Development of Tusam (*Pinus merkusii*) Stecklings

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Uses and distribution

P merkusii produces highly valued wood, which is excellent for furniture, sawn-timber, windows, doors, parquetry, crates, boxes, matches and paper. The species is also tapped for good quality oleoresin.

P. merkusii is a tropical pine of Southeast Asia that occurs naturally in Myanmar, Thailand, Laos, Cambodia, Vietnam, Indonesia and the Philippines. It is the only native pine found in Indonesia (Sumatra). The species was introduced to Java in the early 1920s from one of its natural population in Sumatra. In Java, it has become one of the most extensively planted species covering a total area more than a half million hectares.

Propagation and Tree Improvement

In Indonesia, it is listed as a species of priority for reforestation. A program for genetic improvement of this species was initiated in year 1977 in order to secure a stable supply of good quality planting stocks, i.e. improved seeds. In the breeding strategy, stem form, growth, oleoresin yield and wood density are traits of interest to be improved. Open pollinated seedling seed orchards (SSOs) from the first generation breeding strategy have been established through progressive conversions of progeny tests (1978-1991). Work is continuing on further improvement of the existing breeding populations to give even greater economic returns. Nowadays, improved seeds are routinely produced from these orchards.

It has been observed that seed yields vary according to the parent trees ranging from low to high (Siregar, 2001). In order to optimize the genetic gains, parents with low seed yields but produce the best progenies can be multiplied as stecklings. These low seed yields of particular seed trees belonging to the same family (half-sib or full-sib) are expected to occur in more advanced breeding program, i.e. control pollination. The stecklings also can be used as a means of multiplication in conservation efforts especially for old natural populations of *P. merkusii* that have been indicated to produce very low seed. In addition, seeds of *P. merkusii* rapidly lose their viability when kept in dry cold storage (Waruwu, 1990) and there is lack of adequate seed storage technique for long-term storage, i.e. more than one year. So vegetative propagation is a feasible solution for keeping a stable supply of planting stock.

Attempts need to be done to develop better vegetative propagation methods since early experiments carried out still resulted in very low success of rooted cuttings (Harahap, 1972). Development of appropriate techniques for steckling or rooted cutting and hedge orchard as a source of cutting materials remains a central focus for propagation of *P. merkusii*. The use of stecklings is hoped to compliment with the planting stock production through seeds.

Pathway of planting stock production

Considering the current and future progress of breeding, annual planting stock of *P. merkusii* could be sourced directly or indirectly from the available seedling seed orchards (Figure 1). In the future, it seems that the method of deployment of improved seed will remain in the form of seed from open-pollinated SSOs (Anonym, 2000). Separate SSOs will be established using families in the elite population and thinned them based on progeny test evaluation. Multiplication of superior full-sib families through cutting technique is carried out followed by routine testing of materials to meet the requirements of clonal forestry program.

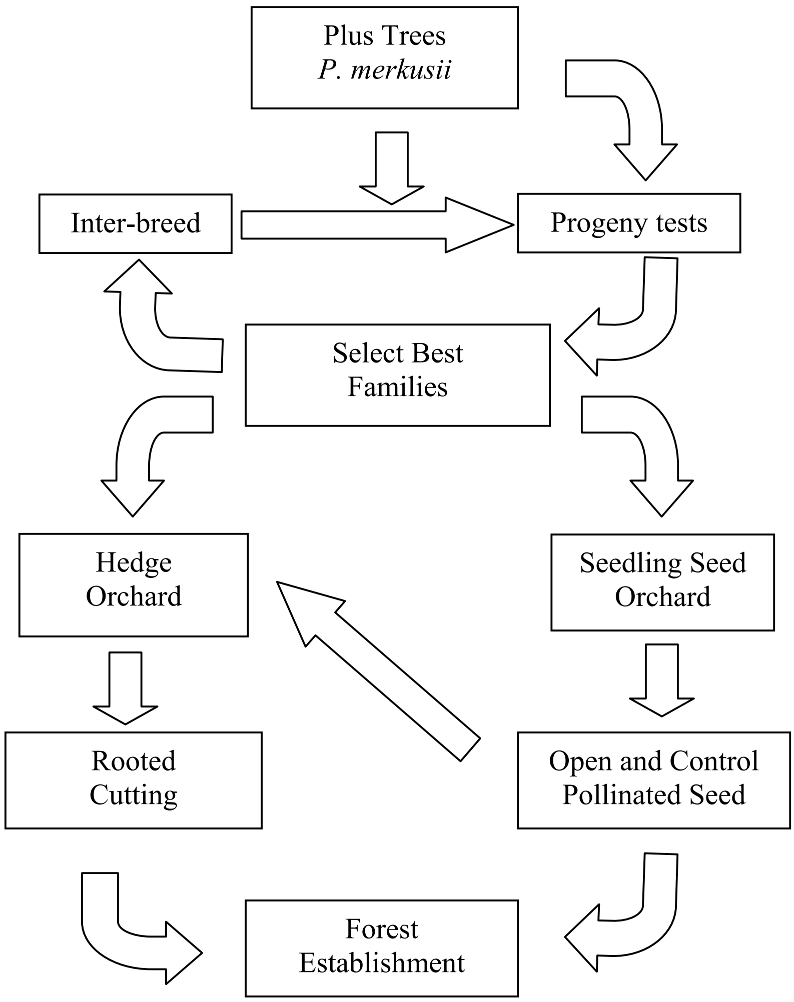

Figure 1. Possible pathways of improved *P. merkusii* planting stock production

Hedge Orchard

Hedge orchard which is also known as stool bed can be established from open and control pollinated seeds derived from the best progeny tested families or parents. This orchard is able to produce cutting materials (juvenile shoots) at all times which are used to vegetatively multiply the numbers of planting stock obtained from seed orchards, especially the best families with very low seed yields. Hedge orchard is established from at least 5 months old seedlings. The seedlings are grown following 20 cm x 20 cm distance in a nursery bed (1 m x 5 m in size). After being adapted to the bed, hedging is done at a particular point that is about 10 cm from the uppermost part of the seedling. The first interfascicular shoot is observed within the first week after hedging and subsequently followed by neighbouring shoots covering the hedged point to finally form crowded shoots (coppices). Development of interfascicular shoots on a hedged seedling stock as well as hedge orchard are presented in Figure 1.

Figure 1. Examples of induced interfascicular shoots on 5-month-old seedling stocks (left) and two years old hedge orchards of *P. merkusii* (right).

Three to four shoots as juvenile materials for cutting are harvested biweekly. So, it can be harvested around 3000 juvenile shoots from a nursery stool bed. As the seedling stocks grow, the shoots production increase depending on the number of hedging points in each seedling stock. At the first year, seedling stock is expected to have only one hedged point, while in the second year the seedlings can produce more branches (2-4 branches) that can be hedged to form another group of coppices. Seedling stocks of more than three years of age are not used and replaced with new ones since it reduce the percent rooted cuttings. In the nursery, the harvesting rate and shoot production are arranged in sustainable manner. An additional stimulating treatment can be applied to obtain more shoot formation (coppices) that is done by spraying 20 ppm 6-Benzylaminopurine (BAP) on to the seedling stocks.

Rooted cuttings

Factors affecting the success of rooted cutting have been determined after a series of experiment focusing on the following treatments: application of hormone with IBA/indole butyric acid (dosage and mode of application), rooting media and sources of cutting materials (age of seedling stock and cluster order). The findings are summarized in Table 1 (Hidayat et al. 1995).

Table 1. Summary of factors affecting the success of *P. merkusii* rooted cutting

Factors	Rooted Cutting (%)	Primary root number per cutting	Primary root length
IBA concentration	**	*	**
Rooting media	**	**	**
Age of seedling stock	*	*	*
Cluster order	*	ns	**
Mode of IBA application	ns	ns	**

Note:
** = Significantly different at 1% level of confidence
* = Significantly different at 5% level of confidence
ns = not significantly different

Based on the results of these experiments and additional improvements from gained experiences, a protocol for production of *P. merkusii* stecklings was developed and was subsequently tested on operational scale with satisfied results. Main recommendations in order to obtain more than 80% success of rooted cutting are as follows:

1. Cutting materials (shoots) are taken from any part (clusters) in the juvenile seedling stocks (less than 3 year old) with a size of 6-12 cm.
2. IBA hormone is applied to the basal part of cutting with a concentration of 4000 ppm. Hormone is prepared either in powder (talc as carrier) or liquid (50% ethanol). When using liquid method, IBA is diluted in 50% ethanol. The cuttings are then treated by quickly dipping (3-5 seconds) their basal part in these IBA solutions.
3. Cuttings are grown in a mixed rooting medium containing coffee compost and sand (40:60). Single shoot can be directly put into a single tube or polybag and maintained in a simple propagation house capable of maintaining high humidity (RH > 90%). Cuttings are watered twice a day (manual or automatic sprayer).
4. Temperature and humidity inside the propagation house are monitored three times a day (morning, mid-day and late afternoon). In case of high temperature and dropped humidity, additional watering or spraying (fogging) can be undertaken.
5. Prior to inserting a cutting into media, its base is treated with fungicide Benlate solution (3 gr/10 liters) for 5 minutes. Media are fried or dried under the sunlight to achieve sufficient sterilization.
6. The cuttings are sprayed with Benlate solution biweekly. After 7 weeks, cutting samples can be taken out carefully to check the root initiation and formation. As root formed, a foliar fertilizer (Gandasil D) at recommended dosage is sprayed biweekly until 14 weeks and mycorrhizal spores are inoculated.

Most of experiments reported in vegetative propagation of tropical trees were based on small-scale cutting propagation. Little has been done to studies that achieved mass production of planting stocks. Sakai et al. (2002) recently has reported the success of mass propagation method from the cutting of three dipterocarp species. This however was done using a better vegetative propagation system than that of *P. merkusii*. This sytem uses fog evaporative cooling inside a greenhouse to reduce the leaf-to-air vapor pressure deficit (leaf-to-air VPD) inside the propagator, even under high irradiance conditions. Had this system been used in mass propagation of *P. merkusii* cutting, constant success on rooted cutting may have been possible.

Conclusion

An alternative method to current planting stock production of *P. merkusii* can be done through rooted cutting of juvenile shoots. Hedge orchards which are established from improved seeds serve as important element in supporting mass propagation method from *P. merkusii* stecklings. The use of these available propagation techniques will be more effective if integrated in the existing tree improvement, conservation and reforestation programs.

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