

Sandalwood (*Santalum album*): A possible high-value tree species for saline soils

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INTRODUCTION

Sandalwood (*Santalum album* L.) is an evergreen **semi-root-parasitic tree**, which makes association with the host plant species through "**haustoria**" development to meet its nutrient and water requirements. The tree is valuable source of high-priced fragrant oil, which is required for the industrial manufacture of various products and thus has good **demand** in the **international market**. In India, farmers' have already started adopting and practicing Sandalwood as a **highly profitable** farming practice, therefore species cultivation and management practices needed to be standardized, particularly for the salt affected soils. However, only **scarce** information is available on performance of sandalwood with the **host species** in the saline environment. Therefore, we **hypothesized** that the salt tolerance of Sandalwood may vary with the type of host species as well as compatibility with the host species. Therefore, the overall **objective** of present study was to provide an insight into the salt tolerance of Sandalwood in association with host species, with a future aim to develop package of practices of species for the salt affected soils.

METHODOLOGY

The present experiment was carried out at ICAR-CSSRI for six months during 2020-21, to observe the effects of **saline irrigation** (ECiw 9), including control and **ten host plant species** (*Acacia ampliceps*, *Azadirachta indica*, *Citrus aurantium*, *Casuarina equisetifolia*, *Dalbergia sissoo*, *Leucaena leucocephala*, *Melia dubia*, *Phyllanthus emblica*, *Punica granatum*, *Syzygium cumini*) on the growth potential and physiology of sandalwood. The different salinity levels were considered to determine the threshold level of salinity tolerance in sandalwood. The different host species was considered as sandalwood's ability to form haustorial connections (Fig. 1) varies with the type of host species-which ultimately influence the survival, growth and productivity of sandalwood. Therefore, our **aim** was to assess the growth potential and salinity tolerance of sandalwood in association with the different host plant species.

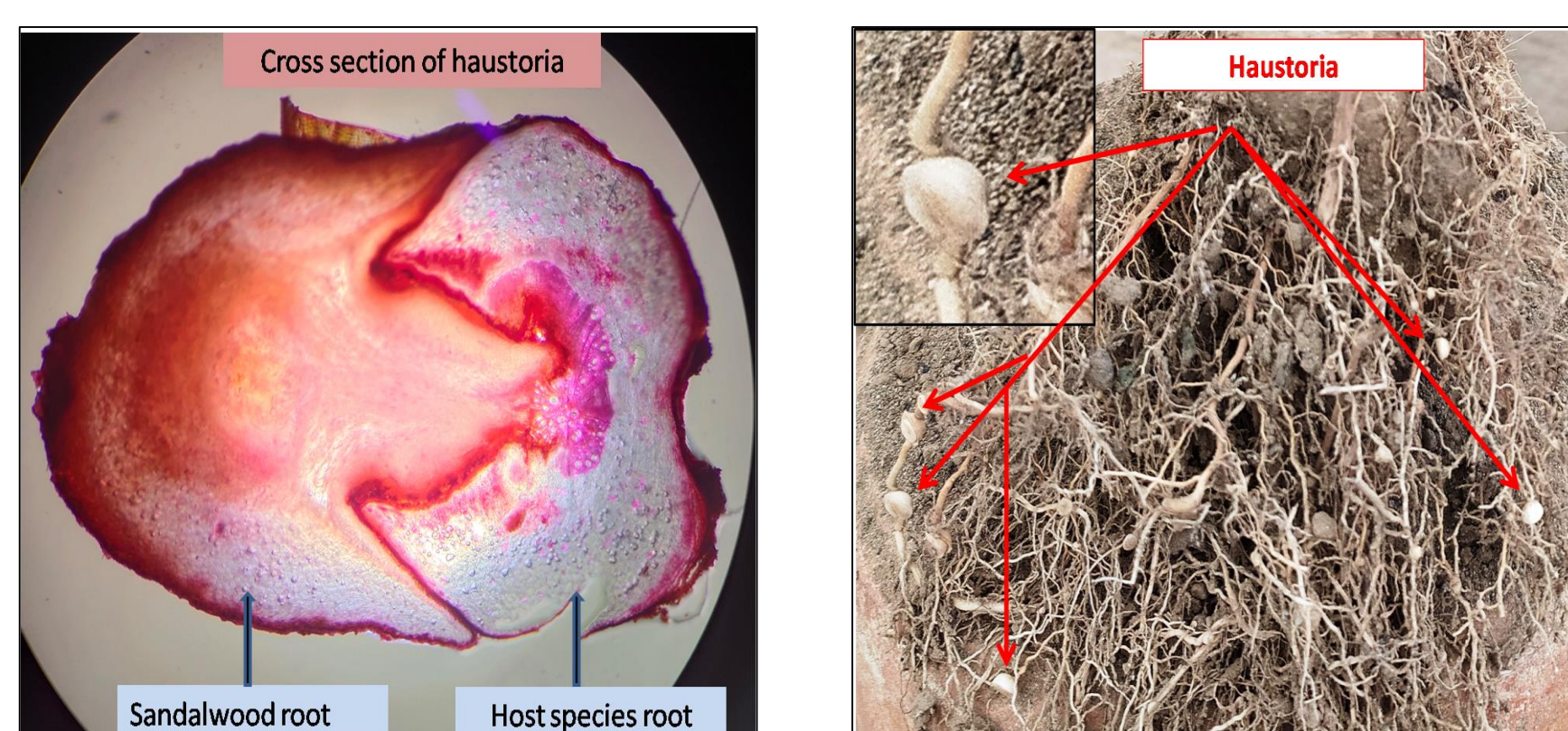


Figure 1. Haustoria formation between the Sandalwood and host root

RESULTS

The results of present investigation showed that under controlled conditions, the maximum ($p < 0.05$) height (79.0 cm) and collar diameter (5.4 mm) **growth** of sandalwood were observed with *Melia dubia* and *Dalbergia sissoo*, respectively. Under saline conditions (ECiw 9), the maximum ($p < 0.05$) height (65.0 cm) and collar diameter (4.7 mm) growth of sandalwood were recorded with *Dalbergia sissoo* and *Azadirachta indica*, respectively (Table 1; Fig 1). Similar trends were observed for the other growth parameters, such as number of leaves and branches and total plant biomass in Sandalwood. Salinity stress increased the **Na⁺/K⁺ ratio** in Sandalwood leaves, and its higher value (3.4) was observed with *Citrus aurantium*, while lower value (0.91) was recorded with *Dalbergia sissoo* (Fig 3). The **physiological processes** such as photosynthetic rate, relative water content and chlorophyll content decreased by 29, 35 and 67 %, respectively, under salinity stress. Similarly, among 10 host species, Sandalwood grown with *Melia dubia*, *Dalbergia sissoo* and *Azadirachta indica* showed highest increased for **antioxidant enzymatic** activities (Apx, CAT, Pox, GR and SOD) under saline condition. The **number of haustoria** on an average reduced by more than 50 per cent under saline conditions, compared to control (Fig. 4).



Figure 2. Effect of salinity and two host species on the growth of Sandalwood.

Table 1. Effect of salinity and different host species on height and diameter growth of Sandalwood

Host species	Height, cm		Collar diameter, mm	
	Contr ol	EC 9	Control	EC 9
<i>Melia dubia</i>	76.4	60.2	5.82	4.25
<i>Casuarina equisetifolia</i>	64.1	42.0	3.80	3.51
<i>Citrus aurantium</i>	67.2	53.3	4.84	3.60
<i>Phyllanthus emblica</i>	70.8	59.2	5.71	4.21
<i>Syzygium cumini</i>	67.4	60.1	4.04	3.69
<i>Acacia ampliceps</i>	57.5	54.7	4.79	3.96
<i>Punica granatum</i>	69.6	50.4	4.84	3.60
<i>Azadirachta indica</i>	68.2	65.0	5.10	4.60
<i>Leucaena leucocephala</i>	75.2	62.7	4.35	4.00
<i>Dalbergia sissoo</i>	79.0	65.8	5.45	4.80
Mean	67.4	60.1	4.82	4.00

DISCUSSION

Results of the present study indicated that imposed salinity levels had only **slight to moderate effect** on the sandalwood growth; however, its growth pattern was **mainly governed** by the type of host species. The performance of host plant is the single most important criteria for satisfactory growth performance of sandalwood under saline conditions. The results showed that salinity stress resulted in a decrease in number of root-induced haustoria, while increase in leaf **Na⁺/K⁺ ratio** and antioxidant enzymes activities, indicates **existence of a salinity tolerance** mechanism in the Sandalwood. The sandalwood produced maximum haustorial connections with *Melia dubia* under controlled and with *Dalbergia sissoo* under salinity stress conditions, suggesting the **species specific preference** of sandalwood for haustorial formations under the contrasting environmental conditions.

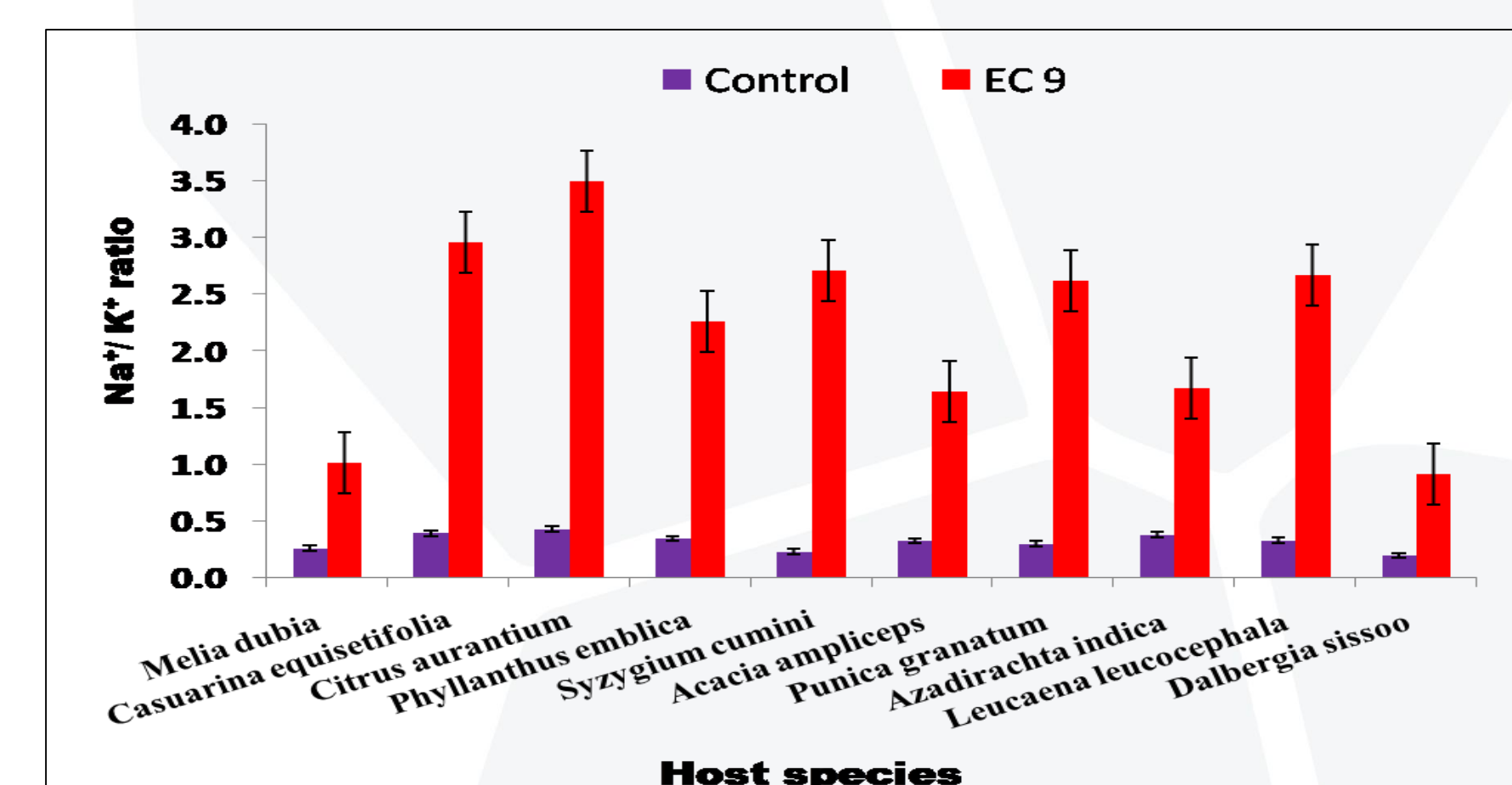


Figure 3. Effect of salinity and host species on Na⁺/K⁺ ratio in sandalwood leaves

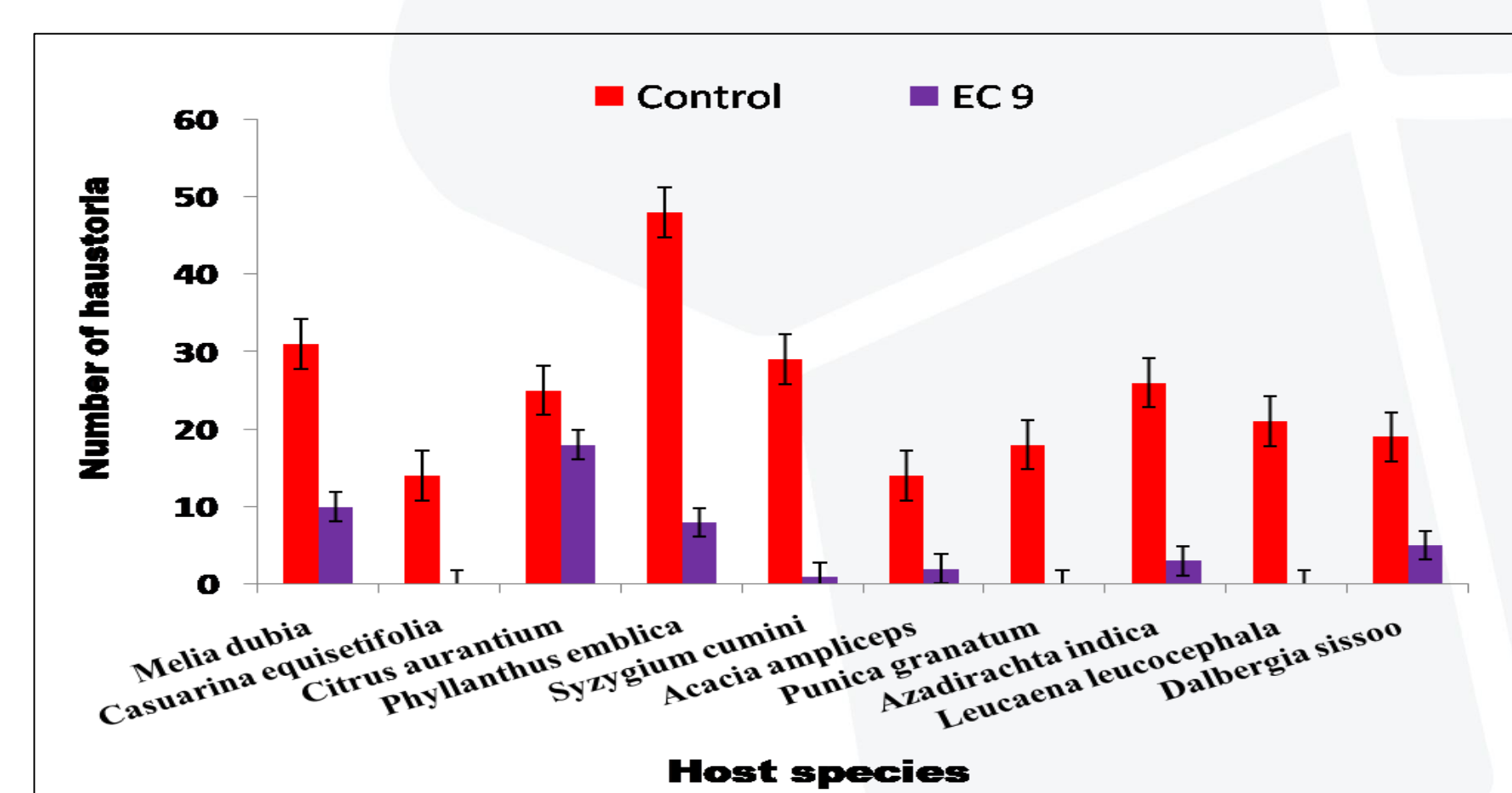


Figure 4. Effect of salinity and different host species on number of haustoria in sandalwood roots

CONCLUSIONS

Our findings showed that sandalwood growth varied with the host species both under control and saline conditions, and it exhibited a **good growth potential** under the saline soils conditions. Therefore, based on results obtained so far, sandalwood has shown good prospects of **successful cultivation** with suitable compatible host species such as *Melia dubia*, *Dalbergia sissoo* and *Azadirachta indica* in the saline environment.

GLOBAL SYMPOSIUM ON
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