



Sandalwood (*Santalum album* L.) locally known as Chandan is highly valued tree world over for its fragrant heartwood and oil extracted from it. In terms of current market price, it is one of the most valuable trees in the world. Apart from being highly treasured for its aroma the heartwood it is also one of the finest woods suitable for carving due to very uniform fibres with close straight grains. Sandalwood oil is used in perfumes, cosmetics, aromatherapy and pharmaceuticals.

It is a small-medium sized tree naturally and mostly occurs in dry deciduous and scrub forests in Deccan region, mainly, in Karnataka and Tamil Nadu states of India.



Naturalized populations are also found in Kerala, Andhra Pradesh, Bihar, Madhya Pradesh, Rajasthan, Gujarat, Maharashtra and Orissa. In Rajasthan, the naturalized Chandan is restricted to south - eastern parts of the state. Natural regeneration is found in Haldighat forests in Rajasmand and Choti Sadri area of Pratapghar Forest divisions.

Currently, sandalwood resources in natural forests in southern India have diminished to great extent because of illicit felling, smuggling, forest fire, grazing and to some extent due to spike disease. Historically, India was the major producer of 'Sandalwood oil' in the world, however, at present due to these factors a drastic reduction in the production of natural sandalwood has occurred over the years.

However, recent deregulation and encouragement of cultivation by some state governments has increased interest in cultivation of this species by farmers and private tree growers all over India. In recent years, the sandal cultivation has been taken up vigorously in Gujarat and Rajasthan and these states are now emerging as major sandal cultivating states in the country.

Soil and Climatic Requirements for Cultivation

Sandalwood is capable of growing in a wide variety of soils from gravelly loam to sandy clay soils and even in soils with very poor nutrients. Red laterite, sandy loam, gneiss, quartz and sand mixed black soils are preferred. It can withstand the soil pH up to 9.0. It does not grow in waterlogged soils. Sandal is capable of growing at elevations from sea level to 1800 m and annual rainfalls of 500-3000 mm and even beyond this range. It can withstand extreme temperatures from 4° C to 46° C. The formation of heartwood, its total content and oil content are said to be best in hot drier regions.



Seed Collection and Treatment



Trees start flowering generally from 3 years of age. It flowers and fruits twice a year during March-April and September-October. Fresh ripened purple coloured fruits are collected from mature trees and soaked in water for a day. Then the seeds are de-pulped by rubbing and washed thoroughly before drying under shade. The seeds may be treated with fungicides to avoid infection and stored under 5% moisture, at 10°-15°C temperature in plastic jars or polythene bags.

Seed Germination and Raising Nursery

Either sunken or raised seed beds of 10.0 m X 1.0 m sizes can be used for germinating sandal seeds. Only sand seed beds are best for germination. Sand and red earth may also be mixed in 3:1 ratio. Application of 500 gm of Dithane Z-78 (0.25%) or 0.02% Ekalux per



seed bed is advisable. In Rajasthan seed sowing may be done in May- June. Around 2.5-3.5 kg seed is spread uniformly over the bed, covered with sand. Germination is around 50-60% with fresh seeds and it may go down with stored seeds. Sandal is highly susceptible to fungal and nematode diseases in initial stages. Seeds beds need to be sprayed with fungicide Dithane Z-78 (0.25%) once in 15 days to avoid fungal attack and 0.02% Ekalux nematicide solution once in a month to avoid nematode attack. Seed beds may be watered twice daily. Seedlings in 4 to 6 leaf stage are transplanted to polybags along with a seed of Arhar (*Cajanus cajan*) or *Alternenthara* plants and kept under shade for a week. Polybags should contain soil mixture of ratio 2:1:1 (Sand: Red earth: Farmyard manure). Polybags of 30 cm x 14 cm size are the best suited. To avoid nematode attack Ekalux of 2 gm/polybag should be thoroughly mixed before filling the bags. Plantable seedlings of about 30 cm height can be raised in 6-8 months time. A well branched seedling of 1.0 ft -1.5 ft height with a brown stem is ideal for planting in the field.

Plantation



Pits of 30cm x 30 cm x 30 cm should be dug and kept open for one week. 10- 15 g Phorate and 10-15 g of Carbendazim is added to the pit. Sandalwood being a hemi root-parasite requires an intermediate host as well as a long term secondary host. Redgram (Arhar), Sesbania, Drumstick etc., can be used as intermediate host with Sandalwood. It can be grown as pure block plantation or planted in agroforestry system with horticultural crops like Indian gooseberry (amla), mango, pomegranate, citrus, sapota, guava, ber, etc., and also can be planted with forestry species like *Casuarina*, *Pongamia*, *Melia dubia*, *Senna siamea* etc., as permanent hosts. Farmers are following various spacing like 3m X 3m, 4m X 3m, 4m X 4m, 4m X 5m or 4m X 6m based on pure block plantation or kind of crops being planted with.

Irrigation and Fertilization

Though sandalwood is a rainfed crop, requires watering in summer months till plants are fully established. Irrigation depends on the type of soil and climate. 15-20 Kg of organic fertilizers like FYM, neem cake or Vermi compost may be applied to the plants regularly after planting. Inorganic fertilizers mainly NPK may be applied to seedlings after establishment @ 150-200 gm/plant.

Growth and Yield

It requires at least 15-20 years to economically harvest heartwood from sandalwood trees. Generally, heartwood formation starts from 7-8 years onwards. Heartwood formation and its total content and oil content depend upon soil and climatic conditions. It is believed that in hot dry conditions, heartwood formation starts early.

However, it is not necessarily to wait very long period for economic gain from sandalwood plantations. Farmers are growing it as agroforestry crop in between various agricultural and crops. Profits may be earned every year

from these intercrops.

Estimated Economic Returns from Sandalwood Plantations

Heartwood and sandal oil yield may vary according to the locations. Growth data from natural forests indicated 4-10 kg heartwood/tree from 20-30 year old trees. During 2008, IWST Bangalore had estimated Rs.1.43 crores/ha of total returns, considering 3-4 kg heartwood/tree at procuring rate of heartwood @ Rs.3500/kg. A report from 2017, estimated Rs.2.98 crores/ha taking into account of Rs.6000/kg heartwood price and 15 kg



heartwood/tree and also taking into account of security cost which is almost 30% of the total returns. Recent studies have indicated that, under scientifically managed plantations, at least 15 kgs of heartwood/tree with a GBH of 45cms may be expected at the age of 15 years. Karnataka Forest Department has placed the estimated return around Rs.1.5 crores/acre in 15-20 years rotation.

Protection of Sandalwood Trees

Many farmers and tree growers experienced that protection of sandalwood tree from theft through illegal felling is tough to handle. The protection issues may crop up from 4-5 years after planting and increase substantially by the time sandalwood trees reach 10-12 years of age and above. Several methods like barbed wire fencing, employing armed security guards, solar electric fence, use of hunting dogs for patrol, etc., may be employed for effective protection.



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Farmers' Guide for Sandalwood Cultivation



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