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THE *PERSEA* GERMPLASM RESOURCES POTENTIAL AS DISCOVERED DURING AN INTERNATIONAL COLLECTION PROJECT

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SUMMARY

During a long-term project many hundreds of avocado and other Persea trees were surveyed, and a few hundred were collected and conserved. Evaluation of the genepool for horticultural purposes has been commenced.

The most important general conclusions are: 1. The diversity of the avocado resources is still very high. 2. In many places and centers of origin important material was lost forever. 3. Many other representatives of the avocado groups and avocado relatives are in an endangered situation. 4. Based on this work and other sources, the exploration and collection should be continued, in order to preserve important resistant traits.

BACKGROUND

The avocado (Persea americana) and its close relatives-other species of the sub-genus Persea – are native to tropical America and became endangered through the process of forest eradication. It is most important to rescue enough material from those endangered populations in order to have a germplasm bank with high diversity and a big potential of resistance to limiting factors. The future of the avocado industries depends on the existence and study of this genepool.

METHODS

After dealing with the avocado germplasm subject for several years, we managed to start an international project in 1989.

Its objective was to study the avocado germplasm resources, as well as those of other Persea species, under different ecological conditions in Central and South America, and their potential as horticultural material.

During the years 1989-1996 exploration trips were done in the countries of origin, and the tree populations were described. Many places were visited 3 or 4 times, in order to see flowers in the blooming season or to collect seeds from a ripened fruit.

The field exploration and collection of material was followed by the establishment of gene pool orchards in Mexico, Guatemala, Costa Rica and Israel. In these countries, cooperation with local scientists was continued during the whole period. Cooperation with local people for a shorter period was established in Honduras, Panama, Ecuador, Peru and Chile. Material was collected also in the USA, Hawaii and Spain before and during the period of this project.

Parallel to the exploration and collection, a biochemical study was carried on by Dr. G. Bufler in Hohenheim University, Stuttgart, Germany. DNA study by different methods helped to establish "finger-print" of individual accessions. Database of avocado material was established in which avocado passport data and molecular data is included. Avocado descriptors was written by the team of this research – A. Barrientos, L. Lopez-Lopez, M.W. Borys (Mexico), G. Bufler (Germany) and A. Ben-Ya'acov (Israel), and published by the IPGRI, Rome.

In the present article, the germplasm potential of the Persea, as found during the project will be described.

RESULTS AND DISCUSSION

The germplasm explored during the International project will be listed according to its botanical classification.

1. Genus: Persea, sub-genus Persea.

1.1. Species: Persea americana

1.1.1. Sub-species: Drymifolia (Mexican avocado)

This avocado race is well distributed in the highlands of Mexico. Many individual trees were explored in the states of Vera-Cruz, Puebla, Mexico, Queretaro, Gerero, Michaocan and Guanojuato. The most primitive population was found in the village of Aquila, in Vera Cruz. The oldest known Mexican avocado tree was found in the village of Tochimilco, in the Puebla state. This tree was planted before the Conquest. The Mexican avocado trees in the state of Chiapas are a minority, among the Guatemalan trees. They are called "Tzi-tzi". It looks easy to distinguish the "Mexican" trees among their "Guatemalan" neighbors, as the race characteristics of each group are very clear and no intermediate type could be found. But the genetic analysis made in Germany has showed that many Guatemalan trees have Mexican identification traits and vice versa.

Avocado trees of the Mexican race can be found also in Guatemala, where they are called "Matuloj", and as in Chiapas, here also they are a minority among many Guatemalan trees. The only other big center of Mexican race avocado trees is the "Nacionales" of Ecuador. We do not know of any good explanation about the existence of source of this group of trees.

The horticultural potential of the Mexican avocado is mainly in the fact that this race is the hardest in regard to low temperatures. This could be taken in to account in breeding programs. In some cases, both in Mexico and in Ecuador, the trees stand a high concentration of lime in the soil. Very few "Mexican" avocado type trees were selected as commercial cultivars, although they have very

good flesh quality. “Negra de la Cruz” in Chile and Bacon in California were selected under colder climate conditions. In CICTAMEX genepool in Coatepec Harinas, Mexico, few cultivar candidates are included.

1.1.2. Sub-species: Guatemalensis (Guatemalan avocado)

Many seedlings of the Guatemalan race are distributed in the highlands of Guatemala and Chiapas. Few trees can be found in other parts of Mexico or in Honduras. In regard to germplasm conservation, primitive types were collected. Their typical fruit is small, and its shell is thick and woody. The smooth seed is an important trait, typical to the Guatemalans, including the primitive ones. Scattered avocado trees mixed with pine trees in the village of Motozintla, Chiapas, are most typical to this “primitive” Guatemalan avocado trees. The “Aguacate de Mico”, according to our experience, is also a “primitive” Guatemalan, and not another Persea.

The agricultural potential of the Guatemalan avocado is very high, as it is the best – and probably the only – source for selection of new commercial cultivars from native population. In Guatemala, many of the seedlings grown in backyards and in coffee plantations, have high productivity and excellent quality: their seeds are small, the skin is not too thick and the flesh is nice and tasty. The ripening season is between September and June; hence selection work can supply cultivars for a relatively long season.

In the highlands of Honduras, “Aguacate de Anis” was earlier described by Wilson Popenoe, and is easy to find even today. The tree and the fruit characteristics are typical of the Guatemalan race, but the fruit has a strong anise smell. For us, this is an exceptionally interesting Guatemalan avocado, of which the horticultural value should be evaluated.

1.1.3. Sub-species: Americana (the West-Indian avocado)

We have surveyed the lowland avocado of this race all along the Pacific and the Atlantic oceans, from sea level and up to 1000m. above sea level from Sinaloa in Mexico to Ecuador (Pacific side) and from Vera Cruz in Mexico to Colombia (along the Atlantic shores). They can be found also in Hawaii, the Caribbean Islands, and the Canary Islands. There is an open question in regard to the place of origin, and the ways of distribution.

The West-Indian avocado shows a big diversity because of its wide distribution. A few typical groups are mentioned:

- The dwarfing West-Indian in the lowland of Vera Cruz, Mexico and in the Canary Islands
- A vigorous type in other parts of Mexico and Central America.
- Wild trees were found in Avocatosa, Nayarit, Mexico and in Sierra Tantima, Vera Cruz, Mexico.
- Seedling orchards are common to Tapachula, Chiapas, Mexico, to Southern Guatemala and to Brazil.
- Seedlings are well distributed in backyards in Yucatan and elsewhere. Many of the trees in Yucatan are rounder than typical West Indian.
- West-Indian cultivars were selected in Florida, Hawaii, Puerto Rico and Cuba. In the same coun tries, grafted orchards could be found.
- In Coastal Pacific areas of Costa Rica, many of the trees are different from those described in northern countries, and look like Guatemalan x West Indian hybrids. These populations show drought resistance, especially in Guanocaste, salt resistance – in the Nicoya peninsula and inundation resistance in Orotina.

- In the coastal Pacific area of Ecuador, both the trees and the fruit look different, and another type was found in the Amazonian basin and in the slopes of the Vulcan Sierra Madre del Santa Marta, in Colombia.
- Near the Cienaga Grande in Colombia, avocado seedlings are grown in so-called saline soil.

The horticultural potential of the West Indian avocado lies mainly in its resistance to soil retarding factors. West Indian seedling trees and West Indian seedling and clonal rootstocks are known for their resistance to lime induced chlorosis and salinity. It also looks more promising to select root-rot resistant rootstocks among the West Indian seedling population than in any others. On the other hand, the West Indian avocado is more sensitive to cold temperature and to poor aerated soil than other types.

The quality of the West Indian avocado fruit is not considered acceptable by most export markets. But in the Caribbean Islands and in Brazil, their quality is preferred. Hence, the potential of this race for cultivar breeding is limited to local markets.

1.1.4. Not identified P. americana accessions

The exact identification of the sub-species of the Persea americana is not easy in many cases but new methods of genetic analysis will make it possible to improve it in the near future. Some avocado groups don't have any clear and significant symptom of one of the three races described earlier, and we would like to mention them here.

1.1.4.1. The Mountain avocado of Costa Rica

In a study of avocado genetic resources the related species were explored in Costa Rica. It was found in this country that the native avocado population and its botanical relatives are unique and differ from those known from northern countries. One unique item is the mountain avocado of Cost Rica, hereby described as a new sub-species – Persea americana var. Costaricensis.

This is abundant type of avocado, distributed in elevations between 1200 and 2000m. above sea level. The fruit characteristics separate it from other known sub-species: it is much smaller than West Indian (P. americana var. America) and Guatemalan (P. americana var. Guatemalensis) avocados; it has a skin like the West Indian avocado in its pale green color, soft leathery texture, medium thickness and peelability, but a seed like the Guatemalan avocado in its oblate form and smooth surface.

1.1.4.2. The avocado of Monte Verde, Costa Rica

In the natural cloud forest of Monte Verde, Costa Rica, we found vigorous avocado trees, which produce big fruits. This type of avocado is called by local people Nubijena (Nubichena) but the fruit is much bigger than Persea nubigena fruit known from Guatemala.

1.1.4.3. Old avocado trees of Southern Spain

There are some dozens of old avocado trees near Malaga, on the southern coast of Spain. They were planted a long before the avocado industry was established, and probably from material brought by Spaniard explorers during the years of the occupation of Mexico. From leaves and fruit examination it was hard to decide whether they belong to the Mexican race (but with no anise smell) or to the Guatemalan one (but with smaller leaves and not typical fruit). Probably they are hybrids of these two races. Some of the trees were included in horticultural experiments in the station "La Mayora", and some were included in the Israeli gene pool, but no horticultural characteristics can be mentioned here.

1.2. Species: Persea nubigena

The last two centers of the Persea nubigena still exist in Guatemala: Around Cero Chichoy, in Tecpan, and in Miramundo, Jalapa. Both were described by the late Dr. E. Schieber. P. nubigena is a close relative of the Guatemalan avocado, and probably an ancestor of it. Lucille Kopp recommended a unification of the two groups.

Very little is known about the Persea nubigena as avocado rootstock, and as a fruit it does not have any value. But as it is endangered and a very important primitive type, it should be conserved immediately.

1.3. Species: Persea steyermarkii

This species differ from P. nubigena in a few botanical traits, and is considered to be a rare species. The species was described in San Marcos, Guatemala, but we did not manage to find it there. On the other hand, we found a big population of trees on the mountains of Chipas, near Tzontehuitz, north of San Cristobal de las Casas, and few trees in Huitepec, west of San Cristobal. Its horticultural value is not known.

1.4. Species: Persea floccosa

Persea floccosa was described in the past near the border of Vera Cruz and Puebla, in Mexico. At the present time we also managed to find it there. Items in the Israeli collection were brought from Riverside.

1.5. Species: Persea schiedeana

Persea schiedeana is the most distinctive of the subgenus Persea, and is compatible with avocado. It is well distributed throughout the avocado native land, from Central Mexico, through Central America and probably also in Colombia, with the popular name changing from country to country, and even in the same country: Chinini (Mexico), Hib or IB (Mexico-Chiapas), Coyo or Coyou (Northern Guatemala), Zucte or Chucte (Southern Guatemala and Honduras) and Yas or Jas (Costa Rica).

The fruit is very popular in Mexico and is sold in markets in the states of Vera Cruz, Puebla, Oaxaca, Tabasco and Chiapas. In some of these states the Chinini is cultivated as orchards of seedling trees. Probably there are “races” of the Persea schiedeana, that differ in botanical traits and in the elevation of distribution. The Yas of Costa Rica has huge trees but smaller fruits than the other local types, rounder and not edible. In the huge bi-national park of La Amistad, near the border of Costa Rica with Panama, the Yas is completely wild, as part of a primary forest.

It looks important to enlarge the genepool of the Persea schiedeana, and a big task of horticultural evaluation should be started with: rootstocks selection for avocado and for the schiedeana, grafting methods, and cultivar selection. Many of the trees produce poor ugly fruits, but in some trees excellent fruit can be found.

2. Genus Persea, sub-genus Eriodaphne

During the international project the emphasis was on the sub-genus Persea, as its species are compatible with the avocado.

Species of the sub-genus Eriodaphne, mostly incompatible with the avocado, were investigated randomly. Some of them are listed:

1. Persea indica: Native of the Canary Islands. Indicator for the presence of the Root Rot agent.

1. Persea borbonia: Resistant to Phytophthora cinnamomi.
2. Persea cinerascens.
3. Persea lingue: Native of Chile.
4. Persea meyeniana: Native of Chile.
5. Persea longipes: Native of Vera Cruz, Mexico.
6. Persea vesticula: Was investigated in Chiapas, Mexico.
7. Persea donell-smithii: Was investigated in La Cascada, Chiapas, Mexico and Alta Vera Paz, Guatemala.
8. Persea caerulea: In Costa Rica.

About 80 species belong to this subgenus, and the importance of their conservation is for the future, when propagation and hybridization will be easier.

Other interesting genera.

The family Lauraceae is rich in many other genera, beside Persea. We have seen many Ocotea spp. and Nectandra spp. trees, but fruit appearance closer to the avocado can be found only in the genus Beilschmedia. In the states of Vera Cruz and Puebla, Mexico, one can find two important species, B. mexicana and B. anay. Both are edible but incompatible with the avocado. Selection of superior trees was done among those planted in coffee plantations. In Chile we collected seeds of B. miersii, a non-edible but interesting relative of the avocado.

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