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# ROLE OF EDAPHIC FACTORS OVER SEED PRODUCTION AND RATE OF SEED GERMINATION OF WHITE SANDAL (*SANTALUM ALBUM* L.)

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## ABSTRACT

There is only the major hindrances for seed propagation of white sandal (*Santalum album* L.)is the rate of seed germination in nature.Indeed, it is never possible for mass cultivation without having proper seed propagating technology in our hand. Though the plant is a primitive one in relation to precious timber wood as well as medicinal and beauty therapy since human civilization in the globe. This plant can be propagated by means of vegetative propagation viz. cutting, layering, inarching etc. but, all these have certain limitation for large scale propagation. There are many chemicals as well as phyto-hormones which are responsible for seed germination. Out of those we have selected $GA_3$chemical in Burdwan Raj College location having the seeds of white sandal (*Santalum album* L.) procured from different locations of different edaphic factors viz. Mokrampur, West Midnapur, Hirbandh, Bankura and Khandari, East Burdwan. The aims and objectives of this experiment were to study the specific role of edaphic factor of this College location for seed germination of white sandal seeds produced in another locations prevailed different edaphic factors and ultimately its adaptation survivality in various edaphic factors of neighbouring districts.

**KEYWORDS:** Hindrances, Mass Cultivation, Phyto-Hormones, Edaphic Factor, Adaptation.

## INTRODUCTION

White sandal (*Santalum album* L.) is a hemi parasitic tropical tree. The word is very valuable for its essential oils and medicinal uses. The plant mainly grows in Maharashtra, Karnataka, Andhrapradesh, Kerala etc. But recently (Das & Tah, 2013) there is a small population patch developed at Bankura & Burdwan District of West Bengal. The Sandal sapling needs various host plants for its establishment and proper growth and development. There are so many references for angiospermic association as its hot plant. Recently it is noticed that different pteridophytic plants can also act as associated host plant for its establishment, growth and development (Jadab*et. al*., 2017).

Ecologically sandal has adapted various agro - climatic and soil conditions for *in situ* regeneration with an exception of waterlogged areas and very cold places. In India, 8 Sandal growing areas have been identified as potential provenances of Sandal on the basis of population density, phenotypic characteristics, latitude, longitude and eco-climate (Jain *et al*., 1998). The provenances vary in climate and edaphic preference since they are located in different localities of South and Central India. The state of West Bengal is cited in the map of occurrence and distribution of *Santalum album* in India (Srinivasan*etal*., 1992).

In the state of west Bengal in some forest garden under Bankura South, Bankura North, Midnapore West and Burdwan the sandalwood plantation has been undertaken in collaboration with The University of Burdwan. It has been observed soil texture and other composition of the soil is very much different in each forest garden. Obviously it was rigid to understand that the soil environment and other edaphic factors differs very much which is no doubt very much favorable for sandal cultivation as well as adaptation in each forest area.

## MATERIALS

I. Seeds of *Santalumalbum.L*

II. Soil sample which collected from our study site.

III. CHEMICAlS: All the chemicals are available in the soil testing kit for major elements, Gibberellic Acid (GA3) and HgCl2.

IV. APPARATUS: Test tube, measuring cylinder, beaker(up to 500ml), dropper, autoclave, container, the apparatus which available from soil testing kit, markin cloth, polypots, hycopots etc.

V. MISCELLANEOUS: trays, sieving net, weight & balance, water (distilled), farm yard manure (FYM), tap water etc.

## METHODS

**Study Site:** The study was carried out in the nursery of Burdwan Raj College Discipline of The University of Burdwan (23.2459°N latitude and 87.857°E longitude), West Bengal. The study area is about 30m above the mean sea level. It is a fertile land conquered by sandy clay type soils. The climate is familiar as tropical in nature. The temperature deviation is very little in winter (7 to 12°C) but it rises up to 25-36°C in summer. It increases up to 41°C very occasionally.

### Soil testing method

Our laboratory design involves the selection of the soil sample.

### (i) Soil pH

The pH of the soil was determined with the help of a pH meter in 1: 2.5 soils: water suspension ratio with the help of indicator given by the soil testing kit. (I.A.R.I – 2014)

### (ii) Available Organic Carbon

Organic carbon was determined by soil with 1:5 soils: watersuspension ratio with the help of two type of solution which given by soil testing kit (I.A.R.I – 2014) for organic carbon test.

### (iii) Available Nitrogen (N)

#### a) Nitrate Nitrogen

The available nitrate nitrogenwas determined by soil with 1:5 soils: watersuspension ratio with the help ofa solution of nitrate nitrogen estimation and also the steps followed by soil testing kit handbook (I.A.R.I – 2014).

#### b) Ammoniacal Nitrogen

The available ammoniacal nitrogen was determined by soil with 1:5 soils: water suspension ratio with the help of a solution of ammoniacal nitrogen estimation and also the steps followed by soil testing kit handbook (I.A.R.I – 2014).

**(iv) Available phosphorus (P):** Available phosphorus (P) of soil is determined by using Olsen's method. In this method, the extractant is 0.5M $NaHCO_3$ solution adjusted to pH 8.5 with 10% NaOH(I.A.R.I – 2014).

**(v) Available potassium (K)**

Available potassium content of the soil was determined with 2:1 solution (given for Potassium estimation): soil ratio for 1min shaking and next steps also followed for estimation Potassium which given by soil testing kit handbook (I.A.R.I – 2014).

After follow the overall the procedure carried out the tests for pH (acidity or alkalinity), Nitrogen, Phosphate, Potassium and Organic Carbon we compare the colour of the final solution with the respective colour chart. The nearest match would indicate the result.

**SEED GERMINATION METHOD**

First of all sandal seeds were sun dried for about two weeks. A desire number of seeds were then counted for each location and measured their weight by weight balance before pour in the treatments. Three kinds of treatments were made viz i) control (Normal water), ii) 200 ppm GA3 solution, iii) 500 ppm GA3 solution. Seed were treated with each treatment for about 24 hours. Seeds were pretreated with HgCl2 (0.001%) for surface sterilization. After 72 hours of soaking in treatments, seeds were removed from the solutions, blot their surface and again measured their weight. There after seeds were taken to the nursery field for sowing. The germination data were recorded properly in each treatment and the raised seedlings were transferred into hycopotsbeds of nursery at 3 to 4 leaf stage.

**i) Pretreatment by soaking in water**

Sandalwood seeds are soaked in water for 72 hours before sowing. Seeds are sown in sand bed (6 mm deep). Germination starts after 28 days. In-between 61 to 100 days, only 27-32% germination is obtained.

**ii) Pretreatment by Gibberellic Acid**

Before sowing the sandal seeds were pre-treated properly with HgCl2 (0.001%) and imbibed for 72 hours in different concentration of GA3 solutions (200ppm, 500ppm). The treated sandalwood seeds were then sown in the sand bed. The sand beds were watered twice daily in the morning & afternoon. First germination was started after 28 days of seed sowing. The number of seeds germinated in each treatment is recorded and the germination is continued up to 90 days after sowing.

## RESULTS

**Table-1: Estimation of Soil Components.**

| Component | Results | | Remarks |
|---|---|---|---|
| | Average | Experimental | |
| Soil pH | 6-10 | 7.5 | Slightly alkaline |
| Organic Carbon | 0.5-0.75%( % by wt.) | Below 0.5% | Very low in Soil |
| Nitrate Nitrogen | 1.81-20.41(kg/acre) | 20.41 | High in Soil |
| Ammoniacal Nitrogen | 5.89-81.64(kg/acre) | Nil | Absence in soil |
| Phosphorus | 0-29.48(kg/acre) | 22.68 to 29.48 | Medium high in soil |
| Potassium | <45.36 - >158.76(kg/acre) | >158.76 | Very high in soil |

We have computerized the data for calculating the analysis of variances (ANOVA) as per the biometrical model of singh and Chaudhary (2005). The table of variance ratios ('F' values) in each treatment location wise has been cited in table – 2 at a glance.

**Table. 2.**

| Plot | | Source | df | SS | MSS | F |
|---|---|---|---|---|---|---|
| 1 | Scarified/Plant height | Replication | 2 | 140.56 | 70.28 | 0.188 |
| | | Treatment | 2 | 140.72 | 70.36 | 0.188 |
| | | Error | 4 | 1495.26 | 373.81 | |
| | Non-scarified/Plant height | Replication | 2 | 113.91 | 56.95 | 0.153 |
| | | Treatment | 2 | 122.15 | 61.07 | 0.164 |
| | | Error | 4 | 1487.21 | 371.80 | |
| | Scarified/ Leaf number | Replication | 2 | 704.08 | 352.04 | 0.193 |
| | | Treatment | 2 | 701.22 | 350.61 | 0.192 |
| | | Error | 4 | 7294.81 | 1823.70 | |
| | Non-scarified/Leaf no | Replication | 2 | 429.5 | 214.75 | 0.118 |
| | | Treatment | 2 | 595.16 | 297.58 | 0.164 |
| | | Error | 4 | 7242.84 | 1810.71 | |
| 2 | Scarified/Plant height | Replication | 2 | 145.94 | 72.97 | 0.2024 |
| | | Treatment | 2 | 143.65 | 71.82 | 0.1993 |
| | | Error | 4 | 1441.45 | 360.36 | |
| | Non-scarified/Plant height | Replication | 2 | 80.6 | 40.3 | 0.1728 |
| | | Treatment | 2 | 54.36 | 27.18 | 0.1165 |
| | | Error | 4 | 932.64 | 233.16 | |
| | Scarified/ Leaf number | Replication | 2 | 812.66 | 406.33 | 0.2121 |
| | | Treatment | 2 | 811.58 | 405.79 | 0.2118 |
| | | Error | 4 | 7660.76 | 1915.19 | |
| | Non-scarified/Leaf no | Replication | 2 | 497.07 | 248.53 | 0.1800 |
| | | Treatment | 2 | 336.32 | 168.16 | 0.1217 |
| | | Error | 4 | 5522.6 | 1380.65 | |
| 3 | Plant height | Replication | 2 | 220.78 | 110.39 | 0.2023 |
| | | Treatment | 2 | 221.32 | 110.66 | 0.2028 |
| | | Error | 4 | 2182.59 | 545.64 | |
| | Leaf number | Replication | 2 | 875.94 | 437.97 | 0.2047 |
| | | Treatment | 2 | 876.75 | 438.37 | 0.2049 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Error | 4 | 8554.39 | 2138.59 | |
| **4** | Plant height | Replication | 2 | 204.13 | 102.06 | 0.2030 |
| | | Treatment | 2 | 207.44 | 103.72 | 0.2063 |
| | | Error | 4 | 2010.94 | 502.73 | |
| | Leaf number | Replication | 2 | 829.85 | 414.92 | 0.2101 |
| | | Treatment | 2 | 827.34 | 413.67 | 0.2095 |
| | | Error | 4 | 7896.65 | 1974.16 | |

From the above table (**TABLE– 2**) it has been observed that no need of calculation of CD values in each location from the ANOVA table depending up on the values of variance ratio.

**Fig. 01: Sandal seeds for soaking in GA soln.**

**Fig. 02:Seeds sowing in seed bed.**

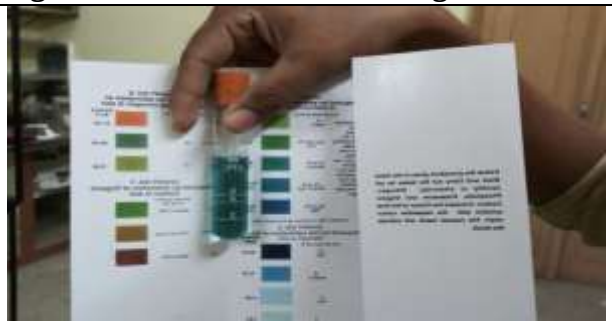

**Fig. 03: Test tube at phosphate estimation.**

**Fig. 04: Germinated seed at bed.**

**Fig. 05: Sandal sapling.**

**Fig. 06: Sapling in hycopot.**

**Fig. 07: Sandal saplings.**

**Fig. 08: Measurement of sapling height & growth.**

## DISCUSSION

Sandal requires a drought prone environments to grow in a gradual mode development. Soil factors is under artificial control in our hands. In the soil sample we have observed that soil pH was slight alkaline, organic carbon was low, nitrate nitrogen was high, phosphorous compound was very high and potassium was also very high.

Indeed, acidic pH is not suitable any plant in initial phase, slightly alkaline pH will help the root system of the plant to anchor it in soil and establish it easily with in a short time. Organic carbon is not a factor at al which is under our hand to manipulate it. Organic nitrate nitrogen was high. This will help the plant in stable gradual way. Phosphorous was also very high which has a specific role to plant growth and development for cell division. Potassium was found very high. Its also very much favourable to all the plant to transport water from soil to leaf of the plant. 'K' has four pyrolic bond by which it has the strong capability to bond different organic compound available in the and transport it to the leaves by cell to cell osmosis process. So, it is needless to the soil factor is at least congenial to sandal plant.

Seed materials was procured from Bankura (S), Burdwan, Midnapore (w) place which were grown in Burdwan Raj College medicinal plant garden since January 2017 in four phases from the result **TABLE-2** it has been observed that **plot-2** was the good germination percentage than the other plots. It is also found that **non-scarified seeds** were found to be better than the **scarified seeds**. Though the seed materials and locations both were same but the various of 'F' values was remarkable, probably due to micro-environmental effect over the location by means of monthly various.

**Germination and dormancy**: In Santalum album germination is sporadic and takes 4-12 weeks time to complete germination (Srinivasan et al., 1992; Srimathi et al., 1995). Srinivasan et al. (1992) recommended nursery bed of sand and soil in the ratio of 1:3 for seed germination and seed density of 500 g/m2 bed. Fresh seeds show dormancy for 2 months period. It is likely that the enforced dormancy of seeds is due to presence of hard seed coat or due to the presence of chemical substances in the seed coat which are impervious to water and gases. Ananthapadmanabha et al. (1988a) have reported that treatments with dilute Sodium hydroxide or dilute hydrochloric acid or gibberellic acid can remove the dormancy principle from the seed. Early & quick germination in a short time 15 days by breaking the false seed coat, indicate the presence of inhibitory principles in the seed coat (Srimathi and Rao, 1969). Pretreatment of seeds with GA3 500 ppm for 16 hrs resulted in 60% germination

under field conditions (Nagaveni et al., 1989). Traditionally the seedlings at 4-6 leaf stage are transferred to poly-bags of 1500 cc. capacity with a potting mixture of sand, soil and FYM in 2:1:1 ratio with Cajnuscajan as a pot host. Plantation seedling of 30 cm height with dark brown stem can be produced in 6-8 months period (Rai, 1990). Germination of Sandal seeds are found profuse from the bird droppings in the forest floor as well as in the village yards and bunds of the agricultural fields. Sandal is also found growing wild in some farmlands, homesteads and wastelands in Hirbundh block of Bankura District. This indicates the potential of growing the tree in the farmlands. The hemi-parasitic nature of sandal is not fully understood and silvicultural techniques to establish it are not fully known. Ananthapadmanabha et al. (1984) reported that sandal plants established haustorial connections with the secondary hosts (e.g. Pongamia). Though sandal plants can survive without host, their experiment has proved beyond doubt that the host plants are absolutely necessary for the better growth of sandal plants. Very slow growth of sandal and the long rotation period is another disincentive for sandal cultivation. However, germination of seeds are very low (15-20%) when the seeds are sown in mother bed (sand beds) after hot and cold water treatment due to its hard seed coat and dormancy. Sandal seeds have been found to germinate fast when the seed coat is completely removed, or seeds are soaked in 0.05% gibberelic acid for 12-16 hrs(Nagaveni and Srimathi, 1981a).

**Causes of Dormancy**

The failure of apparently ripe seed to germinate in a suitable environment may be due to a single factor or a combination of several factors. The main causes of seed dormancy are: impermeable seed coats, mechanically resistant seed coats, rudimentary embryos, physiologically immature embryos and morphologically mature but physiologically dormant embryos.

**Treatments to stimulate germination**

There are various physical and chemical means to stimulate germination of seeds, especially in the dormant seeds. The efficiency of these treatments varies markedly with the degree and kind of seed dormancy. In some species seed dormancy is readily broken by any of the treatments, whereas in other species the seeds respond only to a specific treatment. Sometimes the deep dormancy of seeds cannot be broken by any of the commonly used methods (Mechanical scarification, Acid scarification, soaking in water, Stratification, Dry storage, Chemical treatment, Exposure to light). The ideal time to start rising of Sandalwood

seedling in nursery is during NovemberDecember so that disease free plantable seedlings are available by July (i.e. at the time of monsoon). Sandalwood seeds have post drop dormancy of 50 to 60 days due to impermeable outer covering. Sandal seeds are naked, lacking testa. The dicotyledonous embryo occupies nearly the entire length of the albuminous seed. The stony endocarp, although not to be called seed coat, is referred to as seed coat literally, though it is a false seed coat. Fresh seeds take 4 to 12 weeks to germinate. The different methods tried for germination of sandalwood seeds are.

a) Pretreatment by Soaking in water: Sandalwood seeds are soaked in water for 24 to 36 hrs before sowing. Seeds are sown in sand bed (6 mm deep). Germination starts after 60 days. In-between 61 to 100 days, only 2-3% germination is obtained.

b) Pretreatment by boiling water: Sandalwood seeds are pretreated with boiling water (10 parts of boiling water with one part of seeds) for 1 min and then kept in normal water overnight for soaking. Treated seeds are sown in sand bed. Germination starts after 50 days. In-between 51 to 100 days, hardly 5% germination is obtained.

c) Pretreatment by alternate wetting and drying: Sandalwood seeds are exposed to alternate wetting and drying for 12 hrs wetting followed by 12 hrs drying in sun. This process is repeated for 7 days and then the seeds are sown in sand bed. Germination starts after 40 days. Inbetween 41 to 100 days, 4 to 5% germination is obtained. Little germination is found even after 100 days.

d) Pretreatment by Gibberellic acid Sandalwood seeds are soaked in 0.05% (w/v) gibberellic acid (GA3 ) solution for 16 hrs. The soaked seeds are then sown in germination bed (sand bed) of uniformly sieved sand. The germination bed is treated with fungicide (0.25% dithane M45) as prophylactic measure against insect pest attack. Seed density is 500 g/m2 . Germination starts after 21 to 30 days of sowing and upto 90 days we get 35 to 45% germination and after 90 days there was no germination of seeds. The results are given in the following tables 1 and 2. Results Soaking in cold water or hot water or alternate soaking in hot and cold water did not improve either the rate of germination or the percentage of germination in case of sandal seeds. Soaking the seeds in 0.05% GA3 for 16 to 24 hrs gives good germination of sandalwood seeds.

In sandal seeds, the duration of the germination is much prolonged after the dormancy period. It starts in 30 days and reaches hardly 50% in 90 days. Afterwards rate is very slow and germination period extends over 140-150 days. But in this period some other factors like fungus, nematodes, and rodents may invade the seeds, thereby reducing their germination capacity. Also such delayed germination affects nursery management and increases the cost. Therefore, in order to get maximum germination in shortest possible period, pre-treatment should be given to the sandal seeds.

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