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An Autotetraploid of the Key Lime, *Citrus aurantifolia*

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Abstract

The origin of an autotetraploid plant of Key Lime, *Citrus aurantifolia* (Christm.) Swing. is recorded. Some of the phenotypic effects of autotetraploidy are described. The discovery of this autotetraploid occurred as a result of research to obtain tetraploid forms of *Citrus* that could be used as potential parents in crosses with diploid forms to produce triploid seedless cultivars. The fruit of the autotetraploid is more than twice as large as comparably grown diploid Key Lime fruit and is a useful improvement over the original diploid form. Container-grown plants of the autotetraploid are attractive ornamentals that produce fruit year-round with true Key Lime flavor and aroma.

Polyploid plants have been of interest to horticulturists and plant breeders concerned with plant improvement. The interest of plant breeders in autotetraploid forms has generally been in their genetic potential for combining with other tetraploids to create improved allotetraploids and/or for combining with diploids to produce triploids with superior traits. Horticulturists have had an interest in autotetraploids because of the phenotypic effects of polyploidy on existing diploid cultivars that might enhance the horticultural usefulness of known cultivars. Autotetraploids may arise spontaneously, usually at low frequencies, or they may be induced by various techniques including the most commonly used one, treatment of dividing cells of appropriate plant parts with the alkaloid colchicine. The origin of the autotetraploid form of Key Lime, *Citurs aurantifolia* (Christm.) Swing., is recorded here for the first time. Some of the phenotypic effects of autotetraploidy in Key Lime that distinguish this clone and also endow it with possible horticultural usefulness are described.

Origin

In 1973 a spontaneous autotetraploid seedling was selected from a population of 30 nucellar seedlings of diploid Key Lime. The diagnosis of autotetraploidy in the seedling was made by an adaptation of the technique developed by Barrett (1) to induce polyploid citrus cultivars by colchicine treatment of apical meristems. The seedling was propagated the following year on potted seedling rootstocks of trifoliate orange, *Poncirus trifoliata* (L.) Rafinesque, and grown in the glasshouse for observation. Repropagations were made at intervals and grown as potted plants in the glasshouse to the present time.

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Description

The description of the autotetraploid Key Lime was made from glasshouse-grown potted plants and comparisons, where mentioned, were made with similarly grown diploid Key Lime plants. As grown under these cultural conditions the tetraploid is a small shrub-like tree ≈ 60 cm tall by 80 cm wide at 3 years of age. The plant is less upright, more spreading in growth habit, and slightly less vigorous than diploid Key Lime.

The tetraploid foliage is dark green with a firm, more rigid and leather-like leaf blade ≈ 0.31 mm thick with a 1.48 length/width ratio. In comparison, the diploid has a lighter green, thinner, and narrower leaf blade ≈ 0.26 mm thick with a 1.77 length/width ratio (Fig. 1). Thorns are present on the branches of both, but they are slightly longer on the tetraploid, ≈ 15 mm in length compared to ≈ 12 mm in length on the diploid.

Flowers of the tetraploid exhibit the general features of tetraploidy shown by other tetraploid *Citrus* forms in being larger, more robust and with thicker and more rigid petals than comparable diploids. Figure 2 shows a flower bud just before petal opening and an emasculated flower bud at the same growth stage of tetraploid and diploid Key Lime. Flowering of the tetraploid, as the diploid, is remontant with multiple crops of fruit per year. Fruit at various stages of maturity, as

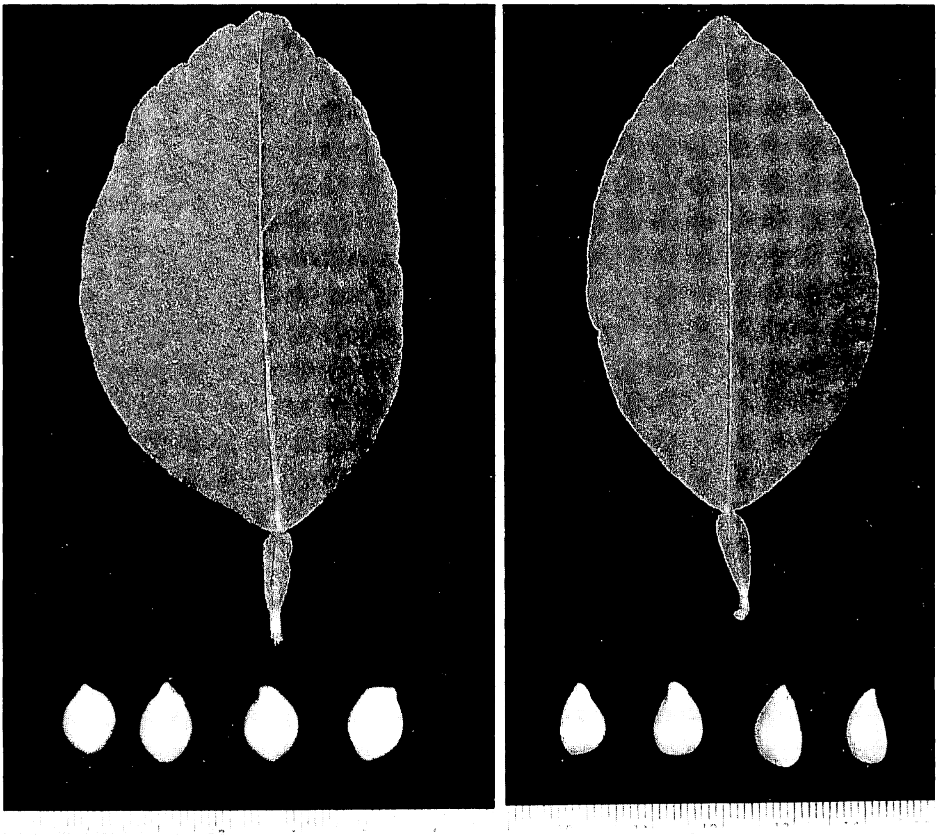

Figure 1. Leaf and seeds. Left–autotetraploid. Right–diploid. Scale–centimeters.

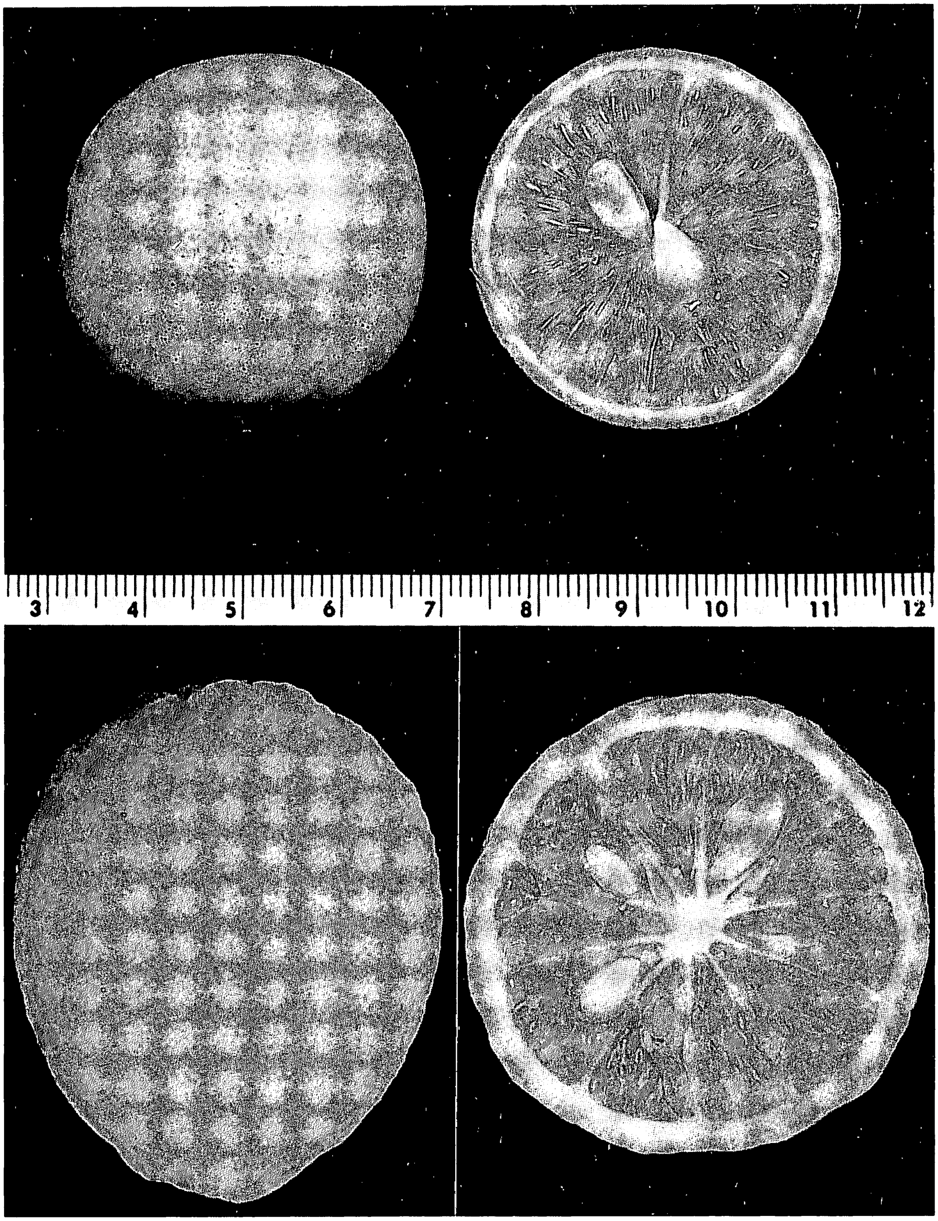

Figure 2. Flower bud–whole and emasculated. Left–autotetraploid. Right–diploid. Scale–centimeters.

well as flowers and unopened flower buds, are often found on a plant at the same time.

Fruits of the tetraploid are much larger than those of the diploid (Fig. 3). Average diameters for the long and short axes were ≈ 59 and 47 mm respectively, for the tetraploid compared to ≈ 40 mm and 32 mm for the diploid. Fruit of the tetraploid weigh

Figure 3. Fruit–whole and cross section. Top–diploid. Bottom–autotetraploid. Scale–centimeters.

≈ 71 g and have a 4-mm-thick rind. Comparable diploid fruit weigh ≈ 32 g and have a 2-mm-thick rind. Seeds of the tetraploid are >95% nucellar, medium small, ≈ 11 mm long by 8 mm wide, weigh 0.17 g and are variable in number, 0-9 per fruit (Fig. 1). Comparable diploid seed are ≈ 11 mm long by 7 mm wide, weigh 0.12 g, vary from 0-7 per fruit, and have the general appearance of being more slender and smaller than the tetraploid seed. Juice samples of the tetraploid have ranged from 8.5 to 9.1% total soluble solids and titratable acidity from 7.3 to 7.4%. Comparable juice samples of diploid fruit have ranged from 7.8 to 9.0% total soluble solids and titratable acidity from 7.4 to 7.8%. No differences could be detected between juice samples of tetraploid and diploid Key Lime in taste tests.

Discussion

The discovery of an autotetraploid Key Lime occurred during attempts to locate or induce tetraploid forms of *Citrus* that could be used as potential parents in producing triploid seedless or near seedless citrus cultivars. Producing an autotetraploid fulfilled the immediate research objective of a segment of the program. Subsequent observations have shown that ploidy change induced phenotypic effects in the autotetraploid that have resulted in improved horticultural usefulness over the original diploid form. The most desirable and valuable phenotypic effect of autotetraploidy in Key Lime is the marked improvement in fruit size. The fruit is more than twice the size of the original Key Lime when grown under comparable cultural conditions.

The autotetraploid flowers and produces fruit of normal development without need for cross-pollination or insect pollinators when grown in the glasshouse. Container-grown plants are attractive ornamentals of restricted growth habit that produce fruit with the true Key Lime flavor and aroma. Such plants could be grown year-round in a glasshouse in areas too cold for outdoor citrus culture. In the main commercial citrus-growing areas of central Florida where alternate long periods of warm and short periods of subfreezing temperatures are characteristic, winters are consistently too cold for field survival of Key Lime. Container-grown plants could be moved to a protected area during the periods of damaging freezes that would otherwise destroy outdoor or field grown trees.

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Effects of Debudding and Defruiting on Alternate Bearing in Pistachio (*Pistacia vera* L.)

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Abstract

Dormant and swelling inflorescence buds, inflorescences and infructescences were removed from both whole and half the canopy of cv. 'Bianca' pistachio female trees in order to investigate their role on alternate bearing. Summer inflorescence bud drop was almost totally avoided in the whole-canopy treated trees whereas in the non-bearing side of the half-canopy treatments, removing after full bloom still promoted a low percentage (about 20%) of inflorescence bud abscission. The latter treatment showed that the influence of the bearing half-canopy on the non-bearing one depended on the stage of the reproductive organs (inflorescence bud, inflorescence, infructescence) at removal time. The research also pointed out the importance of studying alternate bearing in pistachio by whole-tree treatments, because results from scaffold treatments can be affected by the crop load of other parts of the tree.

Introduction

The pistachio is a dioecious plant with male and female organs born in separate trees. Most of the axillary buds, formed during shoot's elongation, are inflorescence buds. Inflorescence buds are producd every year in large amount but, in the course of the development, are subjected to the competition effect of crop load on 1-year-old wood so that in a heavy crop year they abscise copiously during the summer season (1).

The mechanism which causes the phenomenon has not yet been completely determined. Even though bud abscission is related to a well defined phase of embryo development (7), it has been shown that this relationship of competition and/or correlative inhibition in some cases gives a partial explanation of the phenomenon. The early removal of infructescences did not eliminate the phenomenon but only reduced it (2, 3, 6, 7).

A partial explanation was given by Crane and Iwakiri (4), who, while comparing heavily bearing trees to those which had their inflorescence buds removed during the prebloom period, observed that the drop of inflorescence buds occurred in two distinct phases. The first, which precedes the phase of embryo growth, was also found in the non-bearing trees. It was assumed that the first wave of abscission was caused by a stimulus from the roots. The second phase, which affected only the bearing trees, oc-

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