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# Effect of Host Proximity on Growth of Sandal-Wood – A Promising Agroforestry Tree in India

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## ABSTRACT

Indian sandalwood (*Santalum album* L.) is a semi-parasitic evergreen tree. Survival, establishment, growth, and oil content of sandalwood depends on host plants association and host plant proximity. The host proximity distance to sandalwood plants varies with type, habit, ratio, and time of host introduction. Information on primary host proximity and its effect on sandalwood in the field is very scanty. The present study was attempted to study the effect of proximity of *Alternanthera sessilis* on sandalwood plans in the field as a primary host. The experiment consisted of 4 treatments viz., host plants planted around sandalwood plants at 15 cm (Half foot) away from sandal seedlings ($T_1$), host plants planted at 30 cm (One feet) from sandal plants ($T_2$), host plants planted at 45 cm (One and half feet) away from sandal plants ($T_3$) and control, sandal without host plants ($T_4$) with three replications in each treatment. Among the treatments, $T_1$ enhanced both above - and below-ground growth significantly.

**Keywords** Sandalwood, *Alternanthera*, Host, Growth, Morphology.

## INTRODUCTION

The Indian sandalwood tree is highly valued all over the world for its fragrance of heartwood and oil. It is a semi-parasitic medium-sized evergreen tree. Scott (1981) was first recorded the parasitic nature of sandalwood and later documented it with detailed studies. The host-sandalwood haustorial connection act as a physical barrier to the physiological function of sandalwood plants. Appropriate pot-host plants in the nursery stage ensure rapid growth and success of sandalwood plantations (Fox 2000) and the parasitic relationship also continues after establishment. About 70% of sandalwood seedlings establish a haustorial connection with host plants within a month from the day of germination (Nagaveni and Srimathi 1985). The haustorium remains small and ultimately withers away when host plants are absent ; but if a rootlet of a suitable host is present, it grows rapidly assuming the shape of a flattened bell (Rocha 2015). *Alternanthera* is a non-legume, herbaceous, perennial plant that is one of the excellent pot-host plants for sandalwood (Fox *et al*. 1996). *A. sessilis* promotes sandalwood growth (Fox *et al.* 1996) and *A. nana* is enhancing the survival % and out-planting performance of sandalwood (Radomiljac, Mc Comb and Mc Grath

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**Fig. 1.** View of the experiment at the beginning.

**Fig. 2.** View of the experiment at end of 3rd month.

1999). If sandalwood is not getting a suitable host, the growth of leaf and canopy bit size of small diameter leaf yellowish or even chlorosis (Surachman 1989). In some instances, sandalwood plants are found to resort to self-parasitism (Ravi 1990). Usually, with suitable hosts, the sandal trees have a thick canopy, wider and darker green leaves, in contrast to small and yellow chlorotic leaves with unsuitable hosts (Irawan 2017). The size and shape of the haustorial formation depend on the type of host attachment (Deepa 2016). *Cajanus cajan* is the well-known primary host for sandalwood in the field. At the nursery level, *Mimosa pudica*, *Alternanthera sissilis* and *A. nana* are used as best hosts for the early growth of sandal seedlings. *Alternanthera* sp. has fibrous hairy roots containing lots of water, which support sandal growth. Various cultivated forms of alternanthera can be planted as cuttings simultaneously with sandalwood seedlings. Sandalwood lateral roots are generally spread in the surrounding areas up to 1.5–3 m for connecting with the host (Davit 2009). Ananthapadmanabha *et al.* (1984) reported that sandalwood roots cannot be grown beyond 2.2 m from the host plant. The host proximity (distance between host and parasite) determines the growth of sandalwood both in nursery and field conditions (Wawo 2002). Lately, farmers are cultivating sandalwood plants with different horticultural plants without proper knowledge of spacing between host and sandalwood trees. It is well accepted that sandal responds well to different

**Table 1.** Effect of host proximity on the morphology of sandalwood seedlings (mean ± sd).

| Host plant proximity distance | Plant height increment (cm) | Collar diameter (mm) | Number of branches | Number of leaves | Length of the leaf (cm) | Width of the leaf (cm) |
|---|---|---|---|---|---|---|
| $T_1$ - Half feet (15 cm) | 8.84 ± 5.34 | 4.70 ± 0.11 | 4.6 ± 0.35 | 35.75 ± 1.61 | 5.61 ± 0.50 | 1.78 ± 0.36 |
| $T_2$ - One feet (30 cm) | 5.67 ± 5.12 | 4.28 ± 0.56 | 2.67 ± 1.64 | 13.33 ± 8.17 | 4.48 ± 1.41 | 1.48 ± 0.41 |
| $T_3$ - One and a half feet (45 cm) | 5.33 ± 2.65 | 4.17 ± 0.05 | 2.57 ± 0.19 | 12.33 ± 7.53 | 4.09 ± 0.28 | 1.18 ± 0.03 |
| $T_4$ - Control | 3.33 ± 1.23 | 4.19 ± 0.03 | 2.5 ± 0.56 | 12.00 ± 6.71 | 3.78 ± 0.93 | 1.12 ± 0.25 |


**Fig. 3.** Shoot and root system of sandalwood plants at different host proximity distance.

spacing. Hence, the present study was attempted to document the effect of host plant proximity on the growth of sandalwood in nursery conditions.

## MATERIALS AND METHODS

The present study was conducted in Research Nursery, Institute of Wood Science and Technology, Bengaluru, India N 13°00'67.5'' and E 77°34'20.6'') during October – December 2020. The elevation of the study site is 874 m. The mean maximum and minimum temperature ranges from 21.0°C to 33.0 °C. Annual rainfall is 102.9 cm. *A. sessilis* was used as host plants and uniform height sandalwood seedlings were used in this study. A raised bed (10×1m) was formed using potting media (1 sand :1 red soil :1 FYM) and the boundary of the bed was lined with bricks to avoid soil erosion. The length of the bed was divided into 4 equal blocks and each block (treatment) was further sub-divided into sub-plots (replication). The experiment included 4 treatments viz., host plants planted around sandalwood plants at 15 cm (Half feet) away from sandal seedlings ($T_1$), host plants planted at 30 cm (One feet) from sandal plants ($T_2$), host plants planted at 45 cm (One and half feet) away from sandal plants ($T_3$) and $T_4$ control, sandal without host plants (Figs. 1, 2). Each treatment was repeated thrice and each replication had 5 sandalwood plants. Regular watering and weeding were done for both host and sandal plants till the end of the experiment

**Table 2.** Effect of host proximity on the root system of sandalwood seedlings (mean ± sd).

| Distance between sandalwood seedling and host | Taproot length/ plant (cm) | Number of roots/ plants | Dry root weight/ plant (g) | Dry stem weight/ plant (g) |
|---|---|---|---|---|
| $T_1$ - Half feet | 10.08 ± 0.34 | 15.25 ± 0.55 | 1.92 ± 0.44 | 3.64 ± 0.59 |
| $T_2$ - One feet | 7.33 ± 2.22 | 9.67 ± 3.98 | 1.53 ± 0.19 | 3.03 ± 0.66 |
| $T_3$ - One and a half feet | 7.33 ± 6.35 | 9.33 ± 1.15 | 1.31 ± 0.14 | 2.71 ± 0.28 |
| $T_4$ - Control | 6.66 ± 0.15 | 9.13 ± 0.32 | 1.25 ± 0.15 | 2.56 ± 0.19 |

(3 months). The height and collar diameter of sandal plants were recorded at the beginning and end of 3rd month. At the end of the experiment, three plants from each replication were selected randomly for evaluation. Plant height and collar diameter of sample plants were using measuring scale and digital caliper. The length and width of fully matured leaves and taproot length were measured with a scale (Fig. 3). A number of leaves, lateral roots, and branches of sample plants were recorded. Root and shoot biomass (dry weight basis) of sample plants were estimated.

## RESULTS AND DISCUSSION

### Effect of host proximity on morphology of seedling

The data revealed that the host plant proximity had a significant effect on morphological traits viz., plant height, collar diameter, number of branches, leaves, leaf size (length and width) of selected plants. The highest plant height, collar diameter, number of branches and leaves, leaf length and leaf width of experiment plants were 52.5, 4.7, 35.7, 5.61 and 1.78 cm observed in $T_1$ and lowest of the same was noted in $T_4$, respectively. Further, it was observed that all morphological traits were shown followed decreasing trend from $T_1$ to $T_4$ with increase of proximity distance of host plants (Table 1).

### Effect of host proximity on root system and plant biomass

The host proximity distance had shown significant influences on rooting patterns and biomass production. The maximum tap root length, number of roots, mean dry weight of root and shoot was 10.08 ± 0.34 cm, 17.33 ± 1.15, 1.92 ± 0.44 g and 3.64 ± 0.59 g per plant, respectively (Table 2). The minimum of the same was recorded in control.

Host-sandal association (haustorial connection) acts as both a physical and physiological bridge to the sandal plant. Ananathapadmanabha (1984) reported that sandalwood cannot be grown beyond 2.2 m from the host plant and beyond this point, the growth of sandal is significantly reduced. According to Davit (2009), the attraction of root parasites to the host was limited beyond 3 m. The optimum spacing would be 1.5–3.0 m. Sandalwood grows vigorously when it is associated with certain preferred host plants especially leguminous plants. It was reported that the growth of sandalwood seedlings was good when host plants were planted in the same pit of sandal seedlings at distance of 20–30 cm (Doddabasawa and Chittapur 2021). Among different sandalwood- host plants combinations viz., sandal + *Alternanthera sessilis*, sandal + *Sesbania grandiflora*, sandal + *Alternanthera sessilis*+ *Sesbania grandiflora* and sandal + Casuarina, the sandal + *Alternanthera sessilis*, sandal + *Sesbania grandiflora* combinations was supported highest growth (Balasubramanian *et al.* 2018). The results of present study were comparable with earlier findings of various researchers. Moreover, it shown that the host proximity distance had similar influence on both above-ground and below ground system of sandalwood plants in the field. The parasitism between sandal tree and host plant for the uptake and translocation of various mineral nutrients were reported by different authors ( Rangaswamy *et al.* 1986, Brand 2002, Rocha *et al.* 2014).

## CONCLUSION

The present study revealed that primary host proximity distance had significant influences on both above-ground and below ground growth of sandalwood seedlings in the field. Among primary host proximity distances studied, the half- foot host proximity distance (ca. 15cm) is found optimum for best growth of sandalwood in the field while using *Alternanthera sessilis* as primary host. Thus, the survival, successful establishment and fast growth of sandalwood plants in the field is purely dependent on nature of hosts, host proximity distance and hos ratio. Since sandalwood needs host plants throughout its life, sandal- host association is highly complex and warrants a thorough research back-up with regard host–parasite interface, nature, type and ratio of host plants, its effect on sandalwood and vice-versa and host plant management.

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**REFERENCES**

Ananthapadmanabha HS, Rangaswamy CR, Sarma CR, Nagaveni HC, Jain SH, Venkatesan KR, Krishnappa HP (1984) Host requirement of sandal (*Santalum album* L.). *Ind For* 110 : 264—268.

Brand JE (2002) Review of influence of Acacia species on establishment of sandalwood (*Santalum spicatum*) in Western Australia. *Conserv Sci Western Aust* 4 : 125—129.

Davit MW (2009) Determinants of parasitic plant distribution : The role of host quality. *Botany* 87 : 16—20.

Deepa P, Yusuf A (2016) Influence of different host associations on glutamine synthetase activities and ammonium transporter in *Santalum album* L. *Physiol. Mol Biol Pl* 22 : 331— 340.

Fox JED, Doronila AI (1993) Selection of primary host (pot stage) for *Santalum album*. Mulga Research Center, School of Environment Biology, Curtin University of Technology. Report to the Sandalwood Research Institute, pp 23.

Fox JED, Doronila AI, Barrett DR, Surata K (1996) *Desmanthus virgatus* (L.) Willd. An efficient intermediate host for the parasitic species *Santalum album* L. in Timor, *Indonesia. J Sustain For* 3 : 13 —23.

Irawan T (2017) A study report on the effect of host diversity on growth and development of sandalwood in Kupang. In Thomas Lion, Sandalwood cultivation. *Int J Dev Res* 7 : 14826—14830.

Nagaveni HC, Srimathi RA (1985) A note on haustoria-less sandal plants. *Ind For* 111 : 615—618.

Radomiljac AM, Mc Comb JA, Mc Grath JF (1999) Intermediate host influences on the root hemi-parasite *Santalum album* L. biomass partitioning. *For Ecol Manage* 113 : 143—153.

Rangaswamy CR, Jain SH, Parthasarathi K (1986) Soil properties of some sandal bearing areas. *Van Vigyan* 24 : 61—68.

Rocha, Ashokan, Santhoshkumar, Anoop EV, Sureshkumar P (2014) Influence of Host Plant on the Physiological Attributes of field-grown Sandal tree (*Santalum album*). *J Trop For Sci* 26 : 166—172.

Rocha D, Ashokan PK, Santhoshkumar AV, Anoop EV, Sureshkumar P (2015) Anatomy and functional status of haustoria in field-grown sandalwood tree (*Santalum album* L.). *For Res,* pp : 148.

Surachman (1989) Growth Response Against Fertilizers and Hospes. Thesis S-2 FPS UGM.

Wawo AH (2002) Tree Species Diversity of Secondary Host Alleged For sandalwood on the island of Timor, East Nusa Tenggara. Conservation Biology Study Program, Graduate Program, Faculty of Mathematics and Natural Sciences, University of Indonesia. Thesis, pp 127.