

ASSESSMENT AND CONSERVATION STRATEGIES FOR *SANTALUM ALBUM* IN MANMALAI RF OF THURAIYUR RANGE AT TIRUCHIRAPPALLI DISTRICT

P. DURAIRAJ & M. KAMARAJ

PG and Research, Department of Botany, Jamal Mohamed College, Tiruchirappalli, Tamil Nadu, India

ABSTRACT

Survey was carried out in, Manmalai RF in using Transect method. *Santalum album* population shows drastic decline in population due to various reasons. *Santalum album* population is dense one part of the area and occurs mostly in plain and in boundaries Manmalai Reserved forests. Sandal population in Reserved forest occurs mostly in plains and in the boundaries. This RF comprises of 3 beats-Echampatti, Koppampatti and Murungapatti. In Echampatti beat good population of sandal plants occurs. In general, sandal wood trees occurs mostly in plain and upto foot hills and upto the elevation of 300m and along the boundaries of RF. Sandal associates in this RF are *Albizia amara*, *Cassine glauca*, *Acacia chundra*, *A. planifrons*, *Dodonea viscosa*, & *Pavatta indica*, *Zizyphus oenophila*, *Chloroxylon sweitenia*, *Lantana camara*, *Carissa carandus* *Carissa spinarum*, *Erythroxylon monogynum*. Though biotic the interferences are less in reserved forests, still sandal smugglers are the felling of sandal trees of girth 20-30cm to check the heartwood farming. Our results have important implications for the conservation strategies for *Santalum album* populations in Forest area and can be applied for the conservation of other taxa as well.

KEYWORDS: Manmalai, Reserved Forests, *Santalum album*

INTRODUCTION

Sandal (*Santalum album* L.), belonging to the family Santalaceae, is one of the most important economic tree species indigenous to peninsular India (Sreenivasan et al. 1992). It is also known as the “Dollar earning parasite”. The tree is harvested mainly for its heartwood and oil. The wood is commercially known as “East Indian Sandalwood” whereas it’s fragrant oil as “Queen of Essential oil” (Radomiljac et al. 1998). India is among the chief exporters of sandalwood and oil (Ananthapadmanabha 2000). Indian sandalwood oil is considered to be unique and is preferred for the preparation of top-class and sophisticated perfumes, formulations, flavors, cosmetics, toiletries, beauty aids and medicines (Sreenivasan et al. 1992).

Santalum album is a small evergreen tree attaining a height of 12 to 15 meters and a girth of 1 to 24 meters with slender drooping as well as erect branching. It grows well in early stages under partial shade but at the middle and late stages show intolerance to heavy overhead shade. The tree flourishes well from sea level upto 1800m altitude in different type of soils like sand, clay, red soils, literate loam and even in black cotton soils and grows well in red ferruginous loam with varying fertility. Its best growth is on rich and fairly moist fertile soils. Trees growing on stony or gravelly soils are known to have more highly scented wood. It flourishes well where there is moderate rainfall of 600 to 1600 mm in cool climate with long periods of dry weather, but adapts well to different climatic conditions excepting water logged or very cold places.

It is believed that sandal was introduced into India from Timor, in Indonesia (Shetty 1977). The history of occurrence of sandal in India is at least 2,300 years old (Nageswara Rao et al. 2001a). In India, more than 90% of the

distribution of sandal lies in Karnataka and Tamil Nadu states covering around 9,000 sq. kms (Jain et al. 2003) of which 5,245 sq. kms come under Karnataka (Sreenivasan et al. 1992).

In Tamil Nadu, Sandal trees are distributed over an area of 3045 sq.Kms mainly in North Arcot (Javadis and Yelagiri Hills), Salem, Periyar, Coimbatore and Vellore districts and sparsely in Nilgiris, Madurai and Tiruchirapalli districts. Dense populations are found in Chitteries, Javadis, Parts of Shevaroy's and Tenmalai Hills. Higher girth classes is found in most of these populations. Natural regeneration is good in most of the areas.

Sandal is a nationally protected resource in India. Despite the protection status the natural resources of sandal are being indiscriminately exploited, perhaps because of its extremely high export value. It has been extensively harvested and more intensively so in the latter half of this century (Meera et al. 2000; Nageswara Rao et al. 2002). The sandal genetic resources in the country are threatened by variety of biotic and abiotic factors including logging of the trees, poaching, large-scale changes in land-use and poor natural regeneration (Sreenivasan et al. 1992). Since almost all of the extraction is from natural populations, the pressure on the existing populations has been tremendous (Radomiljac et al. 1998; Nageswara Rao et al. 2001a, b; Suma and Balasundaran 2003).

It is feared that associated with the severe exploitation of the natural populations of sandal, the genetic resources of the species may have also been affected (Jain et al. 2003; Nageswara Rao 2004). Such loss of genetic resources may have far reaching consequences on the improvement of sandal for its heartwood and oil quality. The decline in the resource base has had an adverse affect on the industries and the livelihoods of the traditional craftsmen (Chandrashekaraiyah and Dabgar 1998). Despite years of extensive harvesting and poaching of sandal, there are hardly any studies addressing the geographical distribution and the genetic diversity of this species in different parts of India. Researches have recently highlighted that disturbance or logging have led to an irreparable loss of the precious genetic diversity as well as genetic resources of forest tree species (Padmini et al. 2001; Cruse-Sanders and Hamrick 2004; Uma Shaanker et al. 2004; Zheng et al. 2005).

In the light of the threats to sandal genetic resources, active management is required for its conservation and efficient utilization. Information on the basic population genetic parameters are crucial in understanding the dynamics of the species and in formulating management plans to conserve the genetic resources of this species. However, for effective in-situ conservation, of the genetic diversity need to be first identified by mapping the populations. In an attempt to evolve a comprehensive plan for the conservation of sandal genetic resources, in this paper we will be specifically addressing the issues of (a) mapping the geographical distribution of sandal populations in Manmalai Reserved Forest using Geographical Information System (GIS), (b) determining the extent of extraction of sandal populations in Reserved Forests. Addressing these issues, in the long run, will help to conserve genetic diversity of the sandal species in India and would formulate efficient strategy for their genetic improvement and management.

MATERIALS AND METHODS

Study Area

The sandal bearing tracts are grouped into 4 different series in Thuraiyur range in Tiruchirapalli Forest Division

Since 1986-87 a separate scheme entitled 'Sandal Estate Scheme' has been implemented. This scheme is being implemented in the Reserve Forests of this working circle area. The areas under this scheme overlaps the Tribal Resources Development working circle. The details of R. F. With extent of areas under this scheme is furnished below

Sandal Estate Areas

Manmalai R.F : 1200 hac

Manalodai R.F : 800 hac

Sengattupatti Ext. R. F : 1000 hac

Total sandal estate area: 3000 Ha chain link fencing was carried cut to form sandal nucleus plot, in following areas.

1986-87 Sengattupatti RF 20 ha

1987-88 Manmalai RF 30 ha

Total sandal estate area: 3000 Ha chain link fencing was carried cut to form sandal nucleus plot, in Manmalai RF

1987-88 Manmalai RF 30 ha

Extent of Sandalwood Population in Manmalai RF

In Tiruchirappalli Forest Division, the Sandal bearing tract is occurred mainly in Pachchamalai Hills. These hills bear a rich population of sandal wood trees. Major portion of Pachchamalai falls under Manmalai Rf in Thuraiyur Range taken for the Survey of Sandal wood population. Manmalai Reserved forests Sandal wood population is dense one part of the area and occurs mostly in plain and in boundaries Manmalai Reserved forests. Sandal population in reserved forest occurs mostly in plains and in the boundaries. This RF comprises of 3 beats-Echampatti, Koppampatti and Murungapatti.

Table 1

Sl.No	Name of the R.F	Area (Ha)
1.	Manmalai RF	3110.61
2.	Manmalai Extn RF	296.47

METHODOLOGY ADOPTED FOR SAMPLING

In sampling method, assessment for Sandal plant population is done using transect line method. In the Reserved forests, 20 transect lines were formed and sandal population (Trees/ Saplings/ Seedlings) was assessed on both sides of the transect line at 10M width. The distance between one Transect line to the next transect line is about 1 km.

RESULTS

Sandal Population in Manmalai Reserved Forests

Sandal wood population is dense one part of the area and occurs mostly in plain and in boundaries Manmalai Reserved forests. Sandal population in Reserved forest occurs mostly in plains and in the boundaries. This RF comprises of 3 beats-Echampatti, Koppampatti and Murungapatti. In Echampatti beat good population of sandal plants occurs. Sandal associates in this RF are *Albizia amara*, *Cassine glauca*, *Acacia chundra*, *A. planifrons*, *Dodonea viscosa*, & *Tarana asiatica* *Zizyphus oenophila*, *Chloroxylon sweitenia*, *Lantana camara*, *Carissa carandus* *Carissa spinarum*, *Erythroxylon monogynum*.

The statement showing the sandal population in T-line 1-20 of Manmalai RF is given below table No-2

Table 2

Transect Line No.	Trees Girth 15cms above	Saplings Girth 15cms below	Seedling Height below 1.007	Total
1	0	26	1	27
2	3	14	0	17
3	20	34	0	54
4	2	20	0	22
5	4	15	0	19
6	23	66	0	89
7	22	51	0	73
8	3	16	0	19
9	16	30	0	46
10	4	19	2	25
11	5	18	20	43
12	1	0	0	1
13	2	6	0	8
14	5	0	0	5
15	0	1	0	1
16	0	3	0	3
17	1	6	0	7
18	0	3	0	3
19	0	0	0	-
20	0	0	0	-
	111	328	23	462

It is inferred from the above statement that the transect line 1-11 have dense sandal population and the population is scattered in the remaining lines. (Figure 1)



Figure 1: Sandal Saplings in the Manmalai RF

Abstract showing the assessment of sandal population in 1.00 Ha given below table 3

Table 3

Sl. No.	Name of RF	Total No. of Sandal Occur T1 to T20 In 40Ha	Total No. of Sandal Occur in 1 ha
1	Manamalai RF	462	12Nos

This drastic degeneration of sandal wood Production can be analysed as follows:

- No policing is being practiced to protect the sandal trees and prevent sandal theft from reserved forests areas during last decade.

- On perusal of record it is found that at present there is no system of booking offences for the illicit cut trees in the field.
- No responsibility or accountability is fixed on the field staff for sandal theft in forest areas.
- Although Joint Forest Management system (Tamilnadu Afforestation Project) has been implemented in sandal belt areas but no protection is provided to sandal trees. Therefore with the introduction of Joint Forest Management in these areas protection of sandal trees have been neglected.
- During the last decade rampant bird hunting in sandal forest eco systems the avian fauna responsible for sandal regeneration is badly affected.

Stock Mapping

Based on the enumeration carried out as a result of sample plots laid in reserved forests stock map has been drawn and shown in Figure-1

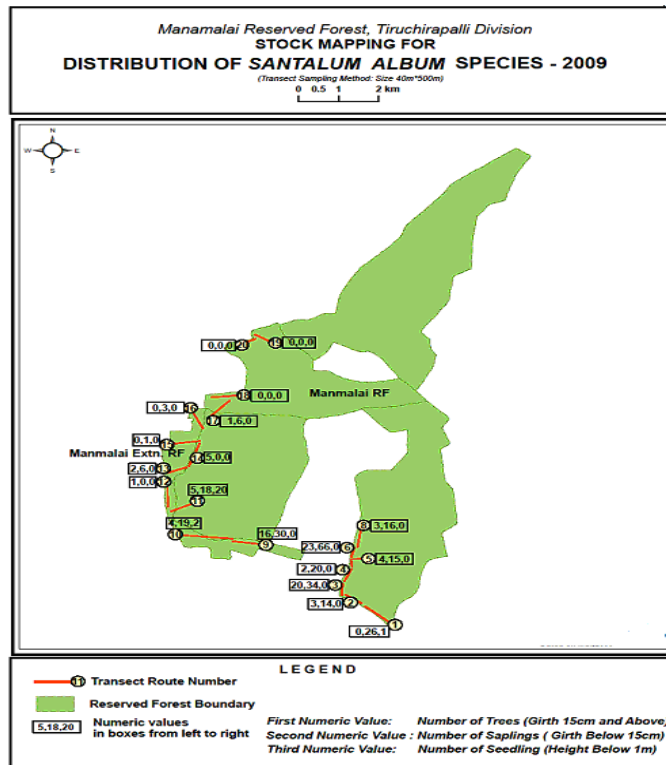


Figure 2

DISCUSSIONS

Silvicultural System

Natural regeneration was relied upon to restock the forests with sandal. However as discussed in under due to uncontrolled illicit felling of sandal trees at the earliest stage of heart wood formation i.e. plants reaching 20-25cms girth are not spared to grow in the forest.

Calculation of Yield

Though sandal is considered to be slow growing tree under forest conditions (1cm girth/year), it can grow at the rate of 5cm of girth or more per year under favourable soil and moisture conditions. The heartwood formation in sandal starts around ten years of age. The table No 4 below gives an idea of growth and development.

Table 4

Age (Years)	Girth at Breast Height cm	Yield of Heart Wood in kg
10	10	1
20	22	4
30	33	10
40	44	20
50	55	30

* The above data taken from Brochure-Sandal Published by Indian Council of Forestry Research and Education

Artificial Regeneration

An area of 20 ha per year will be selected as sandal nucleus plot in the locality where recruits population. i.e. sandal natural regeneration are encouraging. These areas will be fenced with chain link and iron angle post. Inside, the number of sandal recruits or saplings of maximum 15 cm girth are to be identified and noted in the plantation journal, before the plot is fenced. There should be atleast 50 sandal seedlings per ha in such plot will be selected for fencing since this area will ensure suitable climatic, edaphic and ecological conditions. The existence of flourishing natural stands of sandal trees in a conclusive evidence of the suitability of the area. The areas to be selected in study area, where ever the areas are having more population of sandal.

The following operations are to be carried out in selected sandal nucleus plot:

In wider gap areas artificial regeneration of sandal may be encouraged by planting minimum number of taller sandal seedlings. Maintenance work of artificial regeneration of sandal may be carried out atleast 3 years.

Apart from that bush sowing with quality sandal seeds may be carried out.

If the sandal nucleus plot is well protected and carried out all the above operations with in 5 years, the existing saplings will be started flowering and seeding (fruits) and will attract the birds. The natural regeneration will take place true the birds entire reserved forests.

A Journal is to be maintained describing details of sandal recruits at the time of fencing and planting sandal saplings. Time to time tending up works planting operations are to be mentioned in the journal.

Each year a plot of above said sandal regeneration status will be surveyed and demarcated in the month of January to March in the previous year. The area is to be fenced with iron angle and chain link. At least 50 seedlings/ha of not less than 20 cm height are to planted in between the natural bushes.

Cultural Operations

No soil working will be done. All climbers will be cut and removed. The miscellaneous growth need not be removed. When the seedlings are over 2 meter in height, any miscellaneous growth likely to suppress the saplings will be cut back.

Within the sandal bearing reserve forest areas natural regeneration of *Santalum album* is quite good. Due to uncontrolled illicit felling this precious plant species is under threat to survive in nature. Therefore other than supplementation of artificial regeneration by planting tall saplings within sandal nucleus plot, no separate sandal plantation is to be raised in reserved forest areas. The method of artificial regeneration within the sandal nucleus plot is described in successive paras.

Sandal Regeneration Operation

To improve sandal stock, artificial regeneration can be done successfully by the following methods.

- Bush sowing
- Planting seedlings

Bush Sowing

The conventional method of planting by clear-felling and artificial regeneration reduces the sandal host ratio. It is said over 200 plants per ha. may lead to self parasitism and poor growth rate of sandal. Naturally growing bushes should be retained to avoid invasion of weeds such as lantana and sandal seeds should be dibbled under these bushes. These will provide effective protection against browsing and function as hosts to young saplings of sandal also. The sandal seeds for dibbling into bushes may be obtained from the natural regeneration area itself Kolan, Javadhis. The Research wing of the Forest Department may be contacted in advance for supply of good seeds.

Sandal fruits are collected fresh from the identified superior seeds stands during April-May and September-October. They are soaked in water and rubbed to remove the soft pulp. The wet seeds are dried under shade and stored in polythene or gunny bags. Fresh seeds weigh about 6000 seeds to a kilogram and take 4-12 weeks for germination after the dormancy period. 80% of the seeds are viable upto 9 months. Germination is about 80% under laboratory conditions and 60% under field conditions. Germination can be hastened by pretreatment by acid scarification with concentrated H_2SO_4 for 30 minutes with stirring and washing in running water or by soaking seeds in 0.05% of gibberellic acid overnight and then sowing. Soaking seeds in cow-dung did not improve the germination.

Bush sowing will be done immediately after the onset of north east monsoon. Not less than 5 Kg. of seeds will be sown in the 1 Ha. Regeneration plot. Before sowing, the seeds will be well soaked in water to ensure quick germination. The soil under the bushes will be raked with a long handled soil raker over an area of 1'x1. About 4 to 5 seeds will be dibbled in this area. To keep account of the bush sowing spots, paint numbered pegs will be erected near the bushes.

To sow seeds under thick thorny bushes, a steel pipe or aluminum pipe of about 5' long can be used. One end of the pipe will be made sharp to take the soil. Using the pipe, the soil will be raked up under the bushes and seed will be dropped in this area through the pipe. Then the seeds will be covered with soil.

Equally important is the maintenance of chain link fence, and for the purpose, the growth outside the fence may be kept cleared to facilitate finding out any damages to the fence in any of the section. For the purpose of locating the plots, the stone pillars may be numbered with paint indicating the plot No. The object should be to maintain atleast 250 well established and well developed seedlings or saplings per hectare. Climber cutting should also be carried out to facilitate the growth of saplings.

Plantation journals will be maintained for each plot. The number of green trees and the approximate number of well established saplings found at the time of forming the plots will be registered in the journal.

At the end of 2nd and 3rd year, a thorough enumeration will be carried out to find out the result of the tending operations.

Planting of Seedlings

Rising of Nursery

Two types of seed beds are used to raise sandal seedlings (i.e) sunken bed and raised beds. Both of these perform equally well under different climatic conditions. Seed beds are formed with sand and red earth in the ratio of 3:1 and they are thoroughly mixed with nematicides (i.e) thimet at 500 gms per bed of 10mx1m. size. Around 2.5 Kgs. of seeds collected from plus trees is broadcasted uniformly over the bed and the bed is uniformly covered with straw, which should be removed when the leaves start appearing after germination. Seed beds are sprayed with a fungicide (dithane - Z-78) 0.25% once in 15 days to avoid fungal attack and thimet granules at the rate of 10 Kgs. per ha. or ekalulx once in a month to avoid nematode attack. When seedlings have reached 4-6 leaves stage they are transplanted to poly bags along with the host plant (wood apple) *Feronia elephantum* or along with the seed sowing of *Cajanus cajan* as the primary host for better growth of sandal. Seedlings are carefully removed from beds after copious watering and the roots should be intact while planting in the poly bags.

Espacement: 3mx3m

60cm³ pits are to be dug out during May. A weathering period of atleast 30 days shall be allowed before planting. Before planting, one bio-fertilizers application according to soil testing report should be done.

Planting

Planting shall be done in June-July immediately after the receipt of South west monsoon. No planting should be done after July. Taller and healthy seedlings of atleast 60 cm. height and one year old seedlings can be planted. Host plant shall also be planted in the same pit.

Host Species

At the time of planting of sandal, planting of perennial host is found to facilitate the growth of sandal, otherwise sandal growth will be stunted with pale yellowish leaves and ultimately the plant may die within a year. Sandal has as many as 150 host plants out of which some of the good host plants are as follows:

Cassia siamea, Pongamia pinnata, Melia dubia, Wrightia tinctoria, Chloroxylon sweitenia , Albizzia amara, Acacia chundra, Cajanus cajan, Cassia occidentalis.

Causality Replacement

Causalities will be replaced during the month of September- October on the onset of North-east monsoon in the first year as well as during June-July in second year.

Weeding and Soil Working

Weeding atleast to a diameter of 1.5m surrounding the plants and soil working to a depth of 15 cms and a diameter of 1m around the plants shall be done during August-September in the year of formation and during the same period in the second year of planting.

CONCLUSIONS

- Sandal bearing tract of Manmalai RF containing vegetation of Tropical Southern Dry deciduous Forests that present in plain and up to elevation of 300 meters vegetation occurring is Scrub thorn forests.
- Manmalai Reserved forest has a rich population of sandal wood.

- Sandal wood population is found less in the scattered vegetation areas and poor soil type areas
- In general, sandal wood trees occurs mostly in plain and upto foot hills and upto the elevation of 300m and along the boundaries of RF.
- In close canopy and in hilly terrain above 300m elevation the sandal population not occurred.
- Though biotic the interferences are less in Reserved forests, still sandal smugglers are the felling of sandal trees of girth 20-30cm to check the heartwood farming.
- Due to the illicit felling of sandal wood trees of 20 to 30cm girth (fruiting time) by the sandal smugglers. Natural regeneration of sandal would be affected future.
- Spike disease is not noticed in the present young natural regeneration.
- The Sandal Wood cultivation will no way cause any irritable procedures delay/ under valuation of this property up to final payment.
- The Sandal wood can be well protected as that of other tree crops by the title owners themselves.
- The theft of this property at times will not unnecessarily be attracted by any legal proceedings.

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