**Santalum ellipticum** Gaud.

Santalaceae

LOCAL NAMES
English (sandalwood,coastal sandalwood,sandalwood tree); French (bois de santal); Hawaian (iliahialo'e); Spanish (sándalo)

BOTANIC DESCRIPTION
Santalum ellipticum is a sprawling shrub to small tree, 1–5 m tall and 1–3 m in canopy diameter, maximally reaching 12 m tall and 5 m in canopy diameter, and bole diameter at breast height (dbh) of 30 cm. The species forms an extensive network of surface roots capable of grafting onto roots of other species that serve as a source of water and mineral nutrients.

Leaves elliptic to orbicular, ovate, or obovate and leathery to succulent; 2.5–6.1 cm long and 1.7–4 cm wide, with petioles up to 15 mm long; dull, grayish green, with glaucous upper and lower surfaces.

Inflorescence greenish tinged with brown, or orange, produced in terminal compound cymes. Pedicels 0–1 mm long, the floral tube campanulate to conical, 4–7 mm long, with an inferior ovary. Flowers produce a sweet fragrance.

Fruits purple to black drupes, often glaucous, 9–12 mm long, with a distinctive apical receptacular ring. The kernels consist of a hard, woody, smooth or slightly rough, lightcolored endocarp enclosing a single seed.

BIOLOGY
Flowering begins at 3–4 years, but heavy flowering and fruiting may take 7–10 years, and occurs throughout the year, usually with two peaks; fruits maturing about 4 months after flowering. Birds are the principal means of seed dispersal.

Habit at Auwahi, Maui, Hawaii. (Forest & Kim Starr (USGS))

With lichen on branch at Auwahi, Maui, Hawaii. (Forest & Kim Starr (USGS))

Immature fruits at Lahaina Pali Trail, Maui, Hawaii. (Forest & Kim Starr (USGS))

ECOLOGY
Santalum ellipticum grows near the ocean shore, in dry gulches, on slopes or ridges, and frequently in rocky habitats. The species also grows in arid shrub land and forest, often persisting in areas invaded by nonnative species. Associated species include
Wikstroemia sandwicensis and the Nihoa Island fan palm Pritchardia remota in windward, lowland areas. In more dry environments S. ellipticum is associated with Chenopodium oahuense and Chamaesyce hypericifolia.

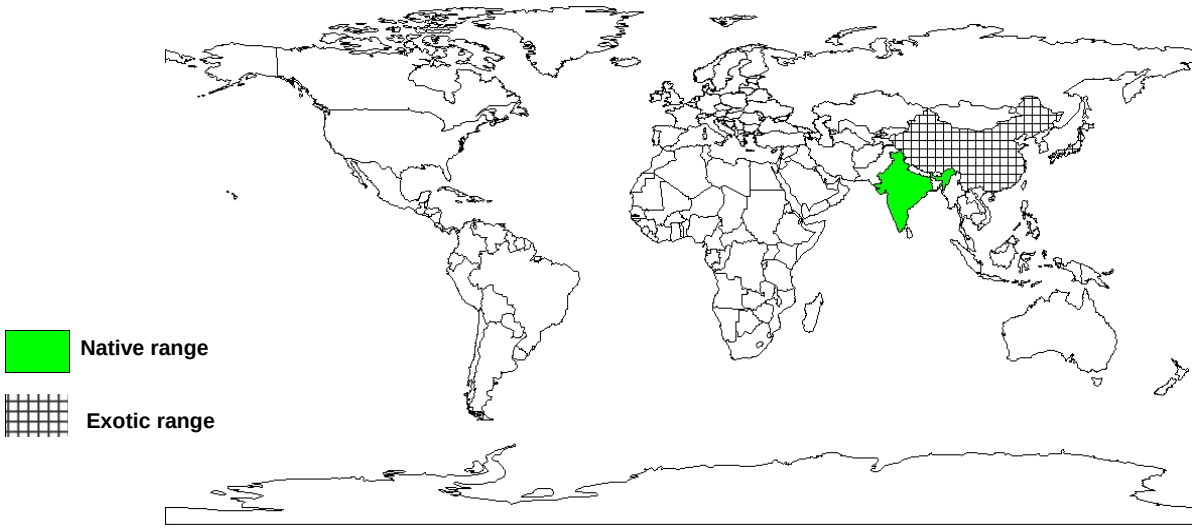
Coastal sandalwood can survive with up to 60–70% shade, with growth rates slower at higher shade levels. The optimum level of shade is up to about 25%, preferably as side shade.

Sandalwood species generally have a capacity for invasiveness in disturbed, more open plant communities. This is not considered a problem because of their very high value, their small stature, and the fact that they do not appear to modify such communities in any substantial way. Being parasitic, importation of viable Santalum seed into the U.S. (including Hawai‘i) is prohibited by federal law.

BIOPHYSICAL LIMITS
Altitude: 0-1390 m
Temperature:
Rainfall: 50-1300 mm
Soil type: S. ellipticum thrives in well drained sandy and clay soils, including those derived from raised limestone; prefers acid to neutral soils (pH 4.0–7.4); and can tolerate shallow and infertile soils.

## DOCUMENTED SPECIES DISTRIBUTION

Native: India
Exotic: China, Japan, Korea, Republic of, Singapore, Taiwan, Province of China




The map above shows countries where the species has been planted. It does neither suggest that the species can be planted in every ecological zone within that country, nor that the species can not be planted in other countries than those depicted. Since some tree species are invasive, you need to follow biosafety procedures that apply to your planting site.

PRODUCTS
Food: The seed kernels are edible (and some say tasty), although the scarcity of seeds and their high value for propagation makes their use as food somewhat inappropriate.

Apiculture: When in flower, the trees are visited by honeybees.

Timber: Sandalwood is used for carving religious statues and objects, handicrafts, art, and decorative furniture, musical instruments and canoe construction.

Essential oils: Heartwood from sandalwood trees yields an aromatic oil which is widely valued and has been the basis of a lucrative and exploitative trade for hundreds of years. The oil is used in cosmetics, for scenting of soaps, perfumery, aromatherapy, and medicinal purposes.

Medicine: A shampoo made from a leaf infusion was used for curing dandruff and eliminating head lice. A drink made from finely ground powdered heartwood, mixed with other plants, followed by laxative was used in curing diseases of both male and female sex organs

Fuel: In Hawai‘i, Santalum spp. were sometimes used for firewood.

SERVICES
Ornamental: The species is quite attractive, especially when in flower, and suitable for home gardens and urban environments, in a mixture of host species, and high protection. Perhaps the greatest value of growing sandalwood in the landscape is the satisfaction of nurturing this esteemed cultural tree. The flowers and berries are attractive, and the flowers are mildly scented.

Intercropping: Sandalwoods are suitable for inclusion in alley cropping systems, especially where the other alley species include good hosts, e.g., Calliandra spp. it is also suitable for inclusion in woodlots, especially when planted along sun exposed edges and in combination with compatible species, e.g Acacia koa.

Boundary or barrier: Sandalwoods are suitable for inclusion in windbreaks, especially where the main windbreak species include good hosts, e.g., Casuarina spp

Erosion control: S. ellipticum provides a small amount of coastal protection, as it can grow within a few meters of the sea.

TREE MANAGEMENT
Seedlings are ready for out planting after about 6 months when height is about 20–25 cm.
Planting should be among established long term host plants or together with intermediate hosts while longer term hosts are established. For high survival rates planting should be at the onset of the rainy season and be kept well weeded in the first 2 years.

Spacing for commercial production should vary depending on type of planting. The final crop should be around 100 mature trees per hectare due to the need to include host tree/shrub species (at a rate of 2–4 per sandalwood trees depending on host species).

In shady situations, plants exhibit reasonably strong self pruning characteristics. Suitable shade regimes to keep plants growing straight and to avoid a bushy habit should be provided by either a strong lateral shade with no overhead shade or a high canopy of intermediate shade.

Surrounding host species may require pruning, especially if they grow much faster than sandalwood in order to allow adequate light to penetrate.

For low fertility soils, fertilizing with a handful (up to 100 g) of slow release
NPK fertilizer per tree may help when trees show signs of yellowing or slow growth.

GERMPLASM MANAGEMENT
Seeds should be collected while still attached to the tree or from the ground, often with the pulp decayed or removed by birds.

The fleshy mesocarp should be removed from the fruits immediately. Hard fruit should be soaked for 1- 2 days to soften the pulp prior to its removal. The de-pulped, cleaned seeds should then be disinfected, rinsed and air dried at a temperature below 25°C, for up to 2 - 3 weeks. Seeds exhibit intermediate storage behavior, with seed rapidly losing viability during storage. If seeds must be stored, they should be placed in airtight containers in the refrigerator (2 - 4°C) as soon as possible following surface drying. Generally, ultra dry storage (e.g., down to about 2% moisture) is recommended for this type of seed.

Sandalwood seeds should be sown as soon as possible after collection to reduce the risk of losing viability during storage. Germination of up to 90% can be achieved with fresh and healthy seed and proper germination technique. Scarification process involving the removal of a small part of the seed coat at the apex of the seed should be done to expose the embryo but not damage it; using nail clippers, forceps, or medium sandpaper. Soaking the seeds in a growth hormone solution like diluted (0.05%) gibberellic acid for 5 days, changing the solution daily is recommended. Seeds should then be dusted with a 1:1 mixture of powdered sulfur and captan to prevent fungus infection.

The optimum temperature for germination should be between 28°C and 31°C. Seeds should begin to germinate after approximately a week and continue germinating over a 2 - 3 week period with a success rate of over 90% even for seeds more than 6 months old.

PESTS AND DISEASES
Sandalwood species resist most insect attack, although weak infestations of whitefly or scale insects sometimes occur. Insects such as cockroaches, sow bugs, crickets, and cutworms may nibble at ground level stem parts. Slugs and snails also feed on newly sprouted plants. Rats (Rattus exulans and R. rattus) and mice voraciously consume sandalwood fruits and seeds. In some areas, these rodents have virtually eliminated natural reproduction.

Sandalwoods are at risk of infection from pathogenic fungi, such as Phellinus noxius, which can also spread from tree to tree through root grafts.

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