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An Intergeneric Hybrid of *Microcitrus Papuana* and *Citrus Medica*

H. C. BARRETT[1]

Abstract

The first reported hybrid between *Microcitrus papuana* H. F. Winters, Brown River finger lime, and *Citrus medica* L., citron, is recorded and some of the prominent attributes of this new intergeneric hybrid are described. The hybrid was made for the purpose of creating a genetic bridge for gene exchange between species and genera in the orange subfamily Aurantioideae of the family Rutaceae. Important barriers to gene exchange are ovule and pollen sterility in the F_1 generation and the widespread occurrence of apomixis in the Aurantioideae. Attributes of this hybrid most relevant to citrus breeding are small stature, remontant flowering and fruiting, ease of rooting from cuttings, very short reproductive cycle, zygotic reproduction, sufficient degree of fertility to function in further breeding, and tenderness to cold. The hybrid appears to have a significant potential for improving citrus rootstocks in the areas of size control and ease of propagation. The attribute of a very short reproductive cycle, inherited from *M. papuana,* may have a potential for obtaining precocious bearing in seedling progenies, and thus reduce the juvenility component of the long time period between origination and completion of validation testing.

Intergeneric hybridization is a technique used by plant breeders to transfer genes from one genus to another. It is infrequently used, but may be resorted to in situations where it is necessary to transfer desired traits present in one genus to another genus where these traits are absent or inadequately expressed. In the USDA-ARS Citrus Improvement Program, intergeneric hybridization has been used with considerable frequency in some segments of the program because of the reason cited. The purpose of this paper is to record the first reported

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Figure 1. Plant of F_1 intergeneric hybrid. Stake is 1 meter high.

hybrid between *Microcitrus papuana* H. F. Winters, the Brown River finger lime, and *Citrus medica* L., the citron, and to describe some of the prominent attributes of this new intergeneric hybrid that may be of value in citrus improvement programs.

Origin

A 1974 pollination of an unnamed seedling of *M. Papuana* by an unnamed seedling of *C. medica* resulted in the production of several F_1 hybrids. They were grown 1 year in the glasshouse and then transplanted to the field for fruiting. The morphology and developmental cycle of these seedlings were relatively uniform, as might be expected in a classic F_1 generation. The hybrid 1533, herein described, is representative of this F_1 progeny and, like its siblings, began flowering and fruiting 2 years later in the third year from seed.

Description

The plant is a shrub, 2-2.5 m tall, with several ascending branched stems; branchlets glabrous at maturity, slender, with medium slender, 12 mm long axillary spines. Leaves are elongate-ovate, medium small, 48 mm long by 16 mm wide, medium dark green with prominent oil glands; short; with nonarticulated petiole, and they emit a limelike fragrance when crushed.

Flowers are borne in axils of current season's growth in short cymes of ca 5, terminal flower strongly dominant, others with suppressed pistils. Unopened flower buds are tinged light purple, open flowers with a corolla of 5 slightly spooned white petals, each 10-13 mm long, 1.5-2.0 mm wide, and a small, 5-lobed calyx with sparse, minute pubescence. The pistil is 8-11 mm long, ovary ca 3 mm diameter, slightly streaked with light purple; stigma 1.5-3.0 mm diameter, light, sulfur-yellow. Stamens slightly shorter than pistil, with ca 20 free stamens in a ring around pistil; filaments are glabrous, some tinged light purple. Anthers are light yellow, many incompletely developed, and produce sparse to light pollen. Flowering is remontant with

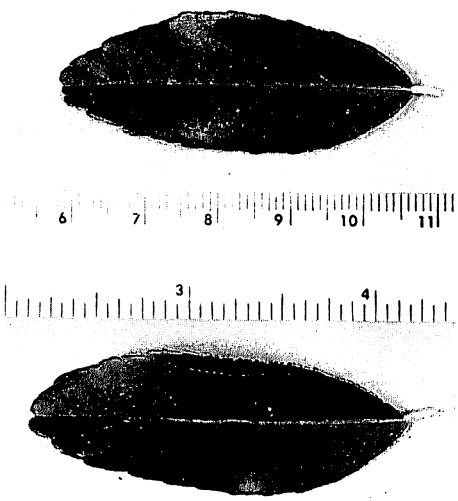

Figure 2. Leaves of F_1 hybrid. Top scale—centimeters; bottom scale—inches.

considerable variability in size, development, and quantity of flowers, depending on time of year bloom occurs.

Fruit are borne singly, elongate-ellipsoidal to cylindrical with short, 7 mm, medium thick stem and small depressed calyx. Base with short, furrowed neck; the apex is nippled and furrowed; light yellow at maturity. The size of fruit is variable, ca 95 mm long, 40 mm diameter and 75 g weight. Rind is thin, 3 mm, often bumpy with finely pitted surface and numerous depressed oil glands, is tightly adherent to flesh and has a limelike odor when crushed. Segments 7, small, 4 mm diameter solid to sometimes hollow axis with thin septa. The vesicles are slender, stalked with very pale, faint-yellow tinge, crisp, firm, noncoherent. The juice is acid, limelike in flavor, with some bitter aftertaste. Sample juice readings of ca 9.2% total soluble solids and 4.7% acid. Seeds are monoembryonic, medium small, ca 8-10 mm long, 4-5 mm wide, ovate, slightly wrinkled, and cream colored.

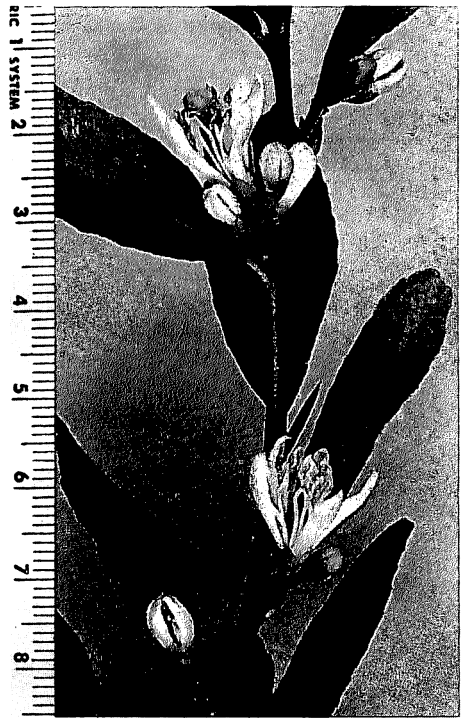

Figure 3. Flowers of F_1 hybrid. Scale—centimeters.

Figures 1 through 4 illustrate the plant, leaves, flowers, fruit, and seeds of the F_1 intergeneric hybrid.

Table 1 lists some of the most prominent morphological characters of both parents, *M. papuana* and *C. medica,* along with those of the F_1 hybrid.

Discussion

The primary purpose of the breeding experiment that gave rise to this intergeneric hybrid was to create a genetic bridge with the potential to circumvent some of the barriers to gene exchange between species and genera in the orange subfamily Aurantioideae of the family Rutaceae. The genus *Microcitrus* contains several species, some of which are known to possess desirable attributes that could

Table 1. Morphological characters of parents and F_1 hybrid.

	Microcitrus papuana	F_1 hybrid	*Citrus medica*
Plant	small shrub, 1-2 m tall; very slender, slightly zigzag branchlets	small ascending shrub, ca. 2.5 m tall; slender straight branchlets	small, spreading tree, ca 4 m tall; thick, straight branchlets
Leaf	very small, linear, narrow-oblong, 28 mm long by 3.5 mm wide	medium small, elongate-ovate 48 mm long by 16 mm wide	medium large, elliptic-ovate, 145 mm long by 67 mm wide
Flowers	very small, borne singly, ca. 75% suppressed pistils; buds white or cream; corolla white; stamens free in ring; filaments glabrous; stigma light yellow	medium small, borne in 5-flowered cyme, ca 80% suppressed pistils; buds light-purple tinged; corolla white with light-purple tinge; stamens free in ring; filaments glabrous; stigma sulphur yellow	medium large, borne in 5-6 flowered cyme, ca 80-85% suppressed pistils; buds purple tinged; corolla white with purple tinge; stamens connivent in tube; filaments lightly pubescent; stigma greenish-yellow
Fruit	very small, 8 g, very slender L/W ratio 3.8/1, slightly curved, cylindrical, abruptly narrowed at base, abruptly beaked apex; segments 5; rind thin, .75 mm, leathery, numerous oil glands; vesicles globose, noncoherent; septa not separated by albedo	medium small, 75 g, elongate ellipsoid to cylindrical, L/W ratio 2.4/1; base with short, furrowed neck, apex nippled and furrowed; segments 7; rind thin, 3 mm, pitted, bumpy with depressed oil glands; vesicles slender, noncoherent; septa not separated by albedo	very large, 480 g, ellipsoid, L/W ratio 1.5/1; base depressed, furrowed; apex nippled; segments 11-13; rind extremely thick, 15-22 mm, pitted, bumpy with depressed oil glands; vesicles slender, coherent; septa separated by albedo

be of value to citrus improvement programs (1). Many crosses between some of these species and other genera have been attempted. Few have produced progeny. Some desired crosses either failed to produce progeny, or if progeny were produced, they were subject to ovule and pollen sterility and no progeny could be produced beyond the original F_1 generation. Among the most important of other barriers to gene exchange is the widespread presence of apomixis in the orange subfamily Aurantioideae, a condition that, when present in parental germplasm, increases the difficulty of obtaining a useful genetic bridge.

The attributes of this intergeneric hybrid most relevant to citrus breeding are its small stature, remontant flowering and fruiting, ease of rooting from cuttings, very short reproductive cycle, and zygotic reproduction with a sufficient degree of fertility to function in further crossing. Its major known negative attribute is its tenderness to cold, an undesirable trait that it shares in common with both parents, other species of *Microcitrus*, and other members of the lemon-lime acid citrus group.

This hybrid appears to have a significant potential for improving citrus rootstocks in the areas of tree size control and ease of propagation. Another, more long-term potential exists for development of scion cultivars with small stature, particularly in the lemon-lime acid citrus group.

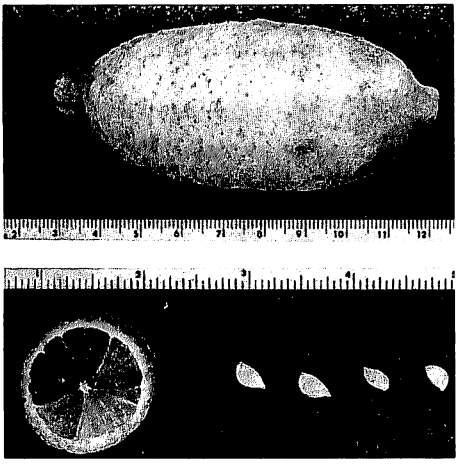

Figure 4. Top—Fruit of F_1 hybrid. Bottom—Cross section of fruit and seeds. Scale—top, centimeters; bottom, inches.

Perhaps the most interesting and a potentially valuable attribute for citrus breeding is the very short reproductive cycle inherited from *M. papuana*. Long juvenility periods, generally pervasive in *Citrus* and most of its relatives, are an important component of the long time period between origination and completion of validation testing that every selection must undergo. Although it is not possible to eliminate the need for or the time required for validation testing of selections, a genetic trait source for a short seed-to-seed cycle could significantly reduce the juvenility component of the complete breeding-selection cycle.

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Evaluation of Ripening and Fruit Quality of 'Gala' and 'McIntosh' Apples at Harvest and Following Air Storage

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Abstract

The high quality of 'Gala' was confirmed in this investigation. Taste panelists preferred 'Gala' over 'McIntosh' regardless of harvest date or length of storage. 'Gala' was firmer, developed higher soluble solids, and had lower titratable acidity than 'McIntosh' but red color and color intensity developed later than 'McIntosh.' The time of ripening of 'Gala,' relative to 'McIntosh,' was not definitively established because of the uncharacteristic pattern of ethylene evolution displayed by 'Gala.' The rapid rise in ethylene evolution that characterize many apple fruit entering the climacteric did not occur with 'Gala.' Rather, the internal ethylene level rose to 1.5 to 2.5 ppm early in September and remained there for over 4 weeks, after which, it started to rise slowly to over 10 ppm by mid-October. 'Gala' lost more weight in storage than 'McIntosh,' but the weight loss was reduced considerably by storage in plastic-lined bags.

Introduction

'Gala' is an apple cultivar that was introduced in 1962 by Dr. Donald McKenzie from a cross made between 'Kidd's Orange Pippin' and 'Golden Delicious' (7). Fruit is round conic with a red blush over a very distinctive golden-yellow ground color. It is a crisp, sweet, and aromatic apple with firm, yellow flesh (1, 2, 7). Fruit size may be medium to small but large fruit are possible if tree vigor is

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