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The Necessity of Avocado Germplasm Resources

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Abstract. Plant genetic resources are widely recognized as vital to a prosperous future for agriculture and society (Levin, 1990; Myers, 1983; Plucknett *et al*., 1987). Wild relatives and feral forms of economically important tree crops often possess unique characteristics, genes, or genetic combinations that could be useful in breeding or scientific study. The practices of modern mankind have resulted in a tremendous loss of global biodiversity. Predictions for the future are that this trend will continue (Rowntree, 1990; Williams, 1990). First, we will outline why plant germplasm resources, in general, are important. Then, we will mention some of the ways germplasm can be maintained for future benefit. Finally, we will discuss some specific germplasm issues that relate to the genus Persea and the avocado industry.

Modern agriculturalists have inherited crop varieties that were adequate for past environments and production requirements but are less than ideal for the demands of agriculture in the 1990's and beyond. Production of all types of crops will be most successful and profitable where botanical knowledge, cultural expertise, and cultivar development advance at a healthy pace. Progress in each of these areas is frequently dependent on the availability of a broad diversity of germplasm related to the crop in question. In other words, successful crop production in the future will be closely related to the availability of germplasm for scientific study and breeding.

Plant germplasm resources provide a repository of unique characteristics that may be of value in several ways.

First, plants related to cultivated varieties may possess unique characteristics that improve our basic understanding of processes contributing to and constraints on productivity. For example, the study of salinity tolerance or disease resistance in a wild species may enhance our ability to manage these problems in a cultivated variety.

Second, plant germplasm resources allow a comparative evaluation and classification of crop selections and relatives into discrete families, genera, and species. A logical taxonomy for crop families and a description of relationships can eliminate confusion in the literature, and provide insight that is essential for other scientific research and genetic improvement programs.

Third, plant germplasm resources provide a source of unique genes that may confer desired characteristics when integrated with existing genetic combinations in future varieties. Whether the desired character is insect resistance, cold hardiness, a unique flavor, or productivity, nature seems to have produced a gene for nearly every possible purpose. The integration of the unique genetic material may be by sexual hybridization or genetic transformation, but plant genomes will continue to provide the major source of genetic material for plant improvement throughout our lifetimes.

Fourth, germplasm resources may yield cultivated varieties directly. Little-known selections or relatives with special characteristics may prove to be of value under unique conditions or for previously untested purposes. For example, suitability as a rootstock is generally unrelated to fruit characteristics and can only be effectively evaluated by cultivation in an appropriate scion/rootstock combination under production conditions.

Fifth, unique genotypes may form the basis for new crops and industries. New markets always exist for unique specialty produce, especially for fruits, vegetables, and ornamentals.

The uses for crop genetic resources continue to change as crop industries evolve in response to altered environmental conditions, production, or consumer preferences. Questions or problems that seem appropriate today will almost assuredly be replaced by other concerns in the years to come. These arguments and others clearly indicate the necessity of crop germplasm resources. How can we assure that germplasm will be available when needed?

We should note that for nearly all crops at least two major types of germplasm resources exist, cultivated varieties and wild relatives. Objectives and methods for conserving these two types of germplasm differ considerably, in ways we have not space to discuss here. However, let us recognize that each plays an important role in scientific and genetic advancement.

Conservation of wild relatives would probably be best accomplished *in situ* or as natural populations in their place of origin. Unfortunately, destruction of natural habitats is proceeding at a frightening pace (Roberts, 1991). Extinction of tropical rain forests with their Lauraceous taxa, including the relatives of avocado, is especially tragic. Even for crop relatives in secure habitats, the necessity of easy access frequently requires that at least some population samples be maintained in close proximity to where research and breeding is conducted. Maintenance of germplasm resources in managed collections associated with research facilities is thus highly desirable, if not essential, for important crop species.

The type of managed germplasm collection that is most practical varies considerably from crop to crop, according to botanical characteristics and financial considerations. For inbreeding annual species, seed storage facilities provide an effective, economical method of preserving germplasm. For perennial tree crops, like avocado, practical considerations require that material be maintained as sexually mature trees in a field or protected enclosure. Emerging methods of micropropagation (Withers *et al*., 1990) and cryopreservation (Ganeshan and Alexander, 1989) offer promise for supporting or increasing the effectiveness of tree crop germplasm collections, but cannot replace them. Issues related to plant germplasm collections are often further complicated by pest and disease quarantine regulations. Other restrictions resulting from the desire to keep specific germplasm resources for oneself or one's country also need to be overcome. Free exchange of germplasm is facilitated by the recognition that thoroughly documented, disease-free, germplasm collections, supplying material freely to all interested parties, are of benefit to everyone. Description, evaluation, and genetic characterization of material *in situ* or in collections is another essential part of assembling and utilizing plant germplasm.

Because germplasm collections are important, a large number of organizations have become involved. Official plant germplasm collections in the United States are coordinated through the National Plant Germplasm System (NPGS). Similar activities at the international level are managed by the International Board of Plant Genetic Resources (IBPGR, 1990).

The official NPGS repository for avocado germplasm is in Miami, Florida. However, California research on breeding, genetics, pathology, physiology, and taxonomy has realized considerable benefit from a modest avocado germplasm collection at the University of California Research and Extension Center in Irvine.

The Mexican, Guatemalan, and to a lesser degree. West Indian subspecies of *Persea americana* Mill, are well represented in the UC collections. Other Persea relatives represented in our collection include: the genera *Beilschmiedia* Nees (Fig. 1A) and *Nectandra* Rol. ex Rottb.; in the genus *Persea* (Clus.) Mill, subgenus Persea, we have *P. floccosa* Mez., *P. primatogena* Williams and Molina, *P. schiedeana* Nees, *P. steyermarkii* Allen (Fig. 1B), and *P. tolimanensis* Schieber and Zentmyer; in the subgenus *Eriodaphne*, we have *P. borbonia* (L.) Sprengl. (Fig. 1C), *P. cinerascens* Blake, *P. donnell-smithii* Mez. {Fig. 1D), *P. indica* (L.) K. Spreng., *P. longipes* (Schlecht.) Meissn., *P. pachypoda* Nees, and *P. skutchii* C. K. Allen. Species *P. nubigena* (Williams) Kopp and *P. lingue* (Ruiz and Pavon) Nees were once contained in our collection but have been lost to root rot. Rejuvenation and expansion of the existing collection is planned to accommodate specific needs and prepare for future demands.

For taxonomic study of the ancestry of *Persea americana* ssp. *guatemalensis*, we need ssps. *nubigena* (Williams} Kopp, *tolimanensis*, and *zentmyeri* (Schieber and Bergh). To check the affinity of *Persea pachypoda* closely related genera are needed. *Phoebe* Nees, *Nothaphoebe* BL, and *Alseodaphne* Nees are also unsatisfactorily delimited versus *Persea*. Should Bentham's (Bentham and Hooker, 1880-1883) and Kostermans' (Kostermans, 1957) view be accepted to incorporate these into *Persea*? Again, not one single species is available in California for investigation. With the exception of *P. americana*, we are limited in our studies to one selection per taxon, and thus we have no idea about population variation. Other research in pathology, physiology, and genetics is similarly limited by the lack of a more complete germplasm collection.

Fig. 1. Flowering shoots of (A) *Beilschmiedia* sp., (B) *Persea steyermarkii*, (C) *P. borbonia*, and (D) *P. donnell-smithii*.

Several practical problems and major constraints in California avocado production perhaps could find solution among some of the avocado relatives. Asian Machilus Nees is considered congeneric with American Persea. A report from Algeria suggested that Persea varieties could be grafted on Machilus and might be more cold hardy than those on Persea (Winkler, 1943). We do not have a single species of Machilus for graft compatibility or affinity studies. Avocado forms and relatives in Asia and Oceania have received little attention and are very poorly understood. Yet selections have been observed that are undamaged by frequent flooding and may possess other useful characteristics. Support is urgently needed for acquisition and study of these forms, as well as adding to our collection of New World material.

In conclusion, investment of resources into germplasm exploration, collection, maintenance, and evaluation will yield dividends to the avocado industry as it has for other major crops. The cost of avocado germplasm collections is moderately high, but the future cost of not supporting them will be higher still.

Literature Cited

Bentham, G. and J.D. Hooker. 1880-1883. Genera Plantarum. L. Reeve and Co., London.

Ganeshan, S. and M.P. Alexander. 1989. Pollen preservation in tropical fruits and vegetables for establishing pollen cryobanks in India. Diversity 5:18-19.

IBPGR. 1990. Annual Report 1989. International Board for Plant Genetic Resources, Rome.

Kostermans, A.J.G.H. 1957. Lauraceae. Reinwardtia 4:193-256.

Levin, D.A. 1990. The seed bank as a source of genetic novelty in plants. Am. Naturalist 135:563-572.

Myers, N. 1983. A wealth of wild species: storehouse for human welfare. Westview Press, Boulder, Colorado.

Plucknett, D.L., N.J.H. Smith, J.T. Williams, and N.M. Anishetty. 1987. Gene banks and the world's food. Princeton University Press, NJ.

Roberts, L. 1991. Ranking the rain forests. Science 251:1559-1560.

Rowntree, P.R. 1990. Predicted climate changes under "greenhouse-gas1 warming, p. 18-33. In: M.T. Jackson, B.V. Ford-Lloyd, and M.L. Parry (eds.). Climatic change and plant genetic resources. Belhaven Press, London.

Williams, J.T. 1990. The implications of climatic changes for plant genetic conservation strategies, p. 167-178. In: M.T. Jackson, B.V. Ford-Lloyd, and M.L. Parry (eds.). Climatic change and plant genetic resources. Belhaven Press, London.

Williams, L.O. 1977. The avocados, a synopsis of the genus *Persea* subg. *Persea.* Econ. Botany 31:315-320.

Winkler, V.H. 1943. Avocado, Alligator-birne, p. 150-155. In: G.A. Schmidt und A. Marcus (eds.). Handbuch der tropischen und subtropischen Land-wirtschaft. Band 2. E.S. Mittler & Sohn, Berlin.

Withers, L.A., S.K. Wheelans, and J.T. Williams. 1990. *In vitro* conservation of crop germplasm and the IBPGR databases. Euphytica 45:9.