 1200 to 2400 HR at 20C day (ventilation set-point) and 14C night (heat set-point) for 4 weeks. Forcing followed with night-break incandescent lighting of 10 $\mu mol \cdot m^{-2} \cdot s^{-1}$ from 2200 to 0200 HR at the same temperatures. Plants were fertilized at each irrigation with 200 mg N/liter, alternating 15N-7P-14.1K and 15N-0P-12.4K (Peters Fertilizer Products, Fogelsville, Pa.). Unpinched plants were treated with two foliar sprays of 1.5 g chlormequat chloride (2-chloroethyltrimethyl ammonium chloride)/liter.

Plants were moved to a simulated consumer environment (SCE) 2 weeks after the first floret of the first inflorescence reached anthesis. Based on recommendations by Conover et al. (1981), the SCE was maintained at 21 ± 1C, 50% ± 15% relative humidity, and 32 ± 5 $\mu mol \cdot m^{-2} \cdot s^{-1}$ provided by cool-white fluorescent lamps from 0800 to 2000 HR. Uniform moisture was provided to the growing medium by capillary mats. Air temperatures and relative humidity were measured at midshoot height by recording hygro-thermographs (Model 594, Friez/Bendix Co., Baltimore, Md.). Photosynthetic photon flux was measured at midshoot height by a solar monitor with a quantum sensor (Model LI-1776, LI-COR, Lincoln, Neb.).

Plants were evaluated for petal abscission after 0, 1, 2, and 3 weeks in the SCE by rating them from 1 (poor) to 4 (excellent). The criteria for the rating system were based on the percentage of the open florets that had abscised petals: 4 = less than 25%, 3 = 25% to 50%, 2 = 51% to 75%, 1 = more than 75%. The overall postproduction rating (PPR) was an average of the ratings from each experiment.

The primary factor that limited the postproduction longevity of *P.* ×*domesticum* was petal abscission. The PPR of the cultivars and breeding lines ranged from 1 to 4 after 3 weeks in the SCE (Table 1; Fig. 1; data for breeding lines are in Deneke, 1988). This range of PPR indicates that there is substantial genetic variation for postproduction quality in *P.* ×*domesticum.* About 80% of the cultivars and breeding lines had a PPR of 1 or 2 and were, therefore, considered unacceptable.

Closely related genetic lines had similar PPR: 'Country Girl' and its sport, 'White Country Girl' both 4; 'Grand Slam' and its sport, 'Lavender Grand Slam', both 3; 'Firedancer' and its sport, 'Purple Firedancer', both 1 (Table 1). These similarities in PPR are not surprising since sports are typically single gene mutations.

Self-pollinations of plants with low PPR usually produced progeny also with low ratings, such as 'Cotton Candy', 'Elsie Hickman', and 80-31-1 (Table 2; Fig. 2). Nevertheless, progeny with higher PPR than their parent were produced; self-pollinations of 'Lisa' (PPR 2) produced a breeding line with a PPR of 4 (data not shown). Self-pollinations of 'Virginia' (PPR 3) produced progeny that segregated into the four PPR groups (Table 2), suggesting that 'Virginia' is heterozygous for genes influencing petal retention. Additional indications of heterozygosity in 'Virginia' were the segregations of its progeny for other traits, including plant height, plant vigor, and flower color (unpublished data). Self-pollinations of first generation seedlings of 'Virginia' produced progeny with lower PPR than their parents. This reduction in PPR may result from either further segregation or from inbreeding depression since plant height, vigor, and fertility were also reduced.

Progeny from cross-pollinations involving at least one parent with a low PPR frequently had low PPR; 'Elsie Hickman' and 80-31-1 are good examples (Table 2). However, 81-35-1, which resulted from a cross of 'Elsie Hickman' (PPR 1) and 'Hazel Herald' (PPR 3), consistently had a PPR of 4 and seldom displayed petal abscission even after 3 weeks in the SCE. Therefore, progeny with excellent postproduction characteristics that exceed those of either parent can result from cross-pollinations.

Progeny of parents with high PPR would also be expected to have good postproduc-

Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-08-31 via free access

tion characteristics. However, 80-31-1 (PPR 1) resulted from a cross-pollination of 'Grand Slam' (PPR 4) and 'Virginia' (PPR 3); this is not surprising in view of the heterozygosity of 'Virginia'. Progeny from self-pollinations of 80-31-1 did not segregate into low and high PPR (Table 2). Since *P.* ×*domesticum* may be a polyploid, a larger population of self-pollinated progeny would be needed to detect all possible segregates.

Postproduction quality can be used as a selection criterion in a breeding program since *P.* ×*domesticum* segregates for petal retention. Few progeny with improved PPR were produced from either self- or cross-pollinations involving parents with low PPR. Four of the five breeding lines with consistently high postproduction ratings were self-pollinations of a parent with a PPR of 3; 'Virginia' was a parent of three of these breeding lines as well as ≈33% of all the breeding lines evaluated in this study. Another superior breeding line is 81-35-1, a hybrid that had one parent with a PPR of 3. The best approach to breeding *P.* ×*domesticum* with improved postproduction characteristics is to use gentoypes with the highest petal retention.

Literature Cited

Armitage, A.M., R. Heins, S. Dean, and W. Carbon. 1980. Factors influencing flower petal abscission in the seed-propagated geranium. J. Amer. Soc. Hort. Sci. 105:562-564.

Benschop, M. and A.A. DeHertogh. 1969. An analysis of the post-harvest characteristics of cut tulips. Flor. Rev. 145 (3758):24-26, 62-65.

Conover, C.A., R.D. Heins, and G. Staby. 1981. Postproduction handling of container-grown plants. Flor. Rev. 168 (4364):20, 22.

Craig, R. 1982. Chromosomes, genes, and cultivar improvement, p. 380-410. In: J.W. Mastalerz and E.J. Holcomb (eds.). Geraniums. Pennsylvania Flower Growers, Univ. Park, Pa.

de Jong, J. 1979. Selection for keeping quality in gerbera, p. 263-267. In: L. Quagliotti and A. Baldi (eds.). Proc. Eucarpia Meeting Gen. and Breeding of Carnation and Gerbera, 24-28 Apr. 1978. presso la Minerva s.n.c. di Bollito, Torino, Italy.

Deneke, C.F. 1988. The post-harvest quality of *Pelargonium* ×*domesticum* L.H. Bailey. PhD Diss., The Pennsylvania State Univ., Univ. Park.

Hanniford, G.C. and E.J. Holcomb. 1982. Regal geraniums, p. 161-169. In: J.W. Mastalerz and E.J. Holcomb (eds.). Geraniums. Pennsylvania Flower Growers, Univ. Park, Pa.

Harbaugh, B.K. and W.E. Waters. 1979. Evaluation of flowering potted plants under simulated home conditions. HortScience 14:743-745.

Sparnaaij, L.D. 1979. Current research on carnation with special reference to breeding, p. 47-55. In: L. Quagliotti and A. Baldi (eds.). Proc. Eucarpia Meeting Gen. and Breeding of Carnation and Gerbera. 24-28 Apr. 1978. presso la Minerva s.n.c. di Bollito, Torino, Italy.

van Eijk, J.P. and W. Eikelboom. 1976. Possibilities of selection for keeping quality in tulip breeding. Euphytica 25:353-359.

van Eijk, J.P. and W. Eikelboom. 1986. Aspects of breeding for keeping quality in *Tulipa*. Acta Hort. 181:237-243.

Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-08-31 via free access