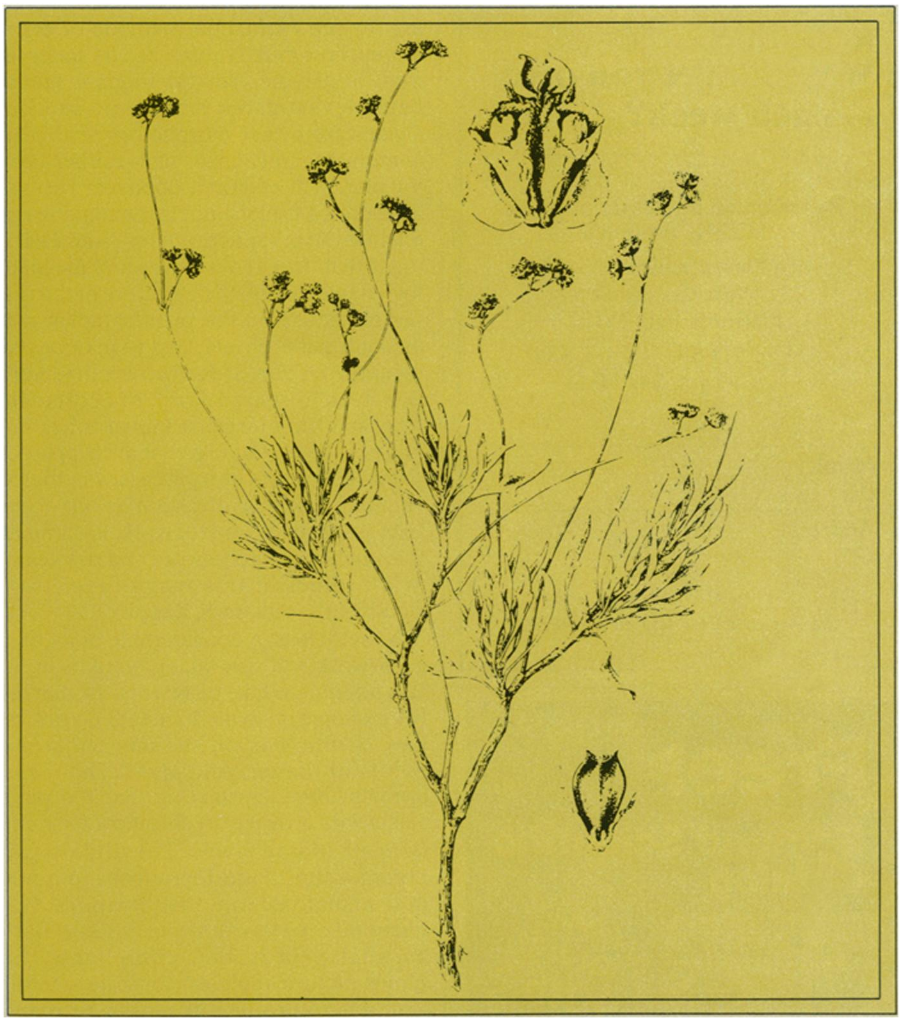
'Wy-oo-lee' Rebound

BY LINDA GARMON

Researchers once again are intensifying efforts to determine whether the guayule (pronounced wy-oo-lee) plant can be a domestic source of natural rubber

Photo and illustration: USDA



The scruffy desert shrub called guayule is at most 3 feet tall, but hopes were sky high among scientists during World War II that it would play a key role in the U.S. economy and national defense. Japan had invaded Southeast Asia, taken over the plantations of the rubber tree *Hevea* and cut off most of the U.S. rubber supply. Consequently, the U.S. government initiated the Emergency Rubber Project — a 32,000-acre planting of the rubber-producing guayule in an effort to make that shrub a domestic source of a crucial material. At war's end, however, as the *Hevea* rubber source was reinstated and as industry turned to the new and less expensive synthetic rubber, guayule was bounced out of the U.S. rubber picture. Thousands of acres of guayule were burned, and eventually all that remained of the plant's halcyon days were samples of seeds — for 25 guayule varieties that had been selected in the rubber project's breeding program — stored at the National Seed Storage Laboratory at Fort Collins, Colo.

Now, the U.S. Department of Agriculture has decided to beef up that seed supply. The department is planting 120 acres of five selected guayule lines and will plant an additional 80 acres this fall in suitable areas of California, New Mexico, Arizona and Texas. "Certified seed" for commercial use will result from these plantings. In other words, the U.S. government is giving guayule a second chance to compete with *Hevea* and synthetic rubber.

Opportunity is knocking twice for guayule not only because of the unpredictable political situation in Southeast Asia, but also because production of synthetic rubber utilizes petroleum — an increasingly expensive feedstock. In addition, because synthetic rubber is chemically different, it cannot totally replace natural rubber. (Thirty percent of the rubber in steel-belted radial automobile tires, for example, must be natural; airplane tires are 100 percent natural.)

Guayule, on the other hand, is nearly the same as natural rubber, say Goodyear officials who have even manufactured demonstrator guayule earthmover tires, auto tires and shoe soles to test its similarity. Still, says Paul Phillips of the University of Utah at Salt Lake City, little is known about what happens to guayule when it is treated to add such qualities as tear-strength, elasticity or resistance to heat — characteristics essential for the production of high-quality tires. And because these properties are determined by the way a polymer solidifies, Phillips is studying the crystallization of rubber when it is stretched, or stress-induced crystallization.

Phillips is working in cooperation with researchers from Mexico, where a pilot guayule-processing plant has been operating since 1976 at Saltillo, Coahuila. There, guayule processors use one of the two rubber extraction procedures currently being considered for commercial use: a water-NaOH-acetone solvent system. The other extraction method, suggested by Firestone Rubber Co., involves an acetone-hexane solvent process.

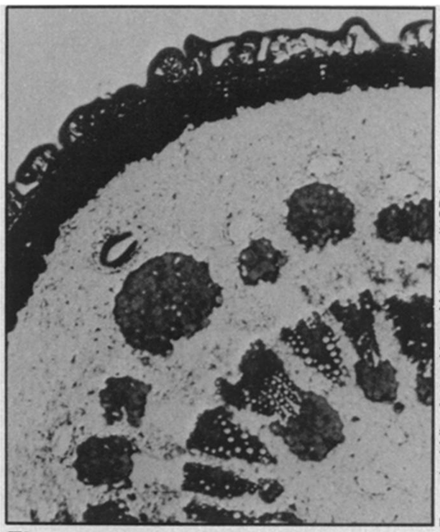
Recently, Donald J. Garrot and colleagues of the University of Arizona at Tucson and Gerald M. Dill of Louisiana State University at Baton Rouge proposed a new technique for extracting the estimated 3 ounces of rubber available in each plant — a technique that uses liquid nitrogen. "The use of liquid nitrogen is proposed as a method to eliminate the length of time required for drying in the conventional extraction of guayule," Garrot and colleagues report in the March ANALYTICAL CHEMISTRY. "The rapid freezing of fresh plant cells, fracturing of frozen membranes during grinding, and subsequent thawing rupture the cells to allow rapid exposure of the rubber to the solvent without extensive grinding, and at the same time the frozen tissue can be easily milled without predrying." Thus far, the researchers have been able to remove in one extraction up to 85 percent of the rubber in small plant samples.

In addition to improving extraction techniques, researchers also are searching for pre-extraction methods of determining how much rubber can be squeezed from a guayule crop. Methods currently being investigated include those using signals from leaf morphology and plant anatomy to recognize high-rubber-bearing plants. In addition, Goodyear recently announced use of a nuclear magnetic resonance (NMR) spectrometer — an instrument that uses radio waves and magnetic forces to examine the structure of the rubber molecules in the plant samples — to estimate rubber yield. Last year, Goodyear joined Arizona State University, Agri-Business Research Corp. of Scottsdale, Ariz. and three Arizona Indian tribes in a cooperative guayule research project. "New techniques and processes in the development of guayule, such as our scientists' NMR spectrometer work, is eliminating much of the guesswork and risk-taking in a project of this magnitude," says Goodyear's William N. Knopka.

Nonetheless, a considerable amount of guesswork and risk-taking remains in the U.S. attempt to take guayule to the market. For example, guayule breeders do not yet have a firm grip on the unusual sexual habits of the guayule plant. The major problem breeders face is that the plant exists with a variety of chromosome numbers, or ploidy levels. The diploid (36-chromosome) form reproduces in a normal sexual fashion; the tetraploid (72-chromosome) form reproduces mostly asexually. To further complicate this ploidy picture, diploids can mate with tetraploids to produce triploids, or plants with 54 chromosomes. Ideally, breeders would like first to develop a suitable hybrid — by crossing guayule with its taller and heartier relatives — and then to cross that hybrid with a guayule tetraploid. The resulting plant would reproduce asexually, turning out exact duplicates of itself. This guayule breeder's dream cannot be realized, though, until hybridization techniques are refined and researchers can easily recognize the plant's ploidy level.

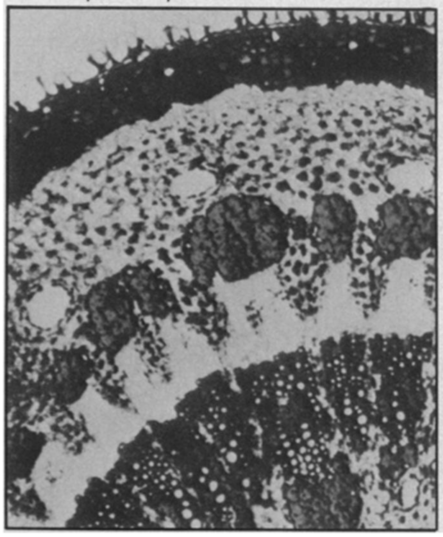
Other bumps that need to be smoothed on guayule's road to commercialization include protecting guayule processors from the potentially hazardous allergens found in the post-rubber extraction guayule leftovers; developing plants resistant to *Phytophthora* root rot and the fungus disease *Verticillium* wilt; and finally, convincing farmers to grow the plant, industries to extract its rubber and companies to buy it.

One way of creating a guayule market, says Dan Bragg of the Center for Strategic Technology at Texas A&M University at College Station, is to require the government to use guayule to replenish its rubber stockpile, now reportedly lacking more than 700,000 metric tons. Guayule is not ready for a laissez-faire commercialization scheme, Bragg says. After all, he says, "What banker is going to make a loan on a crop whose name he can hardly pronounce, much less spell ...." ☐



Top and middle photos: Henry Yokoyama/USDA

The guayule stem cross sections show the concentration of rubber (small, dark spots) 13 days (top) and 35 days (bottom) after the application of bioregulators — chemicals that affect plant metabolism to enhance specific qualities.



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Rubber produced from guayule.