

# Role of Host Species in the Development of Sandal Growth

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## ABSTRACT

*Santalum album* L. is an evergreen hemi-parasitic tree renowned for its fragrant heartwood. It is indigenous to India and distributed in 9,600 km<sup>2</sup>, mostly in the deciduous forests of Deccan region of Peninsular India (Gairola *et al.*, 2008). More than 90 per cent of its natural population of India is in Karnataka and Tamil Nadu (Dutt and Verma, 2005). Sandalwood is semi parasite in nature hence it is depends on the host species for haustorial connection to absorb nutrient and water. Successful establishment of haustorial connection leads to better growth of the sandal seedlings. Different host species were selected at different stages of the sandalwood growth mainly primary host, intermediate and long-term host therefore silviculture of host plant is most critical for successful Sandalwood plantation.

## INTRODUCTION

Sandalwood is a commercially and culturally important plant species belonging to the family Santalaceae and the genus *Santalum*. Sandalwood oil extracted

from the heartwood has been used for perfumery, medicinal, religious and cultural purposes over centuries of years. In addition to oil, the wood and its powder are used for

religious, cultural and medicinal purposes especially in the Asian and Arab regions. There are around 18 sandalwood species belonging to the genus *Santalum* which are; *S. freycinetianum*, *S. haleakalae*, *S. ellipticum*, *S. peniculatum*, *S. pyrularium*, *S. involutum*, *S. boninense*, *S. insulare*, *S. austrocaledonicum*, *S. yasi*, *S. macgregorii*, *S. acuminatum*, *S. murrayanum*, *S. obtusifolium*, *S. lanceolatum*, *S. fernandezianum*, *S. salicifolium* and *S. spicatum*. All the sandalwood species are identified as obligate wood hemi-parasites which means they absorb certain nutrients such as phosphates and nitrates from the host trees via root connections called haustoria.

The global distribution of the sandal family is between 30 degrees N and 40 degrees S from Indonesia in West to Juan Fernandez Island in the north to New Zealand in the South. These species are mainly found in India, Indonesia, Australia, Timor, Hawaii etc. Sandal being a partial root parasite, a well supporting host plant has a role in growth performance of sandal. Through haustorial connections with host plants it gets nitrogen, phosphorous, potassium and water sources (Varghese 1997; Hiremath 2004; Lion, 2017). Haustorium is a modification of Sandalwood root hairs attached to host roots for absorbing nutrients from the host plant. Larger the haustorial connection, better growth of sandal seedlings (Annapurna et al., 2006).

While developing in nursery, mainly the primary host is planted in a container having *S. album* seedling during nursery stage, secondary host as large trees in the plantation stage. *Cajanus cajan* and *Casuarina equisetifolia* are in use for parasitizing in nursery (Kulkarni, 1995). Silviculture of host plant is most critical for successful Sandalwood plantation. The ratio, spacing and arrangement of host and sandalwood should promote haustorial connection, without a chance of soil nutrient extraction and sunlight deprivation (Page et al., 2018).

Due to the high value and the demand, there is a growing attention at present in establishing sandalwood, especially *S. album* plantations in the tropical region including Sri Lanka over the most demanding other forest plantation species, i.e., teak, mahogany etc. by the private sector plantation companies, due to the large domestic demand and the existing high demand. In accordance with that, there is a trend in sandalwood plantation establishment in Australia, India, Sri Lanka, China, and Fiji since recently. However, the plantation sector lacks the information on establishing sandalwood plantations, which is identified as a great risk when considering their profit maximising goal. Without the information such as nursery techniques, host suitability, plantation establishment, growth rates and oil characteristics, managers of sandalwood plantations might therefore face difficulties in achieving the expected outcomes.

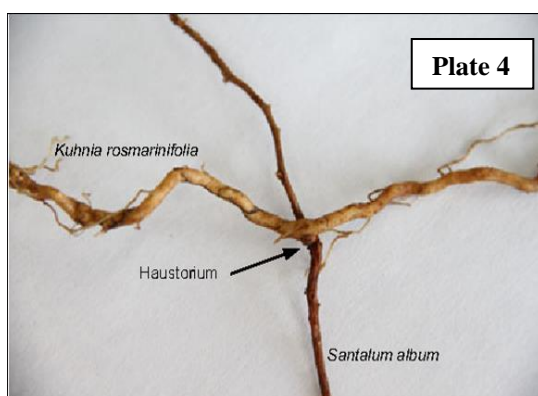
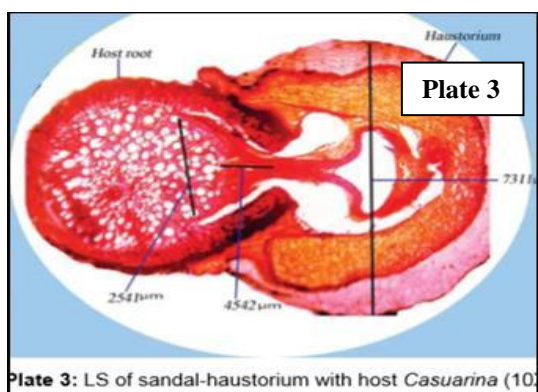
#### **Factors affecting the sandal growth:**

The depletion of sandal tree forest is attributed to factors such as Spike disease, Recurrent annual fires, Invasive weeds, Spread of monoculture plantations, Illicit felling and smuggling, Host-parasite relationship (Dhanya et al., 2010). Among these factors host parasite relationship plays a vital role in promoting the sandalwood growth. As initial establishment of plants in nursery stage primary host is preferred and after the establishment of plants in field condition intermediate and long-term host can be preferred

#### **Sandalwood root parasitism process:**

Sandal parasitism occurs through contact with host roots. The parasitism morphology can be seen from the point of connection of the roots. The contact begins with the formation haustorium growing on roots hairs Sandalwood. **Haustroria** is a modification of Sandalwood roots attached to the roots of the

host plant is used as a tool to absorb nutrients from the host plant. After the root contact occurs then the nutrients from the roots of the host will flow to the root of Sandalwood.



**Host suitability:**

➤ **Site selection:** The preferred site to grow sandalwood is a sandy-loam over clay, duplex soil type. However, sandalwood will also grow on some loamy-gravels, yellow sands and red sands. The site should be water gaining but well drained. Deep white sands, saline soils, waterlogged or heavy clay soils are not suitable.

➤ **Host species:** Sandalwood is dependent on nutrients and water from host plants to survive and grow. The best hosts are nitrogen-fixing trees, especially the wattles (Acacia species). Extensive trials have shown that jam (*Acacia acuminata*) is an excellent long-term host for sandalwood. Rock sheoak (*Allocasuarinahuegeliana*), manna wattle (*Acacia microbotrya*) and mulga (*Acacia aneura*) are also useful long-term host species, but should be planted in combination with *A. acuminata*.

➤ **Host establishment:** The site should be ripped in rows spaced 4-5 m apart and to a depth of 0.4 m. Depending on the soil type, the rows can also be mounded or scalped. In early winter, spray the rows with a knock down and residual herbicide to control weeds for the first year. Two weeks after spraying, plant six-month-old host seedlings along the rows at 2 m intervals (1000-1250 stems ha<sup>-1</sup>). Any of the above host species can be planted, but the host seedling mix should contain at least 50 % *A. acuminata*. Approximately 50 g of NPK fertiliser can also be applied next to each host to promote growth.

➤ **Sandalwood establishment** A very economic and efficient method to establish sandalwood is by direct seeding. Sow the sandalwood seeds when the host trees are 1-2 years of age. Preferably, for good root connections, the host trees should be approximately 1 m tall before introducing the sandalwood. In April, plant 2-3 sandalwood seeds approximately 0.5 m from every second host (500 sowing spots ha<sup>-1</sup>). Sow the seeds along the rip line, because the host roots will be more concentrated in this region. Plant the sandalwood seeds 2-3 cm below the surface, on the south or east side of the host plant, so as to provide afternoon shade. On hard-setting surfaces, the soil may need to be loosened with a hoe or spade, before

seeding. Sandalwood seeds are available from FPC Manjimup Seed Technologies (See Sandalwood Contacts), or from private seed suppliers.

- Approximately two weeks after the break of the season (e.g. early June), spray each sandalwood ‘spot’, in a 0.5 m radius, with a knock down herbicide. Ensure no spray touches the host plants. Weed control is very important before the sandalwood seedlings emerge. Weeds can smother the seedlings and reduce survival and growth. Sandalwood seeds take 4-8 weeks to germinate after good rains in late autumn or early winter. Sandalwood seedlings normally emerge in July/August.
- **Sandalwood to host ratio:** At age 5 years, the parasitic requirements of sandalwood trees greatly affect the survival and performance of the host. A ratio of one sandalwood to one host will place too much stress on the host. At sandalwood age 2 years, the sandalwood to host ratio should be 1:2 or 1:3. Therefore an area with 1000 jams ha<sup>-1</sup> should have no more than 400 sandalwood ha<sup>-1</sup>, at age 2 years. This may require selective thinning of sandalwood throughout the area to achieve the right balance.

**Categories of Host Plants:**

- 1. Pot hosts (Initial or Primary):** The primary host is planted into a container having *S. album* seedling during nursery propagation
- 2. Intermediate hosts:** Bridging nursery and field
- 3. Long term hosts:** Secondary, Field stage



Table. 1: Categories of host Plants for Sandalwood

Location	Species of Sandalwood	Short term host	Middle Term	Long Term
Indonesia	<i>S. album</i>	<i>Desmanthusvirgatus</i>	<i>A. villosa</i>	<i>Cassia siamea</i>
Australia	<i>S. album</i>	<i>Alternantheranana</i>	<i>A. hycarpa</i> <i>Sesbaniaformosa</i>	<i>Dalbergiasps</i>
India	<i>S. album</i>	<i>Cajanuscajan</i>	<i>Sesbaniaformosa</i>	<i>Casuarina equisetifolia</i>
Kaledonia Baru	<i>S. album</i>	<i>Alternantherasesilis</i>	<i>Acacia spirobilis</i>	<i>Paraserianthesfalcataria</i>

Three stages of parasitism have been identified for the successful establishment of *S. album*

plantations. Screening of fast-growing tree species showed *Melia dubia* followed by *Leucaena leucocephala* as the best primary and intermediary host (Choudhury, 2016).

The stages of primary host requirement revealed that, providing *Cajanus cajan* as a host immediately after transplanting Sandalwood seedlings (2 leaf stage) in containers to be the optimal stage for boosting the growth of seedlings. Sandalwood seedlings in general exhibited better growth when grown in the same container with a leguminous host. *Mimosa pudica* proved as the best host, significantly enhancing growth and nutrient status of *S. album* seedlings. Among non-leguminous species, the best growth of sandal seedlings was exhibited with a host of *Alternanthera sessilis* (L.). Host species were found to influence haustorial number, connection, size and chlorophyll contents. Maximum number of haustoria and effective haustorial connections were observed with *A. Sessilis* (Annapurna et al., 2006).

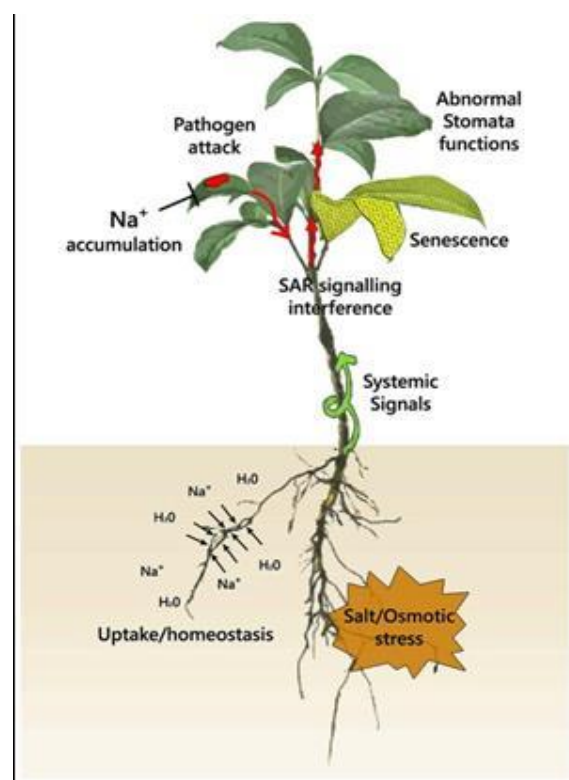
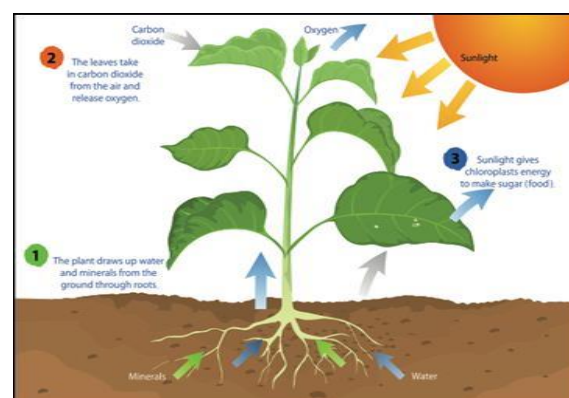
### Host Silviculture:

Host species silviculture is a critical aspect to a successful Sandalwood plantation. The growth and size characteristics of the host species will influence their **optimal spacing, Arrangement and Management**. The ratio, spacing and arrangement of hosts and sandalwood should aim to – Promote haustorial connection, maximise the number of different host available, protection from heat, allow room for sandalwood to extract soil resources and permit sandalwood to intercept direct sun for part of the day. As the planting matures, if any of the above become limiting there may be need for management interventions.

### Role of Host plants

- Reduced stress

- Additional seasonal sources of water and Nutrition
- Access to sunlight
- Protection from pests and diseases
- Reduced weed burden
- Sustained host vigour
- Enhanced nature conservation and Boost sandal growth (Woodal and Robinson, 2002)



## CONCLUSION:

Host influences the physical, physiological and chemical activities of sandalwood. Larger haustoria connection ensured the better growth of sandalwood seedlings. *Melia dubia*, *Leucaena leucocephala* and *Casurina equisetifolia* can be used as a primary, intermediary and long term host. Host plant should be provided within a week after transfer of sandal seedling. Sandal tree growing with host showed high Carbon assimilation rate, plant water potential and leaf nutrient contents. Considering the high demand and diminishing supply of sandal tree, there is great potential for raising it, not only in forest lands but also in private lands such as home gardens and other agroforestry systems.

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