

ABOUT OUR COVER

JOJOBA: A NEW HORTICULTURAL CROP FOR ARID REGIONS

Jojoba (*Simmondsia chinensis* (Link) Schneider) until recently was a relatively unknown Sonoran Desert shrub. Realization that the unique liquid wax in the seed could be substituted for the oil of the endangered sperm whale and that the plant could be grown with relatively small amounts of irrigation water has stimulated much interest among researchers in arid regions throughout the world. Major research programs on the domestication of jojoba are being conducted in the Department of Plant Sciences of the University of Arizona and the Department of Botany and Plant Sciences of the University of California-Riverside. Research programs are also underway at the Ben-Gurion University at Beer-Sheva, Israel, by state and federal agencies in Sonora and Baja California, Mexico, and in a number of other countries with arid and semi-arid regions. An International Committee on jojoba was formed in November, 1972 and 3 international conferences on jojoba have been held to date. The 4th international jojoba conference is scheduled for November 5-7, 1980, in Hermosillo, Sonora, Mexico.

About 2400 hectares of jojoba have been planted in southwestern Arizona and southern California since 1972. Many plantings of various sizes have also been made in Central and South America, the Middle East, Africa, and Australia by both commercial growers and research institutions.

Jojoba is a dioecious, evergreen woody shrub that varies in both height and width at maturity from approximately 1 to 5 m. There are usually several main stems which are brittle and easily broken. Jojoba appears to be very long-lived and some plants in natural stands may be 150 to 200 years old. The natural range of jojoba is restricted to isolated favorable locations in southern Arizona, coastal and inland southern California, Sonora, and Baja California, Mexico. It occurs from sea level on the Mexican coast and southern California to at least 1500 m in Arizona, usually on well-drained, well-aerated soil on mountain slopes, although plants growing in the warmer extension of its range in Baja are often found on relatively level land. Jojoba produces a very deep root system with several main roots produced in favorable soils; few surface feeding roots develop under natural conditions.

In pistillate plants single axillary flowers usually develop at alternate nodes on newly matured growth, how-



Natural stands of jojoba, San Carlos, Arizona

ever, flowers may also develop singly at every node, and, on occasion, double or multiple flowers may occur at alternate nodes or every node. In staminate plants, clusters of flowers usually form at alternate nodes.

In natural stands in Arizona most flower buds form in late summer or early fall after the previous crop of seed matures. Most flower buds remain quiescent until warm days in February and March when anthesis occurs. At anthesis pistillate flowers are grey-green, urn-shaped, and quite inconspicuous. Each ovary contains 3 ovules. The clusters of staminate flowers at anthesis are very conspicuous due to the large quantities of pollen produced.

Jojoba appears to be wind pollinated. Bees are attracted to staminate but not pistillate flowers. Pollination usually occurs about March, and fruit develop and mature by July and August. Each ovary initially contains 3 ovules but only a single seed usually develops in most clones.

The fruit are capsules which turn gradually from green to tan or brown on maturation. Upon drying, the fruit may or may not split to release the seed. At maturity, most seed are dark brown; size varies from 700 seed/kg to 5300 seed/kg. Cotyledons make up the bulk of the seed, and contain about 50% liquid wax which can be extracted using standard pressure or solvent techniques.

The liquid wax from jojoba is clear, odorless, and has longer carbon chain lengths than sperm whale oil. The wax has many potential uses. It is an excellent base for the manufacture of high-grade cosmetics, for ointments, and as an antifoaming agent in the production of penicillin. When hydrogenated, it forms a hard, white crystalline wax with a melting point of 70°C and is suitable for both high-quality candles and polishes. When sulphurized it is very stable, remains liquid, and maintains its viscosity over a wide temperature range.

It can be used as a lubricant for machinery operating at high temperatures and pressures. Cosmetics and lubricants containing jojoba wax are already being marketed. To supply the existing demand seed have been harvested from wild stands during the past 2 years with about 114 metric tons of dry seed harvested in 1978.

Jojoba is very susceptible to cold damage. Natural stands in Arizona and at its northern range in California are located on mountain slopes interspersed with rocks. These slopes have good air drainage and are several degrees warmer than adjacent low-lying valleys. Plantings in valleys near natural stands often fail because the cold air moves down and concentrating in the valleys results in killing freezes. Adult plants can survive temperature as low as -9.5°C; however, flower buds are damaged at -4° to -5°. We believe commercial plantations should not be planted in areas where temperatures go lower than -4°.

Jojoba plants must have good soil aeration and drainage and do poorly in heavy clay soils. Although jojoba is resistant to drought and salinity, and natural populations are found in areas receiving as little as 12 cm of annual precipitation, the highest yielding specimens are found in areas receiving from 38 to 50 cm annually. Supplemental irrigation will be required in most areas suitable for commercial production.

The genus *Simmondsia* has only one species with no known closely-related plants. However, natural stands provide an extensive, readily-available source of highly variable germplasm for plant improvement. Extensive germplasm collections have been made both in the United States and Mexico.

Jojoba can be planted by direct seeding at a spacing of 20-25 cm in the row and 4 m between rows. The best plants will be later selected to leave a spacing of about 1.5 m between plants in the row with 1 staminate for each 5 pistillate plants. Jojoba can be propagated by cuttings using conventional mist propagation facilities. No known tested cultivars are presently available. Jojoba can be successfully irrigated by furrow, flood, or various drip irrigation systems. Pruning will be required to facilitate mechanical harvesting. Little is known concerning the plant's nutritional requirements. There have been few disease and insect problems on cultivated plants.

Although several limitations may affect the development of this plant as a new crop none seem insurmountable.

LeMoyne Hogan, Chi Won Lee,
D. A. Palzkill, and W. R. Feldman
Department of Plant Sciences
University of Arizona
Tucson, AZ 85721