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'Cipo' Sweet Orange and its Unique Growth Habit

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Abstract

'Cipo' is a seedy, mid-season sweet orange (*Citrus sinensis* [L.] Osbeck) with a distinctive procumbent or "weeping" growth habit. Fruit characteristics of 'Cipo' are very similar to 'Pineapple' sweet orange, a cultivar commonly grown for juice production in Florida. Apomictic 'Cipo' seedlings 24 to 40 weeks old were different from apomictic 'Pineapple' seedlings for several aspects of vegetative morphology, including horizontal or weeping growth of the terminal shoot, broader shoot-petiole angle, and perhaps greater branching. Preliminary observations indicate that these traits are transmitted from 'Cipo' to some hybrid progeny. These 'Cipo' characteristics may have potential value for the development of unique ornamental or dwarf citrus cultivars and for use as genetic markers. Efforts are underway to define the inheritance of the 'Cipo' growth habit and to transmit it to scion and rootstock hybrids for further testing.

Introduction

Hundreds of cultivars of sweet orange (*Citrus sinensis* [L.] Osbeck) have been identified over the past several centuries (5). On the basis of morphological, isozyme, and other biochemical data, sweet orange is considered to be a spontaneous hybrid (or backcross of a hybrid) between mandarin (*Citrus reticulata* Blanco) and pummelo (*Citrus grandis* [L.] Osbeck) (1, 6). Isozyme analysis has revealed that essentially all true sweet oranges have identical alleles at the common isozyme loci, and morphologies of sweet orange cultivars differ little compared to the extreme variability evident in mandarin-pummelo hybrids produced by controlled crosses. These facts suggest that most sweet orange cultivars were derived by somatic mutation from a single progenitor (4). Somatic mutations are common in citrus (2, 8) and have produced a number of commercially important cultivars (5). One sweet orange cultivar that has recently attracted special attention because of its unique growth habit is 'Cipo'. This cultivar is a seedy, mid-season sweet orange that is very similar in many respects to the commercial sweet orange cultivar, 'Pineapple'. However, 'Cipo' is distinctive from 'Pineapple', and nearly all other citrus cultivars, because of its procumbent growth habit. This distinctive "weeping" morphology may have value as a genetic marker, a unique ornamental trait, or a source of tree size control.

History

'Cipo' was introduced into the USA at Orlando, Florida, and Indio, California, in 1977 as seed from an agricul-

Figure 1. Typical growth habits of upright 'Pineapple' (left) and procumbent 'Cipo' (right) sweet orange nucellar seedlings.

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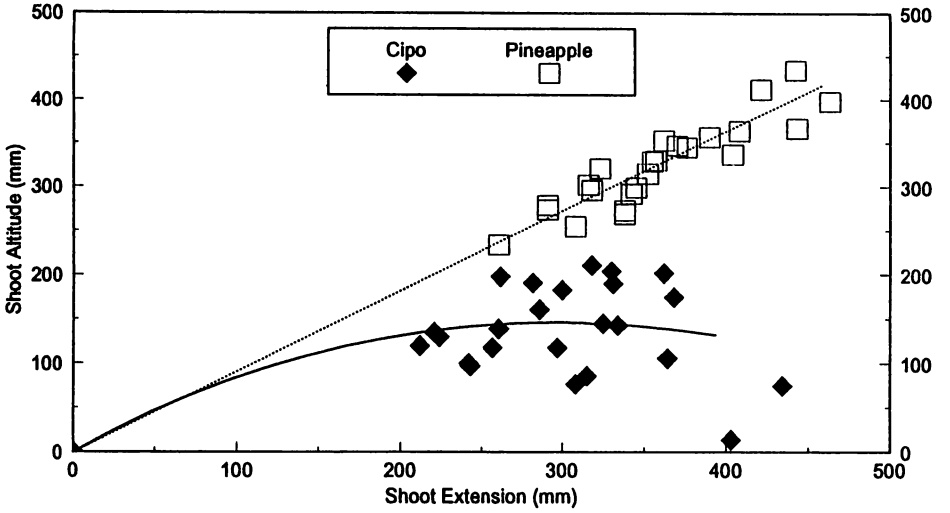

Figure 2. Graphical comparison of shoot tip altitude relative to shoot extension for 'Pineapple' and 'Cipo' nucellar seedlings.

tural experiment station at Taquari, Brazil. The 'Cipo' growing in Brazil was described by W. C. Cooper as an orange tree having "an umbrella-shape branching habit." (3) Since the 'Cipo' habit and general fruit characters were recovered in seedlings in the USA, it seems probable that the seedlings were apomictic (of nucellar origin) and genetically identical to the parent tree in Taquari. The specific origin of the 'Cipo' growing at the Taquari station is unknown. 'Cipo' is now present in the USDA germplasm collections near Orlando, Florida (as 77-155-1), and Riverside, California (as CRC 3896).

Fruit Characteristics

Samples of ten fruit from each cultivar were collected from 'Cipo' (77-155-1) and 'Pineapple' (AHW-93-142) trees in the USDA Citrus Variety Collection near Orlando, Florida. These fruit were subjected to standard analysis criteria used for citrus cultivars (unpublished descriptor list, USDA National Clonal Germplasm Repository for Citrus and Dates, Riverside).

Table 1. Comparative characteristics of 'Cipo' and 'Pineapple' fruit from the USDA Citrus Variety Collection, Orlando, Florida in late February-early March 1993.

	Pineapple	Cipo
Fruit diameter (mm)	70	69
Fruit weight (g)	174	176
Rind color	orange	pale orange
Rind thichness (mm)	5	5
Total soluble solids (%)	13.3	13.2
Total acids (%)	0.86	0.8
Juice color	orange	pale orange
Percent juice	43	43
Seeds per fruit	16	18
Embryony	polyembryonic	polyembryonic

By most of these descriptors, 'Cipo' was very similar to 'Pineapple' (select characteristics are presented in Table 1). Fruit size, rind thickness, soluble solids, percent juice, and seediness are nearly identical for the two cultivars. However, 'Pineapple' rind and juice appear somewhat more deeply colored than 'Cipo'. In addition, 'Cipo' tends to bear fruit mostly inside the canopy of the tree (rather than on the outer surface of the canopy). This trait would present significant difficulty for commercial harvesting and pest control.

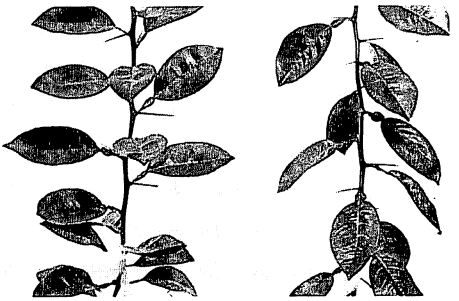

Figure 3. Typical petiole angles of staked 'Pineapple' (left) and 'Cipo' (right) sweet orange nucellar seedlings. Stakes were removed for photography.

Seedling Characteristics

'Cipo' (CRC 3896) and 'Pineapple' (CRC 3858) seeds were obtained from the USDA National Clonal Germplasm Repository for Citrus and Dates (at Riverside, California), planted in soilless potting mix, and grown in a greenhouse. Twenty-four of the strongest seedlings of each cultivar were transplanted into 12.5 cm diameter pots at 12 weeks after planting. The frequency of zygotic seedlings (hybrids) is low for sweet oranges in general (7) and has been estimated at less than 6% for 'Cipo' (author's unpublished data, using *Poncirus trifoliata* [L.] Raf. as pollen parent). Therefore, most or all of these seedlings were expected to be of nucellar origin and genetically true 'Pineapple' or 'Cipo'. Plants of the two cultivars were located side-by-side on the greenhouse bench and maintained under the same watering and fertilization schedule. About 12 weeks after transplanting, the following characteristics were recorded for all 48 seedlings: 1) diameter of stem at the level of the top of the pot, 2) number of side branches on the main stem, 3) "extension" or linear length of the main stem from the top of the pot to shoot tip when pulled out straight, and 4) "altitude" or vertical distance from the plane of the top of the pot to the shoot tip as it hangs naturally. The relationship of the "extension" to the "altitude" gives an indication of the uprightness and straightness of the stem; the more upright and straight the stem, the more similar the "extension" and "altitude" values.

Twenty-six weeks after planting the seed, the plants were repotted into 4-liter pots and staked. For the next 14 weeks, the main shoots were carefully trained upright along vertical stakes, and all lateral branches were removed. At 40 weeks after seeding, the angle of the petiole to the main stem was measured for five fully expanded leaves, near the middle of the stem that had developed after staking, for each seedling. These five leaves were chosen sequentially along the stem in the same growth flush unless there were insuffi-

Table 2. Comparative morphology of Cipo and Pineapple nucellar seedlings (mean ± standard deviation).

	Pineapple	Cipo
Shoot extension (mm)	359 ± 52	303 ± 58
Shoot altitude (mm)	324 ± 50	138 ± 50
Shoot diameter (mm)	4.78 ± 0.59	5.25 ± 0.51
Side branches	0.6 ± 0.9	1.2 ± 1.0
Petiole angle-staked (degrees)	62 ± 7	110 ± 9

cient leaves in any flush. A leaf was not used if it did not have a spine or appeared to be damaged in a way that might affect the petiole angle. These measurements were averaged to give a mean petiole angle for each seedling.

Growth habit was observed to be dramatically different for young seedlings of 'Cipo' and 'Pineapple' (Figure 1). The most obvious difference was the tendency of 'Pineapple' shoots to grow vertically and of 'Cipo' shoots to bend toward the horizontal, or even downward after an initial period of vertical growth. The 'Cipo' characteristic was not so strong as to produce prostrate growth, but it is better characterized as a procumbent habit. This growth characteristic can be graphically represented by plotting shoot altitude versus shoot extension for the two cultivars (Figure 2). In addition to this tendency for horizontal shoot growth, 'Cipo' was compared to 'Pineapple' for other characteristics that might play a role in the procumbent habit (Table 2). Side branches appeared to be produced more frequently on 'Cipo,' but there was so much variability among seedlings that this difference was not statistically significant. The angle between the shoot and the petiole was noticeably greater for 'Cipo,' producing the appearance of mild wilting even in well-watered 'Cipo' seedlings. This characteristic was evident in untrained shoots, but varied markedly among leaves on horizontal stem sections. The 'Cipo' leaf droop was clearly evident and fairly uniform with staking (Figure 3) and could be quantified (Table 2). It was unclear whether this broader petiole angle in 'Cipo' was directly related to the procumbent growth habit.

Conclusions and Significance

The fruit and vegetative characteristics of 'Cipo' indicate that it is a sweet orange. This is verified by the observation that 'Cipo' has the same isozyme banding patterns as other sweet orange cultivars (personal communication from F. G. Gmitter, Jr., and unpublished data, USDA-NCGR, Riverside). However, 'Cipo' is unique among known sweet orange cultivars in its procumbent growth habit. This habit is transmitted to nucellar seedlings and is readily detected at a very young age. The primary characteristics of this habit are horizontal or weeping growth of the terminal shoot, a broad shoot-petiole angle, and perhaps greater branching.

Preliminary indications are that the 'Cipo' growth habit is transmitted to some sexual hybrid progeny (author's unpublished data). This characteristic could be of significant value as a mutation for altered hormone activity, or as a genetic marker (single gene markers are rare in Citrus). The procumbent habit may also be of value for breeding unique ornamental citrus cultivars. Finally, the procumbent characteristic may have some value as an approach to tree size control because grafted 'Cipo' trees in the USDA-NCGR, Riverside, appear substantially smaller than trees of other sweet orange cultivars at the same age. Efforts are underway to define the inheritance of the 'Cipo' growth habit and to transmit it to scion and rootstock hybrids for further testing.

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Book Review

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Title: Klon Zuchtung bei Weinreben in Deutchland (Clone Breeding, Selection and Development, of Grapevines in Germany).
Authors: Harald Schoffling and Gunther Stellmach, Landes-Lehr-u. Versuchsanstalt fur Landwirtschaft, Weinbau und Gartenbau, Trier, Germany.
Publisher: Waldkircher Verlag, D-79177 Waldkirch, Germany
Price: DM 180

This book is an authoritative voice describing scientific development and preservation of existing grape cultivars throughout the world. One of the primary objectives of the research was to preserve the true characteristics of the traditional grape cultivars in Germany. Numerous clones were propagated vegetatively and tested intensively and repeatedly, over an extended period, to select unchanged clones (clones unaffected by somatic mutations and/or systematic infections) which can be used profitably by winegrape growers.

The authors maintain that production of "less discriminating" plant material has lead to the unrecognized inclusion of negative somatic mutations as well as systemic infections. With time this has resulted in the multiplication and use of grapevines which vary in their performance or even fail to maintain their original production potential. The book stresses the importance of eradicating these negative factors in clones of high value. The extensive scientific work on which this book is based has been called "systematic preservation-breeding" or a systematic approach to clonal preservation and development of winegrape cultivars. In Germany this practice has been legally established and is based on careful individual plant selection with subsequent biometrically correct tests of the descendants. "Klon Zuchtung" can be literally translated as clone breeding, clone selection or clone development. They believe that this practice is especially important in "old" varieties or cultivars, because the original specimens are unknown and therefore not available for propagation. Consequently, sanitation procedures were applied to well-chosen examples of the respective cultivars to eradicate any pathogens. Then, the cultivars were cloned, in order to produce mother plants, and proceeded to undergo years of genetic evaluations.

The authors, have been working on the theory and practice of "Klon Zuchtung" of *Vitis vinifera* cultivars for decades. In the present work they report the objectives and methodology used for serious and systematic clone development and preservation. They treat the complete subject of cultivar preservation, beginning with classical selection and propagation up to and including the latest modern cultural techniques. They have also attempted