Selection for cold tolerance in cherimoya trees

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The cherimoya, *Annona cherimola* Mill., is becoming increasingly popular as an ornamental and commercial fruit tree in California. Such popularity is well justified. It is an attractive tree with large, shade-giving leaves and sweetly perfumed flowers; most important, its fruit is reputed to be the most delicious of any from the Americas. Despite these virtues, cherimoyas can currently be grown only in a relatively small area of southern California, within 15 to 20 miles of the Pacific coast from the Mexican border to Santa Barbara.

The reason for this narrow distribution is that cherimoya has strict climatic requirements. The plants are cold-tolerant to only about 28°F. For example, the severe winters of 1947-48 and 1948-49 left every tree in the large collection at UCLA severely damaged or dead. Also, the plants are heat-tolerant to only about 100°F, above which leaf and flower damage occurs. Fortunately, cherimoyas have been reported to be variable with respect to both heat and cold tolerance, providing a substrate for improved tolerance through selection. A program of selection would thus expand the area in which cherimoyas can be grown successfully.

Because trees have long life cycles, tree crop improvement is typically a slow process. In this study, we surveyed a large number of seedlings for biochemical genetic markers (isozymes) before selection. By comparing selection response to biochemical genotype, we used isozymes as a short-cut method for identifying the potential crosses that should produce the highest percentage of successful seedlings.

We first analyzed cherimoya cultivars and found that each varied from the others for a number of isozyme genes. The seedlings that we first tested were volunteers of unknown parentage growing in the cherimoya collection at the South Coast Field Station. These seedlings were stressed in a growth chamber to the limits of cherimoya's cold tolerance. By comparing the genetic markers of the undamaged seedlings with those damaged, we found three genes linked to cold tolerance. All three of these occur in the variety 'Chaffey'. A similar approach was used to select for heat tolerance by leaving plants in the lathhouse during the summer, since Riverside's summers approach the limits of cherimoya's heat tolerance. In this case, one gene was found to correlate with heat tolerance. This gene is represented in the variety 'White'.

Intolerance to temperature extremes limits growth of the cherimoya, an ornamental tree with a delicious, exotic fruit, to a small area of southern California. Painstaking selection of more tolerant varieties produced two sets of seedlings that could expand the range of the cherimoya to other areas.

Crossing for temperature tolerance

Using this information, we performed a series of crosses involving 'Chaffey' to produce cold-tolerant seedlings and a series involving 'White' to produce heat-tolerant seedlings. The first set of seedlings were cold-tested; not a single seedling was damaged. Similarly, none of the second set suffered heat damage.

The obvious benefit of this project is that it produced two sets of cherimoya seedlings well suited to temperature extremes. At least one of these is likely to have the characteristics of a good commercial and/or ornamental variety, expanding the range of the cherimoya in California. But the project has yielded other benefits as well.

Cherimoya varieties are very difficult or impossible to distinguish by morphological characteristics such as fruit shape or leaf size. The biochemical markers we have developed are reliable for distinguishing all of the cherimoya varieties in California, even before the trees flower or set fruit. Furthermore, we have demonstrated that the genetic basis of these markers is simple and Mendelian. Simple, Mendelian genes are unknown for most commercial and ornamental tree species, but when discovered, they can provide the sort of short-cut for selecting desirable traits demonstrated in our selection tests. Thus, isozymes can serve as a useful tool for future improvement of cherimoya, bringing the tree into the yards of more Californians and the fruit onto their tables.

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