NURSERY TECHNIQUES FOR RAISING SEEDLINGS AND WILDINGS OF DIPTEROCARPS ON A LARGE SCALE

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ABSTRACT

A large scale enrichment planting project has been initiated in Danum Valley Field Centre (DVFC, Sabah, Malaysia) to restock logged areas with dipterocarp seedlings. During the first phase of the project, two thousand hectares of logged forest will be planted, requiring approximately 800,000 plants. At the moment, approximately 300,000 plants of dipterocarps are already growing in the nursery. The main species are *Dryobalanops lanceolata* (kapur), *Shorea parvifolia* (seraya punai) and *Parashorea malaanonan* (urat mata daun licin). These plants were originated from either seeds, wildings collected from the forest or rooted cuttings. Different techniques had to be adapted to handle each of these three forms of planting material. This paper describes some of the nursery techniques used in the RBJ-Face Foundation operational nursery to allow large scale manipulation of dipterocarp plants.

INTRODUCTION

A cooperative project between Rakyat Berjaya Sdn Bhd (a subsidiary of Innoprise, Yayasan Sabah) and the Face Foundation (Forests Absorbing Carbon-dioxide Emission, Netherlands) was initiated in Danum Valley (Sabah, Malaysia) with the objective of promoting the rehabilitation of forests to absorb CO_2 from the atmosphere. One side of the project involves large scale enrichment planting of logged forests using seedlings of dipterocarp trees. Dipterocarps are the most abundant timber trees of Malaysian rain forests, in some areas accounting for 80% of the canopy trees (Ashton, 1982).

During the first phase of the project, two thousand hectares of logged forest will be planted, requiring approximately 800,000 plants. Seeds will be used whenever they are available. However, dipterocarps exhibit erratic fruit setting, taking 1 to 10 years between seeding years

(Ashton *et al.*, 1988), and their seeds have brief viability preventing long term storage (Sasaki, 1976, 1980; Boontawee & Nutivijarn, 1989; Tompsett, 1989). In years with seeding, large numbers of wildings can be found on the forest floor, and can be transferred to the nursery. Procedures have to be improved to prevent large percentages of mortality during transfer. Vegetative propagation by cuttings is an alternative method of supplying planting material of dipterocarps (Smits, 1983, 1986, 1987, 1990; Hamzah, 1990 a, b, c), but methods have to be adapted for this technique to be used for mass production of planting material at reasonably low costs.

This paper describes some of the nursery techniques used in the RBJ-Face Foundation Operational Nursery to allow large scale production of planting stock of dipterocarps.

MATERIALS AND METHODS

Nursery facilities

A 3,600 m^2 nursery with capacity for 600,000 seedlings was established in the Ulu Segama region (Sabah, Malaysia). The nursery is located in the middle of the Ulu Segama Forest Reserve, 11 km from Danum Valley Field Centre and a short distance from the planting sites. The nursery consists of 1 layer of 30 % shade netting suspended by a structure of wires attached to wooden posts. The ground is covered by a thick (20 cm) layer of gravel and a thick iron mesh (holes 5 cm^2) is used for holding up poly-bags containing seedlings. Irrigation is provided by Sumisansui Mark II (Japan) hose pipes, fed by river water from a dam located at a site 10 m above the nursery level. Relative humidity in the nursery ranges from 50 to 100 %, temperature ranges from 22 to 34°C, maximum photosynthetically active radiation (PAR) measured with a Parkinsons Leaf Chamber is 280 μmol m^{-2} s^{-1} (26 % of full direct radiation).

Plant material

The species used for these experiments are *Dryobalanops lanceolata* (kapur), *Shorea leprosula* (seraya tembaga) and *Parashorea malaanonan* (urat mata daun licin). These plants originated from either seeds, wildings collected from the forest or rooted cuttings. All the planting material was originated from the forest of the Ulu Segama region.

Comparison of germination rates after sowing of seeds in sand beds or direct sowing into poly-bags

Seeds of different species of dipterocarps were collected from the forest following the sporadic fruiting observed in July-September 1992. Wings of seeds were removed and seeds sown in the nursery. An experiment was carried out to compare germination of seeds in sand beds to direct sowing into poly-bags. A batch of 10,000 seeds of *S.leprosula* was used for this experiment. Half of the seeds of each species were sowed in sand beds in the nursery. The other half was directly sown in 7 x 21 cm poly-bags containing forest top soil, in which seedlings are kept until field planting. Sand beds and bags were watered twice a day. Assessments of germination were carried out two weeks after sowing, sampling 10 % of seeds sown for each treatment. This experiment was repeated using a batch of seeds of *S.leprosula* and *P.malaanonan*, but in this case, bags were covered with transparent plastic supported by a wooden frame, forming a roof 40 cm from the floor.

Comparison between different methods of establishment of wildings

Wildings of *Dryobalanops lanceolata* (n = 50,000), *Shorea leprosula* (n = 2,600) and *Parashorea malaanonan* (n = 5,200) were collected from the forest and taken to the nursery. In order to maximize collection, wildings were pulled out from the soil, consequently loosing all secondary roots. Using this method, one person can collect up to 180 wildings per hour in a well stocked area. Wildings were planted in 7 x 21 cm poly-bags containing forest top-soil.

Since roots are severely damaged during this operation, special attention must be given to minimize evapotranspiration of wildings until a new root system is formed. For this reason, immediately after planting, wildings were watered and kept in plastic covered chambers to maintain high humidity during an acclimatization period until a new root system was formed.

An experiment was established to compare the survival of wildlings in plastic chambers with and without irrigation, and in the open. Irrigation was provided twice a day using Sumisansui Mark II hose pipes inside the plastic chambers. A batch of 3,000 wildlings of *D.lanceolata* was used for this experiment. One third of the wildlings were kept in plastic covered chambers, one third in plastic covered chambers with irrigation, and one third were kept uncovered but watered twice a day using the irrigation system described (Sumisansui hose pipes). Wildings of *S.leprosula* (n = 300) and *P.malaanonan* (n = 300) were also exposed to some of these conditions, and figures are given for comparison. Assessments of survival during the acclimatization phase were carried out two weeks after wildings were introduced in the nursery. During assessments, samples (n=10) of plants kept in non-irrigated plastic chambers were used for determinations of root volume using water displacement method. Figures of root volume of seedlings of *S.leprosula* are given for comparison.

A second experiment was carried out to test the effects of two different periods of acclimatization on wilding survival and establishment. A batch of 400 wildlings of each of the species listed above was used for this experiment. Wildings were kept for either two or four weeks in the irrigated acclimatization chambers described above, before the chambers were open. Assessments of survival were carried out two weeks after opening the chambers.

Large scale production of cuttings

An experiment was established in order to test the rooting of dipterocarp cuttings directly planted in poly-bags, so to reduce the number of operations required. A batch of 1000 cuttings of *Dryobalanops lanceolata* was used for this experiment.

Two-node cuttings, *ca.* 7 to 10 cm length, were prepared according to the method described by Moura-Costa and Lundoh (in press). The main stem of stockplants were cut across the third node down the apex, using pruning scissors. Leaves were trimmed, reducing the leaf area to *ca.* 30 cm^2, approximately 1/3 of the original and the basal end of cuttings were dipped briefly in a fungicide solution (0.1 % w/v Benlate). Cuttings were set to root directly in 7 x 21 cm poly-bags containing forest top-soil. The rooting environment was the same as for the establishment of wildings using irrigated plastic covered chambers. Assessments of rooting were carried out after 12 weeks.

RESULTS AND DISCUSSION

At the moment, approximately 300,000 plants of dipterocarps are already growing in the nursery.

Comparison of germination rates after sowing of seeds in sand beds or direct sowing into poly-bags

Percentage germination of seeds ranged from 66.0 to 97.4 % (Table 1). Germination rates and seedling establishment after direct sowing into poly-bags were not significantly different from the levels achieved using sand beds. However, it was observed that rain-water splashing caused disturbance to seeds in poly-bags, and some of them dropped from the bags. For this reason, bags were covered with a plastic roof, and germination rates were higher. Germination of seeds directly sown in poly-bags was adopted as a standard practice in our nurseries, since it reduces the number of operations required for raising seedlings.

After seedlings reached *ca.* 8 cm height the plastic covers were removed, so seedlings can be kept in the same beds until field planting. Seedlings have been fertilised once a week with a liquid formulation of NPK 11:8:6 and trace elements (Bayfolan, 15 ml/l).

Table 1: Comparison between germination of dipterocarp seeds sown in sand beds or direct sowing on poly-bags. Assessments carried out 2 weeks after sowing. (n = 5,000; means ± SE).

	S.parvifolia	*D.lanceolata*	*P.malaanonan*
Poly-bags	87.6 ± 1.3	na	na
Poly-bags covered by a plastic roof	97.1 ± 2.1	na	66.0 ± 4.2
Sand beds	91.62 ± 1.2	97.4 ± 1.2	72.4 ± 3.8

Comparison between different methods of establishment of wildings

By enclosing wildlings in plastic covered chambers, it was possible to achieve much higher percentages of survival than if keeping them in the open (Table 2). No significant difference was observed between survival of wildlings kept in irrigated and non-irrigated plastic chambers. It was observed that survival was very high while wildings were kept in the acclimatization chambers, but some degree of mortality occurred after wildings were exposed to normal nursery conditions. This is possibly due to the low root volumes of wildlings after two weeks acclimatization period (Table 3, compare figures for a seedling of the same age).

Because of the mortality observed after the two-week acclimatization period, it was decided that wildlings should be kept in the chambers for a longer time. However, if wildings had to be kept for more than two weeks in these acclimatization chambers, it was found to be necessary to apply more water to seedlings in order to maintain high levels of relative humidity. This was made possible by applying irrigation by Sumisansui Mark II (Japan) hose pipes inside the chambers, so relative humidity inside the chambers did not drop below 96 %.

Significantly higher survival was achieved if wildlings were acclimatized for four weeks, instead of two (Table 4). Species differences were observed, with *S. parvifolia* showing higher levels of survival (94.4 %) followed by *D.lanceolata* (88.2 %) and *P.malaanonan* (40.9 %). Longer periods in the acclimatization chambers might be required for increasing survival rates of wildings of the latter two species.

Table 2: Survival of dipterocarp wildings after two weeks acclimatization period. (means ± SE). (n= 1000 for *D.lanceolata* and 300 for the other species).

	Open	Closed chambers	Irrigated chambers
S.leprosula	7 ± 0.8	95 ± 5.2	na
D.lanceolata	15 ± 1.3	100 ± 3.2	100 ± 4.1
P.malaanonan	na	100 ± 2.4	na

na: not available

Table 3: Root volume of dipterocarp wildings after two weeks acclimatization period in plastic covered chambers. Root volume of 2 week-old seedlings of *S.leprosula* raised from seeds is shown for comparison. Figures are the means of 10 replicates.

	Root volume after two weeks acclimatization period (ml)
Shorea leprosula	0.15
Dryobalanops lanceolata	0.10
Parashorea malaanonan	0.09
S.leprosula seedlings	1.50

Table 4: Percentage survival of dipterocarp wildings after acclimatization period of 2 or 4 weeks. Assessments were carried out two weeks after opening the acclimatization chambers. (n = 200; means ± SE)

	Length of acclimatization period	
	2 weeks	4 weeks
S.parvifolia	25 ± 3.1	94.4 ± 3.2
D.lanceolata	69.1 ± 3.3	88.2 ± 2.5
P.malaanonan	na	40.9 ± 4.2

Large scale production of cuttings

The results achieved with this experiment are encouraging. Eighty five percent of *Dryobalanops lanceolata* cuttings rooted after 12 weeks. Using this method it is possible to cut the number of operations required for cutting production. Cuttings were rooted directly in the poly-bags in which they stay until field planting. Furthermore, it was also shown that it is possible to adapt our nursery facilities for production of cuttings using the methods developed for establishment of wildlings. In this way, the cost of cutting production is much reduced allowing the use of this technique for large scale production of dipterocarp planting stock.

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REFERENCES

Ashton, P.S., 1982. Dipterocarpaceae. *Flora Malesiana ser.1, Spermatophyta* **9**:251-552.

Ashton, P.S., Givnish, T.J. & Appanah, S., 1988. Staggered flowering in the Dipterocarpaceae: New insights into floral induction and the evolution of mast fruiting in the aseasonal tropics. *The American Naturalist* **132**(1):44-66.

Boontawee, B. & Vutivijarn, T., 1989. The germination of some dipterocarp seeds under different storage periods. Pp. 451-454 in Fourth round-table conference on dipterocarps. Soerianegara, I., Tjitrosomo, S.S., Umaly, R.C. & Umboh, I. (Eds.). Biotrop Special Publication **41**., Bogor. Pp. 451-454.

Hamzah, A., 1990 a. A note on growth behaviour of branch cuttings of *Hopea odorata*. *Journal of Tropical Forest Science* **3**(3):303-305.

------, 1990 b. A note on the effect of leaf number on rooting of *Hopea odorata* stem cuttings. *Journal of Tropical Forest Science* **3**(4):384-386.

------, 1990 c. A note on the rooting of *Shorea bracteolata* stem cuttings. *Journal of Tropical Forest Science* **3**(2):187-188.

Moura-Costa, P.H. and Lundoh, L., submitted for publication. A system for vegetative propagation of *Dryobalanops lanceolata* (Dipterocarpaceae) by cuttings. *Journal of Tropical Forest Science*.

Sasaki, S., 1976. The physiology, storage and germination of timber seeds. In: Seed technology in the tropics. Chin, H.F., Enoch, I.C. & Raja Harun, R.M. (eds.). University Pertanian Malaysia, Kepong. Pp. 111-116.

------, 1980. Storage and germination of dipterocarp seeds. *Malayan Forester* **43**(3):290-308.

Smits, W.T.M., 1983. Vegetative propagation of *Shorea* cf. *obtusa* and *Agathis dammara* by means of leaf-cuttings and stem-cuttings. *The Malaysian Forester* **46**(2):175-185.

------, 1986. Vegetative propagation and possibilities for its use with Dipterocarpaceae. In: Disckusi tebatas beberapa aspek pembangunan hutan. Menelusuri cara-cara inovatif reboisasi di Indonesia I. Wirakusumah, S. (ed.). Jakarta. INHUTANI I. 8 pp.

Smits, W.T.M., Olderman, R.A.A. & Limonard, T., 1987. Mycorrhizae and Dipterocarpaceae in East Kalimantan rain forests. Annual report for the Netherlands Foundation for the Advancement of Tropical Research, 1986. Pp. 67-78.

Smits, W.T.M., Yasman, I., Leppe, D. & Noor, M., 1990. Summary of results concerning vegetative propagation of Dipterocarpaceae in Kalimantan, Indonesia. In: Breeding tropical trees: population structure and genetic improvement strategies in clonal and seedling forestry. Proceedings of the IUFRO Conference, Pattaya, Thailand. Gibson, G.L., Griffin, A.R. & Matheson, A.C. (eds.). Oxford Forestry Institute, Oxford. Pp. 449-450.

Tompsett, P.B., 1989. A review of the literature on storage of dipterocarp seeds. In: Fourth round-table conference on dipterocarps. Soerianegara, I., Tjitrosomo, S.S., Umaly, R.C. & Umboh, I. (Eds.). Biotrop Special Publication **41**., Bogor. Pp. 427-446.