

Santalum album L.

Common names: Sandal, White sandal

Sanskrit name: Chandan

Malayalam names: Chandanam

Tamil names: Sandhanam, Selegam, Srigandam, Ulocidam

Description: Evergreen trees, to 10 m high, bark surface dark grey to nearly black, rough. Leaves simple, opposite, 3.7-12 x 2-4 cm, elliptic, elliptic-ovate or ovate-lanceolate, apex acute, base acute or round, glaucous beneath. Flowers bisexual, 5-6 mm across, reddish-purple, in axillary and terminal paniculate cymes, much shorter than leaves. Tepals 5, basally connate into a campanulate tube of 2 mm long, shortly connate to the basal part of the ovary; lobes 2.5 x 1.5 mm, ovate, thin, fleshy, minutely ciliate. Stamens 5; filaments 1 mm; anthers 0.7 mm, ovoid, 2-celled. Ovary superior later half inferior at the time of flowering, globose, 1 mm, 1-celled, ovules 2-3, pendulous from below the long, acuminate, central column; style 1.5 mm, stigma 3 lobed. Fruit a drupe, 8-12 mm across, globose, blackish-purple, annulate above, beaked with the basal part of the style; seed one.

Distribution: Peninsular India and Malesia to Australia



Medicinal values

In *Ayurveda*, sandal oil is treated as a cooling, exhilarating, antipyretic, expectorant and stimulant. It is also used as an astringent to the bowels and as an aphrodisiac. In *Unani* medicine, sandal wood dissipates the effect of hot sun and fever and satiates thirst and leaves give cool and refreshing feeling. The wood is ground into paste and applied on local inflammations, on boils, skin diseases and also on fore head during fever. The decoction made of sandal wood is prescribed for genitor-urinary defects. For migraines, the sandal paste is applied on the nostrils for relief. The wood and oil have bitter and astringent taste. It has alterative, diuretic, diaphoretic, disinfectant, stimulant, and cooling properties. The wood paste with lime juice is used to cure itching, scabies, eczema, inflammations and other skin diseases. The sandal paste mixed with milk is a remedy for leucorrhoea and thirst.

Cultivation

Agro-ecological requirements

Normally grows in sandy or stony red soils, but a wide range of soil types are inhabited. This habitat has a temperature range from 20° C to 38° C and annual rainfall between 500 and 3000 mm.

Planting stock production: Propagated by seed.

Seed Processing: The seeds have morpho-physiological dormancy and can be treated with Gibberellic acid solution (500ppm w/v) for 16 to 24 hours. To remove surface contamination, the seeds are soaked in 0.02 percent Agallol (organo mercuric compound) solution for half an hour.

Host Plant Selection:

Santalum album is known to parasitize a large number of plants from grasses to trees. Better growth of sandalwood was observed with leguminous host species such as *Acacia*, *Sesbania*, etc. probably due to higher availability of nitrogen which might increase the number and size of haustorial formation. Sandal wood also requires a primary host at the nursery stage and long term secondary host when planted in field. Studies providing *Cajanus cajan* (L). As the primary host.

Secondary hosts are *Casuarina equisetifolia*, *Acacia nilotica*, *Pongamia binnata*, *Melia dubia*, *Wrightia tinctoria*, and *Cassia siamea*.

Nursery Methods:

Sandalwood seedlings are raised in two types of seed beds: sunken and raised beds. Under different climatic conditions, both beds perform equally well. Both seed beds are made entirely of sand and red earth in a 3:1 ratio, and they are thoroughly mixed with nematicides (Ekalux or Thimet at 500 g per bed of 10 m by 1 m). The seed is evenly distributed across the bed. The seed is covered with about 1 cm of sand. One bed requires approximately 2.5 kg of seed. The bed is covered with straw, which should be removed once the seedlings sprout leaves.

The seed beds are sprayed with (1) the fungicide Dithane Z-78 (0.25 percent) once in 15 days to avoid fungus attack, and (2) 0.02 percent Ekalux solution once a month to avoid nematode damage.

Sandalwood seedlings suffer from a virulent disease caused by a combined fungal and nematode infection. The initial symptom is wilting of leaves followed by sudden chlorosis and root decay. On account of this disease the mortality rate is very high, but this can be controlled by the application of nematicide and fungicide (Ekalux and Dithane) as mentioned above.

When the seedlings have 5 to 6 leaves, they are transplanted to the polyethylene bags along with the seed of the primary host *Cajanus cajan*. The seedlings are carefully

removed from the bed with all the roots intact and then carried in a container with fungicide solution [sic] (Agallol 0.1 percent). Roots should not be allowed to dry.

Shade can be provided for a week immediately after the transplanting. Watering should be done daily, but excess moisture is to be avoided. Host plants are pruned frequently, so that they do not overgrow the sandal and hamper its growth. Poly bags should contain a soil mixture in the ratio 2:1:1 (sand: red earth: farmyard manure). Poly bags 30 by 14 cm are best. To avoid nematode damage, Ekalux at the rate of 2 g/poly bag or 200 g for 1 m³ of poly bag mixture should be thoroughly mixed in before filling the bags.

Plantable seedling of about 30 cm height can be raised in 6-8 months. A well-branched seedling with brown stem is ideal. At the time of planting in the field a perennial host, if given, increases the growth of sandal. Sandal has over 300 host plants; some of the good hosts are *Casuarina equisetifolia*, *Acacia nilotica*, *Pongamia binnata*, *Melia dubia*, *Wrightia tinctoria*, and *Cassia siamea*. It is ideal to plant sandal in 50 cm³ pits, 3 by 3 m apart in alternate rows with host plants.

Plantation Techniques

Sandal has been successfully regenerated by the following techniques:

- (i) Dibbling seeds into bushes
- (ii) Dibbling seeds in pits or mounds
- (iii) Planting container-raised seedlings.

(i) Planting Seeds in Bushes

This planting technique is used in open scrub jungles with many bushes. The seeds are planted during the monsoon season. To sow the seeds, a bamboo pole with an internal diameter of 4 to 6 cm and a length of 1.5 m can be made into an instrument. To rake the soil, the septa at the nodes are removed and one end of the pole is sharpened or a hollow metal piece is attached. The pole is inserted at the base of the bush, and four to five seeds are transferred through the hole to the base of the bush. This method has had a fair amount of success.

(ii) Dibbling seeds in pits or mounds

The standard trench mound technique used for afforestation of other tree species has also been used for sandal, but this time a perennial host plant is grown alongside the sandal, either on the mound or by the side of the pit.

(iii) Planting container-raised seedlings

The area needed for this purpose has been completely cleared. Pits of 50 cm³ are dug at 3 m intervals. In the pits, healthy sandal seedlings, preferably taller than 30 cm, are planted. In the alternate rows, various secondary host plants are planted. This method has proven to be effective in a variety of situations.

After Care: It is recommended to work the soil to a radius of 50 cm once every 6 months. The host plant tends to overgrow sandalwood and should be pruned so that the sandal receives the most sunlight. Adequate fire and grazing protection is required.

Irrigation: When plant comes to water requirement, irrigation should be provided at an interval of 2 to 3 weeks when the plants are young in hot and summer climatic condition. Go for drip irrigation in regions where the water sources are limited.

Manure and fertilizers

Well rotten farmyard manure (FYM) like cow dung, garden compost, vermin - compost or any manure made from green leaves can be used.

Diseases and pests

Spike disease is one of the important diseases of sandal. This disease is caused by mycoplasma-like organisms (MLO). It can occur at any stage of development of the tree. As the disease progresses, the new leaves become smaller, narrower or more pointed and fewer in number with each successive year until the new shoots give an appearance of fine spike. At the advance stage of disease, the inter nodal distance on twigs becomes small, haustorial connection between the host and sandal breaks and the plant dies in about 2 to 3 years.

Harvesting & Post-harvest processing

For production of heartwood, fully grown trees 25-30 yrs old are uprooted. The cleaned heartwood sawn into billets about 2.5 ft. long and are trimmed and kept for drying in a closed warehouse. In this process the aroma and wood are improved. Generally, the heart wood is equivalent to about one third of the tree by weight. As it is a slow growing tree and it takes many decades before it is harvested (by felling the tree). The oil is extracted from the wood. This is a highly expensive item to buy (Approx. Rs. 60,000 (\$1500 per kg).

Yield

Though sandal is a slow-growing tree in the forest (1 cm girth/year), it can grow at a rate of 5 cm girth or more per year in favorable soil and moisture conditions. Sandalwood heartwood formation begins between the ages of 10 and 13 years. Assuming that 250 trees are growing well, each tree can add 1 kg of heartwood per



year, for a total of 250 kg of heartwood added per year. Adopting intensive practices can increase the returns.