‘Ayelet’ and ‘Galya’: New Seedless Lemon Cultivars

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Abstract. Two lemon (*Citrus × limon* L. Burm. F.) cultivars, Eureka and Villafranca, were subjected to a mutation-inducing process, which led to the production of seedless mutants in both cultivars. This mutation-inducing process did not affect many other lemon traits.

Lemon is a highly acidic citrus fruit as a result of its high citric acid content (≈5%). As a result of its high level of vitamin C, it is used as an antioxidant to prevent browning in food and was used by the British Navy as an antiscorbutic treatment. The lemon was probably first cultivated in China or northern India. Its name was probably derived from the Persian “limun.”

There is evidence from 700 C.E., and speculation from as early as 200 C.E., of cultivated lemon in Italy. During the Crusader period, the lemon spread throughout the Mediterranean region. Previously, the citron (*Citrus medica* L.), which was probably first imported into the region by Alexander the Great, was the only citrus species in this region. Lemon is relatively cold-sensitive and is therefore cultivated in regions with mild winters.

When fruit development is separated from fertilization and seed development, the resulting parthenocarpic fruits are seedless (Fos et al., 2000; Robinson and Reiners, 1999; Talon et al., 1992; Varoquaux et al., 2000). We have observed that, in the absence of pollination, the two lemon cultivars, Eureka and Villafranca, tend to set parthenocarpic fruits.

Material and Methods

To obtain seedless ‘Eureka’ and ‘Villafranca’ lemons in a pollinating environment, we induced mutations by exposing buds (mV₁) to ⁶⁰Co gamma irradiation (13.3 Gy/min; Spiegel-Roy and Vardi, 1989). The irradiated budwoods were then grafted onto Troyer rootstocks. To avoid the formation of chimeras, individual budwoods (six buds from each base) from the irradiated plants were grafted onto fresh rootstocks (mV₂)

6 months later. The mV₂ plants were planted in the field and screened for seedlessness. We successfully produced a seedless cultivar of ‘Eureka’, which we named ‘Galya’, and a seedless cultivar of ‘Villafranca’, which we named ‘Ayelet’ (Fig. 1A–D). Approximately 300 budwoods were irradiated and four mV₂ individuals of each irradiated budwood were planted.

The total soluble solids (TSS) was measured by refractometer (PAL-1; ATAGO, Tokyo, Japan). The acidity was determined by 0.1 N NaOH titration.

Results and Discussion

Approximately 1% of the trees (mV₂) produced seedless fruit. From each of the

Fig. 1. Seeded and seedless lemon cultivars. (A) ‘Villafranca’; (B) ‘Ayelet’; (C) ‘Eureka’; (D) ‘Galya’.

Fig. 2. Fruit weights of seeded and seedless lemon cultivars. The results are the mean of 10 fruits (± SE).

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Fig. 3. Fruit acidity of seeded and seedless lemon cultivars. The results are the mean of 10 fruits ($\pm$ SE).

Fig. 4. Total soluble solids (%) of seeded and seedless lemon cultivars. The results are the mean of 10 fruits ($\pm$ SE).

Fig. 5. Sugar/acid ratios of seeded and seedless lemon cultivars. The results are the mean of 10 fruits ($\pm$ SE).

two cultivars, we selected one mutant whose yield was similar to that of the wild type. The yields of 'Villafranca' and 'Ayelet' were the same, $\approx 50,000 \text{ kg}\cdot\text{ha}^{-1}$. The yields of 'Eureka' and 'Galya' were also similar to each other, at $\approx 40,000 \text{ kg}\cdot\text{ha}^{-1}$. No seeds were found in either of the two mutant cultivars in contrast to the five to 15 seeds per fruit in both 'Eureka' and 'Villafranca' (Fig. 1 A–D). The seedless fruits were slightly larger than those containing seeds (Fig. 2). The acidity of 'Ayelet' (on 'Volcameriana' rootstock) was not significantly different from that of 'Villafranca' (on 'Volcameriana' rootstock). In contrast, 'Galya' was much less acidic than 'Eureka' (Fig. 3). The TSS content of the seeded and unseeded varieties were about the same (Fig. 4). Although the sugar/acid ratios of 'Villafranca' and 'Ayelet' were about the same, the sugar/acid ratio of 'Galya' was higher than that of 'Eureka' (Fig. 5) as a result of the difference in the acidity of these two cultivars. No horticulture problems were observed on the mutant's lemons versus the weight.

Literature Cited

- Fos, M., F. Nuez, and J.L. Garcia-Martinez. 2000. The gene *pat-2*, which induces natural parthenocarp, alters the gibberellin content in unpolinated tomato ovaries. *Plant Physiol.* 122:471–480.
- Robinson, R.W. and S. Reiners. 1999. Parthenocarp in summer squash. *HortScience* 34:715–717.
- Spiegel-Roy, P. and A. Vardi. 1989. Induced mutation in *Citrus*, p. 773–776. *Proc. 6th Intl. Congr. SABRAO*, Tsukuba, Japan.
- Talon, M., L. Zacarias, and E. Primo-Millo. 1992. Gibberellins and parthenocarpic ability in developing ovaries of seedless mandarins. *Plant Physiol.* 99:1575–1581.
- Varoquaux, F., R. Blanvillain, M. Delseny, and P. Gallois. 2000. Less is better: New approaches for seedless fruit production. *Trends Biotechnol.* 18:233–242.