Guazuma ulmifolia Lam. Guácima

Sterculiaceae Chocolate family

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Guazuma ulmifolia Lam., known as guácima and numerous other local names, is a limby, small- to medium-sized tree (fig. 1) common in pastures and disturbed forests. It ranges from the middle of Mexico to northern Argentina (fig. 2). Its fruits and foliage are consumed by domestic animals and wildlife and the wood is an important source of firewood in rural areas.

HABITAT

Native Range

Guácima grows along both coasts of Mexico from about 27° N. latitude southward. The northern coastal range converges at the Isthmus of Tehuantepec and proceeds through the Yucatan Peninsula, Central America, and South America into northern Argentina and Paraguay to about 28° S. latitude. The species also grows in the Greater and Lesser Antilles (*19, 20, 29, 40*) and is planted and possibly naturalized in Hawaii (*26*).

Guácima grows in a number of the Holdridge life zones (*10*). It is common in the tropical moist, tropical dry, subtropical moist, subtropical dry, premontane moist, and premontane dry forest life zones (*5, 6, 40, 41*). Guácima has been successfully planted in the premontane wet forest life zone (*5*).

Climate

Guácima is most common in areas that receive from 700 to 1500 mm mean annual precipitation (*24*), but will grow in zones with annual precipitation of up to 2500 mm. Nearly all the native range has an annual dry season, usually from 2 to 7 months. Guácima trees defoliate when drought becomes severe but remain green if soil moisture is adequate.

Climates in the native range are tropical or subtropical. Most of the habitat is continuously warm. However, trees in the northern and southern extremes of the range probably experience infrequent light frosts.

Soils and Topography

Guácima is adapted to a wide variety of soils and can be found growing on soils with textures ranging from sands to clays. The species probably grows on all the soil orders occurring within the native range. Soils of the orders Inceptisols, Alfisols, Ultisols, Oxisols, and Vertisols are particularly important habitats. Well-drained sites are best, but guácima also grows on somewhat poorly drained soils. Very stony soils and even fresh road fills are often colonized. The species is more commonly found on soils with a pH above 5.5 (*5*) and does not tolerate salty soils (*13*).

The species is most common and seems to grow best in lower slope positions in moist regions and along intermittent and permanent streams in dry areas. Natural stands grow in areas from near sea level to 1,200 m; however, most of the population is found below an elevation of 400 m (*5*). Pastures, fencerows, and roadsides are the preferred habitat in all topographic positions.

Associated Forest Cover

Successional stages of the semideciduous forests in Jalisco, Mexico, may include guácima associated with *Acrocomia mexicana* Karw. ex Mart., *Casearia parvifolia* Willd., *Castilla elastica* Cervantes, *Cochlospermum vitifolium* (Willd.) Spreng., *Cyrtocarpa procera* H.B.K., *Forchhammeria pallida* Liebm., *Heliocarpus* spp., *Luehea candida* Mart., *Lysiloma acapulcensis* (Kunth) Benth., *Piptadenia* sp., *Spondias purpurea* L., *Thouinia* sp., *Trema micrantha* (L.) Blume, and *Xylosma flexuosum* Hemsl. (*31*). Abandoned fields in coastal valleys of Guanacaste Province, Costa Rica, support successional trees, such as *Castilla elastica, Cecropia peltata* L., *Cochlospermum vitifolium*, and *Mutingia calabura* L., along with guácima (*9*). Limestone hills with shallow soils in the

Figure 1.—*A guácima* (Guazuma ulmifolia) *tree growing in Puerto Rico.*

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Figure 2.—*The native range of guácima* (Guazuma ulmifolia) *in tropical America.*

Cabo Cruz area of Cuba support guácima in stands of *Andira inermis* (W. Wright) H.B.K., *Bursera simaruba* (L.) Sarg., *Coccoloba diversifolia* Jacq., *Lysiloma latisiliqua* (L.) Benth., *Mastichodendron foetidissimum* (Jacq.) Cronq., *Pera bumeliaefolia* Griseb., *S. mombin* L., *Swietenia mahagoni* Jacq., and *Zanthoxylum martinicense* (Lam.) DC. (*36*). In the Alisio Forest, which is located along streams in the Llanos of Venezuela, guácima occurs with *Hymenaea courbaril* L., *Lonchocarpus velutinus* Benth., *Fagara chiloperone* (Mart.) Engl., *Senegalia glomerosa* (Benth.) Britton & Killip, *Casearia* spp., *Cordia bicolor* A. DC., and *Genipa americana* L. (*11*).

LIFE HISTORY

Reproduction and Early Growth

Flowering and Fruiting.—The slightly fragrant flowers are yellow or cream and are borne in clusters at the base of the leaves (*19*). In Puerto Rico, flowering is irregular and usually takes place from April to October (*19*). In Costa Rica, flowering is concentrated in the largely leafless period from March through April (*15*).

Green fruits appear immediately after flowering but remain small for at least 4 months (*16*), then they enlarge and mature over a 3- or 4-month period (*15*). Mature fruits are round or elliptical, black or dark brown, and 1.5 to 3.5 cm long (*20*). They are warty, hard, and woody, and have five internal cavities that contain the seeds. One hundred mature guácima fruits collected in Puerto Rico averaged 2.79 ± 0.07 g each (author, personal observation). Large, open-grown trees may produce 5,000 to 10,000 fruits in a single crop (*16*), although in forests where competition is high, production may be quite low.

Seed Production and Dissemination.—Large quantities of guácima fruit are collected by hand under producing trees or by picking directly from the trees. It is opened with pruners, and the seeds are extracted with a probe or by rapping on a hard surface. Pulverizing and sifting or blowing can be used to separate large quantities of seeds (*14*). Thirty-seven undamaged fruits from Costa Rica yielded an average of 59.8 ± 2.3 seeds per fruit (*15*). Thirty fruits from Puerto Rico contained an average of 68 ± 4 seeds per fruit (author, personal observation). Average weight is 0.0042 g per seed or 239,000 seeds per kg. About 225,000 seeds per kg are normal for Costa Rica (*5*).

Seedling Development.—Germination is epigeal and begins in about 8 days (author, personal observation). The seeds secrete a gelatinous coating that appears to inhibit germination. Without treatment, only 5-percent germination was obtained. The best conditioning treatment, immersion in boiling water for 30 seconds, resulted in 87-percent germination. Scarification and acid treatment was also effective (*37*). The latter mimics what may happen when fruits and seeds are chewed and pass through an animal's gut.

Seedlings develop rapidly in the nursery. New seedlings are ready to transplant from germination trays into containers (usually nursery bags) in 30 days (*3*). Twelve seedlings grown in the nursery by the author averaged 38 ± 3 cm in height (plantable size) in 3 months. To obtain 30- to 40-cm plants in nursery bags, 14 to 16 weeks are required in Central America (*5*). Stumped plants (seedlings with the tops removed) with a root collar diameter of 1.5 to 2.5 cm require 8 or 9 months.

Preplanting site preparation should consist of plowing or another form of cultivation. An initial tree spacing of 2 by 2 m is recommended. If the pollarding method (periodically harvesting all limbs without felling the tree) is used to produce firewood, a thinning to 4 by 4 m or 6 by 6 m is recommended (*5*).

Vegetative Reproduction.—Stumps of guácima sprout so readily that it is often difficult to eradicate from pastures (*16*). The species is reported to reproduce from cuttings (*2*).

Sapling and Pole Stage to Maturity

Growth and Yield.—Guácima is a small- to medium-sized tree. Heights of 8 to 20 m and 30 to 60 cm in d.b.h. are commonly attained (*15, 20*). In Mexico, heights of 25 m and d.b.h.'s of up to 70 cm are reported (*29*). In Puerto Rico, the largest guácima tree known to the author measured 12 m high and had a 96-cm d.b.h. Its age is unknown.

Crown architecture develops according to Roux's model in which a monopodial trunk meristem grows and initiates alternate or whorled branches continuously (*8*). Crowns, especially in trees growing in the open, tend to be spreading and very limby. Guácimas usually develop short, curved boles that are often deeply grooved.

The growth rate of individual trees and stands can be described as moderate to good. A plantation in Guatemala averaged 2.1 m in height with 94-percent survival in 3 years (*21*). An arboretum plot in Colombia averaged 6.9 m in height with 92-percent survival and averaged 0.013 m^3 of wood per tree at 3 years (*17*).

A large study evaluated the growth of guácima in small plots on 23 sites throughout Central America. Over a span of

12 to 40 months, depending on the site, survival rates of 33 to 100 percent were observed. Only four sites had survival rates below 90 percent. Overall, the sites averaged 1.42 m of height growth per year (*5*). Mathematical models have been prepared to predict height, diameter, and dry weight of wood produced in 1- to 5-year-old plantations containing 2,500 trees per hectare in Central America (*12*); depending on age and site quality, 1 to 6 t/ha/yr are produced. At one site in Colombia, guácima produced 12 to 15 m^3/ha annually over 9 years (*32*).

Mean d.b.h. increment for 14 trees averaging 15 years old, each on a different site in Puerto Rico, was 0.87 cm/yr (author, personal observation). Growth of older trees under intense competition tends to be slow. The mean 5-year diameter increment of guácima in a dense subtropical moist forest was only 0.02 ± 0.03 cm/yr (*41*).

Pasture trees in Central America are often pollarded for firewood. Harvests per tree of up to four wheelbarrow loads are reported (*7*). In a study documenting dry weight of limb regrowth on pollarded trees, 16 kg of limbs per tree were produced the first year, 71 kg were present after the second year, 168 kg after the third year, and 311 kg after the fourth year (*5*). Prediction models and weight tables have been developed for yields of periodically harvested firewood from crowns of open-grown guácima (*34*). It is recommended that pruning under the pollarding method be carried out at heights above 2 m at intervals of 2 to 4 years (*5*).

Rooting Habit.—Most trees produce deep, abundant roots (*1*), and older trees develop a small buttress. The root: shoot ratio of a group of 3-month-old, 10-cm-tall seedlings was reported at 0.45 (*27*).

Reaction to Competition.—Guácima is very intolerant of shade. It is a pioneer species that specializes in colonizing open or disturbed places (*20*). Reproduction can be abundant in pastures and other disturbed areas frequented by livestock or wild ungulates. Because guácima is small in size and intolerant, it does not survive in high forests. The presence of this species in forests with medium and low canopied forests indicates former use of the land for pasture or other heavy disturbance.

Guácima generally makes up only a small percentage of the basal area in a secondary forest. An average guácima basal area of 0.2 m^2 (five trees) out of a total stand basal area of 31.4 m^2 was observed in a subtropical moist forest based on measurements of sixteen 0.05-ha plots in the U.S. Virgin Islands (*41*). On the upper slopes of moist limestone hills in a subtropical moist forest in Puerto Rico, guácima accounted for 3.1 m^2/ha of a total of 22.1 m^2/ha (*6*). Basal areas in 12 plots established in Puerto Rico in a secondary forest with guácima present averaged 14.7 ± 2.0 m^2/ha of which 4.7 ± 1.2 m^2/ha was guácima (author, personal observation). In two 4-ha plots in Costa Rica, guácima contributed 0.3 and 0.7 m^2 of totals of 12.7 and 19.8 m^2 of basal area (*9*).

Damaging Agents.—In Costa Rica, 12 to 42 percent of the seed crop is destroyed by the bruchid beetle, *Amblycerus cistelinus*. Predation is more severe in moist areas than in dry ones (*16*). Slugs consumed a number of new seedlings being grown in the nursery by the author. The insects *Phelypera distigma* (Curculionidae), *Lirimiris truncata* (Notodontidae), and *Hylesia lineata* (Saturniidae) all feed on guácima leaves in Costa Rica (*15*).

Dead trees and dead limbs of live trees are consumed by the wet-wood termite, *Nasutitermes costalis* (Holmgren), in Puerto Rico (*22*). Guácima wood in use is very susceptible to attack by dry-wood termites, *Cryptotermes brevis* (Walker) (*43*), and the wood is not resistant to rot (*19*).

SPECIAL USES

The sapwood of guácima is light brown, and the heartwood is pinkish brown to brown. It is moderately soft and easily worked (*19*). The specific gravity of the wood varies from 0.40 to 0.65 g/cm^3 (moisture content not given) (*5*) in Costa Rica, 0.55 to 0.57 g/cm^3 (moisture content not given) (*20*) in Paraguay, and 0.49 to 0.55 g/cm^3 ovendry in Puerto Rico (author, personal observation). The wood has been used for furniture, trim, boxes, barrel staves, shoe lasts, and tool handles (*19, 38*). It is still used for temporary posts, rough carpentry, and vegetable stakes in rural areas (*5*).

Guácima wood is considered to be excellent firewood (*24*). It splits and dries easily and burns well with glowing coals and little smoke. The caloric value is 18,400 kJ/kg, and 0.98 percent ash is left (*5*). In colonial times, charcoal made from guácima was preferred for making gunpowder, and the wood is still used to make charcoal for fuel (*24*). Rope and twine are sometimes made in rural areas from the fibrous inner bark (*25*).

The mucilaginous green fruit is edible raw or cooked (*18*). Mature guácima fruit is hard and woody and has a sweet taste and a pleasant spicy smell. Cattle and horses readily eat it, and range horses in Costa Rica may eat up to 4,000 fruits in 1 day (*15*). The fruit can be fed to pigs whole and to chickens if ground. Collared peccaries, tapirs, deer, agoutis, and squirrels have been observed consuming the fruit (*15*). Dried green fruit from Central America contained 8.4 percent moisture, 30.4 percent crude fiber, 7.9 percent protein, 3.5 percent fat, and 5.0 percent ash. The material tested 40.4 percent digestible nutrients, and the principal amino acids were aspartic and glutamic acid (*4*). Another analysis of fruits (presumably mature) from Panama showed 20.0 percent moisture, 6.1 percent protein, 1.2 percent fat, 32.2 percent crude fiber, and 6.0 percent ash (*23*).

The leaves have an impressive nutrient content. Calculated on dry weight, a sample from Central America contained 17 percent protein, 26 percent fiber, and 9 percent ash (*33*). Guácima foliage is readily eaten by cattle, horses, collared peccaries, and tapirs (*15*) and has been used to feed silkworms (*26*). During periods of drought, animals consume even the fallen leaves (*39*). The flowers are a source of nectar for honey bees (*18*).

Guácima, an important pasture shade species, is also planted for shade along city streets and around residences, especially in dry areas. The roots cause no trouble in confined spaces. Guácima develops a dense crown in dry climates but can become straggly in wet areas (*35*). Because the trees already grow in fencerows, they are widely used as living fenceposts (*13*).

As a medicinal plant, guácima has been used to treat many ailments, notably influenza, colds, burns, dysentery, and fractures (*28, 42*). Plant extracts were shown to lack

diuretic properties; however, a leaf extract of ethanol suppressed the bacteria *Shigella dysenteria, Staphylococcus aureus*, and *Bacillus subtilis* in vitro. Guácima leaves contain caffeine but not alkaloids, saponins, steroids, terpinoids, flavonoids, quinones, or tannins (*42*).

GENETICS

There are three species of *Guazuma*, all natives of tropical America (*18*). The wood of these species is much alike but is generally distinguishable from others of the family Sterculiaceae (*30*). A comparison of seedlings (0- to 2.6 years old) from eight provenances throughout Central America showed significant, though slight, differences in growth traits and leaf form (*33*).

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