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The Challenge of Mango Breeding

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The mango is a lucrative and highly esteemed crop in every country where it is grown from India to the United States. Although man has been cultivating mangos for over 4,000 years little work has been done in the area of genetic improvement. This is not to say that the mango is not in need of horticultural improvement. To the contrary, there is a great deal of work awaiting the enthusiastic plant breeder. As with most fruit crops there is always the need for fruit of higher quality with good storage and shipping characteristics, cultivars which fruit early or late in the season to extend the period of marketing and of course disease and insect resistance is always desirable. Other problems encountered in mango cultivation are extreme alternate bearing in many cultivars, lateness to come into bearing (8 to 10 years from seed), large tree size which hinders harvesting and other cultural operations, poor fruit set especially in wet weather and a marked sensitivity to cold temperatures.

With the amount of breeding work needed to improve the cultivation of the mango one could wonder why so little has been done in the 4,000 years man has been growing this fruit. The difficulties encountered in mango breeding are many and we may start from the genetic nature of the mango itself. The mango is thought to be an amphidiploid. It is an outbreeding highly heterozygous species. Due to this heterozygosity results of intervarietal hybridization cannot be accurately predicted. Parents with desirable characteristics cannot be depended upon to transfer these characters to their offspring while parents of no special significance could produce highly desirable offspring.

Mango flowers are born on terminal panicles each panicle producing from 1000 to 6000 flowers. Flower size ranges from 6 to 8 mm and hermaphrodite and male flowers are born on the same panicle. This large number of very small flowers of mixed type makes hand pollination laborious and expensive. The major problem facing one who has hand pollinated thousands of mango flowers is the high percentage of fruit drop, somewhere around 99.9% (1). Thus, out of thousands of hand pollinations one could expect only a handful of progeny. This small number of offspring tends to make hand pollination a discouraging task. The small percentage of fruit set, coupled with the fact that only one seed is obtained per fruit, makes it extremely difficult to study the heritability, dominance, or other genetic behavior of specific mango characters.

Polyembryony occurs in certain varieties of mangos, most notably the Philippine varieties, and it may be a useful tool especially in the development of easily propagatable rootstocks. But polyembryony may also be a great hinderance to the breeder when a polyembryonic variety is used as a female parent. The inability to distinguish the zygotic seedling or the crowding out of the zygotic embryo by vegetative embryos and the subsequent death of the zygotic embryo defeats the purpose of hybridization.

As previously mentioned, seedling

mangos come into bearing anywhere from 8 to 10 years after planting. Before yield data can be recorded with any certainty another 4 to 5 years must pass. This makes mango breeding a rather long term proposition and there are not many plant breeders willing to work in an area where they may never see the results of their efforts. The prolonged nature of any mango breeding program necessitates continuous long term support from a well established governmental or private institution. Private institutions generally do not support such long term projects and the governments in many mango producing countries have neither the stability nor continuity to lend such support. Large tracts of land are required for progeny testing of mangos since spacing is generally between 10 to 15 m between trees and rows. Again, most mango growing countries cannot afford the luxury of setting aside such large areas of land for protracted lengths of time.

What can be done in the way of surmounting the many problems inherent in mango breeding? A major impetus would be the shortening of the juvenility period and this has already been accomplished to some extent by grafting seedling scions to established rootstocks shortening the juvenility period to 3 to 4 years. Much more work needs to be done in this area including the testing of various growth stimulators and the use of improved fertilization and other cultural practices designed to force trees into maturity as quickly as possible.

Hybridization techniques are also under study to find the most rapid and efficient method of hand pollination. These techniques are for the most part based not on the pollination of large numbers of flowers per panicle but rather on the pollination of a few flowers per panicle incorporating a large number of panicles. Success has been improved, but not dramatically. Self incompatability has been reported in certain mango cultivars and presents some exciting possibilities for the future. Self incompatability could pave the way for the use of isolated seed gardens and pollination of screened in plants by natural agents reducing labor and expense while possibly increasing the number of hybrids obtained.

Thus far, limited use has been made of high density plantings to lessen the amount of land needed for testing hybrid progeny. Primary screening for fruit size and quality may be done on plants grown under very close spacings saving only the best of these for further testing under wider spaced conditions. These techniques could incorporate closely spaced established rootstocks for high density planting culling out only the scions, leaving the rootstocks to be regrafted. This method could serve both to shorten the juvenility period and save valuable space.

Because of its high degree of heterozygosity the need for inbreeding and subsequent crossing to achieve heterozygosity does not seem to apply in mango breeding. It may be most profitable to make desired crosses with the idea of later backcrossing in order to increase the incidence of a desired character in an otherwise heterozygous offspring population. One may say that it is here, in the selection of parental material that mango breeding has had its greatest failing. There are literally hundreds of *Mangifera indica* cultivars of quite acceptable fruit quality but as mentioned earlier the problems that most of these cultivars have in common are alternate bearing habit, shyness to bear, lack of precosity, failure to set fruit particularly during the rainy season, large tree size and sensitivity to cold. A considerable pool of genetically valuable species exists within the genus Mangifera. Our knowledge of these 62 species is quite limited and little work has yet been done in hybridizing these with *Mangifera indica.* The genetic potentials of these plants are enormous. Their value as sources of precosity, disease and insect resistance, increased fruit set, cold tolerance, dwarfness and regular bearing should be one of the greatest assets in a mango breeding program. It has been speculated for example, that highland species may carry genes for greater cold tolerance while Philippine and Indo-Chinese species may carry genes to enhance fruit set in wet weather. Further, there are at least three other species out of fifteen edible species of Mangifera cultivated in the Indo-Burmese region where this genus originated. It seems as though interspecific hybridization could start with these if indeed any of these species proves to possess desirable qualities.

In summary: Mango breeding is now in its infancy. There are many problems to be surmounted but there are also some significant assets that breeders will be able to work with. A vast genetic pool is available not only within the species *M. indica* but within the whole genus Mangifera. Advances have been made into hybridization techniques, techniques for shortening juvenility and the possible uses of polyembryony and self incompatability. All these advances if given sufficient support and guidance may someday take the uncertainty out of mango breeding and further advance our knowledge of the principles of genetics.

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