Albizia lebbek (L.) Benth. , 1844

syn.: Acacia lebbeck (L.) WILLD., Acacia sirissa HAMILTON, Acacia speciosa (JACQ.) WILLD., Albizia latifolia BOIVIN, Inga leucoxylon HASSK., Mimosa lebbeck L., Mimosa serissa ROXB.

Lebbekbaum

Familie: Fabaceae
Subfamily: Mimosoideae

engl.: lebbek, siris tree, woman's tongue tree
franz.: bois noir, vielle fille
span.: acacia amarilla, cabellos de ángel, lengua de mujer

Arabic: sultanaulasjar
Bengali: siris, sirish, sirisha
Burmese: kokko
Hindi: siris, sirisha
Javanese: tekik
Punjabi: sarin, shrin
Sanskrit: bhandi, sirisa, sirisha
Sinhalese: mara
Thai: khago, ka se
Tamil: karuvagei, vagei
Urdu: darash

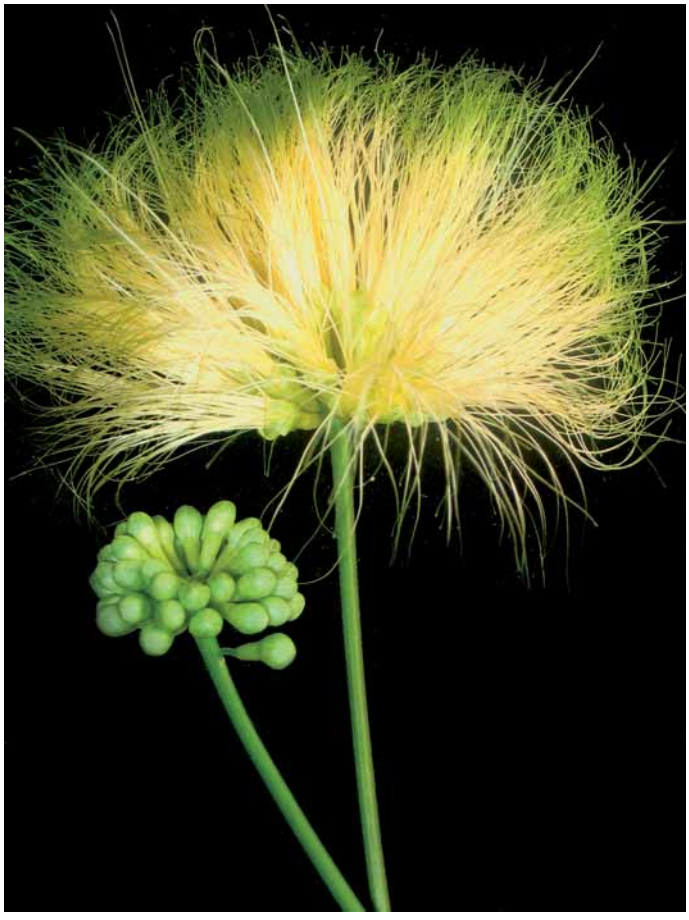

Fig. 1: Albizia lebbek. Inflorescences: fully expanded flowers (above); flowers buds (below)

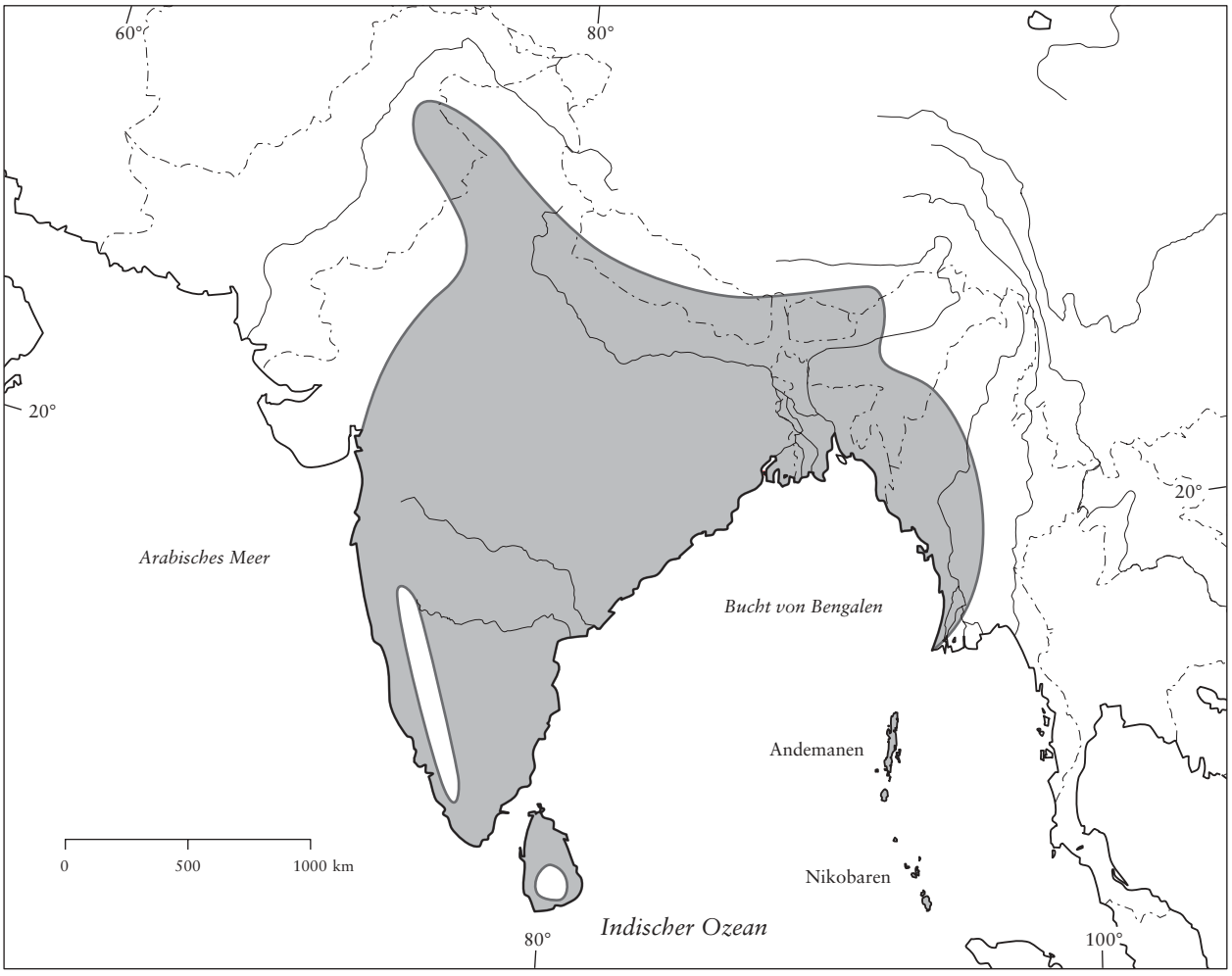

Fig. 2: Native range map

Albizia lebbek, widely known by its Hindi name, siris, is a medium-sized deciduous tree native to the Indian subcontinent and Myanmar (Burma). It is cultivated and has become naturalized well beyond its native range, including in many countries from Southeast Asia to Australia, in western Asia, northern and West Africa, throughout the Caribbean, in Central America and in northern and eastern South America [1, 15, 18, 23, 50]. It grows to a height of 18 to 25 m on good sites, with a spreading crown of thin foliage, finely fissured bark, and attractive, fragrant, greenish-yellow flowers.

It is valued for its timber, as an ornamental and roadside tree, and as a source of shade and fodder in agroforestry and silvopastoral systems. Its rapid early growth, excellent coppicing ability, site adaptability, and nitrogen-fixing capacity have made it a popular species for reforestation of degraded sites, fuelwood plantations and agroforestry systems in Asia, West Africa and tropical America.

Distribution

Siris is generally considered indigenous to seasonally dry tropical and subtropical regions of mainland Asia from eastern Pakistan (34 °N, 72 °E) to Myanmar (Burma; 25 °N, 96 °E) and southwards through India and Sri Lanka (7 °N, 81 °E) to the Andaman Islands (12 °N, 93 °E) from sea level to approximately 900 m elevation. It appears to have spread further eastwards to Southeast Asia and northern Australia and westwards to tropical Africa in the distant past, and might be considered to be indigenous well beyond South Asia.

During the last two centuries it has been widely planted as a garden or roadside ornamental and has become naturalized in many tropical and northern subtropical countries worldwide.

Morphology

Siris is a deciduous tree usually attaining heights of up to 18 m with a straight bole, brownish-gray bark, and spreading, umbrella-shaped crown of thin foliage. It is easily recognized by its fragrant white to greenish-yellow flowers, and the pale, flat, straw-colored pods that remain on the tree long after they mature, often into the subsequent flowering season.

Leaves and young shoots

The leaves are bipinnate, 7–12 cm long, and are alternately arranged on the smooth, green twigs. The leaf stalk (rachis) has a conspicuous disk-shaped gland near its base and another one below the uppermost pair of pinnae. There are usually 2–3 opposite pairs of pinnae, 5 to 20 cm long, each with 3–9 pairs of leaflets (with no terminal leaflet) and small glands between the bases of each leaflet pair. Leaflets, borne on very short stalks (petiolules), are 2.5–5 cm long and 1.5–2.5 cm wide, elliptic-oblong or obovate-oblong (in terminal leaflets), unequal-sided, with an obtuse apex and an obliquely rounded or truncate base; small glands are also present on the pinnae stalk between the bases of each leaflet pair. The leaves typically turn a deep yellow color before falling during the dry season.

The smooth, young shoots are deep green in color, becoming woody, with numerous tiny, light brown, linear, elliptical or oblong lenticels.

The trees remain leafless for a period of 1 to 5 months, depending on locality and the length of the dry season. In northern India, for example, leaf-fall occurs in October-November with new leaves appearing in April or May, while in central and southern India the trees often retain their leaves until as late as February or March. Trees or branches which bear fruit in abundance become leafless earlier and for a longer period than those that do not [45].

Flowers, fruits and seeds

Flowering in siris generally coincides with the initiation of new leaf growth at the end of the dry season and continues for an extended period, usually between March and June in northern and central India and neighboring countries, and between January and April in southern India and Sri Lanka [45]. In the Caribbean region flowering occurs between April and September [24]. Flowering can occur at a very early age, often within the first year, in trees as small as 1 m tall with stem basal diameters of 3 cm [31]. Wind is apparently the principal pollen vector, although the fragrant flowers do attract large numbers of bees, which are likely to contribute to pollination [32]. Trees produce fruits in abundance for many decades, apparently throughout their lives.

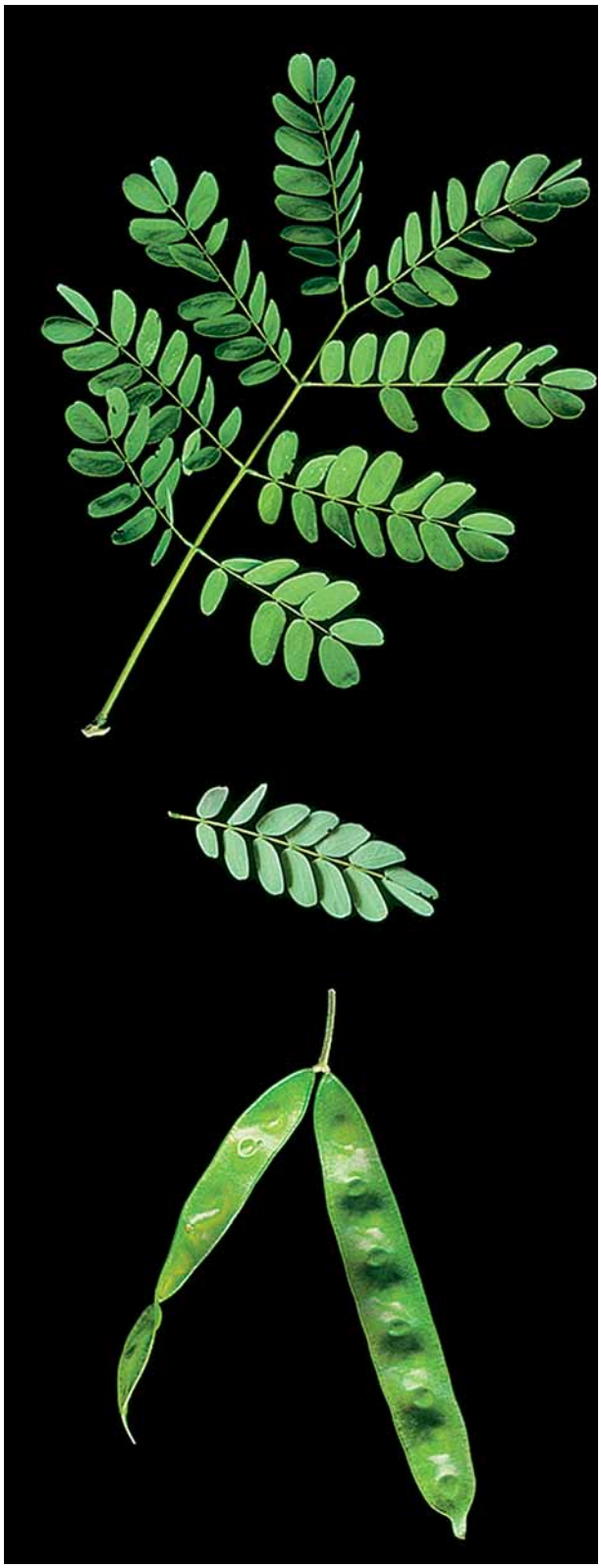

Fig. 3: Compound leaf and immature fruits (pods); paler lower surfaces of leaflets shown at left

The fragrant white to greenish-yellow flowers are borne 15–40 together in rounded, axillary clusters 2–3.8 cm in diameter at the ends of lateral stalks (peduncles) 4 to 10 cm long. Individual flowers are 3 to 4 cm long, with a tubular five-toothed calyx 3 to 4 mm long; a narrow, tubular, white corolla 8 to 10 mm long with triangular 2.5 mm-long lobes; numerous threadlike spreading stamens 15 to 30 mm long that are whitish-yellow at the bases transitioning to pale green at the tip; and a pistil of narrow ovary and threadlike styles [24, 36].

The fruits, flattened pods containing 4–12 seeds, are 10 to 30 cm long and 2 to 4.5 cm wide, linear-oblong, bluntly pointed, thin, green turning straw-colored on maturity, reticulately veined above the seeds, smooth, and shining. The pods are produced in large numbers, remain green for a period of 6 to 8 months after flowering, and may remain on the tree throughout the dry season when most or all of the leaves have been shed, until well into the next flowering season [23, 45]. Mature pods are dehiscent, splitting along their margins to release the seeds, either while still attached to the tree, or from windblown pods that later open or decompose.

The seeds are pale brown, ellipsoid-oblong, compressed, measuring 7 to 11 mm long and 6 to 9 mm broad, with a smooth hard seed coat. Seed weights average 7,000 to 11,000 per kilogram [25, 32].

Fig. 4: Inflorescence showing flowers at different stages of development

Wood and bark

The bark is 1.2 cm thick, variable in color from pale to dark brownish gray, with numerous short, irregular cracks and elevated horizontal lines, often with silvery patches on the branches, exfoliating in irregular thick woody scales. The inner bark is pink.

The sapwood is white, large, and easily distinguishable from the heartwood, which is dark brown with lighter and darker streaks. The heartwood is coarse-grained, moderately hard (specific gravity: 0.55–0.60), elastic, strong, and fairly durable. It seasons and works well, polishes easily, and is considered an excellent furniture wood, having been exported from India during the early 20th century under the trade name of East Indian walnut [2, 45]. The wood is also an excellent source of firewood and charcoal, the heartwood having a caloric content of 5.2 kcal/g [49].

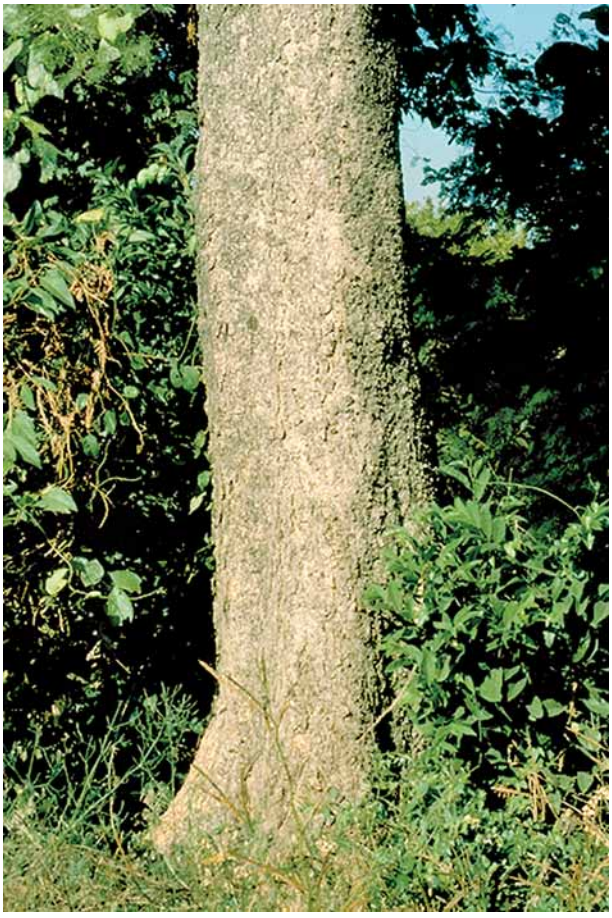

Fig. 5: Stem base of mature tree (northwestern Maharashtra, India)

Rooting habit

Seedlings develop a long, stout taproot at an early age, up to 70 cm after 4 months. If inoculated with *Rhizobium* or sowed in soils that contain these nitrogen-fixing bacteria, lateral roots quickly develop large, branched nodules [31, 45]. They are drought-tolerant, and require only minimal weeding during the first months after outplanting.

Adult siris trees generally develop wide-spreading lateral root systems and a deep taproot, particularly in well-drained soils or in semi-arid conditions. Because the lateral root system is usually superficial, trees tend to be susceptible to windthrow [20, 31, 45, 48].

In studies of young trees up to 17 cm stem diameter conducted in Puerto Rico, the proportion of tree biomass contained in roots was found to be inversely proportional to both tree size and soil moisture holding capacity, and ranged from 40 to 70 percent of total tree biomass [31]. In 3-year-old stands in India, and 4.5-year-old stands in Puerto Rico, root biomass was found to comprise 25 and 38 percent, respectively, of the total tree biomass [16, 35].

Taxonomy and genetic differentiation

Albizia, a genus first described by Antonio Durazzini in 1772 and named after the 18th century Italian nobleman-naturalist Francesco Albizzi, is a large and complicated genus, closely related to *Acacia* in the subfamily *Mimosoideae*, comprised of approximately 150 species of trees, shrubs and lianes native to tropical and subtropical regions of Asia and Africa [26, 29, 37]. In addition to *A. lebbek*, a number of other members of the genus are of economic importance for their timber, gums and resins, traditional medicinal products and use in agroforestry systems as shade trees. These include *A. chinensis* (OSB.) MERR. and *A. procera* (ROXB.) BENTH., both native to South and Southeast Asia; *A. julibrissin* DURAZZ., from Iran to Japan; *A. adianthifolia* (SCHUM.) W.F. WIGHT, *A. anthelmintica* BRONGN., *A. ferruginea* (GUILL. & PERR.) BENTH., *A. grandibracteata* TAUBERT, *A. gummiferea* (J. F. GMEL.) C.A. SM, and *A. zygia* (DC.) MACBRIDE, all native to tropical and subtropical Africa [32].

Despite its widespread use and economic importance in South Asia and elsewhere in the tropics and subtropics, very little information is available on genetic variation in *Albizia lebbek*. However, the results of a provenance trial involving seed collected from populations in 12 widely dispersed locales throughout India showed significant variation among provenances in leaf chemical composition [22], height, stem diameter, branch number and aboveground biomass in 3-year old trees, with provenances from northwestern and central India generally superior in growth traits than those from southern India [43].

Growth, development and yield

The size and form of mature siris trees vary greatly with locality and environment. Open-grown trees typically exhibit low branching and develop shorter boles, larger and more spreading crowns than trees grown in plantations or other closed forests, where trees usually attain a maximum height of up to 18 m, 4 to 9 m of clear bole, and a stem diameter of 0.6 to 1.0 m. Under optimal site conditions in mixed natural forests in the Andaman Islands (India), mature tree heights of up to 30 m and stem diameters as great as 1.4 m have been recorded [45]. Depending on site conditions, annual height and stem diameter growth in siris range from 0.5–2.0 m and 1.0–2.5 cm, respectively during the first 2–5 years of growth [32, 35].

In plantations established on favorable sites in India, average reported height and diameter (d.b.h.) ranged from 4.6–5.9 m and 8.3–10.2 cm at 6 years, and 5–18 m and 10–20 cm at 9 years. In these same plantations, average tree d.b.h. ranged from 26 to 80 cm at 12 years, and 44 to 80 cm at 30 years, with average heights of between 18 and 25 m [13, 45, 48, 49].

Reported values for aboveground biomass in *A. lebbek* plantations averaged 15 t ha^{-1} at 2 years, and 45 t ha^{-1} at 4.5 years, in rainfed plantings in Puerto Rico [31, 35], and 22 t ha^{-1} and 53 t ha^{-1} in two and three-year-old irrigated plantations in India [16]. Mean annual wood volume increments of 5.0 to 8.4 m^3 have been reported from plantations managed in rotations of 10 to 15 years or more across a range of suitable sites in India [30, 49]. Reported annual fodder yields for siris are 1,700 kg ha^{-1} of edible material for trees pollarding every three years, and 2,500 kg ha^{-1} in hedgerow stands browsed by cattle twice per year at a low-rainfall subtropical site [25].

Reproduction and regeneration, propagation, cultivation

The natural regeneration of siris may be good on disturbed sites with loose, exposed, mineral soil and partial shade or full sunlight, although very high seed predation rates by insect larvae often precludes, or severely limits, natural regeneration throughout the tree's native and introduced ranges [31, 48]. Although seedlings do not tolerate heavy shade [45, 48], they may persist for several years under the moderate shade of parent trees or in plantations, and respond well once light conditions improve (personal observation).

Seeds are readily extracted either by opening or crushing the pods by hand, and separating them by winnowing [45]. Seeds may be sown without pretreatment, although soaking them in boiling water for 1 minute, followed by cool water for 24 hours, increases germination rate and uniformity. Germination of freshly extracted seeds in Puerto Rico was 60 to 90 percent; after 1 year of cold storage at 5 to 10°C, percentage germination dropped to 12 percent [31, 32, 37]. However, seeds can be stored for up to 5 years in sealed containers at room temperature with only moderate reduction in percentage viability [45, 48].

Germination takes place on the soil surface, and generally occurs between 2 and 20 days after sowing, with peak germination at 12 to 18 days. Germination and early seedling development are favored by sowing seeds just below the soil surface in a loose, moist medium under light shade or full sun [45, 48]. In Puerto Rico, seedlings raised in plastic sleeves under light shade reached plantable size (20 to 30 cm) in 3 months [32].

Siris seedlings, saplings, and larger trees all coppice vigorously when cut or otherwise damaged [33]. Vegetative reproduction also occurs through layering [31].

Fig. 6: Mature fruits (pods) including seeds (photo: Ulla M. Lang)

Root suckers are readily produced when lateral roots are exposed [40, 45]. Viable shoot buds have been produced through tissue culture from hypocotyl, root, cotyledon, and leaflet explants [12, 41].

Plantations can be established by direct sowing, planting of seedlings, stem or root cuttings, and bare-rooted stumps [17, 29, 45, 48].

In India, direct sowing or bare-rooted stumps have been found to be preferable to planting nursery-grown seedlings, whose growth is often slow after outplanting [45]. Because of rapid taproot development, planting of smaller rather than larger seedlings during the rainy season is recommended [31, 45]. The seedlings are very sensitive to frost but somewhat less sensitive to drought, when they commonly die back to the ground but resprout vigorously when conditions improve [32, 45]. As seedlings do not tolerate heavy shade or root competition, weeding around planted seedlings is required during the first growing season [31].

Ecology

Siris grows from sea level to 1500 m elevation in a variety of climatic zones where annual rainfall ranges from 600 to 2500 mm, with or without an extended dry season [45, 48]. In its north Indian range, characterized by hot, dry summers, cool winters, and a dry season lasting from September to May, mean daily temperatures range from 5 to 46 °C during the coldest and hottest months, respectively. Unlike seedlings, older trees can withstand both light frosts and drought [45, 48].

Siris grows best on moist, well-drained soils [5, 45], tolerates saline, sodic, and lateritic soils, but grows poorly on heavy clays and other poorly drained soils [5, 44]. Its nitrogen-fixing capacity enables it to thrive in nitrogen-deficient soils, and its tolerance of sea spray, limestone soils and alkaline, calcareous sands make siris a suitable species for reforestation in coastal areas [8, 10, 31, 48].

A. lebbek occurs naturally as an early successional species in a variety of forest types, including dry and moist mixed deciduous forests and moist semievergreen and evergreen forests.

In the tropical dry and mixed deciduous forest of northern and central India, siris is typically associated with the commonly dominant species *Hardwickia binata* ROXB. and *Tectona grandis* L. f., particularly in moist ravines and along streambanks [48].

In West Bengal and Bangladesh, siris is usually associated with such species as *Salmalia malabarica* (DC.) SCHOTT. & ENDL., *Hymenodictyon excelsum* WALL., and *Adina cordifolia* HOOK. f. in open forest formations.

In the dry, deciduous scrub forests of southern India, it is often found with *Santalum album* L., other *Albizia* species, and members of the genera *Acacia*, *Zyziphus*, *Cassia*, and *Terminalia*. Siris also occurs as an aggressive colonizer in the dry plain forests of Punjab (both in Pakistan and India) dominated by *Prosopis spicigera* L., *Salvadora oleoides* DECNE., and *Capparis decidua* FORSK. [48].

Pathology

Siris is reportedly susceptible to insect pests under plantation conditions in India, particularly in the Andaman Islands [48]. Approximately sixty coleopteran, hemipteran, and lepidopteran pests have been reported to feed on the young shoots, leaves, sap, seeds, and dead wood of this species in South and Southeast Asia [7, 28, 42, 48]. The principal insect pests in India include the hemipteran *Oxyrhachis tarandus* FABR. *(Membracidae),* which attack

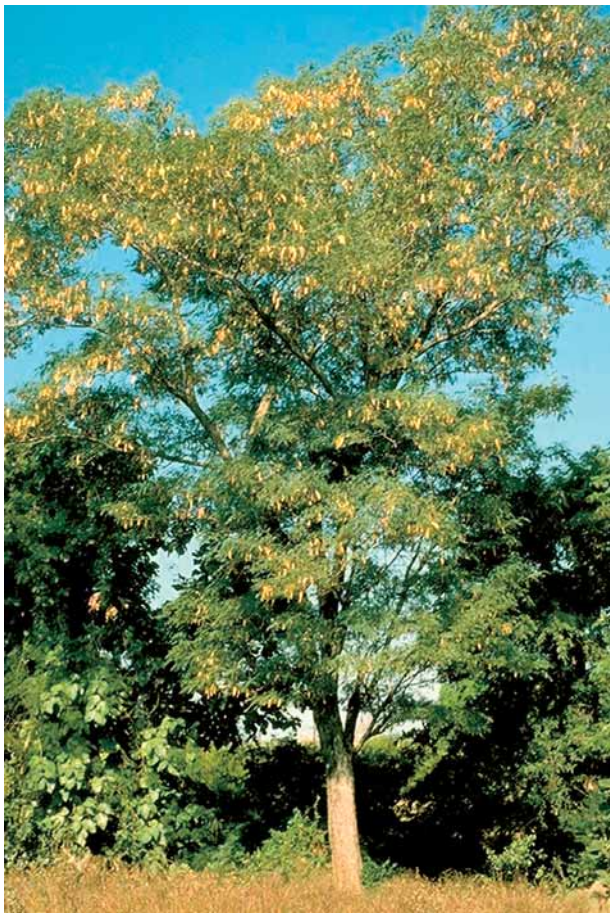

Fig. 7: Full grown tree in northwestern Maharashtra, India

the young shoots of seedlings and saplings, and the defoliating larvae of the lepidopterans *Eurema blandasilhetana* WALLACE and *E. hecabe* L. The bark- and sapwood-feeding larvae of the coleopterans *Xystrocera festiva* and *X. globosa* OLIVIER have been reported to cause serious damage in siris planted for shade in tea gardens in Myanmar, Malaysia and Java; damage by *X. globosa* is reportedly the primary cause for the disappearance of siris as an avenue tree in several cities in Egypt [48]. In India, important seed predators include the larvae of the lepidopteran *Stathmopoda basiflectra* MEYRICK, and those of the coleopteran *Bruchus pisorum* L., *B. saunersi* JEKEL, and *B. sparsemaculatus* PIC. [48]. In Puerto Rico, seeds are particularly susceptible to attack by *Bruchus* sp. larvae which emerge from eggs laid in ripened pods by the adult [31].

Several fungi have been reported as leaf, stem, and root diseases throughout the species' native and introduced range [14]. Siris is highly susceptible to a vascular wilt caused by *Fusarium oxysporum* SCHL. ssp. *perniciosum* (HEPT.) TOOLE, considered the most important fungal disease of the genus *Albizia*. Spread mainly through transfer of infected soil, this pathogen invades the fine roots, causing gummosis of the vessels and, within a year of infection, wilting and death of the host tree [14, 34]. *Phellinus fastuosus* (LEV.) RYV, *P. gilvus* (SCHW.) PAT., and *Flavadon flavus* (KL.) RYV. have been recorded as the cause of heart and butt rot in siris. *Endodothella albiziae* (SYD.) VON ARX (reported in Africa, Pakistan and the Philippines) and *E. deightonii* (SYD.) VON ARX (reported in Africa and South Asia) infect the leaves, causing numerous small yellow spots on which the fruiting bodies appear as minute black dots. *Camptomeris albizae* (PETCH) MASON is a weak pathogen associated with foliar necrosis in siris in Africa, South Asia and the Dominican Republic. *Helminthosporium albiziicola* THIRUM & NARAS. is a similar fungus that forms brownish pustules on reddish leaf spots on siris in India. The powdery mildew, *Leiveillula taurica* (LEV.) ARNAUD, reported in Pakistan, causes leaf necrosis accompanied by a characteristic superficial white powdery growth of the fungus. Several rusts have been reported to attack siris in its native and introduced ranges, sometimes causing leaf-shedding and dieback, although none are considered to be very serious [14].

Because the foliage is highly palatable, young siris trees are subject to browsing damage by livestock and other grazing animals [6, 38, 45, 48].

Uses

Siris is a valued timber species within its native Asian range. It seasons and works well, and is used for furniture, flooring, veneer, paneling, carving, posts, and a variety of agricultural implements. The bark, which contains 5 to 15 percent tannin, is used in India for tanning and dying, and its high saponin content has led to its use as a detergent [46, 47]. The cut bark yields a reddish-brown gum that is used as a substitute for gum arabic (from *Acacia senegal* WILLD.) [11, 29].

In its native range, siris is planted as a shade tree in coffee, tea, cardamom and cacao plantations. It is also pollarded and used as a host for the lac insect in India [27, 48]. The flowers are reportedly a good source of honey [19, 23].

The leaves contain 15 to 30 percent protein and have *in vitro* digestibility values of 45 to 75 percent for fresh leaves. The leaves and green twigs, along with the green fruits and flowers, are considered very good fodder for cattle, camels, goats and elephants [19, 25, 29, 45].

Siris leaves, flowers, seeds, bark, and roots are all used in traditional South Asian medicine. The flowers are used as a cooling medicine and as an external application to relieve boils, skin eruptions and swellings. The seed oil is used externally to promote healing of lesions in leprosy among the Irular tribal community in Tamilnadu (southern India).

The powdered root bark and root-gum are used as a dental powder for strengthening the gums. In Ayurveda the root is used to treat hemicrania; the acrid bark for diseases of the blood, leucoderma, itching, skin diseases, piles, inflammation, erysipelas and bronchitis; the leaves are used to treat ophthalmia, and the flowers for asthma.

In Unani medicine the root is used to treat ophthalmia; the bark is regarded as anthelmintic and used to relieve toothache and to strengthen the gums and teeth, and to treat leprosy, deafness, boils, scabies, syphilis, and paralysis; the leaves are reportedly useful for treating night blindness; and the seeds are used to treat gonorrhea and tuberculous glands, their oil applied locally for leucoderma [4, 8, 21, 36, 39, 51].

Further information

In its native South Asian range, siris has important symbolic value among certain religious communities. Buddhists hold the tree sacred [3], and Hindus use the flowers for religious ceremonies [6].

Literature

[1] Adams, C. D., 1972: Flowering plants of Jamaica. Univ. West Indies, Mona, Jamaica.
[2] Ali, S. I.; Quraishi, S., 1967: A taxonomic study of the genus Albizzia Durazz. from West Pakistan. Pakistan J. Forestry **17**, 3, 365–370.
[3] Allen, O. N.; Allen, Ethel K., 1981: The Leguminosae: a sourcebook of characteristics, uses, and nodulation. Univ. Wisconsin Press, Madison, WI.
[4] Asolkar, L. V.; Kakkar, K. K.; Chakre, O. J., 1992: Second Supplement to Glossary of Indian Medicinal Plants with Active Principles, Part I (A–K). Publications and Information Directorate, Council of Sci. and Industr. Res., New Delhi.
[5] Bangash, S. H., 1977: Salt tolerance of forest species as determined by germination of seeds at different salinity. Pakistan J. Forestry **27**, 2, 93–97.
[6] Benthall, A. P., 1933: The trees of Calcutta and its neighborhood. Thacker Spink and Co., Calcutta.
[7] Bhasin, G. D.; Roonwall, M. L., 1954: A list of insect pests of forest plants in India and the adjacent countries. 2. List of insect pests of plant genera 'A' (Aberia to Azima). Ind. For. Bull. 171, Dehra Dun, For. Res. Inst., 44–46.
[8] Chatterjee, A.; Pakrashi, S. C.; 1992: The Treatise on Indian Medicinal Plants. Vol. 2. Publ. and Inf. Directorate, Council of Sci. and Industr. Res., New Delhi.
[9] Cook, O. F.; Collins, G. N., 1903: Economic plants of Porto Rico. Contrib. National Herbarium. **8**, 2. Smithsonian Inst., Washington, DC.
[10] Chopra, R. N.; Nayar, S. L.; Chopra, I. C., 1956: Glossary of Indian medicinal plants. Council of Sci. and Industr. Res., New Delhi.
[11] Farooqi, M. I. H.; Kapoor, L. D., 1968: Some Indian plant gums – their botany, chemistry and utilization. Indian Forester **94**, 9, 662–666.
[12] Gharyal, P. K.; Maheshwari, S. C., 1983: In vitro differentiation of plantlets from tissue cultures of Albizia lebbek. Plant Cell Tissue Organ Culture **2**, 1, 49–54.
[13] Ghosh, R. C., 1976: Afforestation problems of saline and alkaline soils in India. Van Vigyan **14**, 1, 1–17.
[14] Gibson, I. A. S., 1975: Diseases of forest trees widely planted as exotics in the Tropics and Southern Hemisphere. I. Important members of the Myrtaceae, Leguminosae, Verbenaceae and Meliaceae. Commonwealth Mycol. Inst., Unit of Tropical Silviculture, Dep. Forestry, Univ. Oxford.
[15] Grisebach, A. H. R., 1864: Flora of the British West Indies. Lovell Reeve and Co., London.
[16] Gurumurti, K., 1982: Energy plantation: Gandhinagar (Gujarat). Unpubl. rep. For. Ecol. Branch, For. Res. Inst. and Colleges, Dehra Dun, India.
[17] Holdridge, L. R., 1943: Arboles de Puerto Rico y las Islas Vírgenes. Trop. For. Exp. Sta.., For. Serv., U. S. Dep. Agric., Río Piedras, PR.
[18] Hutchinson, J.; Dalziel, J. M., 1958: Flora of west tropical Africa. 2nd ed. Crown Agents for Overseas Governments and Administrations, London.
[19] Irvine, F. R., 1961: Woody plants of Ghana. Oxford Univ. Press, London.
[20] Kessel, C. van; Roskoski, J. P. et al., 1983: $^{15}N_2$ fixation and H_2 evolution by six species of tropical leguminous trees. Plant Physiology **72**, 3, 909–910.
[21] Kirtikar, K. R.; Basu, B. D.; Anon., 1935: Indian Medicinal Plants. Reprint of 1933 2nd ed.. Bishen Singh Mahendra Pal Singh, Dehra Dun, India.
[22] Kumar, N.; Toky, O. P., 1994: Variation in chemical composition of seed and foliage in Albizia lebbek (L.) Benth. of different provenances. Agroforestry Systems **25**, 217–225.
[23] Little, E. L., Jr., 1983: Common fuelwood crops: a handbook for their identification. Communi-Tech Associates, Morgantown, WV.

[24] LITTLE, E. L., JR.; WADSWORTH, F. H., 1964: Common trees of Puerto Rico and the Virgin Islands. Agric. Handb. 249. U. S. Dep. Agric., Washington, DC.
[25] LOWRY, J. B.; PRINSEN, J. H.; BURROWS, D. M., 1994: Albizia lebbeck – a promising forage tree for semiarid regions. In: GUTTERIDGE, R. C.; SHELTON, H. M. (eds.): Forage tree legumes in tropical agriculture. CABI Publishing, Wallingford, UK. http://www.fao.org/ag/AGP/AGPC/doc/Publicat/Gutt-shel/x5556e0a.htm#TopOfPage
[26] MABBERLEY, D. J., 1997: The plant book. 2nd ed., Cambridge Univ. Press, Cambridge, UK.
[27] MACMILLAN, H. F., 1962: Tropical plants and gardening. 5th ed. Macmillan and Co., London.
[28] MAHMOOD, S. H.; AHMED, M.; ASLAM, M., 1969: Empoasca albizziae, new species (Typhlocybinae, Homoptera), a pest of Albizia lebbek, in Pakistan. Pakistan J. Zoology, Lahore **1**, 1, 49–54.
[29] NATIONAL RESEARCH COUNCIL, 1979: Tropical legumes: resources for the future. Nat. Academy of Sci. Press, Washington, DC.
[30] NATIONAL RESEARCH COUNCIL, 1980: Firewood crops: tree and shrub species for energy production. Nat. Academy of Sci. Press, Washington, DC.
[31] PARROTTA, J. A., 1987: The influence of density on stand development, biomass partitioning and nutrient allocation in Albizia lebbek (L.) BENTH. plantations in Puerto Rico. Ph.D. diss., Yale Univ., New Haven, CT.
[32] PARROTTA, J. A., 1988: Albizia lebbek (L.) BENTH. Siris. Res. Note. SO-ITF-SM-7, South. For. Res. Sta., For. Serv., U. S. Dep. Agric., New Orleans, LA, U.S.A.
[33] PARROTTA J. A., 1990: Coppice growth in clearcut and lightly thinned Albizia lebbek plantations. J. Tree Sciences **10**, 1, 13–18.
[34] PARROTTA J. A., 1990: Occurence and spread of Fusarium sp. in plantation monocultures of Albizia lebbek in Puerto Rico. Nitrogen Fixing Tree Res. Rep. **8**, 118–119.
[35] PARROTTA, J. A., 1992: The role of plantation forests in rehabilitating degraded tropical ecosystems. Agriculture, Ecosystems and Environment **41**, 2, 115–133.
[36] PARROTTA, J. A., 2001: Healing Plants of Peninsular India, CABI Publishing, Wallingford, UK and New York, NY, USA.
[37] PARROTTA J. A., 2002: Albizia lebbek (L.) BENTH. In: VOZZO J. A. (ed.): Tropical Tree Seed Manual. Agric. Handb. 721. For. Serv., U. S. Dep. Agric., Washington, DC.
[38] PÉREZ-ARBELAEZ, E., 1978: Plantas útiles de Colombia. 4th ed. Litografía Arco, Bogota.
[39] RAGUPATHY, S.; MAHADEVAN, A., 1991: Ethnobotany of Kodiakkarai Reserve Forest, Tamil Nadu, South India. Ethnobotany **3**, 79–82.
[40] RYAN, G. M., 1904: Reproduction by root suckers. Indian Forester **30**, 10, 450–458.
[41] SHARGAL, P. K.; MAHESHWARI, S. C., 1981: In vitro differentiation of somatic embryonids in a leguminous tree: Albizia lebbeck. Naturwissenschaften **68**, 8, 379–380.
[42] SHARMA, P. C., 1965: A note on the control of Sternocera aurosignata (buprestid root borer). Two and a Bud, Tocklai, Assam **12**, 1, 3.
[43] TOKY, O. P.; KUMAR, N.; BISHT, R. P., 1996: Variation in growth of 3-year old provenance trial of Albizia lebbek (L.) BENTH.in arid India. Silvae Genetica **45**, 1, 31–33.
[44] TOMAR, O. S.; YADAV, J. S. P., 1982: Effect of irrigation with saline and sodic water on the growth of Albizia lebbeck and soil properties. Ind. J. Forestry **5**, 4, 290–297.
[45] TROUP, R. S., 1921: The Silviculture of Indian Trees. Clarendon Press, Oxford, UK.
[46] VARSHNEY, I. P.; BADHWAR, G., 1970: The study of the saponins of Albizia lebbek BENTH. seeds from Madhya Pradesh. J. Indian Chemical Soc. **47**, 8, 907–909.
[47] VARSHNEY, I. P.; BADHWAR, G. et al., 1973: Lebbekanin C, a new saponin from Albizia lebbek pods. Planta Medica **24**, 2, 183–189.
[48] VENKATARAMANY, P., 1968: Silviculture of genus Albizia and species. Silviculture of Indian Trees 22. Governm. of India, New Delhi.
[49] WEBB, D. B.; WOOD, P. J.; SMITH, J., 1980: A guide to species selection for tropical and subtropical plantations. Trop. For. Pap. 15. Commonwealth For. Inst., Dep. Forestry, Univ. Oxford, England & Overseas Development Administr., London.
[50] WILLIAMS, R. O.; WILLIAMS, R. O., JR., 1941:. The useful and ornamental plants of Trinidad and Tobago. 3rd ed. A. L. Rhodes, Trinidad and Tobago.
[51] YOGANARASIMHAN, S. N., 1996: Medicinal Plants of India. Vol. 1 – Karnataka. Interline Publishing, Bangalore, India.

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