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The effect of host plants on the growth of sandalwood seedlings (*Santalum album* Linn.)

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Abstract

The necessity for sandalwood seedlings to gain acceptable growth rates through the propagation of pot host plants is important. An experiment was undertaken to evaluate the performance of sandalwood seedlings under the effects of *Desmanthus virgatus, Alternanthera spp., Crotalaria juncea, Sesbania grandiflora, Cajanus cajan, Capsicum frutescens, Breynia cerua, Lycopersicum esculentum, Acacia oraria, Duranta repens, Erigeron linifolius, Acacia holocericea, Acacia auriculiformis, Elephantopus scaber, Desmodium trifolium* and *Andropogon subtitis* pot host treatments.

The results showed that sandalwood seedling growth is considerably enhanced with an adequate pot host. The best host in terms of dry weight, height and diameter of sandalwood seedlings was with *Alternanthera spp., D. virgatus* and *C. juncea.*

Introduction

Almost all sandalwood logging in NTT still comes from natural forests. However, since the population level of natural sandalwood stands is decreasing and demand for sandalwood products is increasing it is necessary to establish sandalwood plantations.

Repeated attempts to establish sandalwood plantations has been largely unsuccessful, this being primarily due to low seedling quality for out planting. Therefore it is necessary to make improvements in the technology of raising seedlings.

The use of a pot host plant is critical to improve the quality of sandalwood seedlings. Information obtained from various publications shows that pot hosts plants increase the growth of sandalwood seedlings. According to Rama and Rao (1911) more than 70 species of plants have been found to have the capacity to become hosts to sandalwood seedlings, however, the hosts have varying influences on the growth of the sandalwood plants. For that reason the selection of pot hosts species must be made on the ability of the pot host species to increase sandalwood seedling growth and as well as being readily available.

Results

The treatment means for height, diameter and dry weight of the seven month old sandalwood seedlings are summarised in Table 1. A statistical analysis shows that the height, diameter and dry weights of the seedlings vary significantly.

With the 16 host plant species that were tested, some clear variations in sandalwood growth occurred. The *Alternanthera spp., D. virgatus* and *C. juncea* treatments were best in increasing the sandalwood diameter and dry weights. Conversely, the *A. holocericea, A. auriculiformis, E. scaber, D. trifolium* and *A. subtitis* proved the least effective in increasing height, diameter and the dry weight of the plants.

Discussion

The growth of the sandalwood seedlings varied according to the pot host species treatment. It is seen in the results that the *Alternanthera spp., D. virgatus, C. juncea* and *S. grandiflora* are the best host plants from the 16 species treatments tested (Table 1). The growth variations occur because the primary host plants have varying capabilities of absorbing nutrients. According to Barrett (1988) only the nutrients N, P and amino acids are derived from the host plant, whereas Ca and K are absorbed through the sandalwood root system direct from the soil.

D. virgatus, C. juncea and *S. grandiflora* are leguminous plant species whilst *Alternanthera spp.* is not. According to Srimathi *et al.* (1982) the leaves of sandalwood seedlings fostered by a leguminous host plant have a higher concentration of basic amino acids than when parasatising a non-leguminous host. The level of sandalwood growth is dependent on the level of amino acid availability.

Previous research undertaken by Balai Penelitian Kehutanan in Kupang indicated the pepper plant

(*C. frutescens*) to be the best primary host and consequently it is being commonly used in establishing sandalwood plantations. However, the results of this research indicate better sandalwood growth with five other species than with *C. frutescens*. Very large increases in sandalwood growth can be achieved if correct pot host species are utilised.

Suitable pot host species should not only increase growth but also have a low level of competition, a small above ground biomass, succulent root system, able to withstand pruning, not short lived and readily available (Rai 1990 and Barrett 1990).

Following the above criteria *Alternanthera spp.* is a very good pot host species. Additionally, *Alternanthera spp.* is easily propagated by cuttings. *D. virgatus* and *C. juncea* is widely distributed and seed is readily available from May to June.

Table 1: Average height, diameter and dry weight of sandalwood seedlings at the age of seven months

Host Species	*Height (cm)*	*Diameter (cm)*	*Dry Weight (g)*
Desmanthus virgatus	44.60 a	0.40 ab	4.024 a
Alternenthera spp.	43.77 a	0.45 a	4.118 a
Crotalaria juncea	43.43 a	0.39 ab	3.779 ab
Sesbania grandiflora	33.31 b	0.34 ab	2.667 bc
Cajanus cajan	28.86 bc	0.29 ab	2.265 c
Capsicum frutescens	27.40 cd	0.31 ab	2.222 c
Breynia cerua	25.65 cd	0.27 ab	2.022 c
Lycopersicum esculentum	23.96 cde	0.28 ab	1.857 cd
Acacia oraria	23.27 cde	0.30 ab	1.804 cd
Duranta repens	21.64 de	0.24 ab	1.557 cd
Erigeron linifolius	18.45 ef	0.25 ab	1.312 cd
Acacia holocericea	15.42 fg	0.21 b	1.140 d
Acacia auriculiformis	15.16 fg	0.21 b	1.140 d
Elephantopus scaber	14.23 fg	0.23 b	1.079 d
Desmodium trifolium	11.18 g	0.19 b	0.851 d
Andropogon subtitis	10.52 g	0.18 b	0.784 d

Footnote: Average values followed by the same letter are not significantly different at the five per cent level by the HSD test.

Conclusion

The experiment suggests that up to the age of seven months the best growth of sandalwood seedlings is achieved with *D. virgatus, Alternenthera spp., C. juncea* and *S. grandiflora* pot hosts. Sandalwood seedlings with these pot hosts have increased growth rates which is greater than that of *C. frutescens* as a pot host.

It is necessary to do further field research on the effect of pot host species on the growth rate of sandalwood seedlings.

References

Rama and Rao R.S.M. (1911). Host plant of Sandal tree. Indian Forest Records 2;4 (159-207).

Barrett, D.R (1988). *Santalum album* (Indian Sandalwood) : literature review Mulga Research Centre, Curtin University of Technology, Western Australia.

Kharisma dan Sutarjo, S. (1988). Pengaruh jenis inang terhadap pertumbuhan semai Cendana (*Santalum album* L.). Santalum 2:1-8.

The Sandalwood Research Newsletter

The SRN is a quarterly newsletter with distribution throughout all nations that have an interest in *Santalum* species. The SRN aims to increase *Santalum* species awareness through the dissemination of *Santalum* species information. Increasing the awareness of *Santalum* species will promote the conservation of *Santalum* species, stimulate plantation establishment and increase research and management collaboration between organisations.

It is hoped that articles will be received on a range of *Santalum* species research and management issues. If you wish to contribute an article to the SRN or wish to be included on the SRN mailing list please write to the Editor giving your name, organisation and postal address. All articles relevant to *Santalum* species are welcomed.

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Selection of sandalwood (*Santalum album*) candidate plus trees in Timor Tengah Selatan District

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Summary

Selection is a key factor of applied tree improvement programs. Selection of sandalwood candidate plus trees has been done in natural stands of sandalwood (*Santalum album*) in Ajaubaki, Oenutnanan, Siso, Buat, Niki-Niki, Kokoi, and Netpala (District of Timor Tengah Selatan).

The parameters in this selection program are: heartwood volume, total height, stem diameter at breast height, crown base height, clear bole height, crown diameter, and straightness. The trees which have the highest 10 per cent of the parameter values are regarded as candidate plus trees.

From this selection program 108 sandalwood candidate plus trees have been selected. The variations between candidate plus trees are more influenced by genetic factors than environmental factors.

Introduction

Sandalwood is an indigenous tree in Indonesia, its distribution ranges from Java to the archipelago of Nusa Tenggara Timur (Kramer in Sri Qanarto and Winarni, 1987).

Almost all the present sandalwood harvesting in Nusa Tenggara Timur (NTT) comes from natural forest stands; and so, as a means of conservation, it is necessary to increase the plantation resource of sandalwood. The objective of tree breeding is to establish highly productive plantations. However, due to high mortality levels in plantations silvicultural research is still required to refine plantation establishment techniques.

On the completion of selecting candidate plus trees from natural stands progeny testing is required to select superior parent trees on the basis of desired characteristics, such as high survival and growth rates. Then the tree breeding program requires the cross-breeding of superior parent trees to increase the genetic gains of desired characteristics, such as disease resistance and heartwood formation.

Information on genetic variation is necessary in the tree-breeding program. This research is done to discover superior sandalwood parent trees.

Results and Discussion

The analysis of variances of the heartwood volume, the total height, the height to crown base, the clear-bole height, the diameter at breast height, the heartwood diameter, and the crown diameter are presented in Table 1. From the results of the analysis variances, it is seen that each of the selection parameters show clear variations.

Selection has been done in uneven aged natural stands. In a forest with trees of variable ages qualitative traits cannot be compared.

Tree breeding improvement programs start with the selection of candidate plus trees.

Geographic variations (provenance), local variations and variations within the tree exist in tree species (Soerianegara, 1970). These may be caused by environmental differences or via genetic variations. Environmental variables like rainfall, temperature, soil, slope and elevation from sea level, have an influence on the phenotype of a tree (Zobel and Talbert, 1984). Variations caused by environmental differences must be determined in tree breeding selection programs.

Appropriate selection can given genetic results to the extent of 3 to 10 per cent of each generation (Wright, 1962).

Heritability values of sandalwood are presented in Table 2. It can be seen that each selection parameter has a moderate to high heritability value. Heritability values range from 0 to 1. The value 1 occurs when individual variations are absolutely caused by genetic factors (Zobel and Talbert, 1984).

It can be seen in Table 2 that tree diameter and heartwood diameter have high heritability values, 0.91 and 0.92 respectively. Indicating the process of heartwood formation gets more influence from genetic factors than from environmental factors.

Since the economic value of sandalwood depends on the quantity and quality of heartwood, heartwood formation is therefore the main criterion in the selection program of superior sandalwood candidate plus trees.

Conclusions and Suggestions

Conclusions

(a) This selection program has succeeded in obtaining 108 sandalwood candidate plus trees in the area of South Central Timor with the selection parameters of heartwood volume, total height, tree diameter, height up to the crown base, clear bole height, crown diameter, and the straightness of the trunk. These selection measures are an early step towards a sandalwood tree-breeding program.

(b) Each selection parameter has been found to vary greatly. This variability is caused by the interaction between genetic and environmental factors. The former has a greater influence than the

Table 1: Averages of heartwood volume, total height, stem diameter, clear bole height, crown base height, heartwood diameter and crown diameter

Location	*Heartwood Volume* m^3	*Total Height* m	*Stem Diameter* cm	*Clear Bole Height* m	*Crown Base Height* m	*Heartwood Diameter* cm	*Crown Ddiameter* m
Ajaubaki	0,04656 a	14,80 a	24,05 a	3,94 a	5,98 a	17,56 a	8,04 a
Oenutnanan	0,02705 b	12,95 b	18,83 b	4,73 b	6,08 b	11,81 b	6,11 b
Siso	0,02493 b	10,87c	23,06 c	2,94 c	5,12 c	11,53 b	6,56 c
Buat	0,04119 c	13,98 d	27,44 d	3,58 d	5,29 d	17,11 a	9,96 d
Niki-Niki	0,07249 d	12,62 e	31,76 e	2,52 e	5,96 a	22,94 c	7,33 c
Kokoi	0,09340 c	11,13 f	30,30 f	2,47 e	6,13 d	21,63 d	9,89 d
Netpala	0,05233 f	10,62 g	32,66 g	2,93 f	4,23 e	24,58 c	10,49 f

(Figure on the same column marked with the same letter denote non-significant differences at 5% according to HSD test)

latter, which indicates a possibility that results from genetic measures are going to be considerably greater in a tree breeding program.

Suggestions

(a) It is necessary to make a selection of superior candidate sandalwood trees in other regions in Nusa Tenggara Timur. The more of these superior sandalwood trees there are, the more variability among these trees there will probably be, and so genetic studies will get more extensive.

(b) It is necessary to progeny test candidate plus trees across a number of sites.

References

Soenardi. (1974). Ilmu Kayu. Yayasan Pembina Fakultas Kehutanan UGM. Yogyakarta.

Soerianegara, I. (1970). Pemuliaan Hutan. Lembaga Penelitian Hutan. Bogor.

Sri Danarto dan W.W. Winarni. (1987). Beberapa alternatif pengembangan sumber benih Cendana (*Santalum album* L.). Fakultas Kehutanan Universitas Gadjah Mada. Yogyakarta.

Sutarjo, S. (1989). Sari Pustaka Cendana (*Santalum album*) di India oleh D.R. Barret. Mulga Research Centre, Curtin University of Technology, Western Australia. AISULI No. 4, 1989 cetakan II. Badan Litbang Kehutanan. Balai Penelitian Kehutanan Kupang.

Wright, J.W. (1962). The genetics of forest tree improvement. FAO Forest. Forest Product Study 16, 1-399, New York.

Zobel, B. and Talbert, J. (1984). Applied Forest Tree Improvement. John Wiley and Sons, North Carolina, USA.

Table 2: Heritability values of selection parameter

Parameter	*Heritability*
Heartwood volume	0,5908
Tree height	0,8032
Tree diameter	0,9105
Clear bole height	0,6455
Height to crown base	0,6701
Heartwood diameter	0,9220
Crown diameter	0,8975

The Sandalwood Newsletter invites all readers to write to the article authors to acquire additional information concerning *Santalum* species issues outlined in these articles. As an aim of the SRN is to incresae the level of liaison between relevant organisations.

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