The Jujube Tree (*Zizyphus jujuba* Lam)

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The jujube (*Zizyphus jujuba* Lam) is a small, deciduous, ornamental fruit tree native to Asia but grown in the southeastern United States for over 150 years. The genus *Zizyphus* is in the *Rhamnacea,* or buckthorn family, and includes about 40 species of plants in tropical and subtropical regions of the northern hemisphere (15). Seven *Zizyphus* species are native to the United States and Mexico, but none is of economic importance (11). *Z. jujuba* and *Z. mauritiana* Lam. are the 2 most important species. Both are of old-world origin. The relationship between *Z. jujuba* and *Z. mauritiana* is obscured in the literature by the frequent illegitimate use of the name *Z. jujuba* by writers referring to *Z. mauritiana* (11). *Z. jujuba* is the less tropical of the 2, and is native where temperatures range from −6°C to 48°C and rainfall from 125 to over 2000 mm (5-80 inches (8). *Z. jujuba* is deciduous and has glabrous leaves. Because it is more important in China than in any other country, it is commonly called the "Chinese date." By contrast, *Z. mauritiana* is evergreen, has pubescent leaves, and is commercially most important in India, where it is called Ber or Indian jujube (15). The phylogenetic relationship between the 2 species has not been worked out, nor has their cross compatibility been investigated. Khoshoo and Singh (12) counted chromosomes for 35 cultivars of Indian jujubes. The basic or x number for the group was 12; 33 cultivars were tetraploid (2n = 48), 1 was pentaploid (2n = 60), and 2 were octaploid (2n = 96). Limited work on the Chinese jujubes (12) indicated that most may be diploids (2n = 24).

Except for a few trees of *Z. mauritiana* in south Florida, *Z. jujuba* is the species of interest in the United States. This paper deals mainly with *Z. jujuba,* the Chinese jujube, and the common name "jujube" will be used to refer to *Z. jujuba* and not to *Z. mauritiana.*

The fruit of the jujube is a drupe, elliptic or oblong, up to about 5 cm long, with thin skin and crisp, whitish flesh of sweet, agreeable flavor, enclosing a hard two-seeded stone (29). Compared to other fruits, fresh jujubes are somewhat dry, pithy, and light in weight (17). The immature fruit is green in color, but as it ripens, brown or mahogany-colored spots appear on the skin. These increase in size until the fruit is entirely brown. Shortly afterward, the crisp fruit begins to soften and wrinkle. The best time to eat the fresh fruit is before it begins to soften but after 50% or more of the surface has become brown.

Jujubes in China, India, and Europe

Jujubes are said to be indigenous to an area stretching from India to China and Malaya (20), though in the more tropical parts of this area, *Z. mauritiana* is probably more common than *Z. jujuba,* if in fact, the distinction between the two is a significant one. The jujube is one of the most common wild fruit trees in India (20). The wild species from which cultivated jujubes are believed to be derived is *Zizyphus sativa spinosa,* which grows wild on most of the city walls in northern China and can tolerate stony, infertile soils (21). It has hooked spines and small, round, brown-red fruit which has a pleasant, sour taste and is gathered by women and children (21). Meyer reported in

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1911 that the spiny branches were used for fencing in China. In the wild, the jujube grows mainly as a bush (11), but in favorable habitats occasionally reaches a height of 25 m (8).

Jujubes have been cultivated for over 4,000 years in China, and nearly that long in India (20). Numerous cultivars have been selected during this long period; a Chinese work published over 300 years ago listed 43 cultivars (16), and today more than 400 selected cultivars are cultivated in China (12). After a tour of the Chinese fruit industry, Pieniazek (24) reported in 1959 that jujube ranked first in number of fruit trees in China, followed by persimmons, pears, citrus, and apples. Jujubes ripen in China in September and October and along with the persimmon, are the cheapest and most popular fruit at that season.

In India, jujubes were being cultivated on an estimated 10,000 hectares in 1967 (20). Fruit are eaten fresh, candied, dried, smoked, and pickled. Made into a confection, jujubes compare favorably with the Persian date in flavor and palatibility (7), and a "butter" can be made from the fresh fruit. In India *Z. jujuba* is an important host for the lac insect (*Tachardia lacca*) which secrets a resinous substance on the twigs, the raw material from which shellac is prepared (10). Jujube leaves are fed to silkworms, the branches are lopped for fodder, and tannin is made from the bark (4).

About the beginning of the Christian era, the Chinese jujube was imported into Europe (14) and is now widely distributed throughout Persia, Armenia, Syria and the Mediterranean region in Spain and France (16). The jujubes known and sold in Europe are from seedling trees, the fruit of which are about the size of olives. In Europe the fruit has long been used as a table dessert and dry sweetmeat (30).

Jujubes in the United States

Jujubes were first introduced into America from Europe by Robert Chisholm and planted in Beaufort, South Carolina in 1837 (25). They were introduced to California and neighboring states from southern France by Rixford in 1876 (25). By 1901 jujubes had escaped from cultivation in Alabama (22) and are now naturalized along the Gulf Coast from Alabama to Louisiana (3).

All of the early jujube introductions into the United States were seedlings from Europe, and it was not until 1908 that the much superior Chinese cultivars began to be introduced. In that year Frank Meyer, a U. S. Department of Agriculture plant explorer, introduced Lang and other Chinese cultivars (13, 21). A second group of cultivars introduced in 1914 included Li, which Meyer said produced the largest fruit he had seen in China (13). A total of 83 jujube cultivars were introduced by Meyer (16).

Early writers and explorers emphasized the heat and drought tolerance of jujubes, and probably because of this, jujubes were thought most likely to succeed in the dry regions of the southwestern U. S. Thus, the Chinese jujube cultivars were tested primarily in California (25), Texas (13), Oklahoma (16), and other southwestern states. In most tests the trees grew well and fruited within 1 to 4 years (16). Because they flowered late and escaped spring frosts, fruiting was reliable, with few or no crop failures (16). A few small commercial orchards were established in California during the 1950's (2), but jujubes have not become an important commercial crop in the U. S.

Although seedling jujubes are not uncommon in the southeastern United States, the improved cultivars have not been widely tested. Six trees, representing 3 cultivars, were planted at

Tifton, Georgia, in the late 1920's or early 1930's. These grew well and fruited regularly (9). According to Harmon (9), the fruit was insipid when fresh, but was delicious and rivaled dates when dehydrated and candied. Mowry, Toy and Wolfe reported in 1953 that jujubes were widespread in Florida (23) but did not produce crops of good fruit comparable to those from the southwestern United States. Seven jujube trees, representing two cultivars and four seedlings have survived near Philadelphia, Pennsylvania, for about 25 years, but have fruited poorly (5). Twenty or 30 trees of improved cultivars are growing near Fairhope in southwest Alabama. Some are over 40 years old and bear heavy crops, at least in some years. They appear free of insect pests and diseases, although many receive little or no care.

Culture and Propagation of Jujubes

Meyer (21) wrote that jujubes can stand a remarkable amount of neglect without any apparent detriment. Trees have survived temperatures as low as −29°C and as high as 49°C (29). Jujubes grow best on deep, well-drained soil of medium texture, although they thrive on all kinds of soil except poorly drained or heavy clay soils (14). In China, trees are planted 4.5 to 7.5 meters apart in orchards (21). Jujube roots extend outward a great distance from the trunk just beneath the soil surface. If injured by cultivation, root sprouts produce a colony of small trees surrounding the main trunk. These suckers can be a nuisance to control, and their formation should be discouraged by mowing rather than discing under trees. Spraying jujube trees for insects and diseases is unnecessary. Fertilizer requirements have never been investigated, but unfertilized trees appear to thrive on sandy soils.

Jujubes require cross-pollination for best fruit set (1), although a few isolated trees fruit regularly. Self-fruitfulness in jujubes appears highly variable from clone to clone (1). Even clones that fruit following self-fertilization produce few germinable seeds (1). Both houseflies and honeybees visit jujube flowers, but Ackerman (1) found that houseflies are ineffective pollinators. He noted that jujube trees flower over a long period of time but that individual flowers are receptive to pollination only during the first 24 hours after opening.

Meyer (21) reported that jujubes in China are propagated primarily by basal suckers, a method that works well for all but the few cultivars that do not sucker readily. Most or all trees of the Chinese cultivars in the U. S. are grafted onto seedling rootstocks, and cannot be propagated by root suckers. Recent Russian reports of success in rooting softwood jujube cuttings under mist (26) suggest the possibility of rooting enough trees of popular cultivars to provide root suckers that would not need to be grafted.

Jujube seeds resulting from cross pollination can be germinated. The stones, most of which contain 2 embryos, are scarified in concentrated sulphuric acid for 2 to 6 hours and stratified at 5°C for 60 to 90 days. After this treatment, germination is about 50% (8). Jujubes may be grafted or budded. Spring T-budding, with wood collected in January or February and refrigerated until the stocks begin to push, has been more successful than August or September budding (28). Whip grafting as soon as the stocks begin to push in the spring has been the most successful method of propagating the jujube (28).

The Jujube as a Dooryard Fruit in the Southern U. S.

Seventy years have passed since the first improved Chinese jujubes were introduced into the U. S. Although the jujube has been a commercial suc-

cess in Asia, commercial production in the U. S. has been insignificant for reasons ranging from the unfamiliarity of Americans with the fruit to lack of information on how to grow the crop in this country to the high price of labor for picking, packing, and processing the fruit.

Despite its failure as a commercial crop, the jujube appears to merit wider use as a dooryard tree in the southern U. S. In areas with loose, sandy soils, it is easy to grow. It appears unaffected by nematodes which damage many other crops on such soils, and does not require spraying for insects or diseases. The trees are highly ornamental, with shiny green leaves in summer and drooping branches with large buds in winter. Most cultivars are notably precocious, often fruiting the first or second year after grafting. Because flowering is late, starting in mid-May at Chico, California (19), frost seldom damages jujubes and fruiting is very regular. Locke reported in 1955 that Lang had not missed a crop since its establishment at Woodward, Oklahoma, in 1924 (17). Older trees have produced over 45 kg of fruit per year in the southwestern U. S. (18). Fruits contain high levels of vitamin C. The range for 35 cultivars of Indian jujubes was 70 to 165 mg per 100g of fruit weight, which was 2 to 4 times as high as for citrus fruit (6).

Research Needed with Jujubes

Several problems related to jujubes need investigation. Trees in the eastern U. S. often produce only light crops, particularly when young. This may be due to pollination problems, since such trees often flower profusely over a long period of time. On some trees many of the fruit drop while immature. Ackerman (1) showed that many jujube cultivars fruit poorly without cross pollination. Studies in India have indicated that in *Z. mauritiana,* some cultivar crosses are incompatible (27). Further studies on cultivar combinations that will give good fruit set in the eastern U. S. are needed. Another problem with jujubes is that the fruit of some cultivars tends to split during rainy weather. This problem could be solved by introducing resistant cultivars or cultivars that ripen their fruit during dry seasons of the year. Fruit that ripened in mid-October along the Gulf Coast, for example, would be less subject to splitting than fruit of present cultivars, which ripens in mid to late September.

It appears that jujube propagation could be simplified if self-rooted trees of the major cultivars could be produced. Root suckers from these trees could then be dug and used instead of grafted plants. Cultivars vary in the degree to which they produce root suckers. Because root suckers may be an annoyance in some situations, being thorny and requiring frequent mowing, it may be desirable in some cases to graft selected cultivars on rootstocks which do not sucker readily.

More information is needed on the relationship between *Z. jujuba* and *Z. mauritiana,* on the possibility of hybridizing the 2 groups, on the chilling requirement of *Z. jujuba* and the frost tolerance of *Z. mauritiana.* Although Meyer (21) traveled widely in China more than 60 years ago and introduced many of the best cultivars he found, the 400 or more jujube cultivars in China probably include others that would be of value in the U. S. Meyer mentioned a "seedless" jujube cultivar, Wuhu tsao, with a kernel so soft that it is almost imperceptible when eaten. He was told that this was the only seedless cultivar in China. Meyer also mentioned several flat-fruited jujubes, a white-fruited jujube, and the quaint "dragon's claw" jujube, which had peculiar gnarled and twisted branches and was cultivated as an ornamental (21). India may also have

jujubes that would be useful in the U. S. The U. S. Department of Agriculture initiated a jujube breeding program at Chico, California, in 1952 (1) but this was terminated about 1959.

Jujube trees grow rapidly on sandy, well-drained soils in the southern U. S. Because they are ornamental, require no spraying, bear fruit when only 1 or 2 years old, and ripen their fruit in September when few other fruits are available in the South, jujubes appear to merit much wider use as dooryard trees in the South. Trees of at least 2 Chinese cultivars, Li and Lang, can be purchased from nurseries in California.

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