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MANGO AND AVOCADO CULTIVARS PRESENT STATUS AND FUTURE DEVELOPMENTS



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ABSTRACT

The cultivar concept applied to fruit crops is discussed and contrasted with vegetables. The need for asexual propagation is emphasized and compared with seed reproduction. Current information on important cultivars of mango and avocado is presented by country of origin and area of commercial production. The relative importance and application of these cultivars to different areas and countries of the world is discussed. Future trends and new markets are mentioned in view of new methods of packing and transportation.

RESUMEN

Se discute el concepto 'cultivar' aplicado a frutales y se lo contrasta con vegetales. Se hace énfasis en la propagación vegetativa y se la compara con reproducción por semilla. Se presenta la más reciente información sobre importantes cultivares de mango y aguacate de acuerdo al país de origen y regiones de producción comercial. Se discute la importancia y la aplicación de estos cultivares a diferentes áreas y países del mundo. Se consideran posibles tendencias y nuevos mercados en vista de nuevos métodos de empacamiento y transporte.

INTRODUCTION

The cultivar concept is the cornerstone of development and progress in horticulture. All horticultural industries are based on the use of superior fruit or vegetable types, unique and different from each other in one or more outstanding characters which increase

their marketable qualities. While superior vegetable types can be obtained through artificially controlled manipulation of gene pools known to produce superior characters, most outstanding fruit types have evolved as the result of careful selection from among highly variable natural populations. In vegetables, and for that matter in agronomic crops, genetic uniformity in a cultivar is of paramount importance so that its superior qualities can be reproduced and perpetuated through the seed. However, the degree of heterozygosity in tree fruit cultivars makes asexual propagation necessary, otherwise genetic segregation changes desirable characters in resulting seedling populations. Thus, if a good quality cultivar cannot be readily propagated by conventional asexual methods, it will not be accessible to growers and to the consuming public.

Mangos and avocados, in contrast to temperate fruits, are relatively recent introductions to western civilization. The mango has been known in India and Southeast Asia for more than 4000 years and became known to Europeans through the voyages of 16th century Portuguese navigators (2). On the other hand, the avocado, a tropical American fruit, was discovered after Columbus' first voyage to the new world (3). Thus, the mango has been selected and propagated in tropical Asia for as long or probably longer than recorded history. This of course explains the multiplicity of mango cultivars found in this region of the world. However, a true scientific approach to mango selection and propagation is a relatively recent development in horticulture. There are today, many places in the world where serious, systematic attempts have been made to obtain new, superior cultivars of both mango and avocado. The most successful and continuous research efforts in the last 70 years have been conducted in Florida, California and Hawaii. Recently, Israeli horticulturists have advanced to the forefront of mango and avocado research, and are putting considerably more effort and funds towards obtaining cultivars for their developing fruit industry than horticulturists in the United States or any other country (1).

MANGO CULTIVARS

The great majority of the best mango cultivars in the world have been obtained by repeated selection from the progeny of trees which were originally selected from naturally occurring types. Due to the nature of mango flowers, their small size and the high ratio of flowers to fruits obtained, mango breeding has generally been very impractical and unprofitable. Consequently, very few cultivars have been developed by this method, and the few hybrids obtained have seldom been good enough to be considered of commercial value.

IMPORTANT AREAS FOR MANGO CULTIVAR DEVELOPMENT

Florida. This state enjoys a unique position in this field and distinguishes itself in having developed, in a relatively short time, a large number of mango cultivars. Today, these cultivars constitute the mainstay of established and developing mango industries in tropical and subtropical areas. Practically all of Florida's valuable commercial cultivars have arisen as selections from populations of first and second generation seedlings of

the best types introduced from other countries. It is interesting to note that none of the original accessions have shown commercial value. Since Florida has a very humid climate, most introduced cultivars were found to be highly susceptible to anthracnose disease (*Colletotrichum gloeosporioides* Penz.), or lacked overall marketable quality.

One of the first successful selections from second generation material was 'Haden', which originated in Miami as a seedling of 'Mulgoba', an Indian cultivar introduced to Florida as early as 1883. 'Haden' combined many desirable characteristics for the U. S. market, the most important of which were lack of fiber, good flavor, and attractive color. It was the standard Florida variety for more than 40 years. Unfortunately, 'Haden' proved to be too susceptible to anthracnose under Florida conditions and its erratic production made it necessary to seek more reliable cultivars. Thus, a second generation group of cultivars appeared in the late 30s, 40s and early 50s. All of these were characterized by productivity, excellent color, eating quality, and extended season of maturity. Resistance to anthracnose was, with a few exceptions, equal to or slightly better than 'Haden'. The most important in this group, some of which have attained commercial value, were 'Irwin', 'Fascell', 'Kent', 'Zill', 'Keitt', 'Sensation', 'Dixon', 'Smith', 'Carrie', 'Adams', 'Ruby' and 'Palmer'. Of these, a few have steadily lost ground to a third generation of mango cultivars appearing in the 50s and 60s which are distinguished by greater resistance to anthracnose, very attractive color, good shelf life and shipping qualities. In some cases, this outstanding holding capacity has been achieved at the expense of slightly more fiber than the desired minimum. This trait, although objectionable to some mango connoisseurs, has not proven to be a disadvantage in marketing because the consuming public does not recognize these subtle differences in mango quality. The most important representative of this group of cultivars is 'Tommy Atkins'. Still under trial are 'Jubilee', 'Van Dyke', 'Duncan' and a few others. Cultivars most popular with Florida mango growers at present are listed in Table 1.

Hawaii. Due to the relatively low mean temperatures during the period of mango fruit development and maturity, most Florida cultivars in Hawaii do not attain a high enough sugar content in the fruit to be flavorful. Because of this, Hawaii has developed its own cultivars such as 'Pope', 'Momi K' and 'Gouveia' (5). A good selection still under trial is 'Ah Ping'. However, 'Haden' is still one of the best known and most popular cultivars in the Islands.

Israel. 'Haden' is also quite popular in Israel although in early spring it is very susceptible to low temperatures which cause small, seedless fruit. 'Mabroka', a cultivar originally from Egypt, is widely planted because it blooms late and escapes potential frost damage in early spring. 'Maya', a seedling of 'Haden', and 'Nimrod' are also becoming very popular, (1). Florida cultivars are actively tested in Israel and it has been found, as in other areas with cool springs and short warm summers, that some varieties such as 'Irwin' are dwarfish, never attaining the size commonly seen in Florida.

Philippines. By far the best and most widely planted mango is 'Carabao', a

polyembryonic type with excellent post-harvest holding capacity. It is shipped to Hong Kong and Japan in increasing amounts. Second in importance is 'Pico', a large-seeded cultivar also with good shelf life. Other minor cultivars are listed in Table 1. Philippine cultivars are all polyembryonic as are most others belonging to the "Indochinese group" native to relatively humid tropical Southeast Asia (7, 9).

Indochina and Indonesia. There are mango types in some areas of Southeast Asia that are consumed as vegetables or pickled when green and immature. Cultivars of this group are adapted to this use because of their low acidity when immature. Nevertheless, when ripe, they are sweet with a distinctive mild, somewhat spicy flavor. In Thailand they are generally referred to as the "waxy" mangos and more specifically as the "Man" or "Mun" group. Also, well known in Thailand are 'Okrong' and 'Nam-doc-mai', while in Indonesia 'Golek' and 'Aroemanis' have traditionally been the most important cultivars.

Despite their excellent flavor no Indochinese mango cultivar has attained commercial importance in Florida because of their relatively unattractive color. However, the Manila or Philippine types are known in Mexico since their introduction by the Spaniards in the 17th century and are still of some commercial importance. Mango cultivars of commercial value in this region are listed in Table 1.

Indian cultivars. The majority of Florida cultivars derive their colorfulness from Indian types. However, the best known commercial cultivars in India lack this color attractiveness and are either yellow or greenish yellow. One of the few exceptions is 'Totapari' (variously known as 'Bangalora' and 'Sundersha') a richly red type which has undoubtedly contributed genetically to the colorfulness of Florida cultivars. The most appreciated cultivars in India are 'Dasher' (variously spelled 'Dusheri', 'Dasahari') 'Chawsa' ('Chausa') and 'Alphonse'. 'Dasher' and 'Alphonse' are considered by the majority of Indian horticulturists (8) as the best of their cultivars. I would add 'Chausa' because of their unusually good shelf life. All three are low in fiber, very sweet, and have an excellent flavor, although the seed (particularly in 'Alphonse') is larger than desirable, and production is generally low by Florida standards. Some of the most important Indian commercial types are listed in Table 1, according to the region where they are best known.

Table 1. Important mango cultivars listed according to their country of origin and commercial production.

Country	Cultivar	Country	Cultivar
<u>Australia</u> :	Kensington	<u>Indonesia</u> :	Golek, Aroomanis, Gadoong, Wangi
<u>Brazil</u> :	Non-plus-ultra, Bourbon, Oliveira-Neto, Haden*, Extrema, Manga da Rosa	<u>Israel</u> :	Haden*, Maya, Nimrod, Sarafend, Mabroka*
<u>Burma</u> :	Nettes, Tazumeik, Sinbaung, Thou-lou-ta-daung, Thalapet, Htaik-pauk	<u>Haiti</u> :	Madame Francis
<u>Cambodia-Vietnam</u> :	Xoai voi, Xoai-thanh-ca	<u>Hawaii</u> :	Pope, Momi K, Gouveia, Haden*
<u>Cuba</u> :	Haden*, Bizcochuelo, Macho	<u>Jamaica</u> :	Bombay*, Julie*
<u>Egypt</u> :	Mabroka	<u>Kenya</u> :	Ngowe, Boribo, Apate, Batwawi
<u>Florida</u> :	Haden, Irwin, Smith, Tommy Atkins, Kent, Keitt, Palmer, Sensation	<u>Mexico</u> :	Manila, Haden*, Irwin*, Keitt*
<u>India</u> :	<u>North</u> : Dusehri, Langra, Chowsa <u>West</u> : Alphonse, Kalepad <u>South</u> : Banganpalli, Jehangir Bangalora, Imanpasand Allumpur-Baneshan, Pairi, Suvarnarekha, Cherukurasam	<u>Malaysia</u> :	Timun, Sourabaya, Serikaya
<u>East</u> :	Himsagar, Gulabkhas Bombay, Bombay Green	<u>Philippines</u> :	Carabao, Pico, Señora Pahutan, Dudul, Binoboy
		<u>Puerto Rico</u> :	Mayagüezano, Haden*, Mangotino, Colombo Kidney*
		<u>South Africa</u> :	Sabre, Peach
		<u>Thailand</u> :	Nam-doc-mai, Tong-dum, Okrong Brahm-Kai-mia, Pen-sen-Man, Prum Kaewsaard
		<u>Trinidad</u> :	Peter* (Bombay)

* Originated elsewhere but commercially cultivated in this country.

CULTIVARS OF LESS IMPORTANTS AREAS

The West Indies is a region in which some mango development has occurred. 'Madame Francis', a fibrous, early mango of fair quality is at present being exported to the U. S. from Haiti during late May and early June before Florida mangos begin maturing. 'Julie', a cultivar originally from the Reunión Islands, has been popular for years in some islands where French and English are spoken. This cultivar is greenish yellow, and of a

characteristic "starchy" flavor, pleasant to some people but generally undesirable. The tree is one of the few dwarf mangos known, although very old trees sometimes grow to large size in Martinique and other islands. 'Julie' and the 'Turpentine' types of tropical America are difficult to categorize as either "Indian" or "Indochinese" and are placed by some in a third group of mangos along with others that cannot be readily classified (7, 9).

'Kensington' is a productive, fair quality mango common in Australia. In Kenya, 'Boribo' and 'Ngowe', two polyembryonic types are popular. In Brasil some well known cultivars are also polyembryonic (4), as are the "Turpentine" and 'Manila' types in Mexico, 'Peter' in Trinidad, and cultivars common in Cuba (see Table 1). The significance and abundance of mango polyembryony (apomixis) in the tropics is explained by the fact that cultivars in this group do not need to be grafted; their seedlings, in most instances, reproduce the characters of the mother tree. Thus anyone who can plant the seed, can propagate good cultivars. This is a happy circumstance since grafting in the tropics is still shrouded in a veil of mystery, accessible only to the few trained horticulturists.

AVOCADO CULTIVARS

California and Florida have been world leaders in avocado pomological research. Their different climates have made necessary the selection and development of two diverse groups of cultivars. Thus, Mexican and Mexican X Guatemalan hybrids proved better adapted to California and West Indian or West Indian X Guatemalan hybrids to Florida.

California. 'Fuerte', a Mexican X Guatemalan hybrid originally from Atlixco (Puebla State), Mexico, was developed in California around 1911, and to date is the most valuable contribution to avocado horticulture. It is one of the oldest cultivars and is still the mainstay of the California avocado industry as well as that of Israel, Australia, Mexico, Chile, South Africa and other countries with a rather cool, dry climate. 'Hass', at present in second place, is slowly replacing 'Fuerte' in many areas due to its greater productivity and reliability. 'Bacon' and 'Zutano' are the other two commercially recommended varieties in California. 'Bacon' is ideally suited to tropical American areas above 1600 m elevation. 'Edranol', a late cultivar no longer recommended commercially for California, does very well in Mexico, where it commands excellent prices as late as April. Other cultivars which have had importance in California at one time or another are listed in Table 2.

Florida. Unlike California, Florida grows a multiplicity of avocado cultivars. This is mostly due to the fact that Florida cultivars cannot be "stored" on the tree for several weeks like those of California, and once they reach maturity they begin dropping. By planting several varieties which mature in succession at different months of the season, the grower avoids having to harvest all his crop in a few weeks, thus eliminating serious labor problems and a glutted market. The season in Florida begins in July and ends in January but approximately 40% of the production is concentrated during the months of October and November.

Commercially, 'Booth 8' is the most important cultivar, contributing at present 30% of the total production. Like most cultivars in Florida, it has rather low oil content (6) but is very productive, although it tends to alternate bearing. 'Lula' is still second in importance; although very few groves of this variety have been planted in the last 10 years. It is particularly susceptible to scab disease (*Sphaceloma perseae* Jenkins) and its tall, upright growth increases the costs of spraying and harvesting. Other avocado cultivars recommended for Florida are listed in Table 2.

Many U. S. developed cultivars are the mainstay of growing avocado industries in tropical and subtropical countries.

Israel. This country, with its Mediterranean climate, relies on California cultivars for its production. 'Fuerte', 'Hass', 'Anaheim', 'Nabal' and 'Benik' are the main export varieties, but the latter is being phased out because of poor production. 'Ettinger', a locally developed type and believed to have originated as a seedling of 'Fuerte', is also quite popular. Some "Fuertelike" selections still under trial are 'Tova', 'Horeshim', 'Neta'im', 'Shefayyim', 'Yehi'am' and 'Scotland'.

Table 2. Important avocado cultivars listed according to their country of origin and commercial production.

Country	Cultivar	Country	Cultivar
<u>Australia:</u>	Sharwill, Fuerte*	<u>Israel:</u>	Ettinger, Fuerte*, Hass*, Nabal*, Benik*
<u>California:</u>	Nabal*, Fuerte*, Hass Anaheim, McArthur, Bacon, Zutano, Rincón, Ryan, Hellen, Edranol, Dickinson, Carlsbad	<u>Mexico:</u>	Fuerte, Hass*
		<u>Puerto Rico:</u>	Avila, Gripiña (Series), Isabela (Series), Semil (Series)
<u>Chile:</u>	Corona, Fuerte*, Nabal*, Hass*		
<u>Cuba:</u>	Catalina, Garcia No. 1		
<u>Florida:</u>	Ruehle, Simmonds, Nadir, Waldin, Tonnage, Booth 8, Booth 7, Hall, Monroe, Lula, Choquette		

* Originated elsewhere but commercially cultivated in this country.

Mexico. Perhaps the largest producer and consumer of avocados in the world, it has relatively few organized commercial groves as such. This is rapidly changing and many new plantings are being made in response to an increased internal demand and the prospect of international trade. California varieties such as 'Fuerte' and 'Hass'

predominate in high areas, with experimental plantings of 'Edranol', 'Ryan', 'Anaheim' and others. Florida cultivars such as 'Lula', 'Booth 8', 'Booth 7', 'Hall' and 'Choquette' are popular in the lower coastal plains, but have less appeal to the Mexican taste than California types.

Chile. This country, in the southern hemisphere, has excellent conditions for avocado growing particularly in the Quillota Valley, north of Santiago. The most planted cultivars are 'Fuerte', 'Nabal', 'Hass' and 'Corona'. The latter is a locally developed "Fuerte-like" variety more productive and somewhat later than 'Fuerte'.

Spain. Limited plantings in Southern Spain in the area of Almuñecar consist mostly of 'Fuerte' and 'Hass'.

CONCLUSIONS

There are literally thousands of locally developed cultivars of both avocado and mango in many countries and areas of the world which will gradually disappear as new superior types are developed or introduced. There are also many cultivars which, while unsuitable commercially in one country or region, can be grown successfully in another where the altitude and climate are more favorable.

Local and international market trends, new methods of disease control, and grove management, new transportation and packing technology, and availability of labor will have a definite impact in the future on the selection of cultivars. As more air transportation is made available to growers and its costs lowered, cultivars the world over will certainly be standardized but probably new ones will be developed to fit conditions still unforeseen today.

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