**(6) Seedlings Purchased From Private Nursery.**

The Project nursery at Chikus was only completed and started raising seedling in December 1992. Therefore seedlings required for planting program in 1992 and some selected seedlings for project's needs during 1993 and 1994 were bought from private nursery.

**Table-N12 Seedlings purchased from private nursery**

(Unit:1,000 seedlings)

| Species | Terengganu | Ramadan | Rim | Kedah | AH | Total |
|---|---|---|---|---|---|---|
| *Acacia mangium* | | | | | 15 | 15 |
| *Alstonia* sp. | | | 1 | | | 1 |
| *Calamus manan* | | | | 4 | | 4 |
| *Cinnamomum* sp. | | | | 0.5 | | 0.5 |
| *Dryobalanops aromatica* | | 1 | 8 | 3 | | 12 |
| *Durio* sp. | | | | 1 | | 1 |
| *Hevea brasitiensis* | | | | | 30 | 30 |
| *Hopea odorata* | 4 | | 1 | | | 5 |
| *Neobalanocarpus heimii* | 11 | | | | | 11 |
| *Palaquium* sp. | | | | 3 | | 3 |
| *Parashorea densiflora* | | | | 4 | | 4 |
| *Parkia* sp. | | | | 0.5 | | 0.5 |
| *Scaphium macropodum* | | | | 4 | | 4 |
| *Shorea bracteolata* | | | | 5 | | 5 |
| *Shorea glauca* | | | | 3 | | 3 |
| *Shorea laevis* | | | | 4 | | 4 |
| *Shorea leprosula* | | | 1 | | | 1 |
| *Shorea parvifolia* | | | 1 | | | 1 |
| *Toona* sp. | | | | 0.5 | | 0.5 |
| Total | 15 | 1 | 12 | 32.5 | 45 | 105.5 |

Note: Terengganu(a commercial vendor)
Ramadan(Ramadan Management Service)
Rim(Rim Nursery Sdn. Bhd.)
Kedah(Seri Alor Star, Kedah)
AH(En Teong Ah Hing,Sitiawan,Perak)

A survey on a few private nurseries in the country indicate that they mostly concentrate on producing rattan seedlings for Community Forestry Project and also ornamental tree species for Urban Planting program. Little emphasis was given for producing high quality species seedlings. Recently, through the "Enrichment Planting" project undertaken by Forestry Department more and more nurseries are shifting their attention in producing these high quality indigenous seedling. The amount produced unfortunately only made up a small percentage of the total requirement.

Except for certain indigenous species most of the seedling produced from these private nursery are raised from wildings and the quality varies widely. Normally forest topsoil is used as the potting medium, but these private nursery used clay soil which is hard and not suitable for healthy growth of the seedlings. Shipments supposedly of a single species often contain other species due to inadequate species identification.

### (7) Seedlings Acquisition From State Forestry Department Nursery

As mentioned earlier, in 1992 and 1993, the Project also acquired a certain species for its planting program from various state Forestry Department Nursery in particular from the states of Perak, Negeri Sembilan and Pahang. Negri Sembilan Forestry Department Nursery in Mantin had supplied about 26,428 seedlings of various species such as *Shorea leprosula*, *Shorea acuminata*, *Shorea parvifolia*, *Shorea laevis*, *Endospermum malaccense* and *Heritiera* sp.. Pahang State Forestry Department on the other hand has provided 1,000 seedlings of *Shorea ovalis* and *Shorea dolichocarpa*. The biggest contributor for the supply of seedlings from Forestry Department came from the state of Perak totaling 35,339.

**Table-N13 Seedlings from State Forestry Department**

(Unit:1,000 seedlings)

| Species | Perak | | | | Negeri Sembilan | Pahang | Total |
|---|---|---|---|---|---|---|---|
| | Manong | Papan | Gerik | Besout | Mantin | Raub | |
| *Acacia mangium* | | 9 | | 15 | 10 | | 34 |
| *Agathis dammara* | | 0.5 | | | | | 0.5 |
| *Dipterocarpus cornutus* | | | 0.5 | | | | 0.5 |
| *Endospermum malaccense* | | | | | 3 | | 3 |
| *Heritiera* sp. | | | | | 1 | | 1 |
| *Hevea brasiliensis* | | | | | 0.5 | | 0.5 |
| *Intsia palembanica* | | | 0.5 | | | | 0.5 |
| *Scaphium macropodum* | | | | | 0.5 | | 0.5 |
| *Shorea acuminata* | 2 | | | | 8 | | 10 |
| *Shorea dolichocarpa* | | | | | | 0.5 | 0.5 |
| *Shorea hopeifolia* | 1 | | | | | | 1 |
| *Shorea hypochra* | | 1 | | | | | 1 |
| *Shorea laevis* | | | | | 0.5 | | 0.5 |
| *Shorea leprosula* | 11 | | | | 0.5 | | 11.5 |
| *Shorea ovalis* | | | | | | 0.5 | 0.5 |
| *Shorea parvifolia* | 7 | | | | 2 | | 9 |
| *Shorea singkawang* | | 3 | | | | | 3 |
| *Swietenia macrophylla* | | | | | 0.5 | | 0.5 |
| *Tectona grandis* | | | 0.5 | | | | 0.5 |
| Total | 21 | 13.5 | 1.5 | 15 | 26.5 | 1 | 78.5 |

Note: Perak State Forestry Department
- Papan Nursery
- Manong Nursery
- Gerik Nursery
- Besout temporary nursery

Negri Sembilan State Forestry Department
- Mantin Nursery

Pahang State Forestry Department
- Raub Nursery

### 1-2-4 Calculating the Cost of seedlings production

The main objective of Chikus nursery is to produce healthy seedlings from both high quality and fast growing species required for the establishment of Multi-Storied Forest in the project site. However, the ultimate goals when producing seedlings are to increase efficiency and reduce production costs as much as possible. The average cost of producing a seedling was done based on records collected from the Project. In the calculation, a period of 12 months was chosen as it is the average time the seedlings are kept in the nursery before they are ready for transplanting. Expenses incurred for raising the seedling is divided by the number of seedlings produced in 1 year ( From July in 1994 to June in 1995 ). The expenses/costs that were taken into consideration include worker salaries, JICA staff salaries (nursery), travel allowances for seed collection team, equipment used in seed collection, fuel expenses and depreciation of machinery.

The Project nursery depended on 2 main sources of raising seedling. One is from seed, while the other is from wildings. Calculation on both of these sources are also made and as expected the cost of raising seedling from wildings is higher by 34 %. The cost of raising seedling from seed is RM. 0.99 per seedling and the cost from wilding is RM. 1.33 per seedling. The average cost of producing seedling (From both seed and wilding) at Chikus Nursery therefore is approximately RM. 1.05 per seedling.

The calculation on the cost of producing seedling from seed and wilding are shown in Table-N14,15.

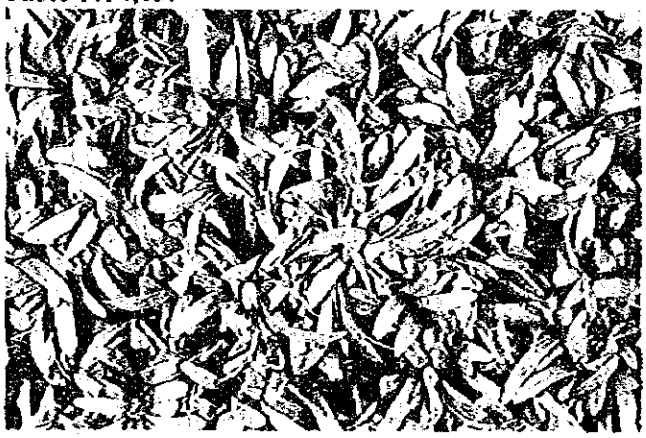


**Photo.-N7 Collected seeds (*Shorea platyclados*)**

**Photo.-N8 Dewinging of Dipterocarp seeds (*Dipterocarpus crinitus*)**

**Table-N14 Method of calculating seedling cost**

| | | | | | |
|---|---|---|---|---|---|
| **A. Staff and Worker Salaries** | | | | | |
| 1. Staff | RM 1,235×12 months×4 workers×47.2% | = | RM | 27,980 |
| 2. Worker (male) | RM 15×10.6 days×12 months× 4 workers | = | RM | 7,632 |
| (female) | RM 15×18.3 days×12 months×11 workers | = | RM | 36,234 |
| 3. Contracts for potting | 78,520 pots × 5 sen | = | RM | 3,926 |
| | **Subtotal** | | **RM** | **75,772** |
| | | | | **[47%]** |
| **B. Cost of Material** | | | | |
| 1. Polythene bag | | | RM | 2,324 |
| 2. Fuel expenses | | | RM | 4,119 |
| 3. Repair of machinery | | | RM | 1,170 |
| 4. Others(Shading net, Watering equipment, Wood etc.) | | | RM | 4,065 |
| 5. Depreciation of machinery | | | | |
| a. Motorcar | RM 46,791 5 year (RM 63,168) | | RM | 12,633 |
| b. Small truck | RM 44,566 5 year (RM 60,164) | | RM | 12,033 |
| c. Tractor | RM 55,000 8 year (RM 85,800) | | RM | 10,725 |
| d. Microbus | RM 63,806 5 year (RM 86,138) | | RM | 17,228 |
| | **Subtotal** | | **RM** | **64,297** |
| | | | | **[39%]** |
| **C. Seeds & Wildings collection cost** | | | | |
| 1. Staff | RM 1,235×12 months×3 workers×23.6% | = | RM | 10,493 |
| 2. Worker(male) | RM 15×10.6 days×12 months× 4 workers | = | RM | 3,312 |
| 3. Allowance | | | RM | 7,779 |
| 4. Fuel expenses | | | RM | 1,099 |
| 5. Other (Rope etc.) | | | RM | 156 |
| | **Subtotal** | | **RM** | **22,839** |
| | | | | **[14%]** |
| | **Total** | | **RM** | **162,908** |
| | | | | **[100%]** |
| **Cost Per Seedling** ( From July in 1994 to June in 1995) | | | | |
| **RM 162,908÷154,454 seedlings** | | | **RM** | **1.05** |

**Table-N15 Cost of producing seedlings from seeds and wildings**

| | Total | Seedling from seeds | Seedling from wilding |
|---|---|---|---|
| **A. Staff and Worker Salaries** | | | |
| 1. Staff | 27,980 | 22,916 | 5,064 |
| 2. Worker (male) | 7,632 | 6,251 | 1,381 |
| (female) | 36,234 | 29,676 | 6,558 |
| 3. Contracts for potting | 3,926 | 3,926 | |
| **Subtotal** | **75,772** | **62,769** | **13,003** |
| **B. Material Cost** | | | |
| 1. Polythene bag | 2,324 | 1,903 | 421 |
| 2. Fuel expenses | 4,119 | 3,373 | 746 |
| 3. Repair of machinery | 1,170 | 958 | 212 |
| 4. Others | 4,065 | 3,329 | 736 |
| 5. Depreciation of machinery | 52,619 | 43,095 | 9,524 |
| **Subtotal** | **64,297** | **52,658** | **11,639** |
| **C. Seeds & Wildings collection cost** | | | |
| 1. Staff | 10,493 | 4,351 | 6,142 |
| 2. Worker(male) | 3,312 | 1,076 | 2,236 |
| 3. Allowance | 7,779 | 4,240 | 3,539 |
| 4. Fuel expenses | 1,099 | 650 | 449 |
| 5. Other (Rope etc.) | 156 | 106 | 50 |
| **Subtotal** | **22,839** | **10,423** | **12,416** |
| **Total** | **162,908** | **125,850** | **37,058** |
| **Number of seedlings produced** | **154,454** | **126,486** | **27,968** |
| **Cost per seedling (RM)** | **1.05** | **0.99** | **1.33** |

**Recommendation**

The Project Nursery in Chikus cannot be considered as a production nursery. Its main emphasis is to provide sufficient number of seedling for the Project planting requirement and also for experiment/research purposes. The cost per seedling can be further reduced if we increase the annual production based on the maximum capacity of the Nursery.

## 1-3 The Process of Seedlings Production

The nursery practices for seedlings production described below are the one being used at the Project Nursery in Chikus.

### 1-3-1 Summary of Nursery Practices

A flow chart of the nursery practices employed at Chikus Nursery is shown in Fig-N5.

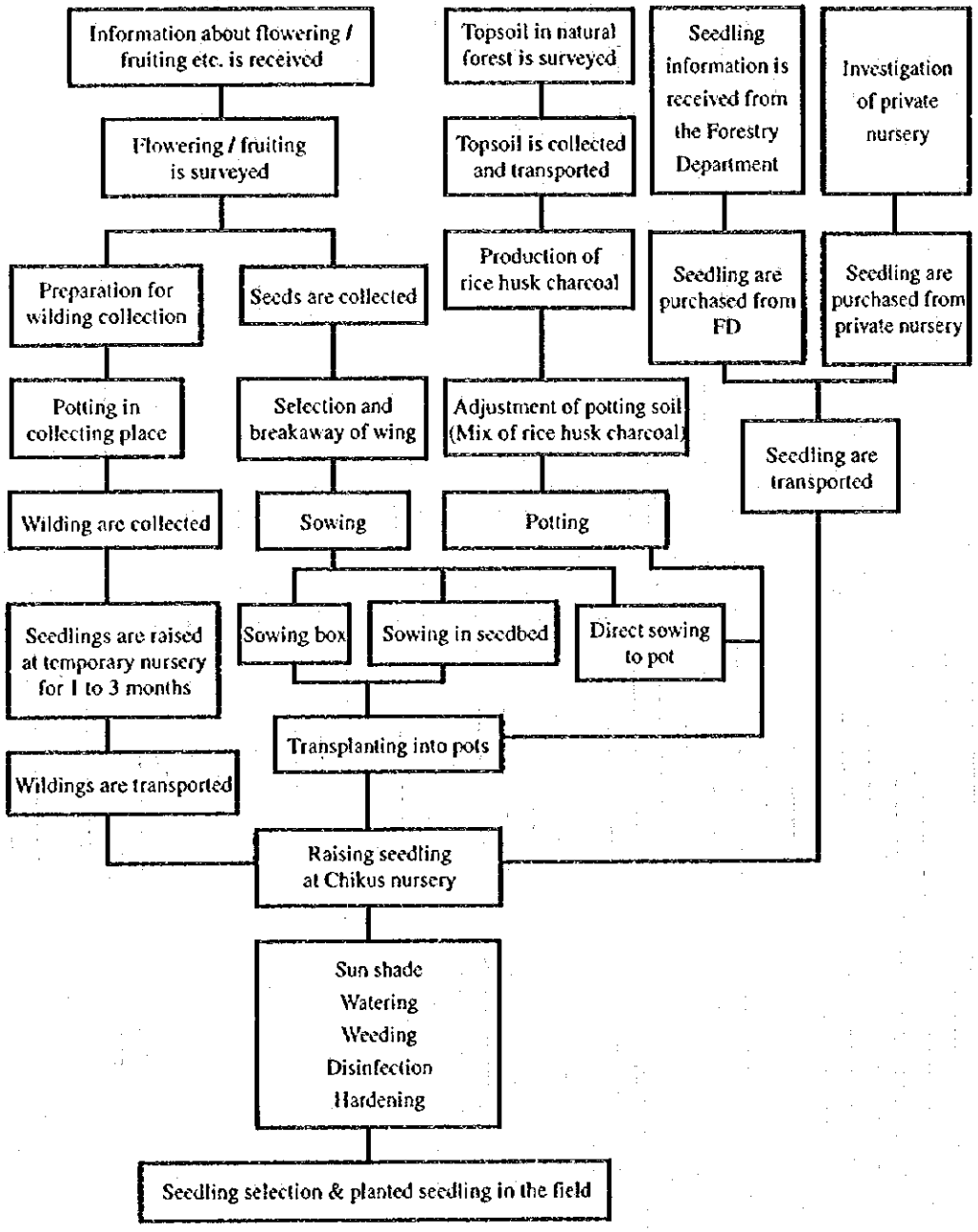



**Fig.-N5 Seedling production work**

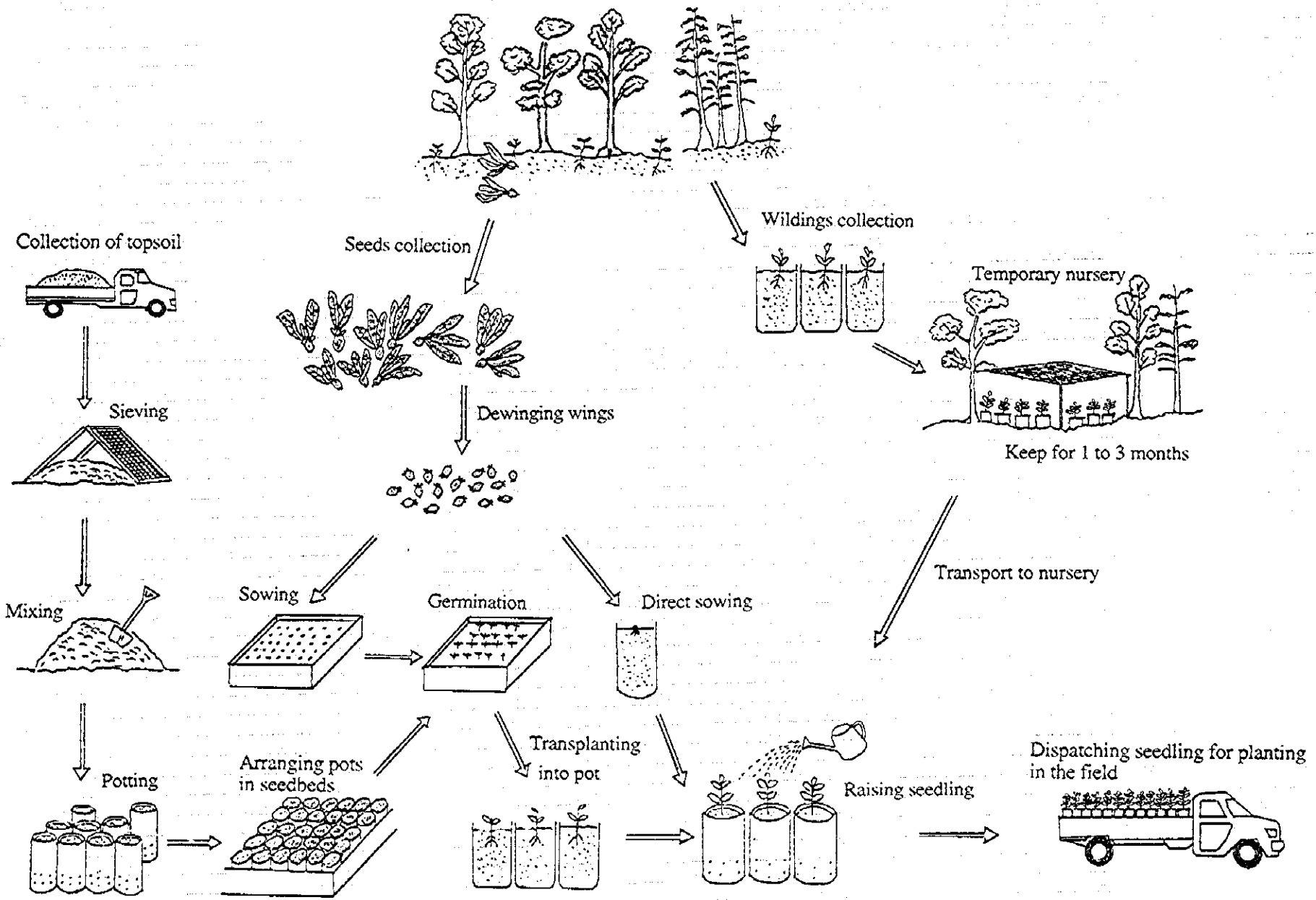



**Fig.-N6 Graphic representation of seedling production work**

### 1-3-2 The Seedlings Production from Seeds

#### (1) Establishment of Beds

Seedlings production in the tropics inevitably requires pots, so the beds with a frame to hold and arrange these pots are necessary and need to be constructed. Semi-permanent bed frames made from bricks or concrete blocks are used for this purpose which have a measurement of 1.2 meters wide by 5 to 10 meters long, running parallel to each other. Each seedbed is separated by a pavement of 0.7 to 1.0 meter wide which will be used for maintenance work and to facilitate transportation of the potted seedlings for planting. 60 % of the total area should be allocated for fixed/permanent seedbeds while the remaining should be used as mobile/moveable beds. It is a common practice in the past to used concrete slap as the seedbed floor. At Chikus nursery this is not so, instead it is only made up of natural ground.

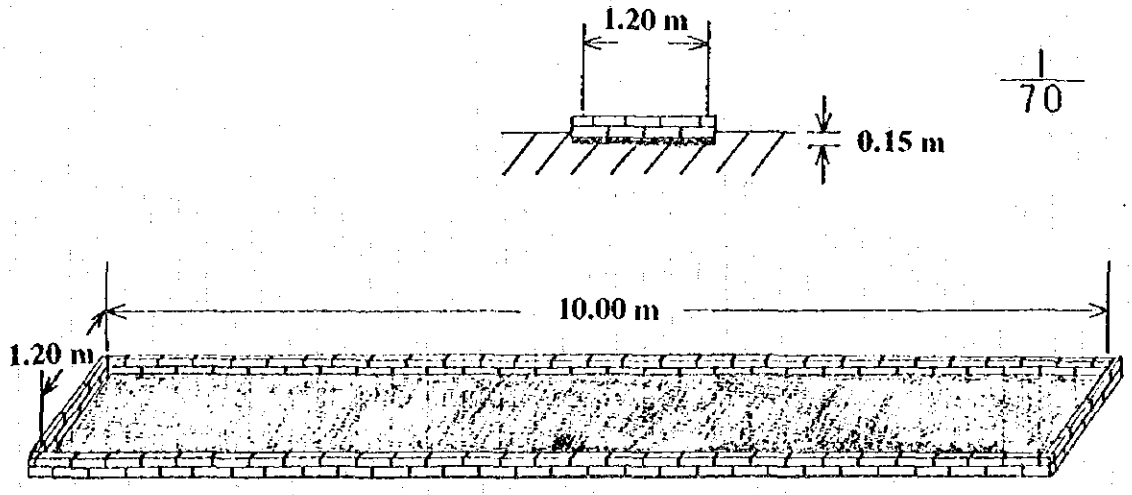



**Fig.-N7 The sketch plan of seedbed**

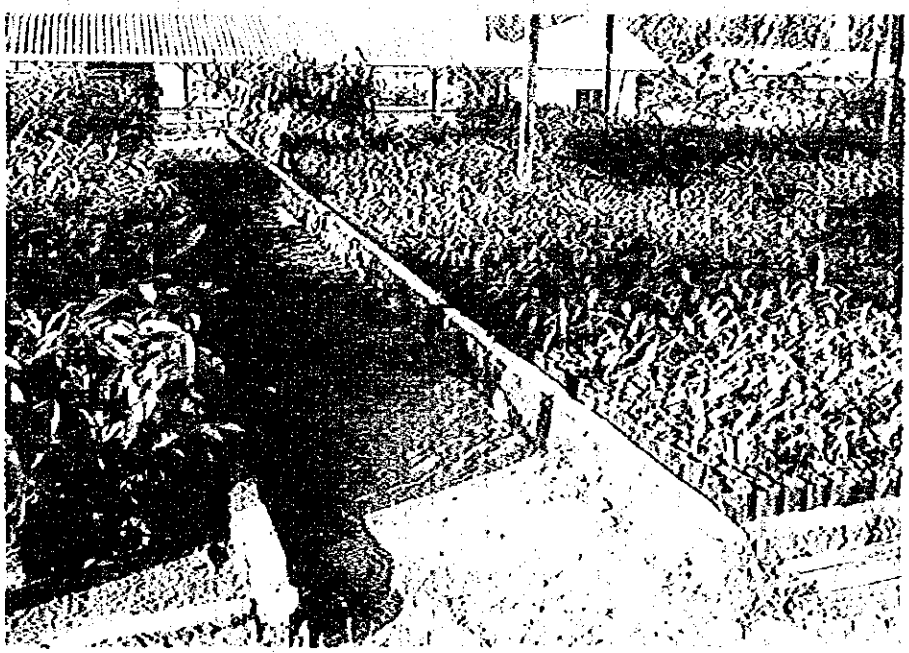


**Photo.-N9 Seedbed and seedlings**
(From the left *Shorea macroptera*, *Shorea platyclados* and *Dipterocarpus oblongifolius*)

**(2) Watering Facilities**

Water sprinkler systems have been installed to cover 120 seedbeds at Chikus Nursery and as a result only a few workers are needed for watering work. However, it is impossible to get uniform mist from the water sprinkler system to all corners of the seedbeds. It is therefore useful to install hydrants at strategic locations where watering can be done manually if needed.

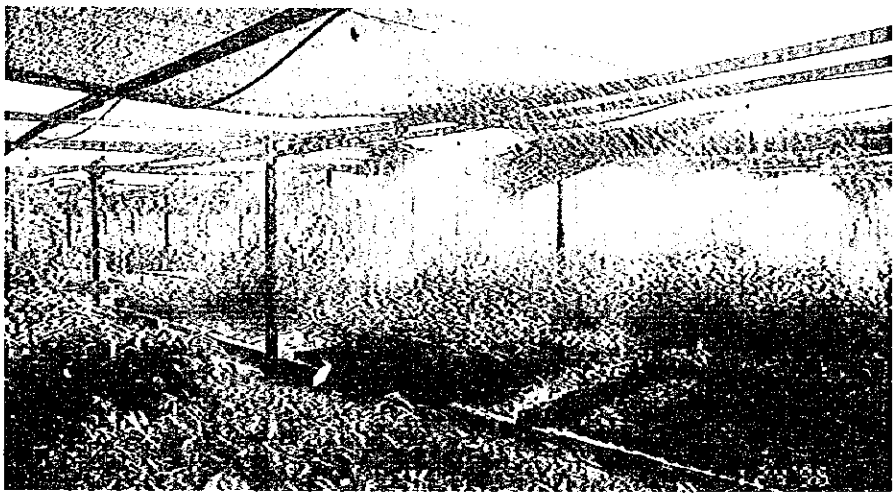


**Photo.-N10 Watering by sprinkler**

**(3) Shading Equipment**

Since Chikus nursery was constructed in an open space, artificial shade is needed to protect the seedlings from direct and strong sunlight especially during their early stage of growth. Shading material is made up black polythene netting which filter the sunlight to between 30 to 50 %. There were 2 ways by which the netting was installed, i.e. shading each bed and shading for each lot.

**a) Shading for Each Bed**

The frame is made up of timber running along the seedbeds. Both sides of the frame have unequal height, with one side having the height of 1.5 meters while the other 1.2 meters. The higher side normally facing toward the east. Along the seedbeds the poles are installed at 2.5 meter intervals and the top part of the frames are fastened with curtain rails running along the entire length of the seedbed. Plastic netting is then sewn on this curtain rail enabling us to control the amount of sunlight needed for the seedlings at any particular time by sliding it open or closed.

**b) Shading for Each Lot**

Each lot may consist of a number of seedbeds with the timber posts installed at specified points. The heights of these posts are roughly 2 meters and plastic netting is fixed on the top. The light that penetrates to the ground varies with the different size of seedlings. During the initial stage of seedling growth, we may need to cover the whole lot. But as the seedlings mature it is advisable to remove alternate rolls of netting to provide more sunlight to the seedbeds. The installation of shade for each lot is better as compared to providing shade for each seedbed because this method allowed the workers easy accessibility within the area.

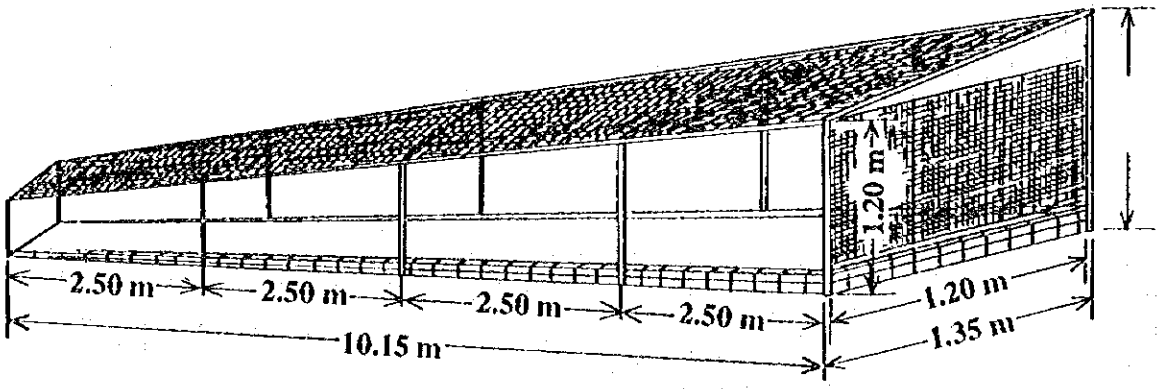



Fig.-N8 Installation of shade for each bed

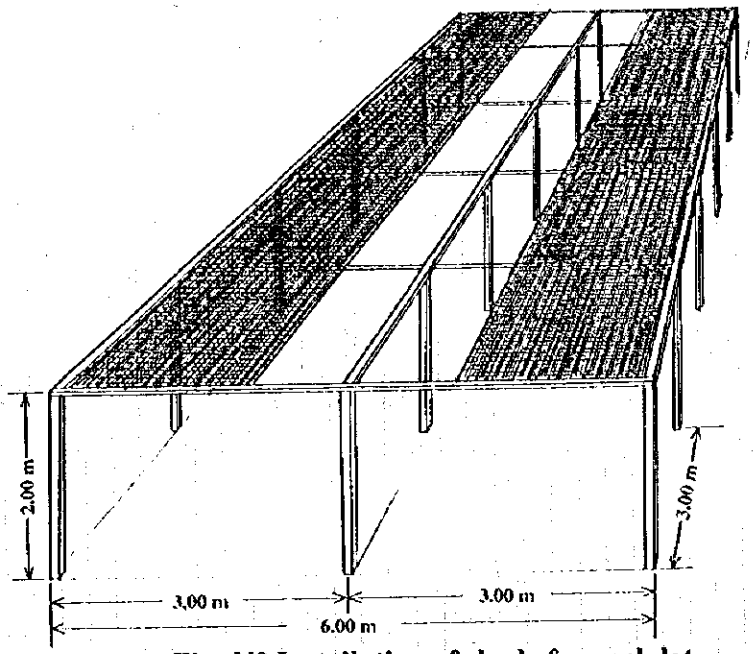



Fig.-N9 Installation of shade for each lot

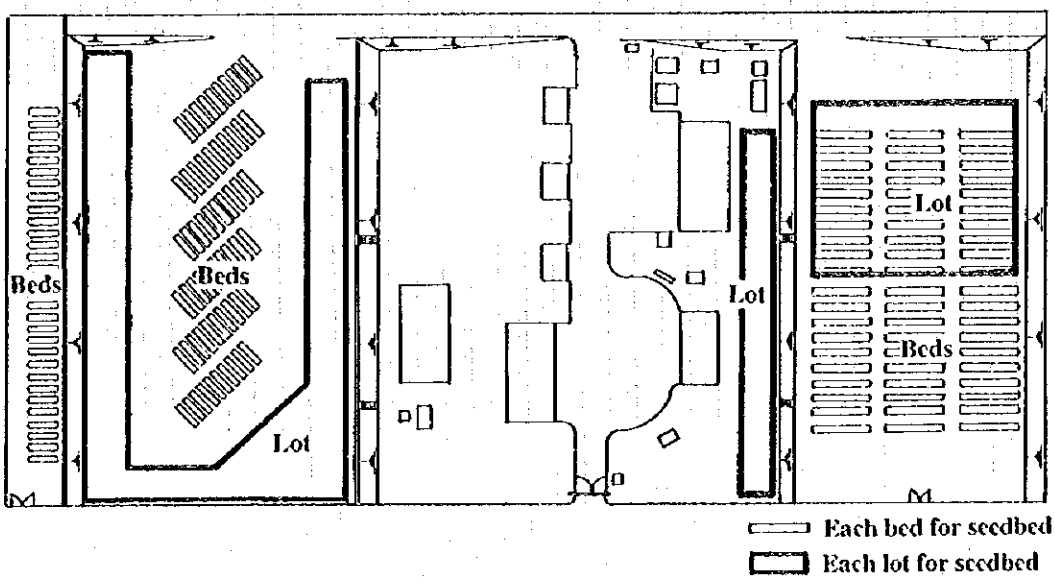



Fig.-N10 Sketch plan for shade installation (each beds and each lots)

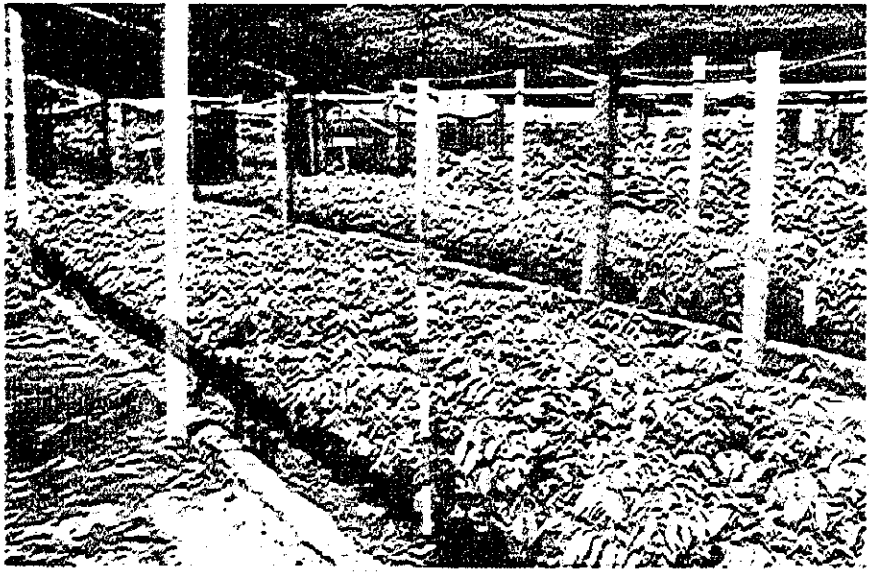


Photo-N11 Seedbed and shading (Each bed)

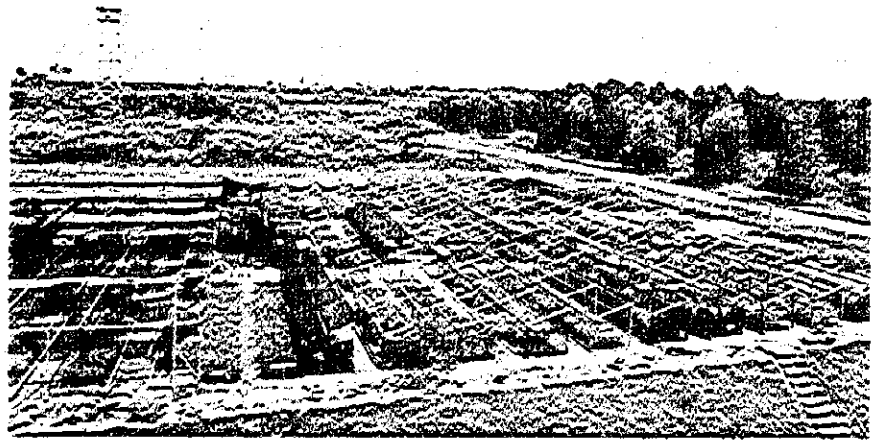


Photo-N12 Seedbed and shading (Each bed)

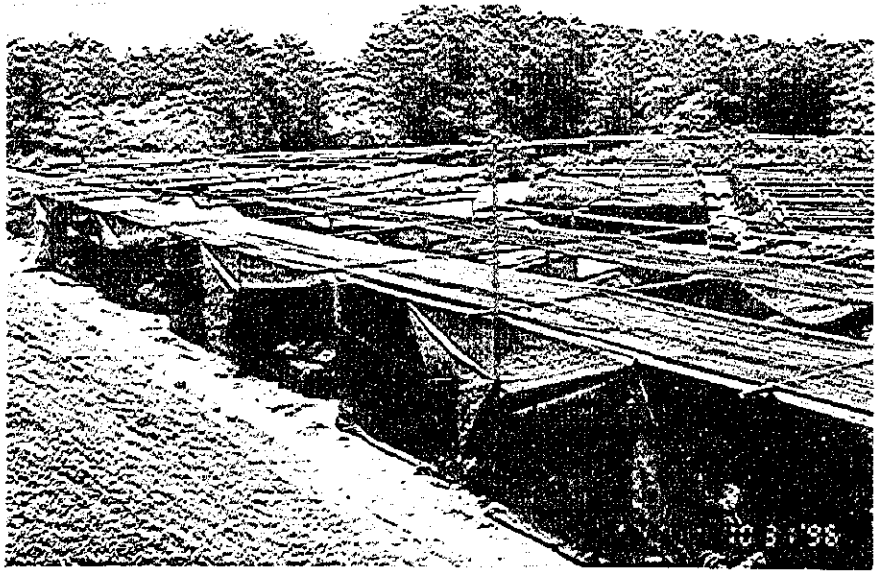


Photo-N13 Seedbed and shading (Each lot)

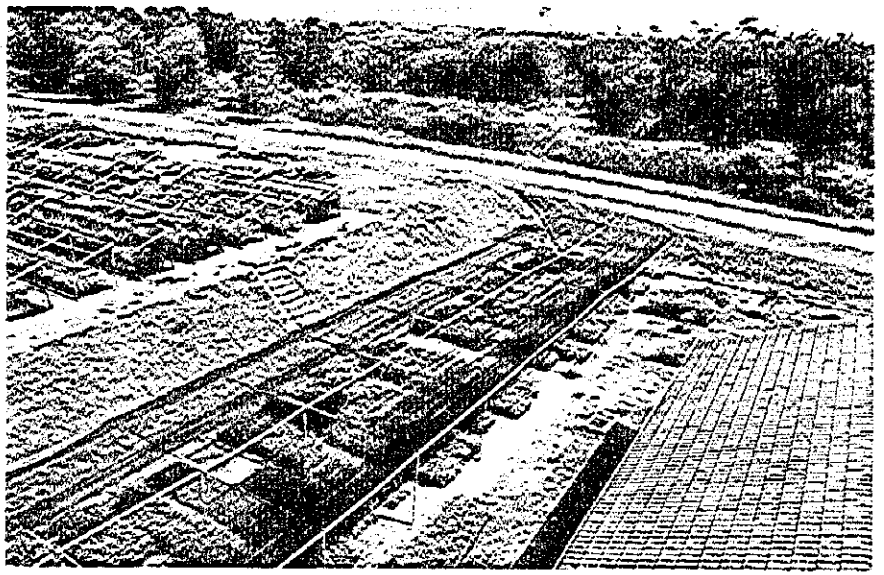


Photo-N14 Seedbed and shading (Each lot)

**(4) Seed Procurement**

**a) Procurement Plan**

Seed of Indigenous species especially Dipterocarps are very difficult to collect and the supply is not stable or consistent. A part from that, the collected seeds could not be stored over a long period of time. Therefore the Project is facing a lot of problems in raising enough quantity of seedlings to fulfill the requirement for its planting program.

On the other hand based on our previous experience, it is possible to plan and raise major Fast Growing species that are needed for the Project. The only setback we face is that most of these seeds were purchased from another country and required import permits which normally took a long time before we were able to receive them.

For the past 4 years, the seeds of fast growing species such as *Acacia mangium*, *Acacia auriculiformis*, *Casuarina equisetifolia* were procured from Australia Tree Seed Center, Forestry Department Peninsular Malaysia Headquarters and Sabah Forestry Development Authority.

**b) Storing Seeds**

As mentioned earlier, storage of Dipterocarps seeds pose formidable problems. So far only a few species were reported to be able to store over a certain period of time. Generally Dipterocarps seeds could be stored for not more than 1 week at the temperature of 20 degree Celsius or below.

As much as possible at Chikus nursery, the seeds are immediately sown after collection. Certain species like leguminous (Merbau and Keranji) have a thick hard coat with low water content, as such they are able to be stored at reasonably longer periods.

**(5) Size of Pot**

2 sizes of polythene bag is used for potting depending on the species of seedlings. A bag of 15 cm by 23 cm is used for indigenous species, while a smaller bag (12 cm × 18 cm) for fast growing species e.g. *Acacia mangium*. After potting, these bags will decrease in size. For example, the bigger bag will be measuring 10 cm in diameter and about 18 cm in height while the smaller bag will measure 8 cm in diameter and 12.5 cm high.

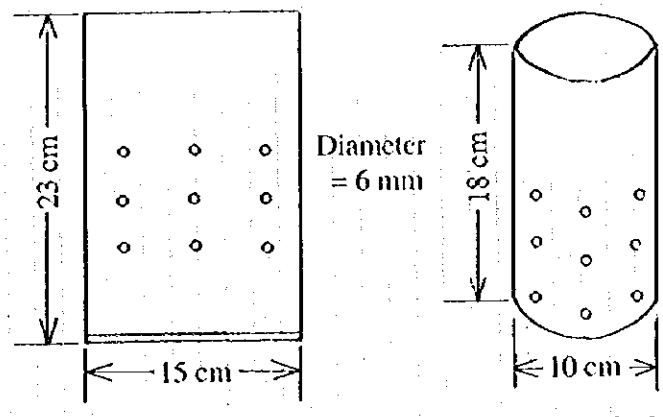



**Fig.-N11 The sketch of polythene bag before and after potting**

**(6) Soil Preparation**

Potting medium is prepare by mixing forest topsoil with charcoal from rice husk at the ratio of 97 to 3. In case the topsoil has a high content of clay, it is first mixed with river sand ( about 30 %) then mixed with rice husk charcoal. River sand is introduced here for purpose of providing good drainage in the pot.

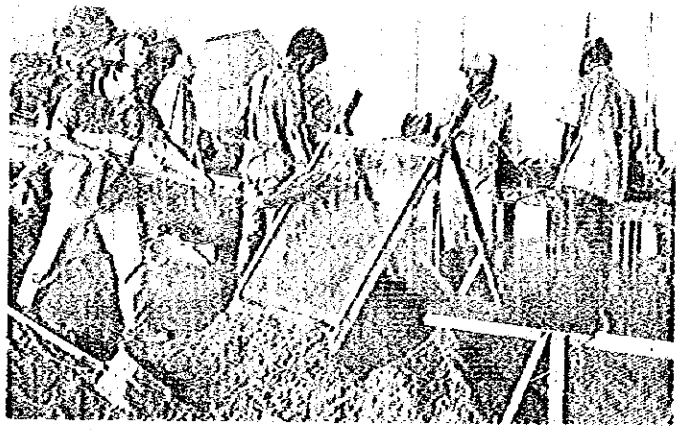


**Photo.-N15 Potting medium preparation**

**(7) Potting**

The potting medium is first place on the concrete floor of potting shed and then packed directly into pot. To facilitate this activity a plastic pipe about 6 cm in diameter and 20 cm long with one end cut at an angle is used to scoop and funnel the potting medium.(Fig.-N12)

The bottom part of the pot should be packed firmly with the potting medium to ensure pot stability when placed upright. The top part the potting medium should be packed slightly loose to enable the roots to from and develop. It is also important to make sure that the potting medium is not very loosely packed and not to overfill as they could be spilt when the pot fall down.

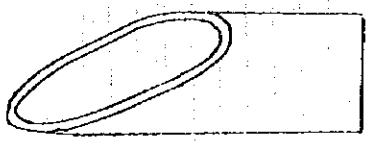
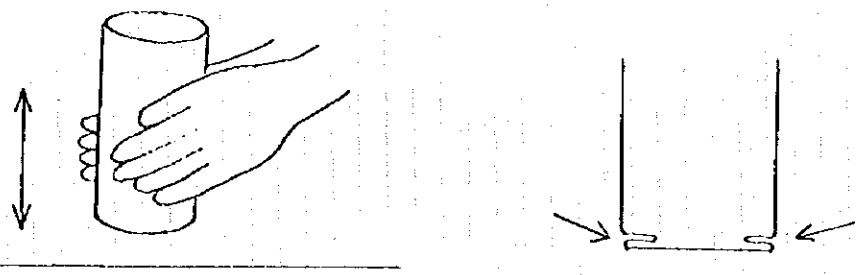


**Fig.-N12 Scoop of funnel**



Fall the pot tap-tap lightly for steady soil  Turn in both corners of the bottom by finger

**Fig.-N13 Potting**

**(8) Sowing**

There are 3 techniques of sowing employed at Chikus nursery. They are as follows :-

**a) Sowing in planter's container**

The container is made up of plastic, measuring 36×45×10 cm, and weighing 550 grams. The container has an opening at the top with a lot of holes at the bottom and by the side for drainage. It is filled up to 90 % with sowing medium and in this case meshed coconut husk.

**b)Direct sowing into pots**

This is the most practical method as it saves time and avoids double handling ( do not need to transplant the seedling from seedbed into pot). It is particularly suitable for large size seeds such as Dipterocarpus and the seeds that had already been rooting. This method makes use of it at the seed so that a germination rates more than 60 % can expected.

**c)Sowing in seedbed**

The seedbed is filled to about 10 cm deep with river sand. This technique will be used when we receive a lot of seeds at one time and method a) or b) cannot be practiced due to insufficient space or pot.

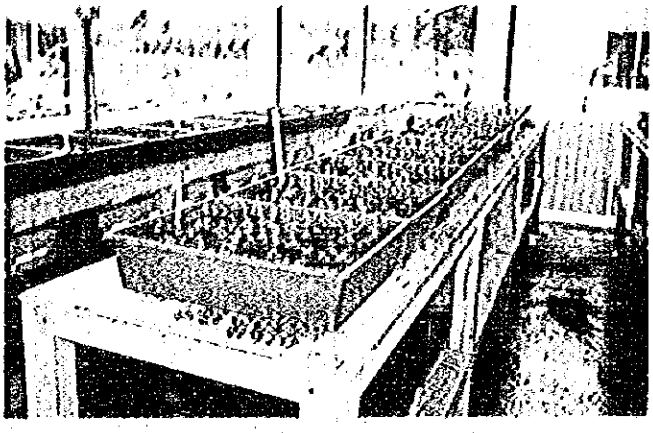


**Photo.-N16 Sowing in planter's container** (*Hopea beccariana*)

**Photo.-N17 Direct sowing into pots** (*Dipterocarpus cornutus*)

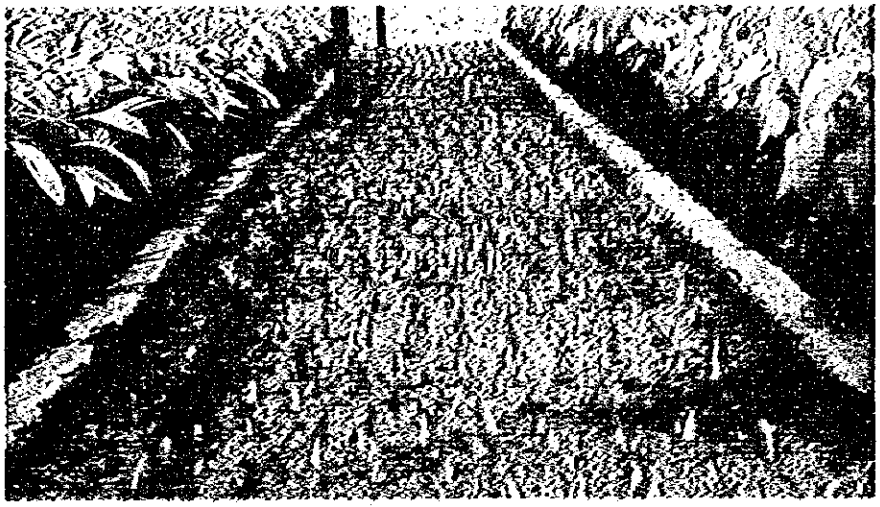


**Photo.-N18 Sowing in seedbed** (*Koompassia malaccensis*)

**(9) Transplanting into Pot**

Transplanting of seedling into pot will be needed if seeds are sown in either the planter's container or seedbed. For most of the indigenous species it is recommended that transplanting should be done between 3 to 7 days after germination. It is important to carry out this activity at the correct time especially for Dipterocarps species in order to enhance root growth.

Special care should be given when drawing out seedlings from planter's container or seedbed to avoid damage to the stem or root. These seedlings are then immediately soaked in water or wrapped with damp cloth to prevent them from drying.

Before transplanting, a few preparations need to be done. For example, make sure enough pots are available to accommodate all the seedlings and they are arranged properly in seedbeds that are shaded. The pots are then watered sufficiently. When all these preparations are completed, transplanting can begin. A hole as deep as the length of the root of seedling is produced by using a stick. The hole is then covered after the root has been inserted. It is important to water the pot again after transplanting to ensure that the root of the young seedling is properly settled in the pot.

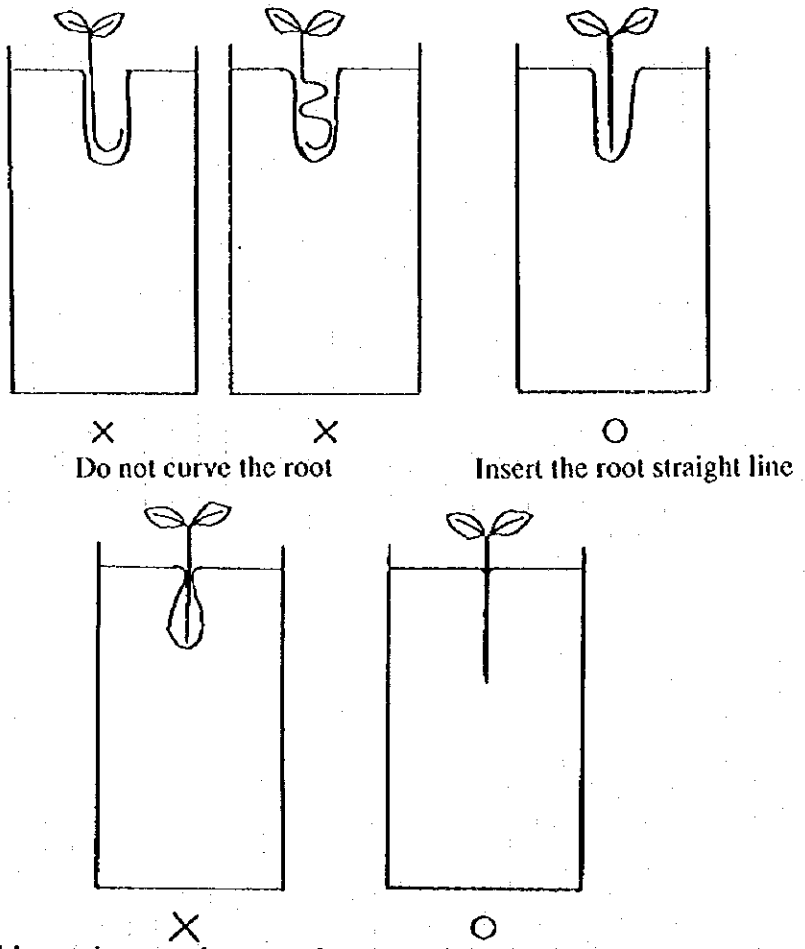



**Fig.-N14 Transplanting seedling into pot**

### 1-3-3 Maintenance Work

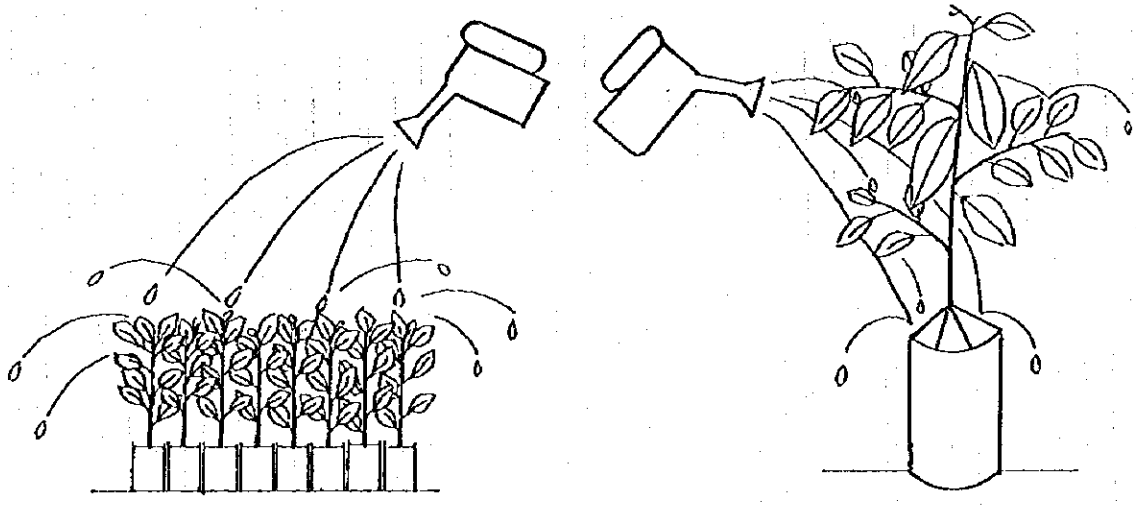
#### (1) Sun Shade

Since the Project Nursery was constructed in an open area, artificial shading is therefore needed. The facilities must be installed first before we can start transplanting seedlings from seedbed into pots. This is because young seedlings are very fragile and cannot survive if exposed to direct sunlight during it's initial stage of growth. For most of indigenous seedling (especially Dipterocarps spp.), black netting which filters between 30 to 50 % of sunlight was used as shading material at Chikus Nursery.

It is generally recommended that the shade be removed gradually as the seedlings grow older and ready for planting in the field. This will allowed the seedlings to harden/acclimatize. Based on the experience at Chikus nursery, removal of shading material should be carried out at a period of between 1 - 2 months for fast growing species and 4 - 6 months for indigenous species after the seedlings are transplanting into pots. The seedlings are then subjected to open conditions (without shading) until they are planted in the field.

#### (2) Watering

Watering is done once a day in order to ensure the seedling received enough water during it's initial growing stage. At Chikus Nursery it is done via automatic water sprinkler system. This system sometimes does not always provide evenly distributed watering to all parts of the seedbeds. Therefore, watering manually is still needed from time to time. It is also important to note that the right amount of water is given to the seedling as too much water can also be harmful to it's healthy growth. Normally the amount of water is gradually reduced before the seedlings are planted in the field. (To increase the survival rate after planting).



The leaves obstruct water from getting into the pot.

Top part of the polythene bag folds inward thus preventing water getting into the pot.

**Fig.-N15 Watering**

**(3) Weeding**

Weeds began to over grown seedlings in about 1 week after sowing or transplanting into pot. Seedbeds or pots must be weeded immediately and regularly because as weeds grow higher, the seedlings are likely to be pick up together with the weeds and transplanting/planting them would be a problem. If this activity is delayed, it could result in lower efficiency and also deteriorate the quality of the seedlings.

**(4) Disinfection**

Under hot and humid conditions, once a seedling contracts a disease it is extremely difficult to control and prevent it from spreading. Preventive measures such as application of disinfectants (organic sulfur and copper agents) once a month to the seedlings is therefore very important and needs to be carried out.

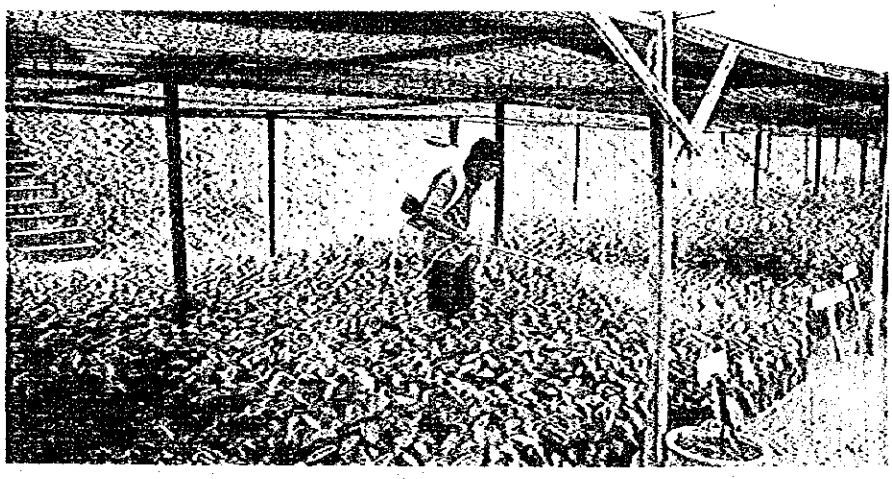


**Photo.-N19 Spraying insecticide**

**(5) Root-Pruning**

As seedlings grow to be over 20 cm high, their roots are apt to come out from the pot. Further growth and when they reach 30 cm high, there is the tendency that the roots might extend into the ground or the seedbeds floor. Check the root system from time to time and carry out root pruning if the roots have already extended out to the ground.

**(6) Introduction Mycorrhiza into Dipterocarp Seedlings**

Introduction of certain Mycorrhizal fungi have been found to have a good influence on the growth and survival of Dipterocarps seedlings. The inoculation of mycorrhiza can be done through specially prepared potting medium which is made up of a mixture of forest topsoil (which had been infected with mycorrhiza) and charcoal. Plant Dipterocarps seedling which has been inoculated with mycorrhiza surrounding seedbeds to further enhance the chances of mycorrhiza introduction in the pots. For this purpose, make sure that the floor of seedbeds are made up of natural ground and not from concrete as commonly found in forestry nursery.

For detailed information refer to a paper prepared by a JICA short-term expert entitle "As To Infection Mycorrhiza Into Dipterocarp Seedlings".

**(7) Hardening**

There are 2 factors involved in the hardening process which are watering and shading. Watering treatment for hardening process should be started about 1 month before planting of seedlings in the field. The amount of water provided to the seedling is reduced gradually to about half the original quantity. Whereas for the shading, it should be removed after the indigenous seedling have reached the age 4 - 6 months after transplanting into pots. The seedlings are then exposed to direct sunlight until they are planted in the field.

**(8) Seedling Selection before transplanting in The Field.**

The suitable seedling height for planting in the field is between 40 - 50 cm. A part from the above mention height, we must also make sure that the rooting system of the seedlings are fully developed. Seedlings that do not meet these requirements should be gathered and later given special treatment such as being provided with additional fertilizer to accelerate their growth. They are again assessed at later stage and if found to be suitable can be transported and planted in the field.

**(9) Standards for Planted Seedling in The Field.**

For all species, Height of seedling : 40~60 cm
Basal diameter of seedling : Over 5 mm
Root condition : Good ( Not only main root )

**1-3-4 Production of Seedling from Wildings**

Wilding collection is relied upon when seed of required species can not be collected or obtained.

**(1) Condition of Wilidings Collection**

Suitable size of wildings for collection is when they are not more than 30 cm in height and having minimum of 2 leaves. The best time for collection is about 2 months after the seeds started to germinate naturally in the forest. Collection should start early in the morning and stop before noon to prevent them from drying up. Special care must be taken as not to damage the root system. It is not advisable to pull out the wilding by hand alone but to used scoop or trowel where all the root system and the soil are taken out at the same time. The collected wildings are then soaked in water or wrapped in damp cloth before they are sent to temporary nursery for transplanting into pots.

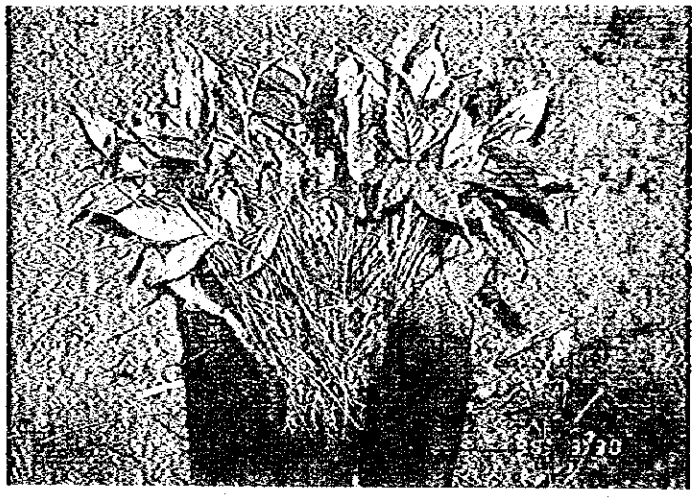


**Photo.-N20 Wilding collection**

**(2) Transplanting into Pots**

Before wilding collection can began, first we have to identify and establish a temporary nursery which must be located very near to the collection area. Preparatory work such as potting and arranging them in a proper manner in the temporary nursery must also be planned and executed at the same time. Wildings collected can not be planted straight in the field. They need to be potted and maintained for a period of minimum 1 month at the temporary nursery and later transferred to a permanent nursery until they reach certain height/size is suitable for planting.

Potting of wildings should be done immediately (same day) after collection. Prior to that make sure all the pots are watered sufficiently. Using a guide bar, a hole of roughly 5 cm in diameter is made in the soil of the pot, into which the root of the collected wildings were quickly placed and later covered up firmly with soil. Root pruning should be done if the root of the wilding exceeds the length of the pot.

**(3) Maintenance Work**

Maintenance work for the seedlings raised from wildings is the same as that of seedlings raised from seeds.

**Photo.-N21 Temporary nursery**

**Photo.-N22 Potting for wilding**

## 1-4 Progress on The Experiments Carried Out in The Field of Nursery

Production of Dipterocarps seedlings and other indigenous species pose many formidable problems, such as the difficulty in seed collection due to it's irregular flowering /fruiting season and the inability of the seeds to be stored over a long period of time. A number of experiments and studies therefore had been carried out to try to solve some of these problems, among them are as follow.

**Experiments on Species Selection**

(1) Phenology observation and data collection.

(2) Relationship between light illumination and seedlings growth.

(3) Relationship between frequency of watering and seedling growth.

**Experiment on Raising Seedlings from Seeds**

(1) Seeds preservation experiment.

(2) Germination experiment.

(3) Experiment on direct sowing of seed into polythene bag.

**Experiment on Raising Seedlings from Wildings**

(1) Size of wildings during collection and its subsequent growth.

(2) Study on the process of wilding mortality under natural conditions.

(3) Experiment on the efficiency of transpiration control chemical.

(4) Study on the effect of different polythene bag size on the growth of wilding.

(5) Fertilizer experiment.

(6) Shading experiment.

**Other Seedlings Production Experiments**

(1) Experiment on the introduction of mycorrhiza into dipterocarp seedlings.

(2) Hardening experiment.

(3) Experiment on cutting.

(4) Experiment on methods of promoting flowering to mother tree.

### 1-4-1 Experiments on Species Selection

The success of seedlings production especially of Dipterocarps and other high quality (indigenous) species required by this project depend largely on knowledge of the phenology of the species. This in turn will help us plan the number of seedlings or wildings that need to be raised in any particular year. The following experiments had been performed to enhance our understanding in this field.

#### (1) Phenology Observation and Data Collection

**a) Method**

24 observation trees mainly of Diptrocarps have been identified and they are located at various parts of the state of Perak and Pahang. These observations trees ranging in size with a diameter of 30 to 100 cm and the height of between 20 to 40 meters. Regular observations and monitoring of the occurrence and the extent of fruiting/flowering of these trees are carried out.

**Table-N16 Observation Tree**

| Obsevation tree number | Species | Location | Pemark |
|---|---|---|---|
| No. 1 | *Shorea parvifolia* | Lentang, Pahang state | Seeds collected Mar.1993 |
| No. 2 | *Dipterocarpus crinitus* | Gunung, Perak state | Seeds collected Mar.1993 |
| No. 3 | *Dipterocarpus cornutus* | Lentang, Pahang state | Seeds collected Mar.1993 |
| No. 4 | *Calophyllum sp.* | Gunung, Perak state | Wildings collected May.1993 |
| No. 5 | *Shorea leprosula* | Chikus, Perak state | Flower experiment Mar.1993 |
| No. 6 | *Shorea leprosula* | Chikus, Perak state | Flower experiment Mar.1993 |
| No. 7 | *Shorea parvifolia* | Chikus, Perak state | Flower experiment Mar.1993 |
| No. 8 | *Shorea parvifolia* | Chikus, Perak state | Flower experiment Mar.1993 |
| No. 9 | *Neobalanocarpus heimii* | Chikus, Perak state | Flower experiment Mar.1993 |
| No.10 | *Neobalanocarpus heimii* | Chikus, Perak state | Flower experiment Mar.1993 |
| No.11 | *Neobalanocarpus heimii* | Batu Gajah, Perak state | Recommended by the district forest officer |
| No.12 | *Palaquium gutta* | Papan, Perak state | Wildings collected May.1993 |
| No.13 | *Shorea pauciflora* | Gerik, Perak state | Seeds collected Aug.1993 |
| No.14 | *Parashorea densiflora* | Gerik, Perak state | Seeds collected Aug.1993 |
| No.15 | *Dipterocarpus cornutus* | Gerik, Perak state | Seeds collected Aug.1993 |
| No.16 | *Shorea parvifolia* | Chikus, Perak state | Flower experiment Jul.1993 |
| No.17 | *Shorea leprosula* | Gerik, Perak state | Seeds collected Jun.1993 |
| No.18 | *Shorea talura* | Papan, Perak state | Wildings collected Jun.1993 |
| No.19 | *Shorea assamica* | Taiping, Perak state | Wildings collected Dec.1993 |
| No.20 | *Shorea leprosula* | Chikus, Perak state | Flower experiment Jul.1993 |
| No.21 | *Shorea parvifolia* | Chikus, Perak state | Designated Jan.1995 |
| No.22 | *Shorea odorata* | Chikus, Perak state | Designated Jan.1995 |
| No.23 | *Dyera costulata* | Chikus, Perak state | Designated Jan.1995 |
| No.24 | *Koompassia malaccensis* | Chikus, Perak state | Designated Jan.1995 |

**Photo.-N23 Observation tree (No. 1 *Shorea parvifolia*)**

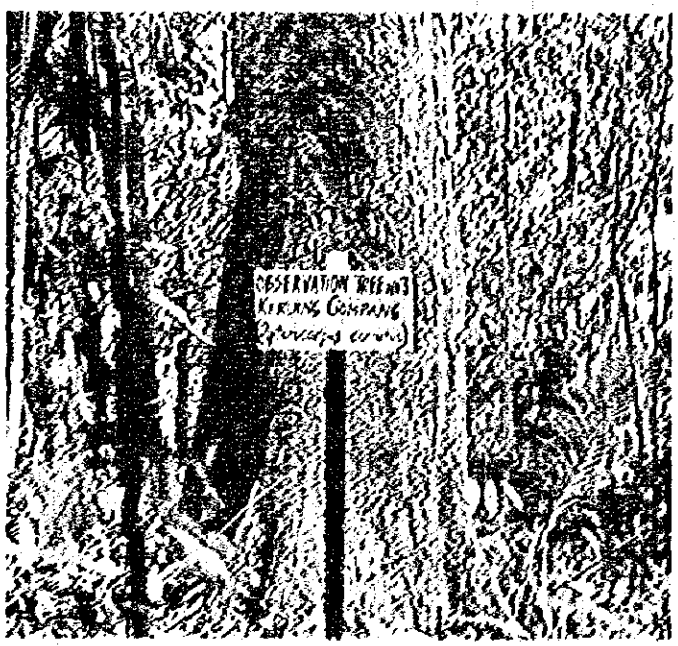


**Photo.-N24 Observation tree (No. 3 *Dipterocarpus cornutus*)**

**b) Results and Consideration**

Observations on the trees identified previously for the study were carried out in August 1993 and February 1994 and revealed no signs of flowering or fruiting. For Observation Trees located at Chikus Forest Reserve, observations were carried out once in every four months . During this period 2 flowering/fruiting occurrences have been noted. The first was in February 1994 for *Hopea odorata*, while the second occurrence was in January 1995 for species such as *Shorea parvifolia*, *Shorea macroptera* and *Shorea leprosula*.

After this, we need to observe regularly not only observation trees of Chikus Forest Reserve but also observation trees in other Forest Reserves. We should be identify more observation trees possibly located to project sites e.g. Bukit Kinta.

**(2) Relationship between Light Illumination and Seedlings Growth**

**a) Method**

Using wildings cultivated for six months to a certain height, an experiment was performed to establish the relationship between different light illuminance with the survival and growth of seedlings. The different relative light illuminance was adjusted to 5 levels i.e. in 5%, 25%, 50%, 70% and 100% by using black plastic netting. The seedlings were grown in the polythene bag measuring 6" × 9". 50 seedlings of each species were used for each illuminance level.

**b) Result and Consideration**

Results are shown in Table-N17, Fig.-N16.

At 5 % relative light illuminance and after 1 year 6 months of experiment, all the seedlings of 5 species died. To get 5 % relative light illuminance, the seedbeds are fully covered with black plastic netting (top, side and end). This has caused the temperature to rise and prevent proper air circulation in the seedbeds.

There is no great difference in term of survival and growth of seedlings of the 5 species that have been subjected to a relative light illuminance of between 25 % to 70 %. The height growth at 100 % relative light illuminance was lower as compared to other relative light illuminance. On the other hand, the survival rate of *Neobalanocarpus heimii* and *Dryobalanops aromatica* were more than 90 %. *Neobalanocarpus heimii* and *Dryobalanops aromatica* are suited to open-field planting, while the low survival rate at 100 % relative light illuminance of seedlings of the remaining three species suggest that they would not be suitable to open planting.

**Table-N17 Relationship between light illumination and seedlings growth**

| Species | Date examind | Relative illuminance | | | | |
|---|---|---|---|---|---|---|
| | | 5% | 25% | 50% | 70% | 100% |
| *Shorea laevis* (Balau kumus) | May. 1993 | 27.4( 70%) | 27.4(100%) | 26.5(100%) | 28.1(100%) | 26.8(100%) |
| | Dec. 1993 | 29.3( 18%) | 29.5( 98%) | 29.0(100%) | 29.7( 94%) | 28.5( 74%) |
| | Feb. 1994 | 29.7( 18%) | 32.0( 94%) | 29.1(100%) | 32.0( 94%) | 30.3( 72%) |
| | May. 1994 | 30.4( 18%) | 43.1( 94%) | 34.6( 90%) | 34.3( 92%) | 30.4( 62%) |
| | Oct. 1994 | ( 0%) | 53.0( 90%) | 44.8( 84%) | 42.1( 86%) | 34.9( 62%) |
| | Growth(cm) | | 25.6 | 18.3 | 14.0 | 8.1 |
| *Heritiera sp.* (Mengkulang) | May. 1993 | 11.6(100%) | 12.2(100%) | 13.2(100%) | 11.8(100%) | 11.5(100%) |
| | Dec. 1993 | 15.3( 94%) | 15.5( 98%) | 15.5( 96%) | 14.8( 96%) | 14.5(100%) |
| | Feb. 1994 | 16.1( 94%) | 17.3( 94%) | 17.4( 98%) | 17.9( 96%) | 15.8( 74%) |
| | May. 1994 | 17.7( 94%) | 22.0( 94%) | 23.4( 76%) | 23.6( 94%) | 18.0( 68%) |
| | Oct. 1994 | ( 0%) | 26.0( 94%) | 29.8( 74%) | 29.1( 90%) | 22.9( 64%) |
| | Growth(cm) | | 13.8 | 16.6 | 17.3 | 11.4 |
| *Neobalanocarpus heimii* (Chengal) | May. 1993 | 41.7(100%) | 37.3(100%) | 37.8(100%) | 37.4(100%) | 43.2(100%) |
| | Dec. 1993 | 45.9(100%) | 48.9(100%) | 45.0(100%) | 45.0(100%) | 50.7( 98%) |
| | Feb. 1994 | 46.7(100%) | 48.9(100%) | 49.1( 98%) | 54.5(100%) | 56.8( 98%) |
| | May. 1994 | 47.8(100%) | 52.2(100%) | 52.4( 94%) | 59.2( 98%) | 58.5( 96%) |
| | Oct. 1994 | ( 0%) | 57.4(100%) | 58.6( 92%) | 61.7( 94%) | 60.0( 96%) |
| | Growth(cm) | | 20.1 | 20.8 | 24.3 | 16.8 |
| *Palaquium sp.* (Nyatoh) | May. 1993 | 27.5(100%) | 31.9(100%) | 30.8(100%) | 32.8(100%) | 32.9( 98%) |
| | Dec. 1993 | 29.5( 98%) | 33.6( 94%) | 32.8( 96%) | 33.9( 92%) | 34.9( 92%) |
| | Feb. 1994 | 29.5( 76%) | 35.0( 96%) | 33.4( 84%) | 35.9( 92%) | 36.5( 86%) |
| | May. 1994 | 30.4( 50%) | 36.6( 96%) | 36.4( 80%) | 40.3( 90%) | 38.6( 56%) |
| | Oct. 1994 | ( 0%) | 39.9( 94%) | 40.9( 74%) | 45.5( 88%) | 41.6( 46%) |
| | Growth(cm) | | 8.0 | 10.1 | 12.7 | 8.7 |
| *Dybalanops aromatica* (Kapur) | May. 1993 | 49.0( 10%) | 55.8( 98%) | 55.1(100%) | 52.4(100%) | 52.1( 96%) |
| | Dec. 1993 | 0( 0%) | 75.6( 96%) | 75.8( 98%) | 70.8( 98%) | 67.9( 94%) |
| | Feb. 1994 | | 76.0( 96%) | 76.0( 98%) | 77.5( 98%) | 74.7( 94%) |
| | May. 1994 | | 85.8( 94%) | 83.1( 96%) | 81.3( 98%) | 75.7( 94%) |
| | Oct. 1994 | | 88.3( 94%) | 94.2( 94%) | 84.4( 98%) | 80.3( 92%) |
| | Growth(cm) | | 32.5 | 39.1 | 32.0 | 28.2 |

**Note : 1. This experiment began in March 1993 for each species.**

**2. Figures for seedlings height are in centimetres.**

**3. Parentheses indicate percentage of seedlings that took root and begin to grow.**

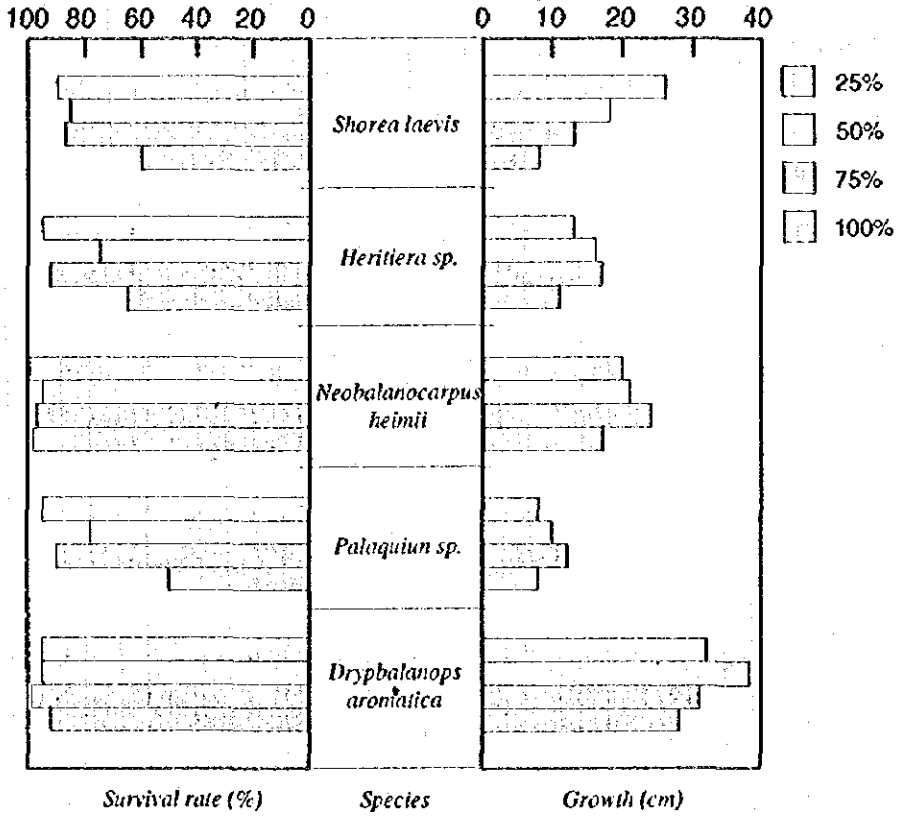



**Fig.-N16 Relationship between light illumination and seedling growth**

### (3) Relationship between Frequency of Watering and Seedlings Growth

#### a) Method

An experiment was performed to measure seedlings survival rate and growth in which potted seedlings were watered at four frequencies such as twice a day, once a day, once every two days, or once every three days. Size of polythene bags used were used 12" × 20 ". 40 seedlings of each species were used for each frequency of watering.

#### b) Result and Consideration

Results are shown in Table-N18, Fig.-N17.

Except for *Pentaspadon motleyi*, all the other species have shown an increase in survival rate if they were watered once a day, once every two days, once every three days as compared to watering twice a day. In terms of growth, watering once daily produced the best result for all the species suggesting a general seedlings preference to dryer condition. *Pentaspadon motleyi* on the other hand was found to flourish better under excessively moist condition. These characteristics should be taken into consideration when selecting species for afforestation.

**Tabale-N18 Growth under different frequency of watering**

| Species | Date examined | Frequency of watering | | | |
|---|---|---|---|---|---|
| | | Twice every day | Once every day | Once every 2 days | Once every 3 days |
| *Shorea leprosula* (Meranti tembaga) | Jun. 1993 | 34.9(100%) | 36.2(100%) | 35.3(100%) | 35.1(100%) |
| | Dec. 1993 | 37.8( 82%) | 39.7( 72%) | 37.3(100%) | 37.3( 95%) |
| | Oct. 1994 | ( 0%) | 40.5( 20%) | 38.3( 29%) | 38.6( 13%) |
| | Growth(cm) | | 4.3 | 3.0 | 3.5 |
| *Dryobalanops aromatica* (Kapur) | Jun. 1993 | 31.6(100%) | 37.4(100%) | 38.5(100%) | 36.4(100%) |
| | Dec. 1993 | 40.2( 87%) | 46.7( 95%) | 44.4( 97%) | 38.5(100%) |
| | Oct. 1994 | 63.8( 23%) | 81.7( 63%) | 71.5( 78%) | 78.9( 83%) |
| | Growth(cm) | 32.2 | 44.3 | 33.0 | 42.5 |
| *Shorea parvifolia* (Meranti sarang punai) | Jun. 1993 | 27.1(100%) | 25.1(100%) | 19.0(100%) | 23.1(100%) |
| | Dec. 1993 | 30.9( 50%) | 30.7( 57%) | 21.6( 67%) | 26.7( 67%) |
| | Oct. 1994 | ( 0%) | ( 0%) | 44.0( 5%) | 31.5( 5%) |
| | Growth(cm) | | | 25.0 | 8.4 |
| *Pentaspadon motleyi* (Pelong) | Jun. 1993 | 20.1(100%) | 20.2(100%) | 17.8(100%) | 17.7(100%) |
| | Dec. 1993 | 25.2( 92%) | 25.0( 87%) | 23.0( 67%) | 21.7( 62%) |
| | Oct. 1994 | 37.8( 43%) | 37.1( 48%) | 27.9( 23%) | 30.3( 20%) |
| | Growth(cm) | 17.7 | 16.9 | 10.1 | 12.6 |
| *Neobalanocarpus heimii* (Cheangal) | Jun. 1993 | 41.6(100%) | 52.9(100%) | 41.4(100%) | 41.1(100%) |
| | Dec. 1993 | 44.6( 97%) | 56.1(100%) | 42.2( 67%) | 42.7( 62%) |
| | Oct. 1994 | 48.3( 65%) | 59.6( 90%) | 38.2( 80%) | 43.1( 68%) |
| | Growth(cm) | 6.7 | 6.7 | 6.8 | 2.0 |
| *Palaquium* sp. (Nyatoh) | Jun. 1993 | 27.8(100%) | 24.5(100%) | 26.1(100%) | 28.2(100%) |
| | Dec. 1993 | 32.4( 80%) | 31.0( 94%) | 31.2( 97%) | 31.8(100%) |
| | Oct. 1994 | 42.0( 25%) | 41.1( 43%) | 43.9( 60%) | 41.1( 38%) |
| | Growth(cm) | 14.2 | 16.6 | 17.8 | 12.9 |

**Note : 1. This experiment was carried out in June 1993.**

**2. Figures for seedlings height are in centimetres.**

**3. Parentheses indicate the percentage of seedlings that took root and began to grow.**

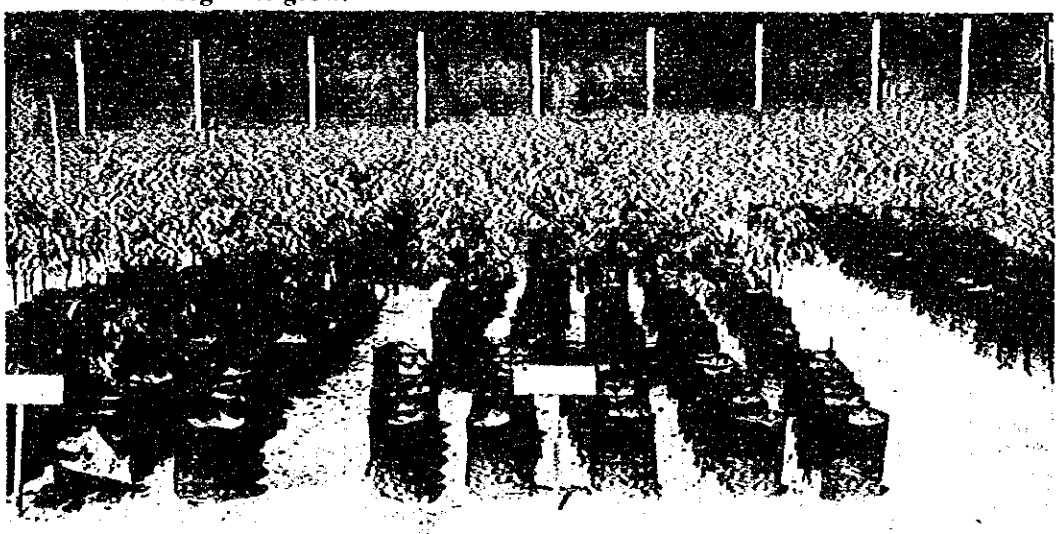


**Photo.-N25 Growth of seedlings on the different watering frequency**

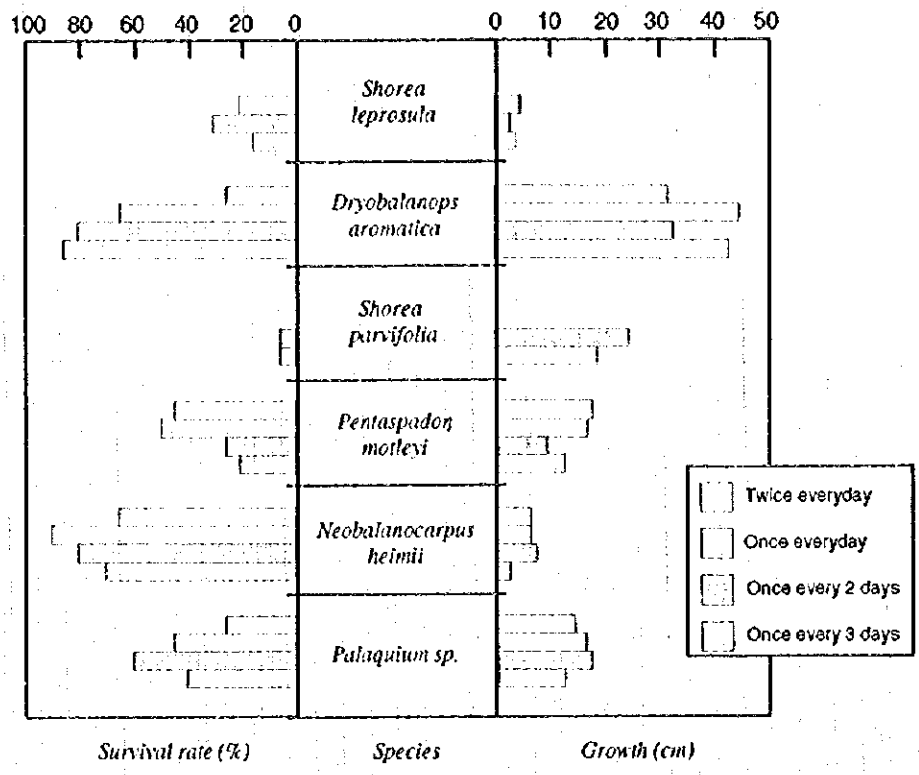



**Fig.-N17 Growth of seedlings on the different watering frequency**

### 1-4-2 Experiment on Raising Seedlings from Seeds

#### (1) Seeds Preservation Experiment

##### a) Purpose and Method

The impracticality of coordinating seeds collection with nursery work schedules necessitated the short term storage (at the proper temperature ) of seeds that had been collected. We therefore performed a seeds preservation experiment to determine the standards and conditions for a seeds storehouse. An experiment was performed to find out the germination rate of seeds from 7 different species which have been stored over a definite period at a fixed temperature of 20 degrees Celsius. These seeds were placed in polyvinyl bags during storage.

##### b) Result and Consideration

Results of the above experiment are shown in Table-N19.

**Table-N19 Germination Experiment after different period of storage**

| Species | Date collected | Length of storage | Number of seeds | Number germinated | Germination rate (%) |
|---|---|---|---|---|---|
| *Parashorea densiflora* | Aug.19.1993 | 27 days | 190 | 0 | 0 |
| *Shorea pauciflora* | Aug.19.1993 | 27 days | 175 | 14 | 8.0 |
| *Shorea curtisii* | Aug.21.1993 | 25 days | 256 | 13 | 5.1 |
| *Shorea leprosula* | Aug.21.1993 | 25 days | 95 | 0 | 0 |
| *Shorea macroptera* | Aug.24.1993 | 22 days | 77 | 0 | 0 |
| *Shorea ovata* | Sep. 9.1993 | 6 days | 100 | 94 | 94.0 |
| *Intsia palembanica* | Sep.10.1993 | 15 days | 32 | 20 | 62.5 |

Most of the Dipterocarps seeds that have been stored for 20 days have been found to be not viable. Only 2 species i.e. *Shorea curticii* and *Shorea pauciflora* stored over the same period of time showed a germination rate of 5 % and 8 % respectively. The seeds of *Shorea ovata* stored for 6 days showed a germination rate of 94 %. Therefore it is possible to store the seed of this species for period of 1 week and still obtain a high germination rate. Other results showed the seeds of *Intsia palembanica* stored for 15 days gave a germination rate of 63 %. Empirically, it is possible to store seeds of leguminous species over a longer period of time as compared to Dipterocarps species which are generally only able to be store for a period of not more than 1 week.

**(2) Germination Experiment**

**a) Purpose and Method**

The purpose of this experiment was to determine weather there are any effects on the germination rate of seeds that have been obtained from 3 different collection methods. The different collection methods are as follow;-

a) Climbing the mother tree and using shears to cut off seed-bearing branches.

b) Positioning a net at a height of one meter around the mother tree and the fallen seeds are collected from it.

c) Collecting seeds that have already fallen to the ground.

Germination rate of the seeds collected by these different collection methods were examined roughly 1 or 2 months after sowing.

Another experiment carried out was to find out if there is any difference in germination rate under the different sowing medium/conditions. These sowing condition are as follow;-

a) The use of saw dust as sowing medium.

b) The use of coconut husk as sowing medium.

c) The use of river sand as sowing medium.

Germination rate were examined roughly 1 month later.

**b) Result and Consideration**

Results of the first germination experiment, i.e. by different collection methods are shown in Table-N20,21,22.

**Table-N20 Germination experiment ( Collected by climbing )**

| Species | Sowing date | Number of seeds sowing | Number of germination | Germination rate(%) | Condition |
|---|---|---|---|---|---|
| *Shorea leprosula* | Aug.28.1993 | 13,500 | 12,265 | 90.9 | ② |
| *S. macroptera* | Aug.26.1993 | 360 | 360 | 100.0 | ② |
| *S. ovata* | Sep.27.1993<br>Oct.10.1993 | 1,061 | 666 | 62.8 | ② |
| *S. pauciflora* | Aug.26.1993 | 11,100 | 10,350 | 93.2 | ② |
| Total | | 26,021 | 23,641 | 90.9 | |

**Table-N21 Germination experiment ( Collected using the net )**

| Species | Sowing date | Number of seeds sowing | Number of germination | Germination rate(%) | Condition |
|---|---|---|---|---|---|
| *Dipterocarpus crinitus* | Mar.15.1993 | 649 | 95 | 14.6 | ① |
| *Shorea parvifolia* | Mar.30.1993<br>Apr. 9.1993<br>Apr.10.1993<br>Apr.11.1993<br>Apr.21.1993 | 6,647 | 5,394 | 81.1 | ① |
| Total | | 7,296 | 5,489 | 75.2 | |

**Table-N22 Germination experiment ( Collected from the ground )**

| Species | Sowing date | Number of seeds sowing | Number of germination | Germination rate(%) | Condition |
|---|---|---|---|---|---|
| *Anisoptera laevis* | Sep.20.1995 | 100 | 32 | 32.0 | ① |
| *Dipterocarpus baudii* | Jan.25.1996 | 240 | 48 | 20.0 | ① |
| *Dipterocarpus cornutus* | Mar.20.1993 | 261 | 80 | 30.7 | ① |
| | Sep.28.1995 | 100 | 45 | 45.0 | ① |
| *Dipterocarpus crinitus* | Aug.23.1995 | 100 | 18 | 18.0 | ① |
| *Hopea beccariana* | Aug.18.1995 | 200 | 169 | 84.5 | ① |
| *Hopea odorata* | Mar.15.1993 | 79 | 79 | 100.0 | ① |
| *Koompassia malaccensis* | Sep.20.1995 | 100 | 36 | 36.0 | ① |
| *Shorea platyclados* | Nov. 3.1995 | 240 | 217 | 90.4 | ① |
| *Shorea parvifolia* | Mar.18.1993<br>Mar.20.1993 | 771 | 333 | 43.2 | ① |
| Total | | 2,191 | 1,057 | 48.2 | |

① : Sown within 3 days after seed collection

② : Sown within 6 days after seed collection

*Shorea parvifolia* was chosen to compare the germination rate of those seeds collected from netting placed underneath the mother tree and the seeds that have been collected after they have fallen to the ground. The result shows that the germination rate of the seeds collected from the net is 40 % more than the seed collected from the ground. The germination rate of some Dipterocarps seeds collected immediately after they have fallen have reach as high as 80 %. This is because not enough time for these seeds to be subjected to attack from insect and other micro-organisms. The timing of seeds collection of dipterocarp is generally difficult. If collection can be carried out at proper timing, a high germination rate can be expected even though they are seed collected from the ground.

Results of germination rate under different sowing mediums or conditions are shown in Table-N23. The best germination rate is obtained from seeds raised from coconut husk sowing medium.

**Table-N23 Germination experiment under different sowing medium**

| Species | Sowing date | Number of seeds | Number of germination | Germination rate (%) | Sowing medium |
|---|---|---|---|---|---|
| *Shorea curtisii* | Sep. 22. 1993 | 900 | 213 | **23.7** | Saw dust |
| | Sep. 25. 1993 | 1,209 | 555 | **45.9** | Coconut husk |
| | Sep. 23. 1993 | 10,291 | 672 | **6.5** | River sand |

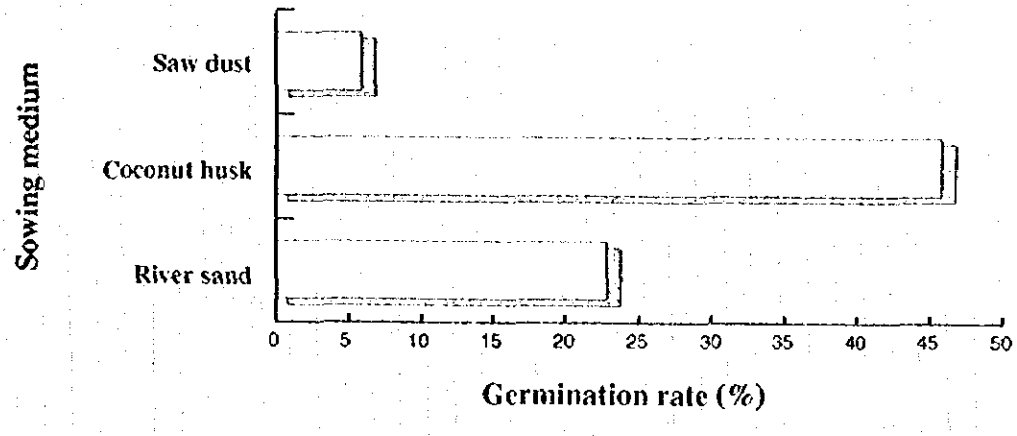



**Fig.-N18 Germination experiment under different planting sowing medium**

### (3) Experiment on Direct Sowing of Seed into Polythene Bag

#### a) Purpose and Method

Direct sowing of seeds into polythene bags have a few advantages such as they are cheaper and avoid double handling of seedlings during transplanting from seedbeds. The experiment carried out was to understand the performance of different species where information/data on their survival rate and growth are noted. The size of polythene bag was 6"×9" and 50 seedlings for each species were used in this experiment. No fertilizer was applied during the experiment.

#### b) Result

Results are shown in Table-N24 .

**Table-N24 Production of seedlings from seeds ( direct sowing)**

| Species | Date examined | | | Date of direct sowing |
|---|---|---|---|---|
| | Jun. 1993 | Dec. 1993 | Oct. 1994 | |
| *Dipterocarpus crinitus* | 7.9 cm | 12.6 cm (100%) | 19.4 cm ( 96%) | Mar. 15. 1993 |
| *Dipterocarpus cornutus* | 13.3 cm | 18.2 cm ( 97%) | 19.6 cm ( 85%) | Mar. 20. 1993 |
| *Shorea parvifolia* | 11.6 cm | 22.7 cm ( 99%) | 35.8 cm ( 87%) | Apr. 11. 1993 |
| *Hopea odorata* | 5.0 cm | 9.1 cm ( 92%) | 11.8 cm ( 70%) | Mar. 15. 1993 |

Note : ( ) survival rate

Though it elapsed for 1 year 6 months after direct sowing, these 4 species have not reached the standards for planted seedling in the field. In particular, *Hopea odorata* needs more than 2 years until a growth reaches the standards for planted seedling in the field.


**Photo.-N26 Seedling raised by direct sowing (*Dipterocarpus crinitus*)**

### 1-4-3 Experiment on Raising Seedlings from Wildings

#### (1) Size of Wildings During Collection and Its Subsequent Growth

##### a) Purpose and Method

The purpose of the experiment is to find out the most suitable size of wilding for collection. The wildings were basically divided into 2 height classes, i.e. 10 cm and 30 cm and information on their survival and growth were collected. The wildings collected were potted in polythene bags measuring 6"×9" and filled with forest topsoil. 50 wildings from each species and height class were used in the experiment.

##### b) Result and Consideration

Results are shown in Table-N25, Fig.-N19.

**Table-N25 Wildings size and subsequent growth**

| Species | Seedling size | | Category | Date of examined | | | | Growth (cm) |
|---|---|---|---|---|---|---|---|---|
| | | | | May. 1993 | Dec. 1993 | Feb. 1994 | Oct. 1994 | |
| *Hopea odorata* | A | Height 30 ~ 50cm | Height (cm) | 39 | 47 | 48 | 50 | 11 |
| | | | Survival rate (%) | 82 | 78 | 78 | 74 | |
| | B | Height 7 ~ 12cm | Height (cm) | 8 | 14 | 18 | 23 | 15 |
| | | | Survival rate (%) | 100 | 96 | 88 | 76 | |
| *Palaquium gutta* | A | Height 20 ~ 50cm | Height (cm) | 32 | 33 | 37 | 46 | 14 |
| | | | Survival rate (%) | 100 | 100 | 100 | 100 | |
| | B | Height 6 ~ 15cm | Height (cm) | 10 | 11 | 13 | 18 | 8 |
| | | | Survival rate (%) | 100 | 100 | 96 | 96 | |
| *Shorea talura* | A | Height 30 ~ 65cm | Height (cm) | 43 | 45 | 46 | 48 | 5 |
| | | | Survival rate (%) | 100 | 100 | 100 | 100 | |
| | B | Height 5 ~ 12cm | Height (cm) | 9 | 10 | 13 | 18 | 9 |
| | | | Survival rate (%) | 100 | 100 | 92 | 92 | |
| *Calophyllum* sp. | A | Height 20 ~ 35cm | Height (cm) | 22 | 23 | 27 | 32 | 10 |
| | | | Survival rate (%) | 100 | 100 | 100 | 100 | |
| | B | Height 8 ~ 15cm | Height (cm) | 13 | 13 | 16 | 19 | 6 |
| | | | Survival rate (%) | 100 | 100 | 100 | 100 | |
| *Gonystylus affine* | A | Height 20 ~ 30cm | Height (cm) | 22 | 23 | 24 | 34 | 12 |
| | | | Survival rate (%) | 100 | 100 | 100 | 100 | |
| | B | Height 10 ~ 15cm | Height (cm) | 14 | 16 | 23 | 29 | 15 |
| | | | Survival rate (%) | 100 | 100 | 98 | 98 | |

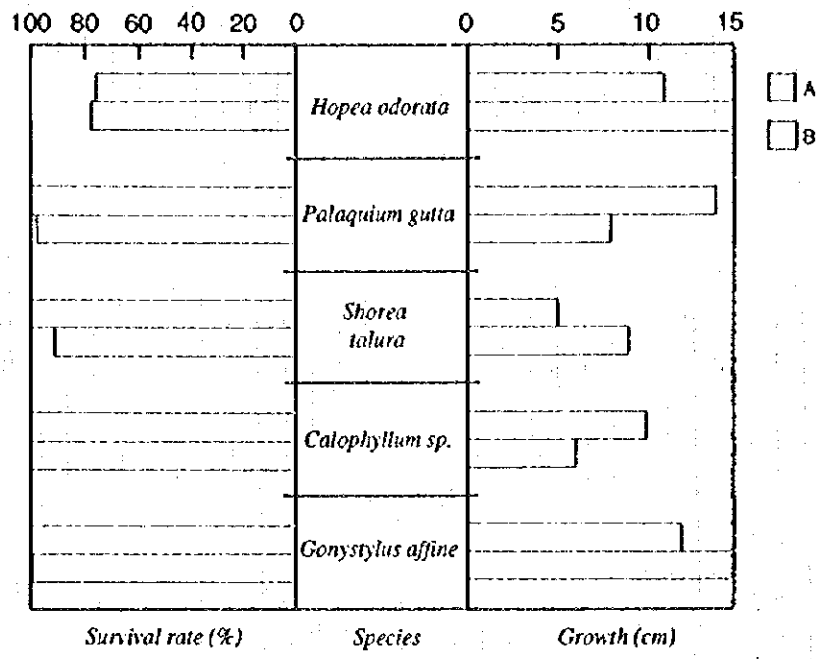



**Fig.-N19 Wildings size and subsequent growth**

Survival and growth of *Hopea odorata* were found to be the best for wildings in 10 cm height classes. There was no significant difference in terms of survival and growth for the other (4) species in this experiment. In this respect it is safe to assumed that wildings collected below 30 cm in height will not pose any problem and are able to produce a desirable survival rate and growth.

**Photo.-N27 Size of wildings during collection and its subsequent growth ( *Shorea talura* : Nov. 1993 )**

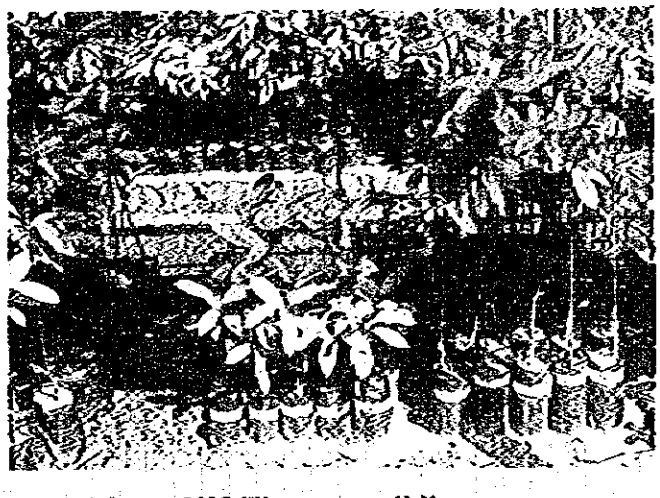


**Photo.-N28 The same wildings after 13 months ( Dec. 1994 )**

**(2) Study on The Process of Wilding Mortality under Natural Condition**

**a) Purpose and Method**

The seed of many species of dipterocarp and other indigenous species had no dormant period. Germination generally occurs within several days to several weeks after falling to the forest floor. Seedlings then appear in extremely large numbers, but many died due to competition, insufficient sunlight, disease and insect attack.

The experiment aims to determine the process and the rate by which the wildings die. 6 mother trees (*Shorea leprosula, S. parvifolia, Neobalanocarpus heimii, Hopea odorata, Pentaspadon* sp. and *Koompassia malaccensis*) were identified in Chikus natural forest for this experiment. Underneath these mother trees, quadrates (2 m × 2 m) were established and designated as experimental plots No. 1 through 6. All the wildings in the quadrant were initially marked and inventory on their survival and measurement of growth were carried out at predetermined intervals.

**b) Result and Consideration**

Results are shown in Table-N26, Fig-N20.

**Table-N26 The process of seedlings mortality in natural forest**

| Plot No. | Seedling height when beginning examination | Number of seedlings | | | Death rate |
|---|---|---|---|---|---|
| | | Mar. 1993 | Feb. 1994 | Jul. 1995 | |
| 1 | Less than 30 cm | 10 | 7 | 5 | 50 % |
| | Over 30 cm | 9 | 8 | 4 | 56 % |
| | Subtotal | 19 | 15 | 9 | 53 % |
| 2 | Less than 30 cm | 2 | 0 | 0 | 100 % |
| | Over 30 cm | 7 | 7 | 6 | 14 % |
| | Subtotal | 9 | 7 | 6 | 33 % |
| 3 | Less than 30 cm | 3 | 2 | 0 | 100 % |
| | Over 30 cm | 6 | 5 | 0 | 100 % |
| | Subtotal | 9 | 7 | 0 | 100 % |
| 4 | Less than 30 cm | 3 | 3 | 1 | 67 % |
| | Over 30 cm | 7 | 6 | 5 | 29 % |
| | Subtotal | 10 | 9 | 6 | 40 % |
| 5 | Less than 30 cm | 15 | 10 | 2 | 87 % |
| | Over 30 cm | 3 | 3 | 3 | 0 % |
| | Subtotal | 18 | 13 | 5 | 72 % |
| 6 | Less than 30 cm | 13 | 8 | 3 | 77 % |
| | Over 30 cm | 12 | 12 | 11 | 8 % |
| | Subtotal | 25 | 20 | 14 | 44 % |
| **Total** | Less than 30 cm | 46 | 30 | 11 | 76 % |
| | Over 30 cm | 44 | 41 | 29 | 34 % |
| | **Total** | **90** | **71** | **40** | **56 %** |

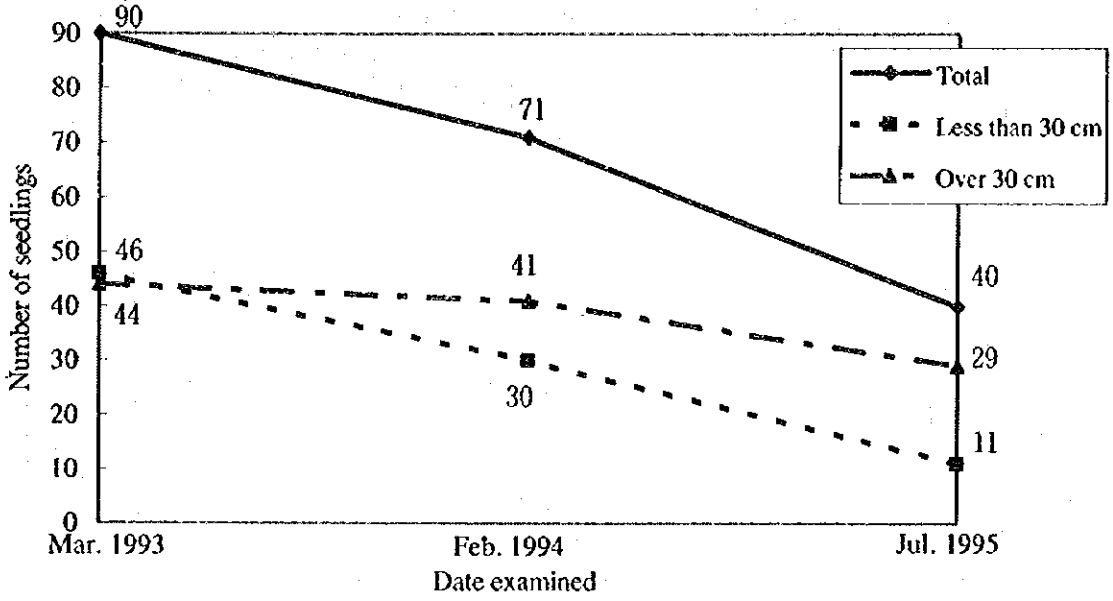



**Fig.-N20 The process of seedlings mortality in natural forest.**

The 6 plots were established in March 1993 and at that time within the plots there were 90 wildings identified and marked. Mortality rate at 1 year after the establishment of the plots were recorded at about 20 % and they further increased to 55 % after 2 year 4 months. The number of wildings that died during the period was 50 out of which more than 70 % was made up of wildings below 30 cm in height. From these results, it is advisable to start collecting wildings early (before they grow too high) in order to secure a larger number of viable wildings.

### (3) Experiment on The Efficiency of Transpiration Control Chemical

#### a) Purpose and Method

High percentage of mortality is expected due to changes in environment when the wildings are moved from temporary nursery to permanent nursery. Wildings were normally kept for a period of 1 to 3 months in temporary nursery (in the forest) after which they were transported to Chikus nursery. The purpose of this experiment was to find a solution/technique to reduce mortality during relocation of wildings from temporary nursery to permanent nursery. The wildings were sprayed with "transpiration control chemical" at temporary nursery in the forest before being transported to Chikus nursery. A comparison was made between the wildings subjected to "the chemical" and those that were not in terms of their survival and growth 2 months later. The wildings used were about 1 month after germination. The chemical agent used was "Midorinaru", a plant growth agent made by Japan's Toho Chiba Kagaku Kogyou and diluted with water at a ratio of 1 : 15 and 1 : 20.

#### Result and Consideration

Results are shown in Table-N27,28, Fig-N21,22.

**Table-N27 Transpiration control chemical experiment ( I )**

| Category | | Species | | | |
|---|---|---|---|---|---|
| | | *Parashorea densiflora* | *Dipterocarpus cornutus* | *Shorea pauciflora* | *Shorea leprosula* |
| Sprayed | Number of seedlings | 670 | 163 | 1,041 | 2,479 |
| | Number of dead | 28 | 8 | 33 | 69 |
| | Survival rate (%) | 95.8 | 95.1 | 96.8 | 97.2 |
| Not sprayed | Number of seedlings | 2,517 | 24 | 240 | 120 |
| | Number of dead | 256 | 6 | 31 | 13 |
| | Survival rate (%) | 89.8 | 75.0 | 87.1 | 89.2 |

Note : Seedlings were transferred in December 1993 and examined in February 1994.

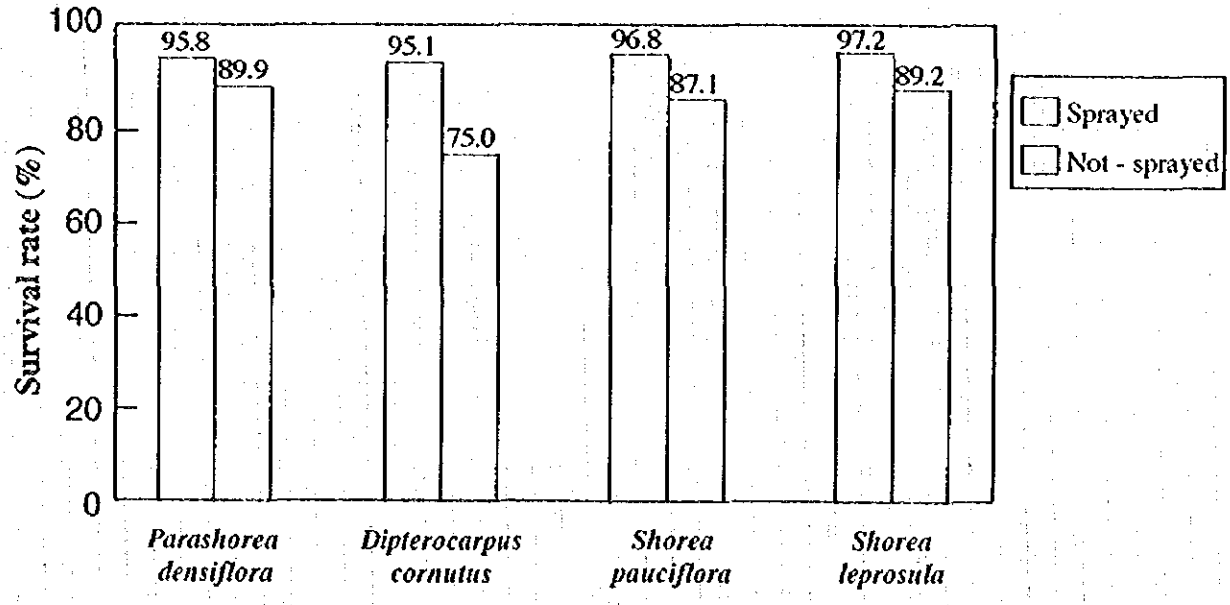



**Fig-N21 Transpiration control chemical experiment ( I )**

Table-N28 Transpiration control chemical experiment ( II )

| Category | | Species | | | |
|---|---|---|---|---|---|
| | | *Shorea macroptera* | *Terminalia catappa* | *Elateriospermum tapos* | *Scaphium macropodum* |
| Sprayed | Number of seedlings | 250 | 250 | 96 | 250 |
| | Height of beginning (cm) | 11.03<br>6~21 | 16.58<br>5~37 | 37.89<br>21~75 | 12.66<br>5~22 |
| | Height of after 3 months (cm) | 19.75<br>8~42 | 38.12<br>11~63 | 53.72<br>24~80 | 19.65<br>7~30 |
| | Number of dead | 2 | 3 | 3 | 1 |
| | Survival rate (%) | 99.2 | 98.8 | 96.9 | 99.6 |
| | Growth rate (%) | 179 | 230 | 142 | 155 |
| Not sprayed | Number of seedlings | 250 | 250 | 96 | 250 |
| | Height of beginning (cm) | 12.68<br>5~22 | 16.86<br>5~31 | 37.90<br>21~65 | 10.76<br>3~23 |
| | Height of after 3 months (cm) | 20.73<br>7~40 | 37.42<br>16~55 | 50.97<br>25~77 | 15.59<br>6~26 |
| | Number of dead | 4 | 3 | 4 | 2 |
| | Survival rate (%) | 98.4 | 98.8 | 95.8 | 99.2 |
| | Growth rate (%) | 163 | 222 | 134 | 145 |

Note : Seedlings were transfered in April 1995 and examined in July 1995.

Average
Minimum~Maximum

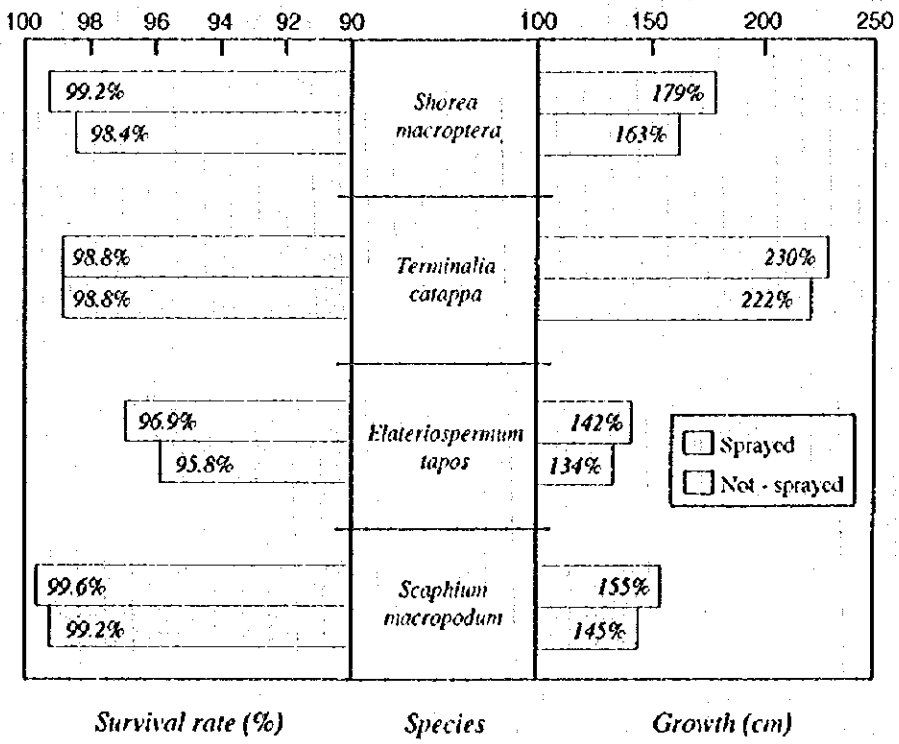



**Fig.-N22 Transpiration control chemical experiment ( II )**

**Transpiration control chemical ( I )**

The result of all 4 species used in the experiment indicated that "the transpiration control chemical" increased the survival rate of wildings roughly 10 %. (No study in terms of growth was carried out)

**Transpiration control chemical ( II )**

There was no difference in term of survival rate between wildings sprayed and those wildings which were not sprayed with chemical in this experiment. However, the growth rate increased to roughly 10 %.

It is believed that the chemical used in the experiment has some effect on the wildings that is by reducing evapotranspiration and helping to promote root growth. This resulted in an increase in survival rate in experiment ( I ) and increase in growth recorded in experiment( II ).

**Photo.-N29 Spraying transpiration control chemical prior to transportation**

**Photo.-N30** Experiment on the efficiency of transpiration control chemical (Sprayed: *Shorea macroptera*)

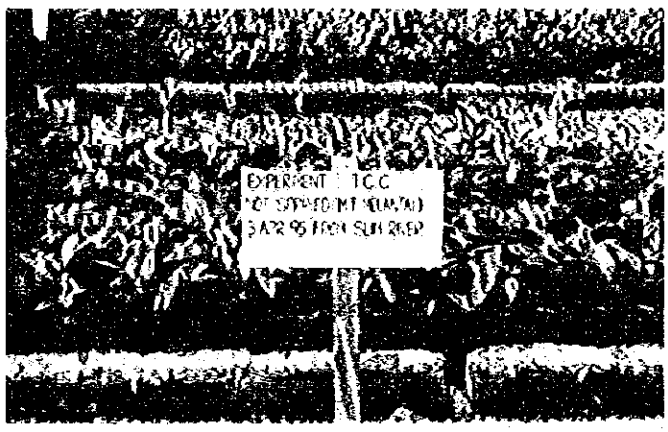


**Photo.-N31** The same (Not sprayed: *Shorea macroptera*)

### (4) Study on The Effect of Different Polythene Bag Size on The Growth of Wilding

#### a) Purpose and Method

The experiment aims at determining the optimum pot size in terms of costs and adequate wilding growth. 6 species (50 wildings for each species) were selected for this experiment and they are planted in 5 different pot sizes. Data on their survival and growth were later collected. Potting medium was from forest topsoil.

#### b) Result and Consideration

Result are shown in Table-N29, Fig-N23.

**Table-N29 Pot size and wildings growth**

| Species | Date examined | Pot size (Diameter(cm)×Height(cm)) A=10×15 | B=10×22 | C=13×16 | D=15×22 | E=18×22 |
|---|---|---|---|---|---|---|
| *Hopea odorata* | May. 1993 | 10.9(100%) | 11.4(100%) | 9.0(100%) | 12.4(100%) | 10.7(100%) |
| | Dec. 1993 | 15.3(100%) | 12.9( 98%) | 11.6(100%) | 15.1( 82%) | 13.5( 98%) |
| | May. 1994 | 15.3(100%) | 13.9( 96%) | 16.3( 92%) | 15.4( 84%) | 15.9( 94%) |
| | Oct. 1994 | 16.1( 84%) | 14.2( 94%) | 17.6( 78%) | 19.4( 82%) | 17.9( 90%) |
| | Growth(cm) | 5.2 | 2.8 | 8.6 | 7.0 | 7.2 |
| *Pentaspadon motleyi* | May. 1993 | 12.4( 96%) | 12.2(100%) | 10.3( 92%) | 10.6(100%) | 13.7(100%) |
| | Dec. 1993 | 18.9( 88%) | 20.1( 90%) | 17.7( 86%) | 17.2( 88%) | 20.6( 94%) |
| | May. 1994 | 22.0( 84%) | 23.4( 88%) | 24.0( 84%) | 22.6( 82%) | 21.1( 90%) |
| | Oct. 1994 | 29.7( 82%) | 25.7( 84%) | 26.1( 78%) | 29.4( 66%) | 26.2( 76%) |
| | Growth(cm) | 17.3 | 13.5 | 15.8 | 18.8 | 12.5 |
| *Shorea leprosula* | Jul. 1993 | 26.2(100%) | 23.3( 98%) | 22.4(100%) | 21.7(100%) | 31.0(100%) |
| | Dec. 1993 | 28.2( 66%) | 25.9( 70%) | 26.2( 86%) | 25.2( 58%) | 33.4( 76%) |
| | May. 1994 | 31.6( 54%) | 31.1( 42%) | 31.5( 48%) | 28.2( 56%) | 33.6( 54%) |
| | Oct. 1994 | 32.4( 18%) | 34.0( 42%) | 33.7( 38%) | 34.7( 40%) | 34.1( 44%) |
| | Growth(cm) | 6.2 | 10.7 | 11.3 | 13.0 | 3.1 |
| *Shorea parvifolia* | Jul. 1993 | 21.1(100%) | 20.4( 98%) | 18.1(100%) | 21.8(100%) | 25.4(100%) |
| | Dec. 1993 | 24.4( 94%) | 20.9( 84%) | 19.5( 84%) | 23.7( 86%) | 30.2( 94%) |
| | May. 1994 | 25.4( 70%) | 24.3( 40%) | 29.6( 76%) | 25.1( 84%) | 33.2( 92%) |
| | Oct. 1994 | 27.0( 62%) | 25.5( 38%) | 32.2( 52%) | 38.0( 80%) | 36.2( 62%) |
| | Growth(cm) | 5.9 | 5.1 | 14.1 | 16.2 | 10.8 |
| *Shorea macroptera* | Jul. 1993 | 15.8(100%) | 16.8(100%) | 14.2(100%) | 12.9(100%) | 14.8(100%) |
| | Dec. 1993 | 15.9( 40%) | 17.7( 58%) | 15.5( 66%) | 16.4( 66%) | 16.4( 44%) |
| | May. 1994 | 16.4( 38%) | 20.5( 58%) | 23.5( 64%) | 17.9( 66%) | 21.6( 42%) |
| | Oct. 1994 | 39.5( 32%) | 23.7( 46%) | 28.7( 46%) | 30.7( 46%) | 27.5( 32%) |
| | Growth(cm) | 23.7 | 6.9 | 14.5 | 17.8 | 12.7 |
| *Heritiera* sp. | Jul. 1993 | 10.1(100%) | 13.3(100%) | 9.7( 98%) | 11.3(100%) | 10.0(100%) |
| | Dec. 1993 | 12.2( 74%) | 13.7( 94%) | 12.1( 92%) | 15.7( 88%) | 13.9( 74%) |
| | May. 1994 | 14.5( 74%) | 15.2( 70%) | 20.9( 86%) | 18.0( 84%) | 17.2( 74%) |
| | Oct. 1994 | 24.9( 74%) | 18.2( 70%) | 24.8( 76%) | 27.3( 84%) | 20.1( 74%) |
| | Growth(cm) | 14.8 | 4.9 | 15.1 | 16.0 | 10.1 |

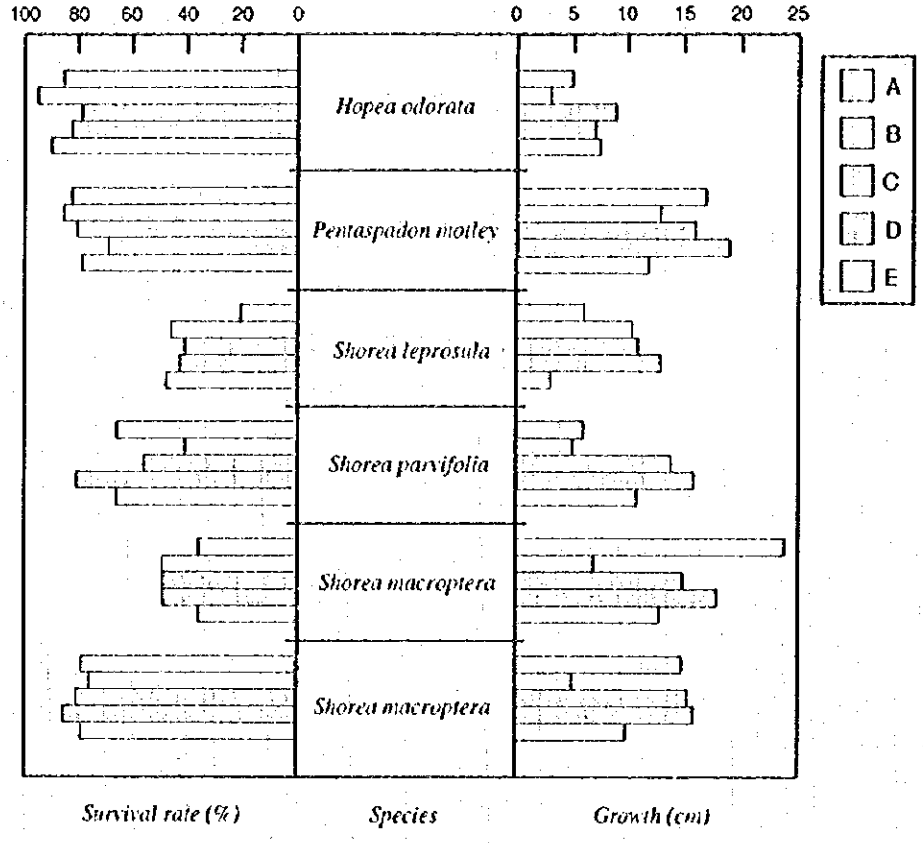



**Fig.-N23 Pot size and wildings growth**

*Hopea odorata* planted in large-sized pots had consistent survival rate and growth. There is no significant difference in terms of growth or survival rate for *Pentaspadon motleyi* planted in different pot sizes. Whereas for species such as *Shorea leprosula, Shorea parvifolia* and *Heritiera* sp. perform the best in survival and growth in pot size D. Pot size A (10 cm × 15 cm) on the other hand seems to favour good growth for *Shorea macroptera*. Based on the result compiled so far, different pot sizes seem suitable for higher survival and good growth for different species. Generally it is expected that the bigger the pot size the better the performance of wildings in terms of their survival rate and growth but this did not prove to be conclusive in the experiment.

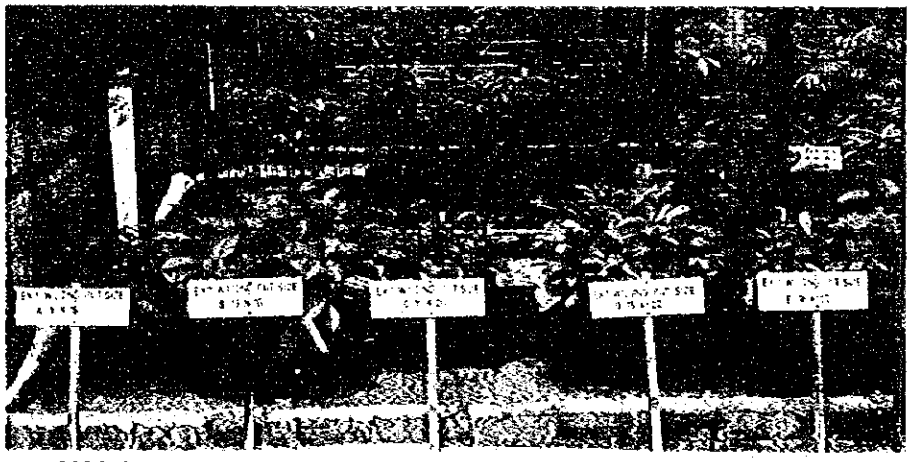


**Photo.-N32 Study on the effect to different pot size on the growth of wilding ( *Heritiera* sp. )**

**(5) Fertilizer Experiment**

**a) Purpose and Method**

The purpose of the experiment was to find the optimum quantity of fertilizer needed for adequate wilding growth. The wildings selected for this experiment were subjected to 3 different levels of fertilizer. The first level being a control where no fertilizer was applied, the second level involved application of 6 grains of fertilizer and the final level where 40 grains of fertilizer were applied to each pot. The fertilizer used was NPK(N-15 %, $P^2O^5$-15 %, $K^2O^5$ - 15 %). The polythene pot measure 6"×9" and filled with potting medium made from forest topsoil. 100 wildings were used for each species selected and subjected to the 3 levels of fertilization. The survival rate and their growth were later recorded at a predetermined interval.

**b) Result and Consideration**

Results are shown in Table-N30, Fig-N24.

Wildings of *Shorea macroptera*, *Pometia* sp. and *Pentaspadon motleyi* that received six grains of fertilizer had good survival rate and showed favorable growth. *Hopea odorata* wildings that received no fertilizer achieved almost the same growth and survival rate as those that did. Surprising for wildings of *Calophyllum* sp. and *Koompassia malaccensis* that received no fertilizer the results show they have the best growth and the highest survival rate. Application of 40 grains of fertilizer to *Shorea macroptera* and *Calophyllum* sp. resulted in the lowest survival rate of the wildings at the end of the experiment. If the growth of the collected wilding is slow and considering the result from the above experiment it is advisable to only apply small doses of fertilizer to enhance their growth.

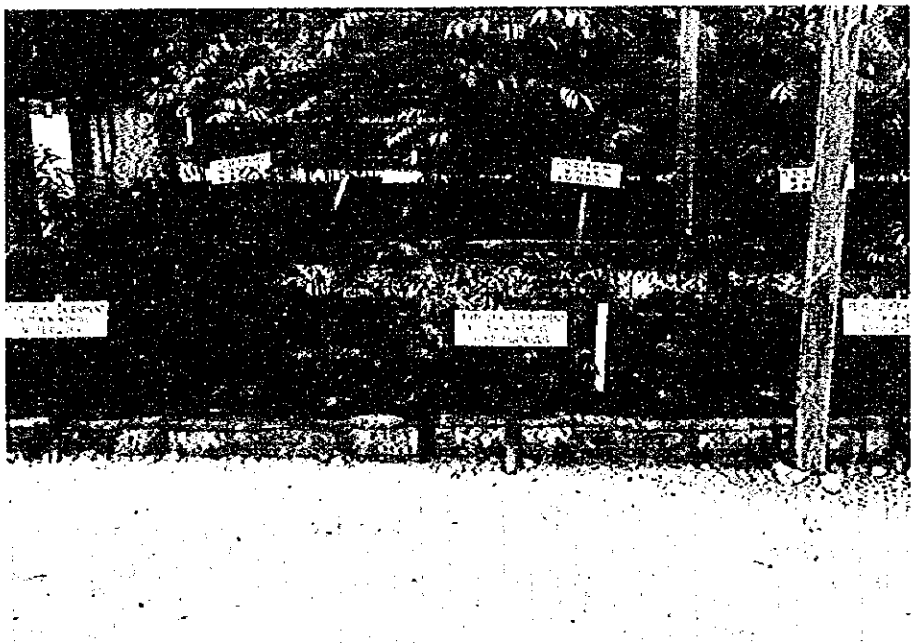


**Photo.-N33 Fertilizer experiment for wilding ( *Koompassia malaccensis* )**

**Table-N30 Wildings fertilization experiment**

| Species | Date examined | Quantity of fertilizer | | |
|---|---|---|---|---|
| | | None | Six grains | Forty grains |
| *Shorea macroptera* (Meranti melantai) | Jun. 1993 | 17.4(100%) | 18.0(100%) | 17.1(100%) |
| | Dec. 1993 | 19.2( 95%) | 22.6( 89%) | 23.0( 25%) |
| | Feb. 1994 | 19.2( 95%) | 23.0( 88%) | 23.0( 25%) |
| | May. 1994 | 23.0( 94%) | 28.0( 88%) | 26.3( 25%) |
| | Oct. 1994 | 49.9( 78%) | 63.3( 87%) | 30.3( 24%) |
| | Growth(cm) | 32.5 | 45.3 | 13.2 |
| *Calophyllum* sp. (Bitangar) | Jun. 1993 | 11.2(100%) | 12.4(100%) | 11.8(100%) |
| | Dec. 1993 | 14.2( 92%) | 15.6( 58%) | 14.7( 59%) |
| | Feb. 1994 | 14.3( 92%) | 15.6( 57%) | 14.7( 47%) |
| | May. 1994 | 20.1( 92%) | 19.2( 57%) | 17.7( 45%) |
| | Oct. 1994 | 27.9( 92%) | 24.3( 57%) | 22.0( 45%) |
| | Growth(cm) | 16.7 | 11.9 | 10.2 |
| *Hopea odorata* (Merawan siput jantan) | Jun. 1993 | 11.7(100%) | 12.0(100%) | 12.4(100%) |
| | Dec. 1993 | 15.8( 97%) | 16.9( 94%) | 16.9( 94%) |
| | Feb. 1994 | 18.0( 95%) | 20.0( 95%) | 20.6( 91%) |
| | May. 1994 | 26.0( 90%) | 29.2( 95%) | 30.7( 88%) |
| | Oct. 1994 | 36.5( 88%) | 40.5( 94%) | 37.2( 86%) |
| | Growth(cm) | 24.8 | 28.5 | 24.8 |
| *Pometia* sp. (Kasai) | Jun. 1993 | 16.8(100%) | 18.0(100%) | 18.1(100%) |
| | Dec. 1993 | 20.6( 89%) | 22.1( 96%) | 20.9( 96%) |
| | Feb. 1994 | 22.0( 89%) | 24.3( 93%) | 23.0( 96%) |
| | May. 1994 | 33.9( 88%) | 36.9( 93%) | 36.1( 96%) |
| | Oct. 1994 | 42.1( 88%) | 48.6( 93%) | 44.5( 96%) |
| | Growth(cm) | 25.3 | 30.6 | 26.4 |
| *Kommpassia maraccensis* (Kempas) | Jun. 1993 | 17.3(100%) | 15.4(100%) | 13.1(100%) |
| | Dec. 1993 | 18.0( 93%) | 16.6( 96%) | 13.9( 96%) |
| | Feb. 1994 | 19.8( 90%) | 17.0( 96%) | 14.8( 93%) |
| | May. 1994 | 20.6( 89%) | 22.1( 96%) | 20.9( 86%) |
| | Oct. 1994 | 29.4( 88%) | 23.0( 85%) | 21.9( 85%) |
| | Growth(cm) | 12.1 | 7.6 | 8.8 |
| *Pentaspadon motleyi* (Pelong) | Jun. 1993 | 21.8(100%) | 20.4(100%) | 19.9(100%) |
| | Dec. 1993 | 24.9( 95%) | 22.5( 98%) | 22.5( 99%) |
| | Feb. 1994 | 26.1( 95%) | 24.1( 97%) | 23.0( 95%) |
| | May. 1994 | 37.7( 94%) | 38.5( 96%) | 37.1( 94%) |
| | Oct. 1994 | 45.0( 81%) | 46.0( 84%) | 41.1( 88%) |
| | Growth(cm) | 23.2 | 25.6 | 21.2 |

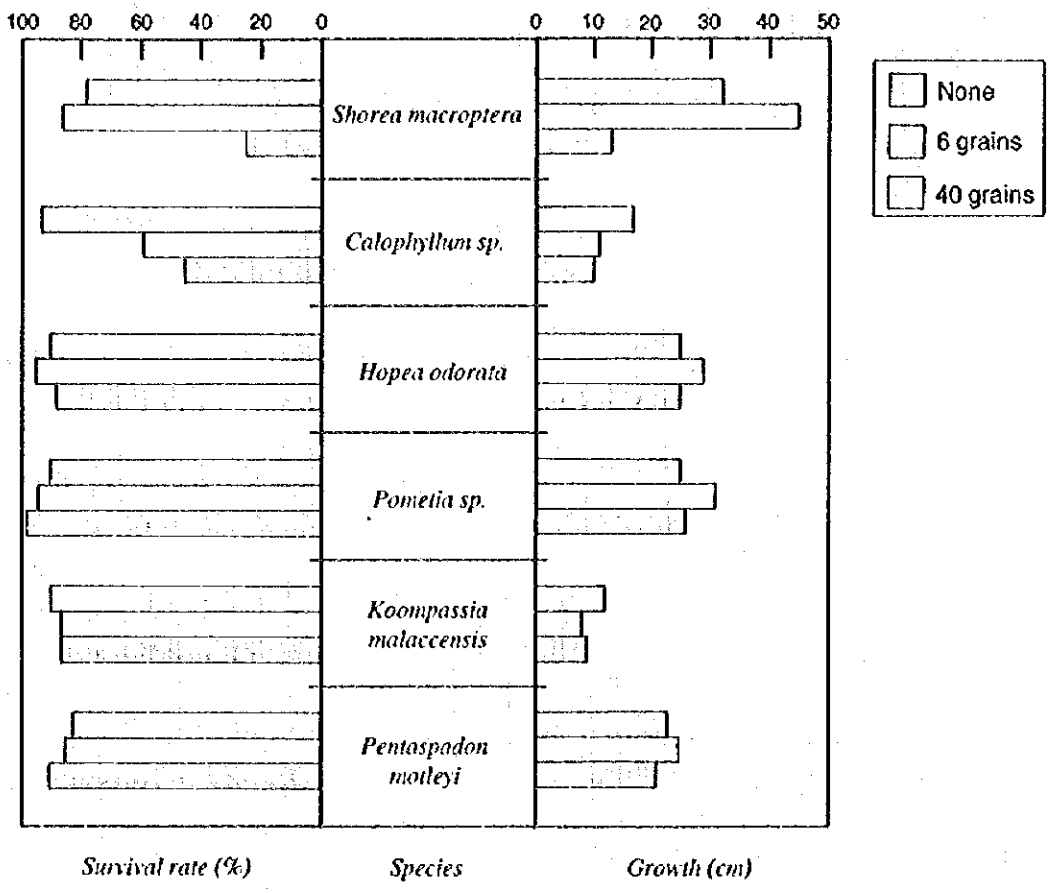



**Fig.-N24 Wilding fertilization experiment**

**(6) Shading Experiment**

**a) Purpose and Method**

The experiment aims at finding the optimum shading rate for adequate wildings. Using wildings immediately after collection, an experiment was performed to record wilding's survival rate and growth after they were subjected to 5 levels of relative light illuminance i.e. 5 %, 25 %, 50 %, 70 % and 100 %. The different relative light illuminance were achieved by using black plastic netting. The wildings were planted in polythene bag measuring 6" × 9" and filled with forest topsoil as potting medium. 50 wildings were used for each species and each level of relative light illuminance.

**b) Result and Consideration**

Results are shown in Table-N31, Fig-N25.

All the wildings from 4 of the species selected died 6 months after the start of the experiment at 5 % relative light illuminance. The other species, *Shorea macroptera* also recorded 100 % mortality after 1 year 6 months. In order to obtain 5 % relative light illuminance, the seedbeds were fully covered with black plastic netting (top, side and end parts) thus resulted in an increase in temperature and prevent proper air circulation. The result also indicates that at relative light illuminance of 50 %, *Shorea parvifolia* registered the lowest survival rate, while at 25 % relative light illuminance *Shorea leprosula* show the lowest growth. However, in general there is no significant difference interim of survival rate or growth of all the species under examination at relative light illuminance of between 25 to 70 %. Survival rate at 100 % relative illuminance for all species was low except for *Pentaspadon motleyi* after 9 months of the experiment as compared with those wildings that were subjected to relative light illuminance of between 25 to 70 %. Survival rate of all the species chosen for this experiment at 100 % relative illuminance after 9 months was considerably lower as compared with between 25 % and 70 % relative illuminance. This is probably due to the inability of the wildings to adopt to extreme variation in environment when they are relocated from under natural forest conditions to an open area. In order to prepare healthy and sufficient number of wildings for planting in the field, it is recommended they be provided with relative light illuminance of between 50 % to 70 % while they were raised at the nursery.

Table-N31 Experiment on wildings provided with different light intensity after collection

| Species | Date examined | Relative illuminance | | | | |
|---|---|---|---|---|---|---|
| | | 5% | 25% | 50% | 70% | 100% |
| *Shorea leprosula* (Meranti tembaga) | May. 1993 | 28.2( 18%) | 54.0(100%) | 32.4(100%) | 44.1(100%) | 32.9(100%) |
| | Dec.1993 | 0.0( 0%) | 56.2(100%) | 36.3(100%) | 47.0(100%) | 39.1( 76%) |
| | Feb. 1994 | 0.0( 0%) | 58.6( 98%) | 48.2( 92%) | 48.0( 98%) | 40.5( 54%) |
| | May. 1994 | 0.0( 0%) | 59.5( 94%) | 53.3( 50%) | 52.8( 84%) | 41.2( 34%) |
| | Oct.1994 | 0.0( 0%) | 60.3( 86%) | 55.2( 42%) | 55.7( 70%) | 49.9( 32%) |
| | Growth(cm) | | 6.3 | 22.8 | 11.6 | 17.0 |
| *Shorea parvifolia* (Meranti sarang punai) | May. 1993 | 19.8( 12%) | 22.9(100%) | 21.4( 98%) | 24.0(100%) | 21.2(100%) |
| | Dec.1993 | 0.0( 0%) | 26.1(100%) | 25.2( 90%) | 27.5(100%) | 25.0( 84%) |
| | Feb. 1994 | 0.0( 0%) | 27.3(100%) | 28.6( 90%) | 27.9( 90%) | 23.5( 50%) |
| | May. 1994 | 0.0( 0%) | 34.7( 86%) | 33.4( 18%) | 32.1( 76%) | 26.7( 18%) |
| | Oct.1994 | 0.0( 0%) | 49.9( 78%) | 36.4( 14%) | 36.6( 68%) | 31.1( 16%) |
| | Growth(cm) | | 27.0 | 15.0 | 12.6 | 9.9 |
| *Shorea macroptera* (Meranti melantai) | May. 1993 | 15.5(100%) | 16.1(100%) | 16.1(100%) | 15.5(100%) | 17.8(100%) |
| | Dec.1993 | 17.2( 98%) | 17.1( 90%) | 18.2( 86%) | 16.2(100%) | 19.8( 82%) |
| | Feb. 1994 | 17.3( 82%) | 19.7( 82%) | 18.2( 86%) | 18.3( 80%) | 20.5( 38%) |
| | May. 1994 | 18.1( 62%) | 35.4( 70%) | 27.7( 86%) | 21.8( 80%) | 25.3( 36%) |
| | Oct.1994 | 0.0( 0%) | 49.3( 58%) | 38.1( 82%) | 34.8( 76%) | 30.1( 36%) |
| | Growth(cm) | | 33.2 | 22.0 | 19.3 | 12.3 |
| *Hopea odorata* (Merawan siput jantan) | May. 1993 | 10.3( 86%) | 10.8( 94%) | 11.4( 98%) | 11.1(100%) | 11.4( 82%) |
| | Dec.1993 | 0.0( 0%) | 15.7( 88%) | 14.0( 96%) | 16.4( 96%) | 14.0( 80%) |
| | Feb. 1994 | 0.0( 0%) | 17.5( 72%) | 15.1( 80%) | 17.7( 82%) | 17.0( 40%) |
| | May. 1994 | 0.0( 0%) | 24.6( 50%) | 18.7( 56%) | 27.2( 60%) | 27.3( 12%) |
| | Oct.1994 | 0.0( 0%) | 36.8( 46%) | 29.0( 54%) | 40.4( 60%) | 36.8( 8%) |
| | Growth(cm) | | 26.0 | 17.6 | 29.3 | 25.4 |
| *Pentaspadon motleyi* (Pelong) | May. 1993 | 15.8( 10%) | 18.2( 94%) | 18.9(100%) | 18.2(100%) | 16.9( 98%) |
| | Dec.1993 | 0.0( 0%) | 25.1( 94%) | 25.2( 78%) | 24.6( 86%) | 23.7( 80%) |
| | Feb. 1994 | 0.0( 0%) | 28.4( 88%) | 27.7( 64%) | 25.7( 60%) | 28.1( 78%) |
| | May. 1994 | 0.0( 0%) | 33.3( 78%) | 31.3( 56%) | 30.4( 52%) | 37.8( 68%) |
| | Oct.1994 | 0.0( 0%) | 42.1( 68%) | 41.8( 54%) | 39.3( 52%) | 48.2( 66%) |
| | Growth(cm) | | 23.9 | 22.9 | 21.1 | 31.3 |

Note : This experiment began in March 1993 for all species.

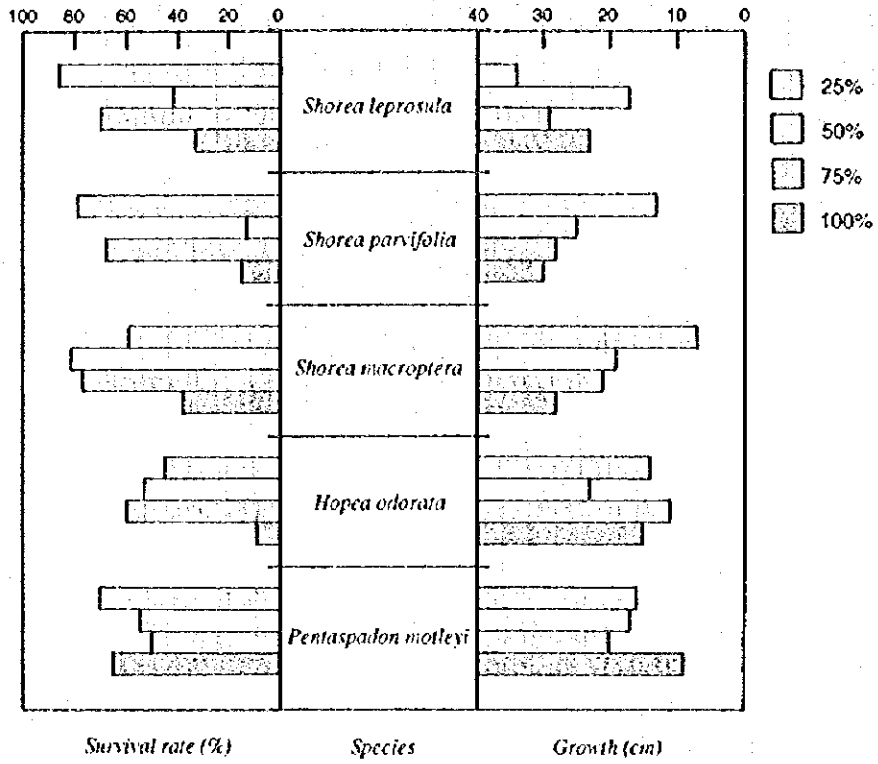



**Fig.-N25 Experiment on wildings provided with different light intensity**

### 1-4-4 Other Seedlings Production Experiments

#### (1) Experiment on The Introduction of Mycorrhiza into Dipterocarp Seedlings

##### a) Purpose and Method

Certain mycorrhizal fungi has been found to have beneficial influence during initial growth of dipterocarp seedlings and their survival after planting in field. An experiment to determine the rate of infection of mycorrhizal fungi to 8 Dipterocarp species was carried out. An additional study on 3 of these species was also performed to examine the correlation between growth, dry weight and mycorrhiza formation. Length, dry weight of top and root, number of leaves and buds, color of leaves were measured and estimated from each seedling. Mycelium and mycorrhiza formed in the potting medium were later measured and recorded. The number of seedlings from each species used in the experiment were either 10 or 50 picked at random from seedbeds.

##### b) Result and Consideration

Results are shown in Table-N32,33, Fig-N26.

**Table-N32 Infection rate of mycorrhiza on dipterocarps seedling**

( Number of seedlings examined : 50 seedlings )

| Species | Sowing date | Age of seedling | Infection rate (%) | | | | |
|---|---|---|---|---|---|---|---|
| | | | Scl | Lac | Cen | Ino | NONE |
| *Shorea ovalis* | Oct. 1994 | 8.0 months | 72 | 24 | 2 | 0 | 2 |
| *Shorea leprosula* | Jan. 1995 | 4.5 months | 23 | 11 | 28 | 17 | 21 |
| *Shorea parvifolia* | Jan. 1995 | 4.5 months | 76 | 4 | 6 | 2 | 12 |

Note : 1. Scl = *Scleroderma* sp. 2. Lac = *Laccaria* sp.
3. Cen = *Cenococcum* sp. 4. Ino = *Inocybe* sp.
* Seedlings of Shorea leprosula was 53 seedlings.

**Table-N33 Infection rate of mycorrhiza on dipterocarps seedling**

( Number of seedlings examined : 10 seedlings )

| Species | Sowing date | Age of seedling | Infection rate (%) | | | | |
|---|---|---|---|---|---|---|---|
| | | | Scl | Lac | Cen | Ino | NONE |
| *Shorea curtisii* | Feb. 1995 | 3.5 months | 30 | 30 | 0 | 0 | 40 |
| *Shorea macroptera* | Jan. 1995 | 4.5 months | 70 | 10 | 10 | 0 | 10 |
| *Shorea dasyphylla* | Feb. 1995 | 3.5 months | 10 | 40 | 0 | 40 | 10 |
| *Dipterocarpus oblongifolius* | Feb. 1995 | 4.0 months | 30 | 40 | 0 | 0 | 30 |
| *Dipterocarpus fagineus* | Feb. 1995 | 3.5 months | 20 | 0 | 20 | 0 | 60 |

Note : 1. Scl = *Scleroderma* sp. 2. Lac = *Laccaria* sp.
3. Cen = *Cenococcum* sp. 4. Ino = *Inocybe* sp.

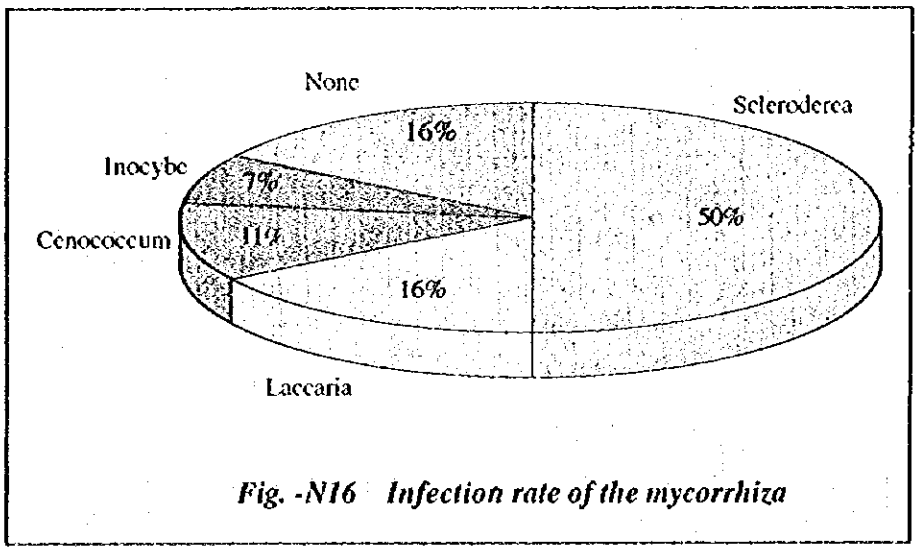



***Fig. -N16 Infection rate of the mycorrhiza***

4 species of mycorrhizal fungi had been detected in the experiment. They are *Scleroderma* spp., *Laccaria* spp., *Cenococcum* spp. and *Inocybe* spp.. More than 80 % of seedlings examined were infected by one or combination of these mycorrhizal fungi. The most common being *Scleroderma* spp. and *Laccaria* spp. *Scleroderma* spp. made up about 50 % of mycorrhiza infection by weight and it was found to be most important in enhancing growth of Dipterocarps.

**Table-N32 Infection rate of mycorrhiza on dipterocarps seedling**

( Number of seedlings examined : 50 seedlings )

| Species | Sowing date | Age of seedling | Infection rate (%) | | | | |
|---|---|---|---|---|---|---|---|
| | | | Scl | Lac | Cen | Ino | NONE |
| *Shorea ovalis* | Oct. 1994 | 8.0 months | 72 | 24 | 2 | 0 | 2 |
| *Shorea leprosula* | Jan. 1995 | 4.5 months | 23 | 11 | 28 | 17 | 21 |
| *Shorea parvifolia* | Jan. 1995 | 4.5 months | 76 | 4 | 6 | 2 | 12 |

Note : 1. Scl = *Scleroderma* sp. 2. Lac = *Laccaria* sp.
3. Cen = *Cenococcum* sp. 4. Ino = *Inocybe* sp.
* Seedlings of Shorea leprosula was 53 seedlings.

**Table-N33 Infection rate of mycorrhiza on dipterocarps seedling**

( Number of seedlings examined : 10 seedlings )

| Species | Sowing date | Age of seedling | Infection rate (%) | | | | |
|---|---|---|---|---|---|---|---|
| | | | Scl | Lac | Cen | Ino | NONE |
| *Shorea curtisii* | Feb. 1995 | 3.5 months | 30 | 30 | 0 | 0 | 40 |
| *Shorea macroptera* | Jan. 1995 | 4.5 months | 70 | 10 | 10 | 0 | 10 |
| *Shorea dasyphylla* | Feb. 1995 | 3.5 months | 10 | 40 | 0 | 40 | 10 |
| *Dipterocarpus oblongifolius* | Feb. 1995 | 4.0 months | 30 | 40 | 0 | 0 | 30 |
| *Dipterocarpus fagineus* | Feb. 1995 | 3.5 months | 20 | 0 | 20 | 0 | 60 |

Note : 1. Scl = *Scleroderma* sp. 2. Lac = *Laccaria* sp.
3. Cen = *Cenococcum* sp. 4. Ino = *Inocybe* sp.

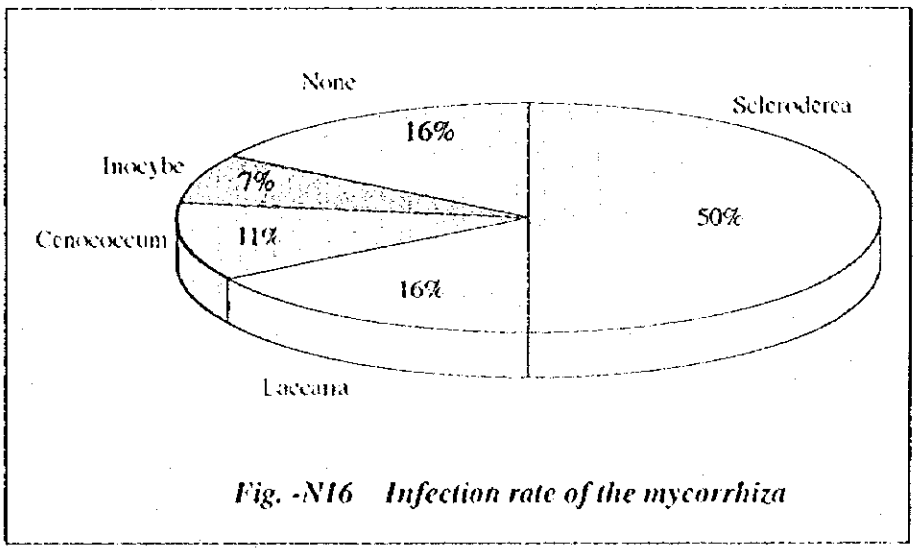



***Fig. -N16 Infection rate of the mycorrhiza***

4 species of mycorrhizal fungi had been detected in the experiment. They are *Scleroderma* spp., *Laccaria* spp., *Cenococcum* spp. and *Inocybe* spp.. More than 80 % of seedlings examined were infected by one or combination of these mycorrhizal fungi. The most common being *Scleroderma* spp. and *Laccaria* spp. *Scleroderma* spp. made up about 50 % of mycorrhiza infection by weight and it was found to be most important in enhancing growth of Dipterocarps.

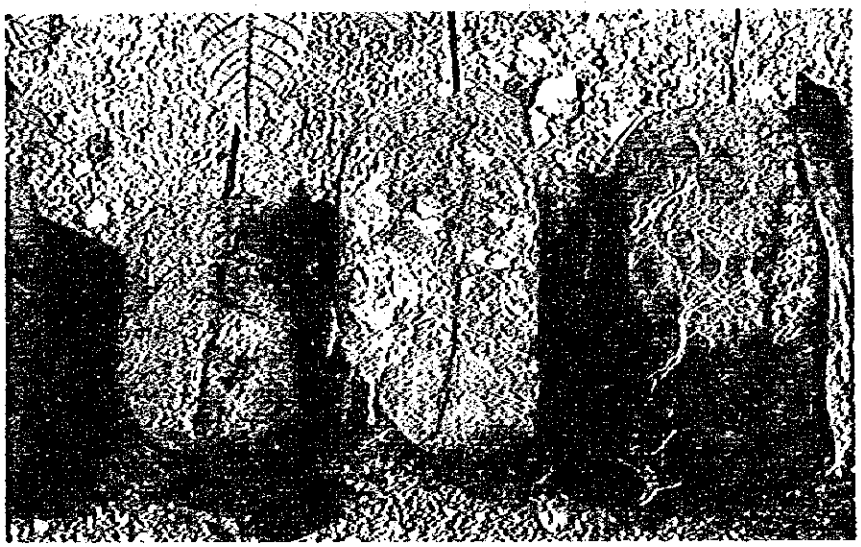


**Photo.-N34 Infected mycorrhizal fungi on the potting medium**

**Photo.-N35 Recorded mycelium and mycorrhiza on potting medium (by Dr. Ogawa)**

**Photo.-N36 Recorded mycelium and mycorrhiza on the root of seedling (by Dr. Ogawa)**

**c) As to Introduction Mycorrhiza into Dipterocarp Seedlings**

**c)-1 Purpose**

Majority of forest topsoil contain mycorrhizal fungi and if we plant seedling in the forest they will be naturally infected by them. However not all mycorrhizal fungi will have a good effect on the growth of a particular species especially Dipterocarps. As many previous studies indicated that of all the mycorrhiza detected, *Scleroderma* spp. is the most influential in terms of growth for Dipterocarps species. Thus this study aims at introducing this particular mycorrhiza during the production of Dipterocarps seedlings at the Project nursery.

**c)-2 Method**

The method employed was to improve the design of seedbed and add the source of inoculation into the potting medium in order to induce high incidence of infection by *Scleroderma* sp. mycorrhizal fungi.

**c)-3 Planting of Infected (With *Scleroderma* sp.) Dipterocarp Seedlings.**

Dipterocarp species of fast growth such as *Shorea leprosula* and *Shorea parvifolia* are planted around or inside the nursery for future shading. These planted seedlings had already been inoculated or infected with mycorrhiza of *Scleroderma* sp..

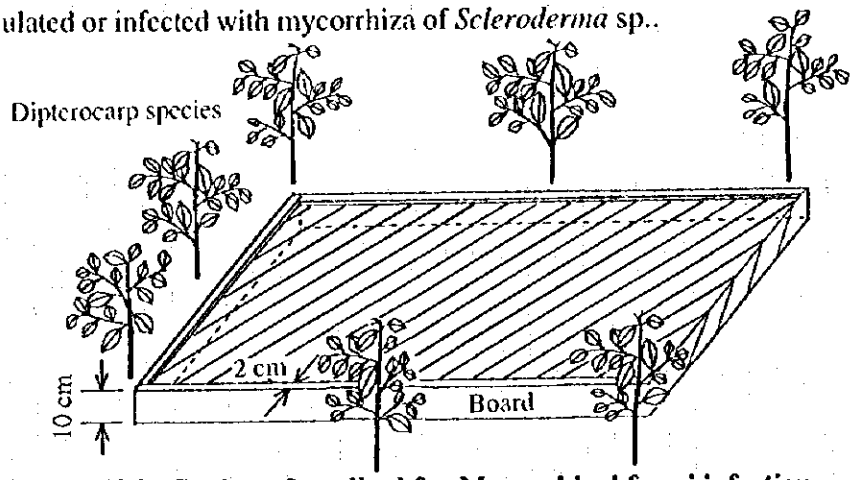



**Fig.-N27 Design of seedbed for Mycorrhizal fungi infection**

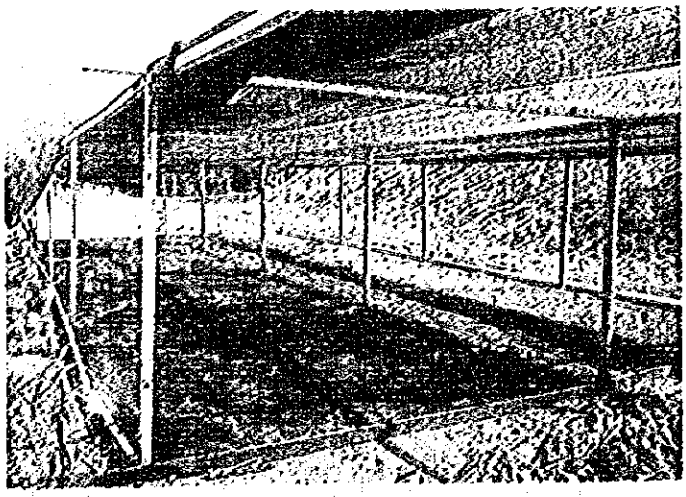


**Photo.-N37 Making seedbed for Mycorrhizal fungi formation**

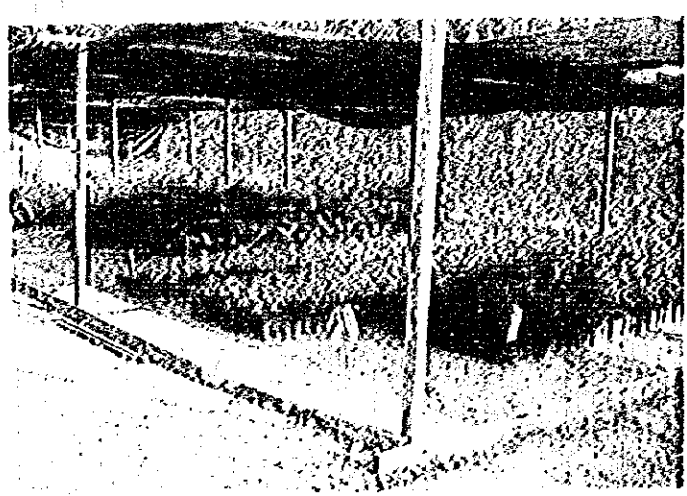


**Photo.-N38 Seedbed for infection of mycorrhizal fungi to the seedlings**

**c)-4 Preparing special medium for seedbeds floor**

As mentioned earlier, most of seedbeds were constructed from concrete and this has made the inoculation of mycorrhiza through the polythene bag impossible. The idea of the experiment was to promote the growth of mycorrhiza on the floor of seedbeds which later penetrates through the polythene bags and finally make it available in the potting medium. The floor of seedbed in this case was made up of a mixture of forest top soil and charcoal (either wood or rice husk charcoal) about 0.1 to 1 cm thick. The charcoal should be roughly 2 % in volume and having pH value of between 6.5 to 7.0. Formation of mycorrhizal fungi had been found unsuccessful if pH value is more than 8. Polythene bags were later arranged on these seedbeds.

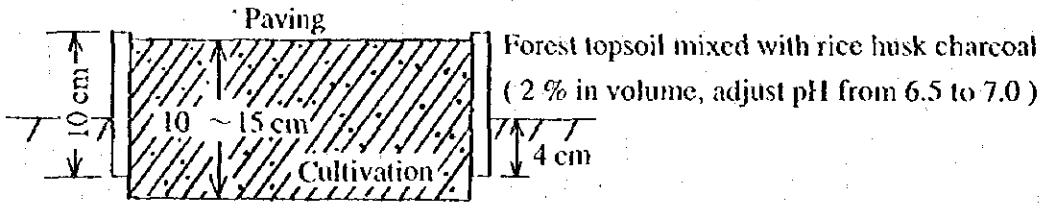



**Fig.-N28 The seedbed floor are fill with a mixture of forest topsoil and charcoal**

**c)-5 Position of hole on the bag**

To facilitate the infection of mycorrhiza from the seedbeds into the polythene bags, it is important to create opening/hole on the side of the bags at the height of between 1 to 2 cm from the bottom. Do not make the hole at the bottom of pot as it will result in the main root extended out into the ground (seedbed).

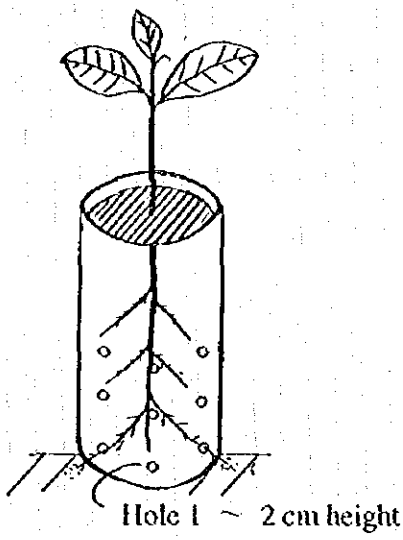



**Fig.-N29 Position of hole on the bag**

**c)-6 Potting medium (A Mixed Rice Husk Charcoal and Forest topsoil)**

Another approach of encouraging the formation of mycorrhizal fungi is by preparing special potting medium. In this case the potting medium is made up of a mixture of forest

topsoil and charcoal (either from wood or rice husk with the ratio of 2 % by volume the pH value kept at between 6.5 to 7.0. Carbide produced from the charcoal accelerates the infection.

**c)-7 Reference Photo. & Table**

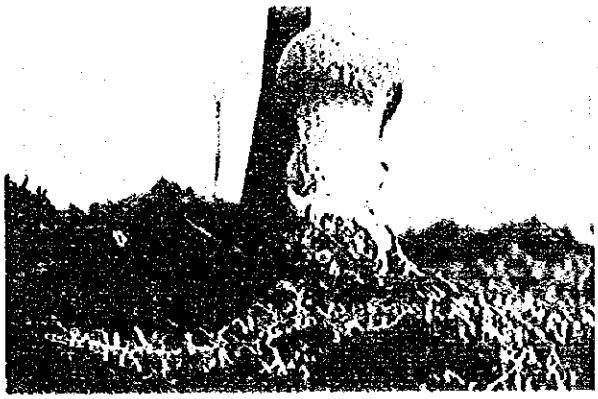


**Photo.-N39 Fruit body of *Scleroderma* sp.**

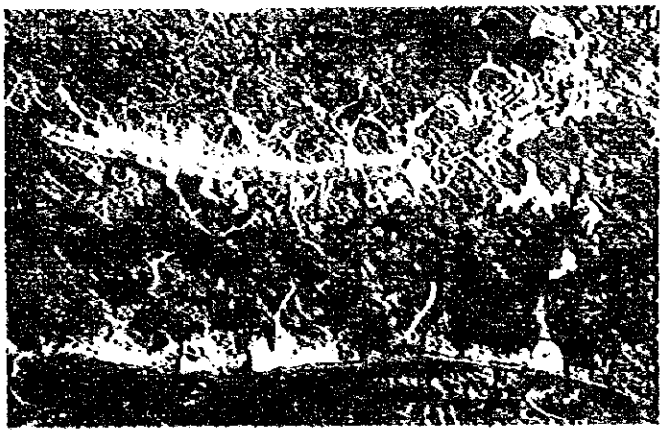


**Photo.-N40 Infected potting soil by mycorrhizal fungi (*Scleroderma* sp.)**

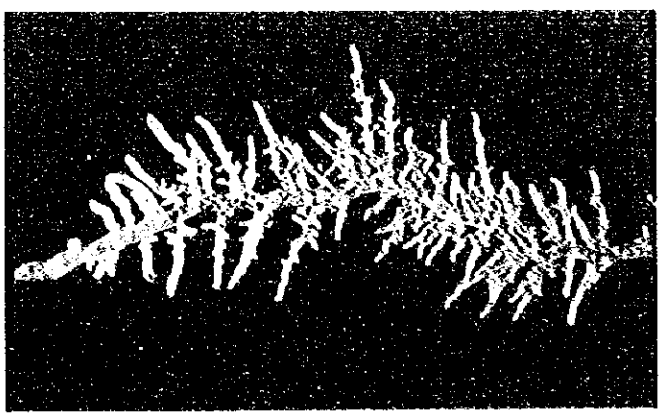


**Photo.-N41 Enlargement photo of mycorrhizal fungi (*Scleroderma* sp.)**

Photo.-N42 Fruit body of *Laccaria* sp.

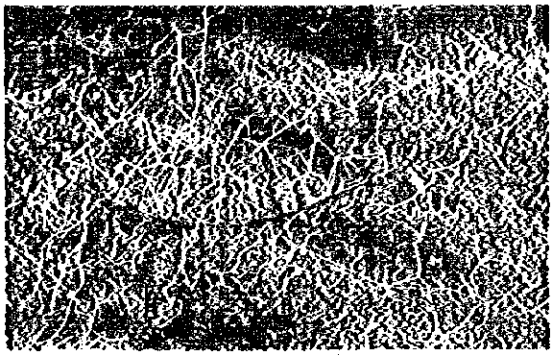


Photo.-N43 Infected potting soil by mycorrhizal fungi (*Laccaria* sp.)

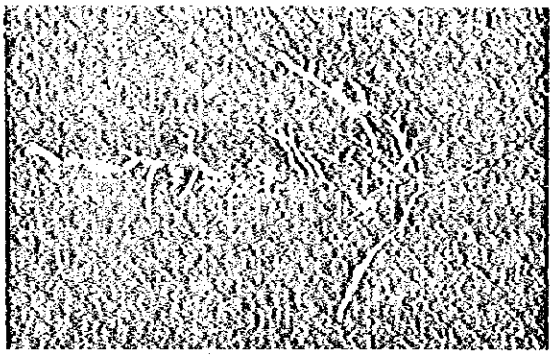


Photo.-N44 Enlargement photo of mycorrhizal fungi (*Laccaria* sp.)

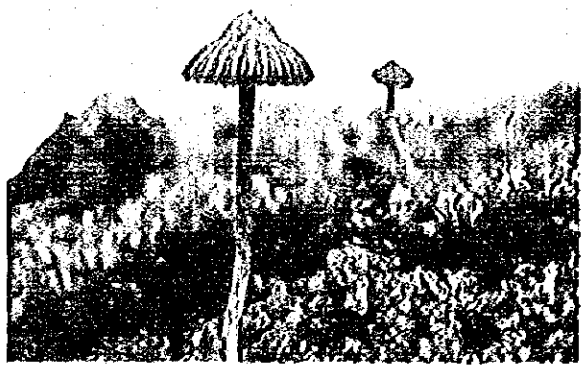


Photo.-N45 Fruit body of *Inocybe* sp.

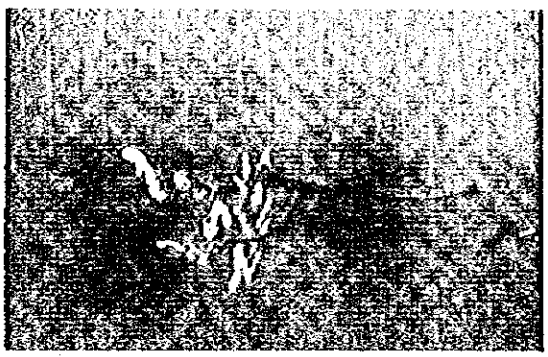


Photo.-N46 Enlargement photo of mycorrhizal fungi (*Inocybe* sp.)

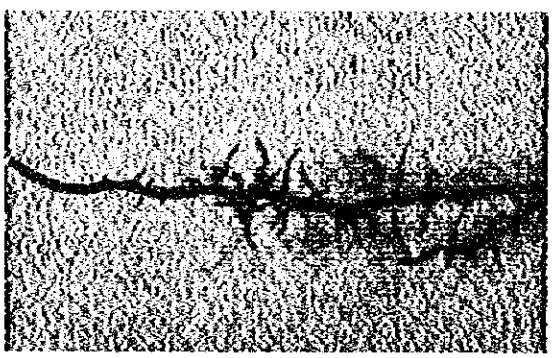
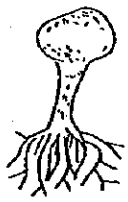
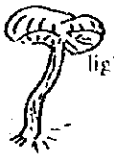
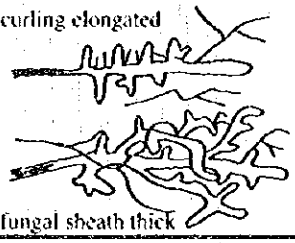
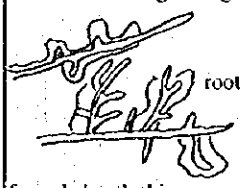
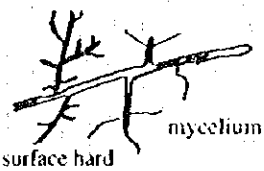
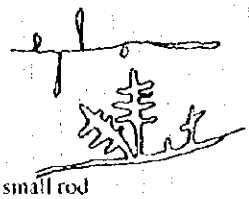


Photo.-N47 Enlargement photo of mycorrhizal fungi (*Cenococcum* sp.)

**Table-N34 The major mycorrhizal fungi and their characteristics. Modified from Ogawa (1995)**

| | 1.*Scleroderma columnare* | 2. *Laccaria* sp. | 3. *Cenoccocum* sp. | 4. *Inocybe* sp. |
|---|---|---|---|---|
| Fruit body | non-gilled<br>  <br>bulb like<br>grayish brown<br>white<br>white rhizomorph | gilled<br>  <br>light brown to brown<br>brownish violet<br>white | no fruit body<br>  <br>sclerotic former<br>0.5-1.0 mm black balls are formed in surface soil. | brown, small<br>gill brown<br>  <br>mycorrhiza |
| Mycelium | rhizomorph, like thread. white and thick, visible, on the surface of pot soil | mycelium like cotton brown to violet visible on the surface of pot soil | rhizomorph like net, black. invisible | transparent to gray |
| Mycorrhiza surface color | pure white | brown, to whitish violet | pure black | white - light brown |
| Morphology | curling elongated<br>  <br>fungal sheath thick | It looks normal growing roots<br>  <br>root tip<br>fungal sheath thin | It looks to be wilted<br>  <br>mycelium<br>surface hard<br>fungal sheath thin |  <br>small rod<br>or small branch |

### (2) Hardening Experiment

#### a) Purpose and Method

The purpose of the experiment was to devise the most effective treatment or method for hardening the seedlings before planting them in the field. All the seedlings were placed in a specially constructed drainage board throughout the duration of the experiment. Refer to Photo.-48. 2 parameters, which include the amount of sunlight and watering frequencies made available to the seedlings manipulated in this experiment. 11 species were chosen and measurements such as seedling height, diameter and the number of leaves were recorded. Additional information such as osmotic potential and T/R ratio of these seedlings were gathered after a period of 8 weeks and 5 months respectively.

The experiment was carried out by Dr. Matsumoto JICA short-term expert in October 1995. A report entitled " Establishment of Hardening Technique " was prepared where results and recommendations on the subject were discussed in detail.

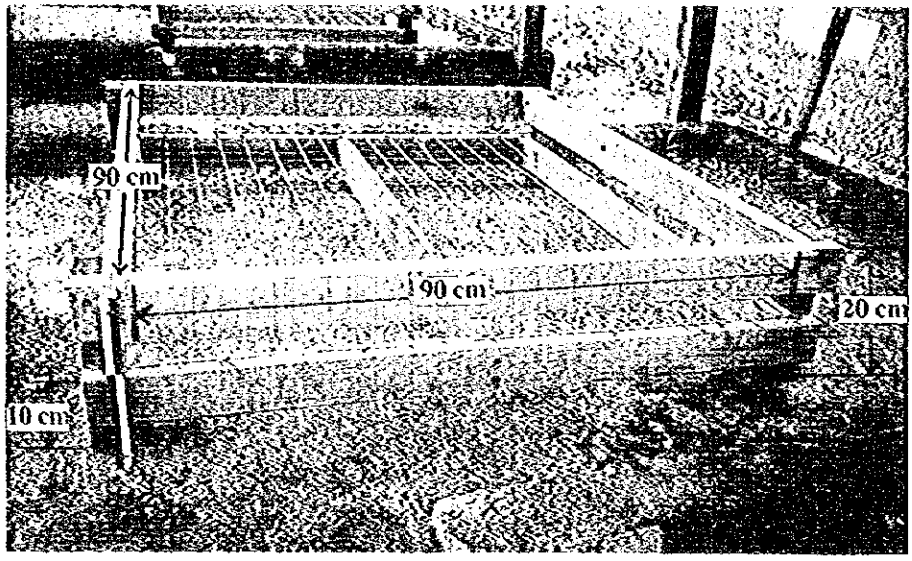



Photo-N48 Draining board

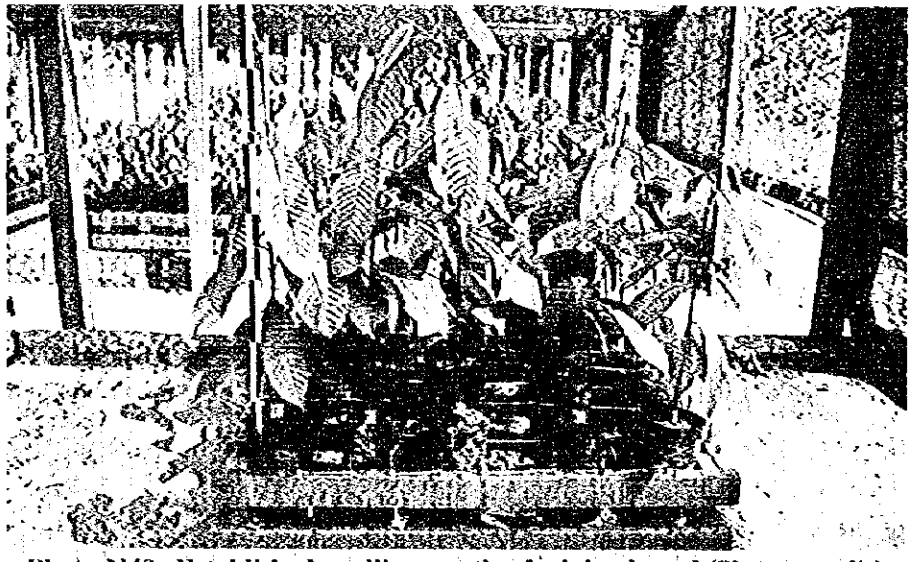


Photo-N49 Established seedlings on the draining board (Shorea ovalis)

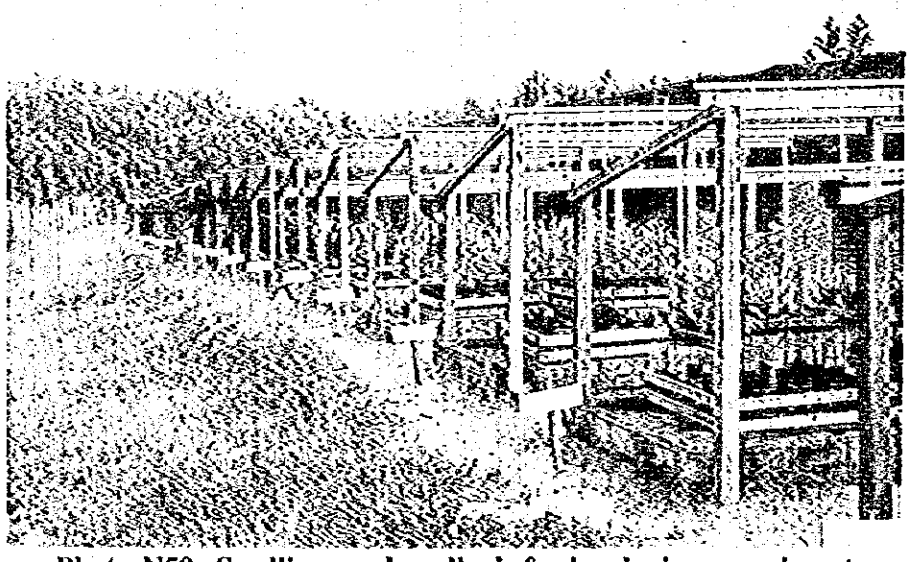


Photo-N50 Seedlings and seedbeds for hardening experiment

**Photo.-N50 Seedlings and seedbeds for hardening experiment**

**(4) Experiment on Cutting**

**a) Purpose and Method**

Vegetative propagation/Cutting is one the best methods of raising seedlings which possess the same excellent genes as that of the individual mother tree. It is also important to rely on this method especially when it is difficult to collect and store the desirable seeds. Normally, a higher rate of success (cutting) will be expected from species that have better rooting formation/ ability.

The project therefore had performed examinations to find possibility of producing seedlings of a certain species by cutting. 14 species were selected for the experiment which began in March 1993 and another 10 species in July 1994. All the species were mainly indigenous and subjected to the same treatment which involved the application of root hormone chemicals. At predetermined intervals the survival rate of these cuttings were recorded.

A large scale production of seedlings by cutting on 2 species (*Shorea talura* and *Azadirachta excelsa.*) was also carried out.

The scion for the experiment was cut to about 10 to 15 cm long and having between one or two leaves. The leaves were then trimmed to one-third or one-quarter of their original size for the purpose of reducing the rate of evaporation. Hormones such as I.B.A. (Indole butyric acid) and S.E.R. (SEREDIX) were applied to the lower part of each cutting to promote rooting. Cutting for the experiment was taken from the shoot of seedlings in which were raised at the Project nursery and also from branches of mature indigenous forest trees in Chikus Forest Reserve.

Cutting beds were prepared and placed in a glass greenhouse and also constructed in the open. Cutting for *Shorea talura* (large-scale experiments) was carried out in a specially constructed airtight tunnel shape enclosure (refer to Photo.-N54).

**b) Result and Consideration**

Results are shown in Table-N35, 36, 37, 38, 39.

**Table-N35 Experiments on cuttings ( I )**

| Species | Number of cuttings | Surviving cuttings | Survival rate (%) |
|---|---|---|---|
| *Casuarina equisetifolia* | 26 | 2 | 8 |
| *Cinnamomum* sp. | 109 | 101 | 93 |
| *Dryobalanops aromatica* | 217 | 8 | 4 |
| *Mesua ferrea* | 98 | 14 | 14 |
| *Pometia* sp. | 108 | 1 | 1 |
| *Shorea leprosula* | 459 | 35 | 8 |
| *Shorea parvifolia* | 138 | 2 | 1 |
| *Dipterocarpus cornutus* | 41 | 0 | 0 |
| *Dipterocarpus crinitus* | 52 | 0 | 0 |
| *Gonystylus affine* | 66 | 0 | 0 |
| *Intsia palembanica* | 53 | 0 | 0 |
| *Koompassia malaccensis* | 157 | 0 | 0 |
| *Palaquium* sp. | 71 | 0 | 0 |
| *Shorea macroptera* | 84 | 0 | 0 |
| Total | 1,679 | 163 | |

Note : This experiment was carried out on March 2 - 3, 1993.
Surviving cutting were examined on May 14, 1993.

All cutting were treated with IBA ( B-indol Acetic Acid).

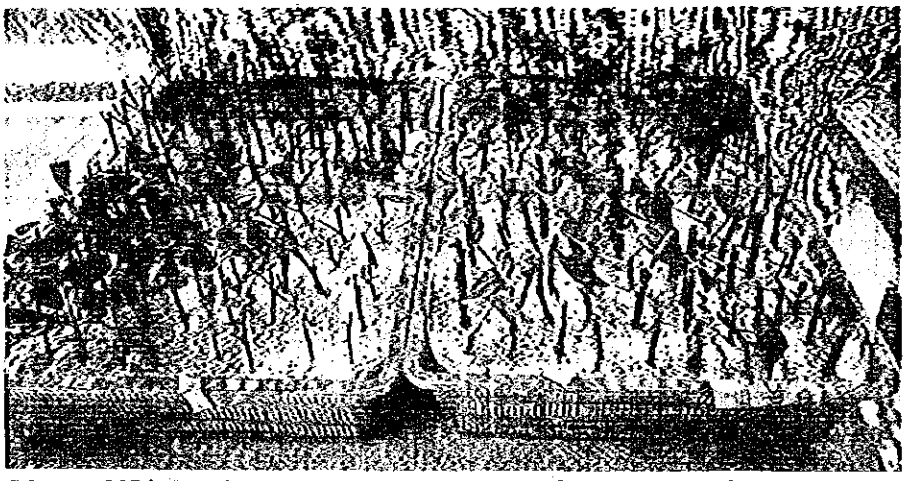


**Photo.-N51 Cutting *Cinnamomum* sp. used in the experiment**

**Table-N36 Experiment Cutting ( II )** **No. 1**

| Species | Glass house | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | IBA | | NAA | | RUT | | SER | | CON | |
| | Total | Live | Total | Live | Total | Live | Total | Live | Total | Live |
| *Shorea leprosula* | | | 100 | 16(16%) | | | | | 80 | 11(14%) |
| *Shorea ovata* | 100 | 5( 5%) | 20 | 1( 5%) | | | | | | |
| *Shorea macroptera* | | | 180 | 48(27%) | | | | | | |
| *Shorea pauciflora* | | | 122 | 14(12%) | 60 | 12(20%) | 60 | 16(27%) | 60 | 17(28%) |
| *Shorea talura* | 50 | 47(94%) | 50 | 49(98%) | 100 | 94(94%) | | | 50 | 49(98%) |
| *Shorea bracteolata* | 80 | 53(66%) | 50 | 36(72%) | 100 | 20(20%) | 33 | 6(18%) | 50 | 13(26%) |
| *Shorea acuminata* | 50 | 5(10%) | 100 | 5( 5%) | 100 | 70(70%) | | | 50 | 0( 0%) |
| *Neobalanopus heimii* | 60 | 7(12%) | 60 | 8(13%) | 60 | 10(17%) | 60 | 10(17%) | 60 | 10(17%) |
| *Dryobalanops aromatica* | 60 | 0( 0%) | 60 | 5( 8%) | 60 | 3( 5%) | 60 | 0( 0%) | 60 | 1( 2%) |
| *Intsia palembanica* | 60 | 48(80%) | 60 | 53(88%) | 60 | 58(97%) | 60 | 44(73%) | 60 | 46(77%) |
| Total | 460 | 165 (36%) | 802 | 255 (29%) | 540 | 267 (49%) | 273 | 76 (28%) | 470 | 148 (31%) |

**Table-N37 Experiments on cutting ( II )** **No. 2**

| Species | Open | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | IBA | | NAA | | RUT | | SER | | CON | |
| | Total | Live | Total | Live | Total | Live | Total | Live | Total | Live |
| *Shorea leprosula* | 20 | 0( 0%) | | | 80 | 0( 0%) | | | | |
| *Shorea ovata* | | | 80 | 0( 0%) | 80 | 0( 0%) | | | | |
| *Shorea macroptera* | | | | | 80 | 0( 0%) | | | 80 | 0( 0%) |
| *Shorea pauciflora* | 60 | 1( 2%) | 60 | 0( 0%) | 60 | 0( 0%) | 60 | 1( 2%) | 60 | 0( 0%) |
| *Shorea talura* | 80 | 75(94%) | 50 | 6(12%) | | | | | 50 | 0( 0%) |
| *Shorea bracteolata* | 80 | 9(11%) | 60 | 1( 2%) | | | | | 50 | 0( 0%) |
| *Shorea acuminata* | | | 80 | 3( 4%) | | | | | 80 | 0( 0%) |
| *Neobalanopus heimii* | 60 | 0( 0%) | 60 | 0( 0%) | 60 | 0( 0%) | 60 | 0( 0%) | 60 | 0( 0%) |
| *Dryobalanops aromatica* | 60 | 3( 5%) | 60 | 0( 0%) | 60 | 0( 0%) | 60 | 0( 0%) | 60 | 0( 0%) |
| *Intsia palembanica* | 60 | 32(53%) | 60 | 14(23%) | 60 | 26(43%) | 60 | 47(78%) | 60 | 9(15%) |
| Total | 420 | 120 (29%) | 510 | 24 ( 5%) | 240 | 26 (11%) | 240 | 48 (20%) | 500 | 9 ( 2%) |

**Note :** This experiment was carried out on July 12 - 13, 1994.
Surviving cuttings were examined on September 16, 1994.
IBA = B-indol Acetic Acid, NAA = Naftalen Acetic Acied
RUT = ( Nad ) Ruton, SER = Seradix 4-indol 3 ylfutyric Acid, CON = Water

Parenthesis indicate survival rate

The first cutting experiment which was done in March 1993 showed that *Cinnamomum* sp. had the highest survival rate. While for dipterocarps species, the highest survival rate was recorded for *Shorea leprosula* which is only about 8 %. The second cutting experiment (conducted in July 1994), resulted in an extremely high survival rate of *Shorea talura* using IBA carried out in both open air and in a glass house. The results of *Intsia palembanica* were also favorable. Even having a low survival rate, *Shorea bracteolata* and *Shorea pauciflora* showed a great potential.

**Table-N38 Cutting experiment on *Shorea talura* in large-scale production**

| | Total | SER | IBA |
|---|---|---|---|
| Number of cutting | 1,720 | 1,560 | 160 |
| Surviving cutting | 1,224 | 1,140 | 84 |
| Survival rate | 71 % | 73 % | 53 % |

Note : This experiment was carried out on Aug. 30, 1994.
Surviving cuttings were examined on Oct. 31, 1994.

**Table-N39 Cutting experiment on *Azadirachta excelsa* in large-scale production**

| | Total | SER | IBA |
|---|---|---|---|
| Number of cutting | 913 | 430 | 483 |
| Surviving cutting | 489 | 262 | 227 |
| Survival rate | 54 % | 61 % | 47 % |

Note : This experiment was carried out on Aug. 30, 1994 and Jan. 5,1995.
Surviving cuttings were examined on Apr. 10, 1995.

For large-scale cutting experiment, *Shorea talura* first indication of growth was noted after 10 days, while almost all the cuttings sprouted after 17 days. Their survival rate was more than 70 %. 1,000 of these cuttings were transplanted into pots and after 1 year 4 months, the average height of these cuttings have reached 40 cm. The project hopes to continue observing the root condition and probably later study the suitability for planting them in the field. In the same experiment, cutting of *Azadirachta excelsa* which was also treated with SER showed a survival rate of more than 60 %.

Note : Until now, *Shorea talura* reported as *Shorea talura*. However, *Shorea talura* was mistake of *Shorea talura* as a result of indentification.

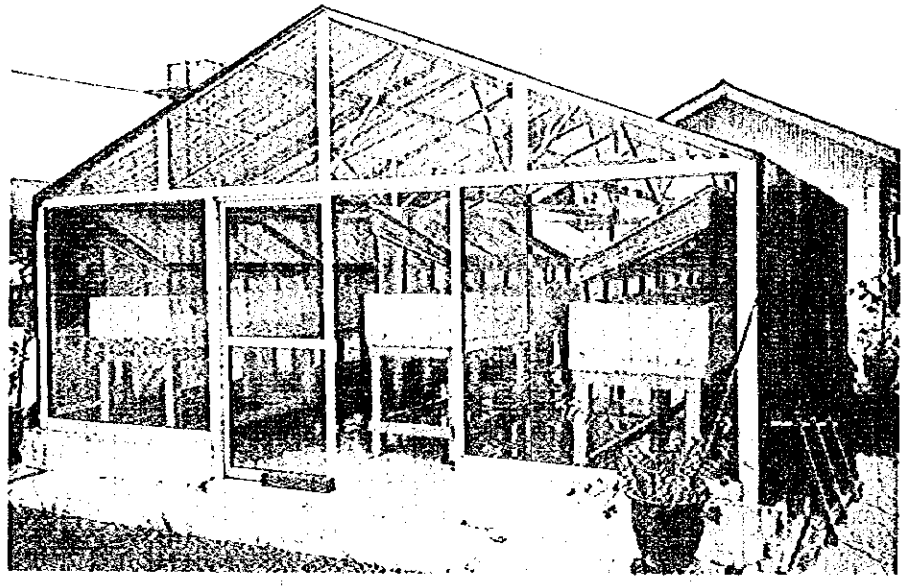


Photo.-N52 Glass house for cutting

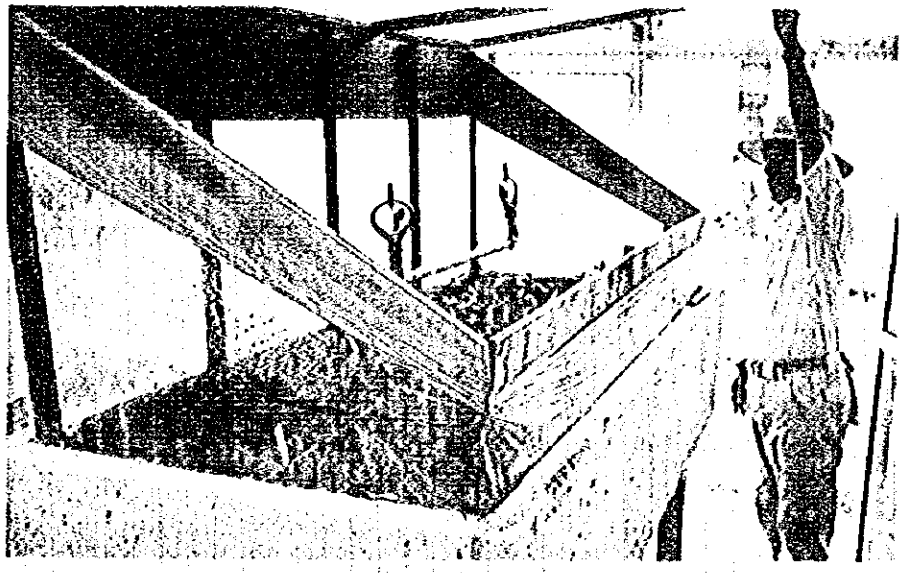


Photo.-N53 Cutting bed in glass house

Photo.-N54 Cutting bed in open-air