Plant Archives Vol. 25, Supplement 2, 2025 pp. 588-591 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-2.071

GROWTH PERFORMANCE OF *SANTALUM ALBUM* WITH SECONDARY HOSTS UNDER SANDALWOOD BASED AGROFORESTRY SYSTEM EXISTING IN FRAMER'S FIELD OF MAHARASHTRA, INDIA

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(Date of Receiving : 22-03-2025; Date of Acceptance : 27-05-2025)

ABSTRACT

This study represents variations in tree height and collar diameter of *Santalum album* existing former field of Jalna, Jalgaon, and Chhatrapati Sambhaji Nagar. (Maharashtra). Fourteen formers' fields were surveyed in selected district, to assess agroforestry plantations featuring Sandalwood and various host species. The *Santalum album* + *Azadirachta indica* plantation in Jalna exhibited the highest tree height of 2.98 meters, while in another tree host combination the *Santalum album* + *Swietenia mahagoni* combination in Chhatrapati Sambhajinagar displayed lowest tree height of 2.47 meters. Similarly maximum collar diameter of 25cm registered under *Santalum album* + *Azadirachta indica* plantation in Jalna while lowest collar diameter of 23cm recorded under *Santalum album* + *Azadirachta indica* combination in Jalgaon. These results reveled that the influence of specific tree combinations on tree growth parameters of sandalwood tree and provide valuable insights for optimizing agroforestry practices in Maharashtra's diverse agricultural landscapes for climate resilient tree farming pattern.
Keywords **:** Sandalwood, Agroforestry system, Tree height, Collar Diameter.

Introduction

The Santalum genus, belonging to the Santalaceae family, comprises sixteen recognized species, all of which are semi-root parasites (Hamilton & Conrad, 1990; Barrett and Fox, 1997). Among these, *Santalum album*, commonly known as East Indian *Santalum album* or Sandal tree, stands out as a small evergreen semi-parasitic tree prized for its light quality aromatic heartwood. *S. album* symbolizes ancient Indian culture and heritage, being indigenous to India and primarily found in the deciduous forests of the Deccan region, covering approximately 9600 km² (Rathore *et al*., 2008). The majority of its natural population, exceeding 90%, is concentrated in the southern Indian states of Karnataka and Tamil Nadu (Dutt and Verma, 2005). Furthermore, Sandal tree is commonly integrated into homesteads, particularly in northern Kerala (Kumar *et al*., 2012). Renowned as the 'Royal Tree' due to its precious fragrance oil fetching high return market. Additionally, the presence of Santalol in the heartwood renders it resistant to termite infestation (Jeeva *et al*., 1998). Tag of royal tree to the sandalwood coupled with cumbersome rules/policies were against farmers and industries, led the biggest setback for taking up of sandalwood plantation in private land. It was only after amendment of policies/ rules related to the cultivation of sandalwood harvest and trade in 2001 and 2002 by the Karnataka and Tamil Nadu state Governments, respectively, rights were given to the farmer/ industries to own sandalwood plantation. This reformation has promoted cultivation of S. album in private land (Rathore *et al*., 2021).

S. album, an evergreen partial root parasite, typically grows to a height of 10-15 meters and reaches a girth of 1-2 meters when it matures between 60 to 80 years (Ghosh *et al*., 1985; Jain *et al*., 1999). Thriving in diverse soil types and climatic conditions, the tree can be found at altitudes ranging from sea level up to 1200 meters, with an annual precipitation of 600-1600 mm. Initially, its bark appears reddish-brown to dark brown and smooth, but as the tree ages, it becomes rough with deep vertical fissures. The leaves are opposite and decussate, while the unscented flowers

are straw-yellow, turning to deep purplish-brown upon maturation, and are arranged in axillary or terminal cymose panicles. Typically, flowering occurs twice a year, from March to May and September to December. The fruit is a single-seeded succulent drupe, purplish-black when ripe (Kumar *et al*., 2011). *S. album* exhibits high polymorphism, with significant variations in leaf dimensions, heartwood color, and oil content among trees (Shwetha, 2023; Bagchi and Veerendra, 1985; Kulkarni, 1995). Anatomical studies have revealed genotypic differences in sandal populations based on characteristics such as xylem cell diameter, epidermal thickness, cortex width, and the number of vascular bundles (Veerendra and Bagchi, 1986).

Despite global demands of 5000 to 6000 Mg for its wood and 100 to 120 Mg for its oil, sandalwood production in India declined from 4000 Mg of heartwood per year in the 500 Mg in 2007 (Gairola *et al*., 2008). The decline in Sandalwood production over recent decades can be attributed to various factors, including the proliferation of illegal sandalwood processing units (Bele, *et al*., 2012) and the monopoly of sandalwood trade by the governments of Karnataka, Tamil Nadu, and Kerala.

Natural occurrence of sandalwood in Maharashtra is limited in the dry region of western Maharashtra and only about 600 hectares approximately in Yavatmal and Amravati Forest Circles. However, plantation by agriculturist have been carried out in the districts of Ahmednagar, Nashik, Pune, Jalna, Latur, Solapur, Dhule and Jalgaon (Chavan and Singh, 2021).

Materials and Methods

An extensive survey was conducted in 42 farmers' field for two years (2021 - 2022) who has established sandalwood-based agroforestry system across Jalna, Jalgaon, and Chhatrapati Sambhaji Nagar districts (Aurangabad) of Maharashtra which fall under Assured Rainfall Zone (AR)**.**

The Jalna district lies between 19° N to 21° N Latitudes and 75° E to 76° E Longitude. It covers an area of 7,612 Sq. Kms, which is 2.47% of the total state area. The minimum temperature ranges between 9^0 C to 10^0 C and maximum temperature ranges between 30^0C & 31^0C.

Jalgaon District is located in the north-west region of the state of Maharashtra between 20° N and 21° N latitudes and 74° 55′ E to 76° 28′ E longitudes, in the northern part of the state. It receives an average rainfall of about 690 mm and the temperature varies from 10^0C to 48^0C.

Chhatrapati Sambhaji Nagar District is located mainly in Godavari Basin and its some part towards North West of Tapi River Basin. The district's North Longitude is 19^0 and 20^0 and East Longitude is 74^0 to 76^0. The Average rain fall here is 734 mm and the Minimum Temperature is 5.6^0 C. Maximum Temperature is 45.9^0C.

Study sites were selected in these three districts based on the primary data collected from District Agriculture department and Jila Panchayats office and followed by field survey of the particular area. Size sample plots were laid out. A, total of 42 farmers' fields in were selected all three districts (14 fields from each district). The G.P.S location were also recorded with the help of Garmin G.P.S

Result and Discussion

Observation on growth attributes (plant height & GBH) of *S. album* along with different host species were recorded and by conducting interview with the beneficially farmers. The *Santalum album* + *Azadirachta indica* (Jalna) plantation exhibited the maximum height, up to 2.98 meters, followed by the combination of *Santalum album* + *Azadirachta indica* + *custard apple* (Jalgaon) showed an average height of 2.87 meters. In contrast, the minimum plant height (2.47 m) was observed in the *Santalum album* + *Swietenia mahogani* planted at Chhatrapati Sambhaji Nagar. These results provide valuable insights for agricultural practices in the region, emphasizing the impact of specific plant combinations on overall height. In terms of Collar diameter, the *Santalum album* + *Azadirachta indica* (Jalna) plantation recorded maximum diameter, of 25 cm, followed by, 23cm in combination of *Santalum album* + *Azadirachta indica* + *custard apple* at Jalgaon region. In contrast, the minimum plant diameter (22 cm) was observed in Santalum *album* + *Swietenia mahagoni* combination *at* Chhatrapati Sambhajinagar.

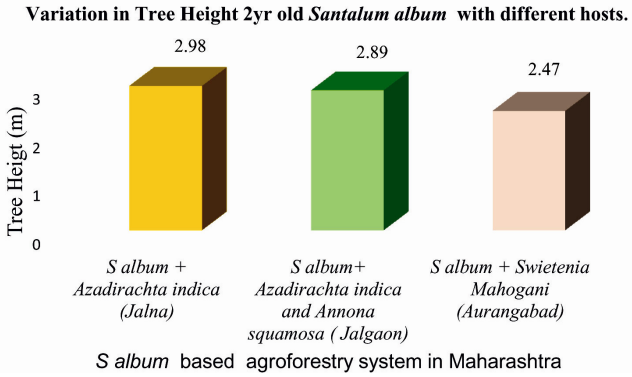

Fig. 1 : Variation in growth performance of *Santalum album* (2yr old) with different hosts esisiting in farmers' field, Maharsatra

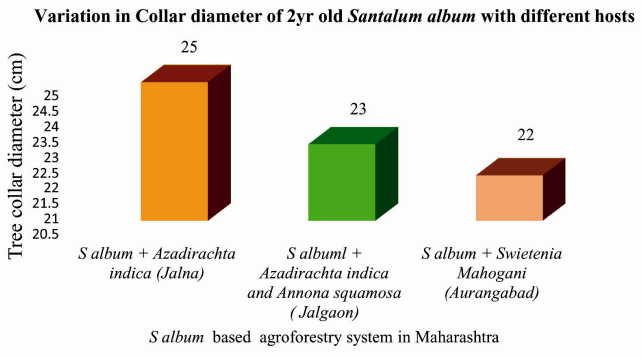

Fig. 2 : Variation in Collar diameter of *Santalum album* (2yr old) with different hosts esisiting in farmers' field, Maharsatra

Conclusion

Based on survey and interactions with the farmers, study reveals that specific and suitable host species will boost the growth of sandalwood besides improving heartwood. The Sandalwood + *Azadirachta indica* combination in Jalna displayed remarkable height and diameter, highlighting its potential for successful cultivation. Conversely, the Sandalwood + *Swietenia mahagoni* plantation in Chhatrapati Sambhajinagar exhibited comparatively lower measurements, indicating potential limitations or factors affecting growth in this combination. These results offer valuable insights for the sandalwood growth specially who are keen to growth sandalwood as commercial plantation to fetch high prize.

Acknowledgement

Authors are thankful to the CAMPA, Ministry of Environmental, Forest and climate change (MoEFCC) New Delhi for funding and Director ICFRE-TFRI, Jabalpur for their constant encouragement and support during the study.

Competing Interests

The authors confirm that there are no financial or other conflicts of interest that could compromise the integrity or objectivity of the research provided in this paper.

Authors' Contributions

Nanita Berry worked as a Project leader and executed overall activities like the selection of species, survey of the forest areas with a prescribed methodology, designed a format for data collection, and compilation, and interpretation, and provided necessary guidance during the project period. Pankaj is involved in the field survey and data collection, compilation and manuscript preparation.

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