Cultivars

The CCA Cherimoya Handbook

Table of Contents

by Norman C. Ellstrand
University of California
Department of Botany and Plant Sciences
Riverside, CA 92521-0124

Introduction

California's cherimoyas are largely propagated as clonal scion cultivars (cultivated varieties) grafted to seedling rootstocks. Despite the genetic uniformity of cherimoya cultivars, they still display some variation. Variation among trees of the same cultivar may be due to misidentification of cultivar genotype, differences in environment, or genetic variation in rootstocks.

At least 40 different names have been associated with cherimoyas growing in California. About two dozen of the names represent registered cultivars. Only five cultivars are widely grown and commercially important: 'White', 'Bays', 'Pierce', 'Booth', and 'Chaffey'. Six varieties have been registered within the last 10 years and are quite promising: 'Carmella', 'El Bumpo', 'Libby', 'Lucida', 'Nata', and 'Santa Rosa'.

Four historically important registered types apparently have disappeared altogether: 'Dorothea Wilkerson', 'Golden Russet', 'Mammillaris', and 'Ryerson'.

Very little is known of the differences among California's important cultivars. A database of differences would be helpful to all members of the industry. Most of California's commercially important cultivars have been important for half a century.

Although it is hard to predict future industry needs, the next generation of important cultivars will probably come from the ranks of current promising registered cultivars, from new genotypes identified by sharp-eyed growers, and from varieties selected in other countries.

New growers are advised to follow these rules of thumb: buy only from reputable nurseries and select several cultivars of which at least 80% have an established track record.

Cultivar Characteristics

Why Have Cultivars Been Developed?

The goal of agriculture is to manage plants and their environment to create a desirable product with the least effort. The management of the environment includes irrigation, pest control, pollination, etc. Likewise, plants can be managed genetically. Wild plants are usually genetically variable, differing in many characteristics.

Cultivation of wild or unselected material is often problematic because a subset of plants may have undesirable characteristics, such as low yield and unattractive or bad tasting fruit.

Even if plants have generally good characteristics, the pre-existing variation in unselected material often leads to management difficulties such as variation in flowering time, time to maturity, nutritional needs, fruit characteristics, post-harvest handling requirements, etc.

Therefore, the best genetic management involves the selection of plants that are both superior to wild plants and genetically more uniform than wild populations. When genetically uniform stock is evaluated, named, and propagated, the resulting product is called a "cultivated variety," that is, a "cultivar."

Types of Cultivars

Some crops are propagated by seed bred for superior characteristics and uniformity. However, the sexual reproduction necessary to create seeds always mixes genes and, unless a crop has been highly inbred for several generations, seed propagated cultivars show at least a little genetically based variation.

In contrast, cultivars propagated by budding, grafting, or cuttings are said to be "clonally propagated" and are essentially genetically uniform. While mutations ("budsports") may occur, they are so rare that, for practical purposes, individuals of a clonally propagated variety are genetically identical.

As a species, cherimoya is extremely genetically variable. Cherimoya does not "breed true"; as Popenoe (1912) noted nearly a century ago, "the variation exhibited by [cherimoya] seedlings in Southern California, many of which have sprung from a common parent, demonstrates conclusively that asexual [i.e., clonal] propagation must be resorted to in order to perpetuate a variety absolutely true to type." Hence, California's cherimoya industry has taken Popenoe's advice; all cherimoya cultivars are clonally propagated scions.

Cherimoya rootstocks are a different matter. They are grown from genetically uncharacterized and unselected seed. To my knowledge, nowhere in the world has any rootstock cultivar of cherimoya been selected.

Sources of Variation Within a Cultivar

Reports of variation within cherimoya cultivars are not rare. Sometimes, more than one genotype has been accidentally given the same cultivar name (Ellstrand & Lee 1987a). Fortunately, biochemical genetic isozyme analysis has made cherimoya cultivar identification feasible (Ellstrand & Lee 1987a, Ellstrand 1991).

Cherimoyas sold from reputable California nurseries are grown from plants checked by this method and therefore can be assumed to be accurately identified and genetically uniform.

However, even when a cultivar name represents a single genotype, variation may still occur. Often, this variation is the result of genotype-by-environment interactions, that is, a genotype may behave differently in different environments.

For example, 'Chaffey' fruits from north of Los Angeles are typically of inferior quality. But 'Chaffey' fruits from south of Los Angeles are characteristically of high quality. Another example is 'Bays' which has good to excellent growth and yields north of Los Angeles, but has slow growth and low yields south of Los Angeles.

In both cases, isozyme analysis has confirmed that trees of the same cultivar name share the same genotype (Ellstrand & Clegg, unpublished data); environmental differences are the most likely explanation.

Trees of the same genotype may vary in performance among adjacent groves or within a single grove. Microhabitat differences in soil, exposure, and pathogens could account for those differences.

Genetic differences in rootstocks could also be an explanation. For example, 'Chaffey'

consistently has the best spontaneous fruit set of all the cultivars at the cherimoya variety collection at the University of California's South Coast Research and Extension Center (Ellstrand & Lee 1986).

Nonetheless, one otherwise healthy 'Chaffey' tree sets only a few fruit each year (Ellstrand & Clegg, personal observation). The only apparent explanation for this variation is an effect from genetic differences among the rootstocks.

Finally, cherimoyas are notorious for "variation of fruits on the same tree" (Popenoe 1912). Such variation may be due to the amount of pollen that a flower receives or the position of the fruit on the tree.

Recent research has shown that the genotype of the pollen parent can have important effects on cherimoya fruit characters (Kahn et al. 1994).

Cultivar Registration

Anyone can name a cultivar. However, formally naming a cultivar by publication of its important characteristics makes a more substantial contribution. Cultivars are then said to be "registered."

The majority of California's cherimoya cultivars have been registered in the following: *Journal of the American Society for Horticultural Sciences* (compiled in Brooks & Olmo 1972), *California Avocado Society Yearbook* (compiled in Schroeder 1989), and the periodical of the California Rare Fruit Growers (presently, *Fruit Gardener*, formerly, *The Journal of the California Rare Fruit Growers)*.

A complete list of registered cultivars is presented in Table 1. The ideal published registration should include a justification of why the new cultivar is superior to prior cultivars, a list of characteristics that permit the grower to distinguish the new cultivar from prior cultivars, a list of economically relevant characteristics, the location and origin of the original tree, and photographs of typical fruit.

An example of cherimoya registration is the one presented (Figure 1) for California's first registered variety by Popenoe (1912).

Figure 1.

Mammillaris

The variety originated as a seedling at Altadena, California, on the property now owned by A. C. Calkins. In flavor it is greatly superior to the majority of local seedlings, and its exceptionally tough skin renders it of value for shipping. Although not a fruit of large size, it must be ranked as one of the best which have originated locally.

Description

Form:	distinctly conical, more uniformly so than with most other varieties
size:	medium
weight:	up to one pound
length:	up to four and a half inches
base:	flattened
cavity:	shallow, broad, flaring, regular
apex:	rather pointed
stem:	short and very stout
skin surface:	covered with more or less prominent conical protuberances, one arising from each carpellary area over the entire fruit
color:	dull green
skin:	thin and very tough
flesh:	clear white, soft, fine grained
seeds:	rather short and blunt, plump, not very numerous
flavor:	very aromatic and rich, strongly resembling the pineapple
quality:	excellent
season:	February-March at Altadena, California.

California's Cultivars: Past and Present

Established Cultivars

At least 40 cultivar names have been associated with cherimoya trees currently or formerly growing in California (Ellstrand et al. 1990). About two dozen of these cultivars have been registered (Ellstrand & Clegg 1991).

Despite this diversity, a survey conducted in 1989 revealed that a small fraction of the named cultivars (about 10%) account for most of California's commercial cherimoya trees (Table 1 in Ellstrand et al. 1990).

California's more or less "established" cultivars are (in descending order of importance): 'White', 'Bays', 'Pierce', 'Booth' and 'Chaffey'. (The list differs slightly from that in the previously mentioned Table because of new information on cultivar identities. For example, see Ellstrand & Clegg [1990a]).

The relative ranking of the "established" cultivars is probably the same today as when that surveyed was conducted. Interestingly, the relative importance of California's cherimoya cultivars has remained fairly static over decades. Four of those five cultivars identified by the survey were listed among California's nine "most important" 42 years earlier (Schroeder 1947)!

As noted above, 'Chaffey' produces inferior fruit north of Los Angeles, and 'Bays' bears poorly south of Los Angeles. Otherwise, the five "estab-

Table 1 — Registrered Cherimoya Cultivars in California

Registered Name	Registration	Comments
Bays	ASHS	Widely grown
Big Sister	CRFG	
Bonita	CRFG	
Booth	ASHS, CAS	Widely grown
Carmelia	CRFG	
Carter	ASHS	
Chaffey	ASHS, CAS	
Dorthea Wilkerson	CRFG	Extinct?
El Bumpo	CRFG	
Golden Russet	Popenoe 1912	Extinct?
Honeyhart	CRFG	
Knight	CRFG	
Libby	CRFG	
Loma	ASHS, CAS	
Lucida	CRFG	
Mammilillaris	Popenoe 19112	Extinct?
McPherson	ASHS	a.k.a. Spain
Nata	CRFG	
Pierce	CRFG	Widely grown, a.k.a Bayott, Escondido White, Thomson-Spain
Ott	ASHS, CAS	
Ryerson	ASHS, CAS	Extinct?
Sabor	CRFG	
Salmon	ASHS	a.k.a Sallmon
Santa Rosa	CRFG	
Whaley	ASHS, CAS	
White	ASHS, CAS	Widely grown, a.k.a. Dr. White Mariella

Abbreviations under "registration" ASHS — American Society for Horticultural Science; SAC — California Avocado Society; CRFG — California Rare Fruit Growers.

lished" cultivars are well proven throughout the present cherimoya-producing areas of California. The following is a brief summary of some of the characteristics of each:

'**Bays'** — (no synonyms), a relatively early variety, fruit is characteristically short and rounded with a somewhat fingerprinted surface.

'Booth' — (no synonyms), a late variety, dark green fruit is characteristically conical with fingerprinted surface.

'Chaffey' — (no synonyms), a relatively long-seasoned variety, fruit is characteristically short and rounded with a somewhat fingerprinted surface.

'Pierce' — (common synonyms include 'Bayott', 'Escondido White', 'Knight', 'Ryerson', 'Thomson-Spain'), a relatively early variety, fruit is characteristically conical with a very smooth surface.

'White' — (common synonyms include 'Dr. White', 'Mariella') a midseason variety, fruit is characteristically conical with faint mammillate or umbonate points extending out of well-marked carpels.

More information on these and other California varieties is available elsewhere (e.g., Brooks & Olmo 1972; Jerris 1990; Schroeder 1947; Thomson 1970). Interestingly, these sources do not always agree with each other on the characteristics of California's cultivars!

Promising Cultivars

Approximately half of the registered cultivars grown in California were registered over half a century ago. Interestingly, most of the remainder were registered within the last decade. Two of those varieties, 'Pierce' and 'Knight', were grown for decades prior to registration (Ellstrand & Lee 1987b), and their performance throughout California's "cherimoya belt" is well known.

The remaining selections by George Emerich, Sam Grossberger, and Rudy Haluza make up what might be considered a good source of the "next generation" of California's cultivars: 'Carmella', 'El Bumpo', 'Libby', 'Lucida', 'Nata', and 'Santa Rosa'.

With the exception of 'Nata', these varieties have yet to be widely planted in a variety of microhabitats to test their relative superiority to the existing "established" cultivars.

Table 2
Common Unregistrered Cherimoya Cultivars in California

'Fino de Jete', 'Lisa', 'M&N', 'Booth', and 'Orton'

Lost Cultivars

Four registered cultivars previously grown in California have disappeared: 'Dorothea Wilkerson', 'Golden Russet', 'Mammillaris', and 'Ryerson'. Furthermore, several unregistered cultivars mentioned in the literature are also apparently no longer available (e.g., 'Janet', 'Selma', 'Trask').

Janet Clegg and I have "rediscovered" at least one presumed extinct cultivar ('Deliciosa') using isozymes, substantial detective work, and the help of a variety of members of California community (Ellstrand & Clegg 1990b).

Lost cultivars were considered to be worth naming at one time and therefore are of potential value either directly as filling a niche in the industry or indirectly as germplasm for future improvement. If you have any information regarding the fate of these "lost" cultivars, especially the registered ones, please contact me.

Existing Cultivar Data Needed

Ideally, a cultivar should be characterized with respect as to how it differs from other cultivars over different environments, different management regimes, and different years.

Very little is written about the differences between cherimoya cultivars in any given situation. Even less is available on the response of a cultivar over coastal California's vast array of microclimates and microhabitats. And virtually nothing is reported on year-to-year changes in cultivar behavior.

However, any quantitative data are worthwhile. For example, comparative studies at the University of California's South Coast Research and Extension Center revealed patterns of variation among cultivars, among trees, and among seasons in spontaneous fruit set (Ellstrand & Lee 1986).

Likewise, a one-year study on seediness in those trees revealed substantial differences among cultivars (Ellstrand & Lee 1985).

A database on comparative performance would be helpful to growers, nurserymen, and packers, perhaps setting some industry standards. Data of interest on differences between cultivars could include flowering season, season of fruit maturity, problems with pests, seediness, flavor, thickness of fruit skin, fruit blemishing, pruning needs, etc.

At the least, the California Cherimoya Association could encourage growers to share their experience with different cultivars in the in the CCA Newsletter.

California's cultivars: Future Perfect?

Sources of New Cultivars

What are potential sources of new cultivars beyond those recently registered? Presently, cherimoya cultivar development in California is not much different from that conducted in the early days of our century.

Growers observe trees with desirable characteristics. Budwood from these trees are grafted to rootstocks. If the characteristics hold up over more than one season on various rootstocks, the grower begins to distribute clonal material under a cultivar name.

If the new cultivar proves itself in other groves, the grower may register it.

Ideally, potential cultivars should be tested in an organized improvement program like that run by researchers at the University of California for improvement of avocado scion and rootstock cultivars.

A genotype's performance should be quantified in different groves over more than one season with sufficient sample sizes for statistical analysis. For long-lived tree crops, demonstrating the superiority of a new cultivar when many of the established cultivars are doing a good job may take a decade or more and thousands of dollars.

On the other hand, a recent report has demonstrated that agricultural research of this type at the University of California pays off 20% per annum on the investment (Alston et al. 1994)!

Plant breeding, as opposed to simple improvement by selection, takes even more effort. Still, creating a new frost-tolerant cultivar from hybridization between 'Deliciosa' (see Hodgson et al. 1950) and an established cultivar could double or triple the area in which cherimoya could be grown in California.

Also, active cherimoya cultivar selection programs are proceeding elsewhere in the world. In Spain, Dr. Jose Farre is testing hundreds of new genotypes. Likewise, varietal testing is being conducted in Chile, Israel, Japan, and New Zealand. Any of these programs might yield a superior cultivar for California.

What Kind of New Cultivars Does the Industry Need?

A problem for anyone involved in crop improvement is anticipating industry needs in a decade or more in the future. For example, in the early 1970s, black-skinned avocado varieties were so rare that consumers judged to be "rotten"; no avocado breeder at that time would have anticipated breeding anything but green-skinned varieties. Nonetheless, we can consider the present needs of California's cherimoya industry.

High costs to the California industry include hand pollination, frost damage to trees, and post-harvest damage to fruits. A variety that is easier to pollinate, is more frost tolerant, and can be handled with less post-harvest damage is likely to find favor with growers provided that factors such as flavor, yield, and general appearance are not compromised.

One set of cultivars likely to meet with grower enthusiasm would be rootstock cultivars. A rootstock genotype that confers some cold tolerance and that has with some resistance to oak-root fungus would be a good start. Clonal rootstocks would be the most desirable.

Rules of thumb for new growers

Given the historical confusion associated with California cherimoya cultivars (Ellstrand 1991), cultivars should be obtained from reputable nurseries who have had their plants genotyped or obtained directly from genotyped material. Growing the "wrong" variety can lead to an unpleasant surprise in three to five years when the tree begins to bear fruit!

What kind of cultivars should a new grower buy? For the home grower, the one buying less than ten trees, the best strategy is to buy only "tried and true" (that is, the "established" or "promising" types listed above) varieties, ideally, more than one variety (because of California's patchwork quilt of microhabitats and microclimates) and more than one tree

of each variety (because of uncontrolled variation among rootstocks).

A new commercial grower would be wise to follow an "80:20 strategy" with about 80% of her trees as "established" varieties and 20% as "promising" or rare cultivars.

Most of the information available on cherimoya culture in California has come from work on the "established" varieties.

The remaining 20% should be considered "experimental."

The thoughtful grower can always be prepared to "top-work" trees if one of the experimental types turns into a cash cow!

Of the 80% in "established" cultivars, at least three cultivars should be planted, both to test the local microhabitat and to provide alternate pollen sources.

Furthermore, groves composed of a single cultivar are ticking time bombs. A pest that evolves adapted to a single variety can rapidly cause havoc with growers or even an industry.

From the great Irish potato famine of the 1840s (caused by a fungus that spread through Europe in a matter of weeks) to the American outbreak of Southern corn leaf blight of 1970, genetic uniformity in crops has repeatedly ended in disaster (Bremermann 1983).

Therefore, the 20% of "experimental" trees should be planted with many varieties, perhaps as many as ten. It should be clear from this chapter that, when it comes to cherimoya cultivars in California, we have a lot left to learn. Every grower can be making a contribution to that knowledge.

Acknowledgments

I thank all the members of California's cherimoya community for their encouragement and patient teaching.

Special thanks go to Paul Arriola, Tracy Kahn, and Janet Clegg for their comments on an earlier draft of this manuscript.

References

Alston, J. M., P. G. Pardey & H. O. Carter. 1994. Valuing UC Agricultural Research and Extension. Agricultural Issues Center, University of California, Davis.

Bremermann, H. J. 1983. Theory of catastrophic diseases of cultivated plants. Journal of Theoretical Biology 100:255-274.

Brooks, H. M. & H. P. Olmo. 1972. Register of new fruit and nut varieties. University of California Press. Berkeley, on 181 - 183.

Ellstrand, N. 1991. The case of the confusing cultivars. California Grower 15 (11): 42-43.

Ellstrand, N. C. & J. M. Clegg. 1990a. Cherimoya cultivar identification. Part IV. What happened to the McPherson? Fruit Gardener 22 (2):6-7.

Ellstrand, N. C. & J. M. Clegg. 1990b. Cherimoya cultivar identification. Part III. Rediscovering Deliciosa. Fruit Gardener. 22 (1):7-8.

Ellstrand, N. & J. Clegg. 1991. Report on cherimoya cultivars. California Cherimoya Association Newsletter 4 (3):6-7.

Ellstrand, N. C., T. L. Kahn, & M. L. Arpaia 1990. Cherimoya cultivars in California I. Status of registered and unregistered cultivars. California Cherimoya Association Newsletter 3 (1):4-6.

Ellstrand, N. C. & J. M. Lee. 1985. Differences in seediness among seven cherimoya varieties: preliminary studies. California Rare Fruit Growers Newsletter 17 (4):9-10.

Ellstrand, N. C. & J. M. Lee. 1986. Cherimoya fruit set: Differences among varieties at South Coast Field Station. California Rare Fruit Growers Newsletter (2):18-19.

Ellstrand, N. C. & J. M. Lee. 1987a. Cultivar identification of cherimoya *(Annona cherimola Mill.)* using isozyme markers. Scientia Horticulturae 32:25-31.

Ellstrand, N. C. & J. M. Lee. 1987b. Cherimoya cultivar identification. Part 1. A tale of two Pierces. Fruit Gardener 19 (1):5-7.

Hodgson, R. W., C. A. Schroeder, & A. H. Wright. 1950. On the comparative resistance of the avocado and certain other tender subtropicals and tropicals to low winter temperatures. California Avocado Society Yearbook 32-44.

Jerris, W. 1990. Evaluation of cultivars. Indoor Citrus and Rare Fruit Society Newsletter 33: 14
Kahn, T. L., C. J. Adams, & M. L. Arpaia 1994. Paternal and maternal effects on fruit and seed characteristics in cherimoya *(Annona cherimola* Mill.) Scientia Horticulturae. In press.

Popenoe, F. W. 1912. The cherimoya in California. Pomona College Journal of Economic Botany 2:277-300

Schroeder, C. A. 1947. Cherimoya varieties in California. Fruit Varieties and Horticultural Digest 2 :68-71.

Schroeder, C. A. 1989. The registry of subtropical fruit cultivars. Journal of the California Rare Fruit 21:55 -58.

Thomson, P. H. 1970. The cherimoya in California. California Rare Fruit Growers Yearbook 2:20-34.