

**EXPERIMENTS ON VEGETATIVE PROPAGATION TECHNIQUES
FOR RAISING SEEDLINGS OF ACACIA MANGIUM AND
HYBRID OF A. MANGIUM X A. AURICULIFORMIS**

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February 1994



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PREFACE

Forest plantation are a powerful tool in the continuing efforts of forestry to increase productivity per unit area. The only mean of reconciling the increasing demands for forest products and services on the one hand with a decreasing area of land available for forestry. A combination of intensive site preparation with the use of uniform, well-grown nursery stock of increase growth and yield, reduces rotation length, facilitates tending and harvesting operations and improves quality and uniformity of wood, as compared with natural forest. Plantations also offer the means of using on a large scale the genetically improved material by tree-breeders. Although there is no case for the indiscriminate replacement of all natural forest by plantations, their judicious use, by providing an alternative source of forest product.

Plantation play a major role as producers of timber, pulpwood and wood-based panel for forest industries. Tree plantation have benefited soil stabilization, habitat improvement, urban and rural amenity and also part of agrisilvicultural system all benefit the human environment. A variety of planting purposes is not surprising; that the scale of tree-planting and the variety of species planted continue to grow in so many countries.

It must be stressed that "good clone" is well suited to the site should be selected for planting materials. Effort had been made by the project to propagate good clone for mass production to make the good quality seedlings available for plantation. The production of genetically improved clone can only be achieved if the research finding can provide sound information and recommendation to be followed.

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FOREWARD AND ACKNOWLEDGEMENTS

SAFODA forest plantation consist mostly of young generation of *Acacia mangium* which will be the major species. Some forest areas have many existing Acacias which have grown over 25cm in height and an average of about 40cm in diameter.

There were also cases of natural self- cross pollination being occurred which we called a natural hybridization between *Acacia mangium* and *Acacia auriculiformis*, that resulted in good form of growth and trait that succeeded from the characteristic of superior plant. There are few advance regeneration of *Acacia mangium* and *Acacia auriculiformis* as well as other species.

The age of these existing hybrids are almost 15 years old and covered an area of about 100ha. which is situated at Ulu Kukut in Northern regions and the whole areas which has an estimated volume of up to 200m³ per HA.

These species become a main eye-attraction to foresters especially from overseas who came here and some of them also follow up on the establishment with the same method of hybridization by collecting the hybrid clones either by marcotting or gathering its seeds for their further experiment and analysis. However, it is pretty difficult to make hybridization plant through seeds.

So far, SAFODA has made their efforts to select the superior tree or plus-tree for the resources of vegetative propagation through marcotting, cutting and grafting to secure its genetic value and hoping very much for the success of the descendant's characteristic genetic of the coming generation for further investigation, study and improvement.

All our trials and observations on vegetative propagation development which focus only on *Acacia* species as our main materials had been compiled together with significant reference table record resulting from our discussion.

This report might not be completed without the significant assistance and consultancy from JICA Short-Term Expert of Japan, Mr. Dr. Tajima. His invaluable and undaunting effort and task to teach and guide Malaysian Counterparts in tree breeding techniques and management was so overwhelming! I am pleased to extend my sincere gratitude and thanks to all staff and workers especially to nursery staff. Without them this report completion was certainly not possible.

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1. MARCOTTING

Improved seed through sexual propagation of plus tree is necessary for the establishment of seed orchards and progeny tests. Both there are the primary objective of tree weeding. It is however, difficult to produce plus tree vegetatively because of age but this can be overcome by marcotting. Marcots are of the same genotype on the parent tree and roots easily compared to cuttings taken from the same tree. Cuttings from old *Acacia mangium* trees are difficult to root although the success rate depends on the technique used. The rooting rate of marcots is higher but in order to get good results, it is important to adopt the right technique and skill through regular practice.

1.1 Merits and demerits of marcotting

Merits

- (a) Easily rooted even on old tree.
- (b) Only a little technique will help to produce a good result.

Demerits

- (a) In vegetative propagation, grafting method has an extremely poor survival ability and could not be used for mass propagation.
- (b) Marcotting skill is really simple but needs much tender care and management after removing from the tree.
- (c) It can be dangerous when doing work on tall matured trees.

1.2 Care during marcotting method.

The girdled (debarked) area of the branch should be well protected so that the rooting material does not remain soggy and an appropriate hormone applied in line with the instructions given. The debarked area should be covered with paper at the upper side or the surrounding area in order to avoid direct sunlight.

1.3 Condition for rooting of marcots.

(a) The timing of marcotting activities

In our observation, marcotting activity can be done almost throughout the year. It is noticed that during the rainy season, the rate of rooting of marcots is low. During the dry season, it is necessary to check whether the moss is dry at least once a month. If dry, watering is required.

During the flowering season, marcotting activities should be avoided, as it will result in poor rooting rate. From past experience, on marcotting on hybrid tree at Ulu Kukut during inflorescence production with about 30 marcots on 7 trees, the result was only 2 clones survived. This was done in August 1991. The result indicated that during flowering peak, the rooting is low and slow. Another trial was carried out for the same purpose. Table of trials on different times for rooting of marcots is shown as below.

Table 1: The timing of marcotting.

Assessment Month	Quantity	Survival	Rate %
March	6	0	0.0
May	7	1	14.3
August	140	40	28.6
October	6	6	100.0
November	7	6	85.7
December	8	5	62.5

Variety : *Acacia hybrid*
 Location : Ulu Kukut
 Trial : 1992

Result

The most suitable time for marcotting activity is in September and this could be continued until end of the year since good results are obtained then.

(b) Tree age

Marcotting does not show a big difference in the survival rate as compared to grafting or cutting but it depends on the tree age and the position of the branch to be marcotted. In the case of *Acacia mangium*, marcots from a young tree roots easier than from old tree but *Acacia hybrid* will root even if marcotting is done on an old tree.

Table 2 Rooting rate of trees of different ages.

Species	Place	Age	Tree no.	Marcot	Survive	Rate %
<i>Acacia mangium</i>	Bongkol	3	4	20	12	60.0
	Mandahan	5	14	70	34	48.0
	U. Kukut	8	8	20	3	15.0
	Bongkol	9	8	36	3	8.0
	Kinarut	10	6	12	1	8.3
<i>Acacia Auriculiformis</i>	U. Kukut	2	13	46	26	56.5
	Bongkol	3	15	60	32	53.3
	Kinarut	3	5	15	8	53.3
<i>Acacia Hybrid</i>	Karamatol	7	6	30	9	30.0
	U. Kukut	18	3	15	9	60.0

Date of trial: July - November, 1992

(c) **Light intensity**

The light intensity is seldom related to the formation of roots. Rooting is promoted by preventing sunlight from shining on the marcotted area which is plastic covered by attaching a piece of paper on the upper side. The yellowing and coiled root formation is temporarily and occurs before planting out in the field.

We studied root production using transparent plastic and black plastic for bagging the marcotted area. With black plastic, it produced a lot more roots than with transparent plastic. We found that by cutting out sunlight, it promoted rooting.

(d) **Watering**

While the marcot is still attached to the tree, it does not need watering regularly like in cutting propagation. Water and other inorganic can be supplied to the other side through the xylem gradually.

The marcot can produce root in wet moss. But in the case of dry moss which we tried we found that the marcot does not produce roots. High humidity caused the moss to turn mouldy. High temperature produced vapour. Even though roots are produced, the marcot will die at later stage because of the dry condition of the moss. We conclude that soaking moss in water is the most effective method.

(e) **Application of rooting treatment**

Rooting can be promoted by applying rooting hormone to the upper surface of the branch. Compared with non-hormone application, there is no significant difference in final root production. However, with hormone treatment, yellowish adventitious roots appeared earlier. The time duration for root production using hormones is also faster by about half a month than non-

hormone treatment. Application of hormones help rooting effectively by increasing the metabolism.

We also examined the effect of rooting of the marcots by using two different kinds of hormones, that is Oksiberon and Seradix-3 on Jiffy 7 and Sphagnum moss in the trial. Oksiberon on Jiffy 7 and Sphagnum moss shows no significant differences. Seradix-3 on Jiffy 7 shows no difference as well but with Sphagnum moss it gave good result. Sphagnum moss is thus recommended as the best rooting material since Jiffy 7 dried up within a short period before roots are formed and attracts a lot of insects once it dried.

Table 3 Comparison of different medium and hormone on vegetative propagation.

Medium	JIFFY-7		MOSS	
Hormone %	Oksiberon 20.0	Seradix 3 20.0	Oksiberon 20.0	Seradix 3 54.3
Total	20.0%		37.0%	

Date of trial : September, 1993.

1.4 Marcotting method

- (a) Marcotting has a comparatively higher rooting rate on young *A. manglum*.
- (b) Normally, the average diameter of a branch suitable for marcotting is about 1.0cm and above. From past experience, branches with diameters below 1.0cm proved unsuccessful for marcotting as they are immature.
- (c) Delay in girdling work will result in a lower rate of rooting. If the inner bark and cambium are not removed, rooting will decrease, since the inner bark will form new bark instead of rooting.
- (d) By applying hormone to the marcotted area, roots are produced faster.
- (e) Damp sphagnum moss should be wrapped over the debarked area first, since excessively wet moss rots easily. The moss is then wrapped with black vinyl and both ends tied tightly.
- (f) Imbalanced branch and leaves could be adjusted by trimming a part of the branch and leaves.

When collecting marcots which had successfully rooted, they should not be thrown to the ground, as it might damage the roots. The best way is to lower the marcots by using a rope which is tied about half way on the marcots and lowering them slowly to the ground.

It is noted that the success of the marcots actually depend on the width of the debarked area, survival is low if the width is too wide. The average should be about 3cm to 6cm. The factors resulting in failure in marcotting are: girdle width too wide, inner bark not completely removed, cleanliness of fleshy sphagnum moss too dry and the covering preparation. Any one of the techniques wrongly done will result in death of the branch or bark reestablishment instead of rooting.

Table 4: Comparison of branch diameter, debarked width and survival

Branch Diameter	Debarked width	Survival
Above 10cm - 13cm	10cm	0
	6cm	0
	3cm	0
5cm - 7cm	10cm	X
	6cm	0
	3cm	0
Under 3cm	10cm	X
	6cm	0
	3cm	0

Note: 0 - Success
X - Death

1.5 Situation of rooting marcot.

Vegetative propagation is a way of raising plant stock that does not involve seeds. Recently a plus-tree selection has been done on *Acacia mangium*, *Acacia auriculiformis* and *Acacia hybrid* in SAFODA plantation projects.

This project aims to conduct several trial in marcot propagation to develop and improve technology which can then be put into practice and disseminated.

To discover the best method and technology, several conditions and position of heights of young trees are selected to determine which method can best be applied in the future.

Table 5 Rooting of marcots.

Date	PT no. 1	PT no. 3	PT no. 5	PT no. 7
8 Aug	2	3	5	5
Observation				
15 Aug	Near root: leaves changing to yellow and beginning to drop.			
22 Aug	Color of all leaf changed yellowish and leaves from lower half of marcot had fallen.			
29 Sept	Upper half losing leaves; began rooting 1	1	3	No change 0
1 Sept	Development of root.			more leaves dropped
5 Sept	Rooted marcots removed 1 1 3			
12 Sept	new roots 1	new roots 1	coppices developed at root base.	rooting began.
19 Sept		new roots 1	new roots 2	
2 Oct	2	All marcots removed 2	2	new root 3
Total	2	3	5	3

Remarks

Method : marcotting or air-layering.
 Variety : *Acacia hybrid*
 Location : Ulu Kukut Project.
 Date of trial : August - October, 2 1991

1.6 Treatment of marcots.

It has been observed that marcotting activity depends mostly on the right season and the use of appropriate technique. Tending and maintenance is more difficult for rooted marcots removed from the tree. The survival rate gradually dropped to 10%. The failure was due to root damage during transportation. We found the roots severely damaged during transplanting into pots. The leaves and bases of roots had also wilted. Steps were then taken by the management to prevent disturbance by shaking once the marcots were potted.

Subsequently the marcots survival rate increased to 60%. Planting out was done after a 4 to 5 week hardening process.

Another technique to improve survival of marcots to soak them in water for 1 - 2 days, but water should be changed everyday.

Observation was carried out every week during marcotting. The first root production was observed in 20 days and root development was follow up for 50 days. The growth has increased a little and the marcotted materials were gathered together in one area nearby the nursery whereby any problems observed could be rectified. Successful vegetative propagation will make it much easier to fulfill the institution's target for tree-breeding.

1.7 Conclusion

Marcotting of all plus-tree should be established in one site near the nursery to facilitate vegetative propagation activities because the longer the time required to prepare and transport shoot cuttings, the lower will be the survival rate.

2. CUTTING

Cutting means any portion of stem, leaf or root, separated from a plant and treated in a definite procedure to produce a new plant. This is one method of obtaining plants vegetatively, unlike marcots which needs to grow roots first before removal from the tree. In the case of cuttings, the portion that is detached is called a scion, i.e it is devoid of roots and can be made to grow into a plant with the help of some rooting hormone and care.

2.1 Misting house

Misting houses in temperate countries include electrical heating. Generally, the skill of a propagator is important in the cutting of fast growing species and the rooting of these cuttings. Sunlight is also required as well as a good misting system. A recent development has enable us to carry out cutting any time and the stock of the cuttings can be kept in the misting house.

2.2 Method of cutting

The method of cutting and the type of equipment used has advanced tremendously lead to successful rooting of scion cutting. The medium used in a misting house is mostly river sand which after sterilizing is poured into raised broad shallow boxes making them handy for carrying out cutting activities. The misting house is installed with adjustable ventilation. The drainage system was made to cater for over-flowing of water especially during the rainy season. The sand was sterilized by placing in the oven with a temperature of 250c for 2 to 3 hours.

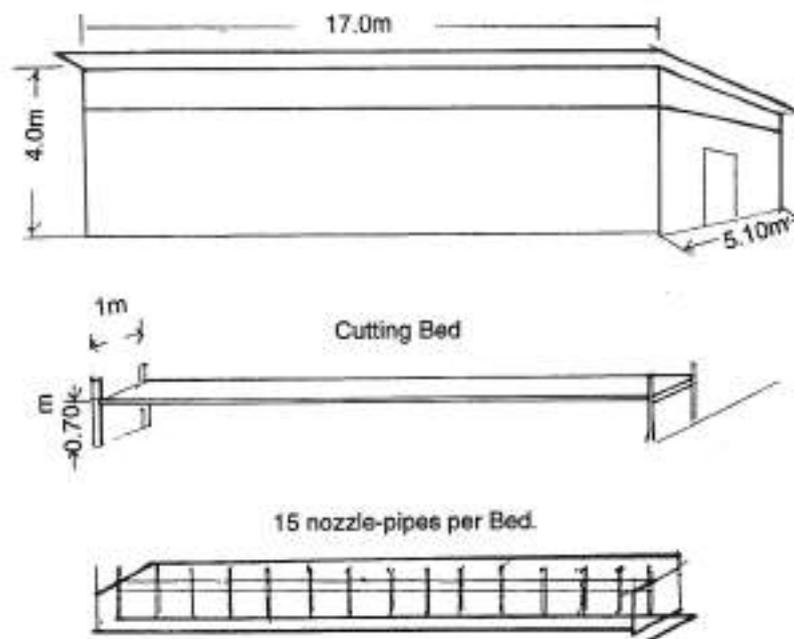
The equipment and tools for daily used should be kept neatly, i.e Sharp knife, secateurs, divers and rooting materials, etc.

2.3 Mist Propagation

Species like *Gmelina arborea* roots easily even in the open. In the case of the Acacias, it is very difficult to root either in the open or under shade. This species should be kept in the misting-house to give them time to develop root because the temperature and humidity is always constant with the installation of an auto-mist system.

Diagram of the misting house

The proposed scale is as below:

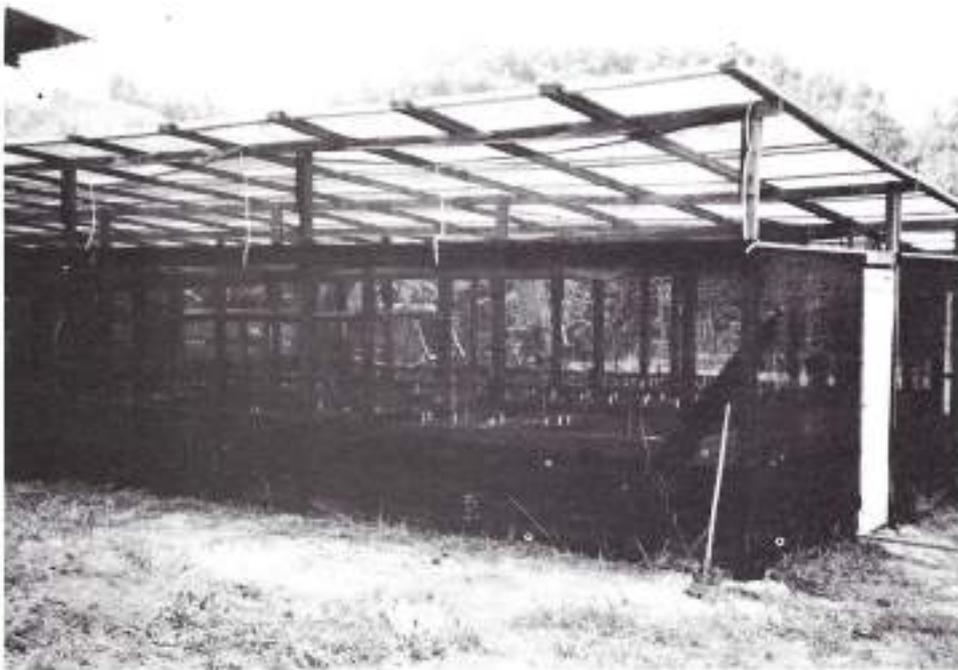


The misting house is 17.0m long by 5.1m wide by 4.0m high. The walls are of glass. The South and East side should be covered with green net while the North and West side should be covered with black polythene sheet with 50% transmitted sunlight. The misting-house is covered with black vinyl - 50% inside at the top to suppress evaporation. A main pipe is installed under the bed and connected to vertical pipes 1.5m high each of which is fitted with a misting head. Each bed contains 15 misting heads

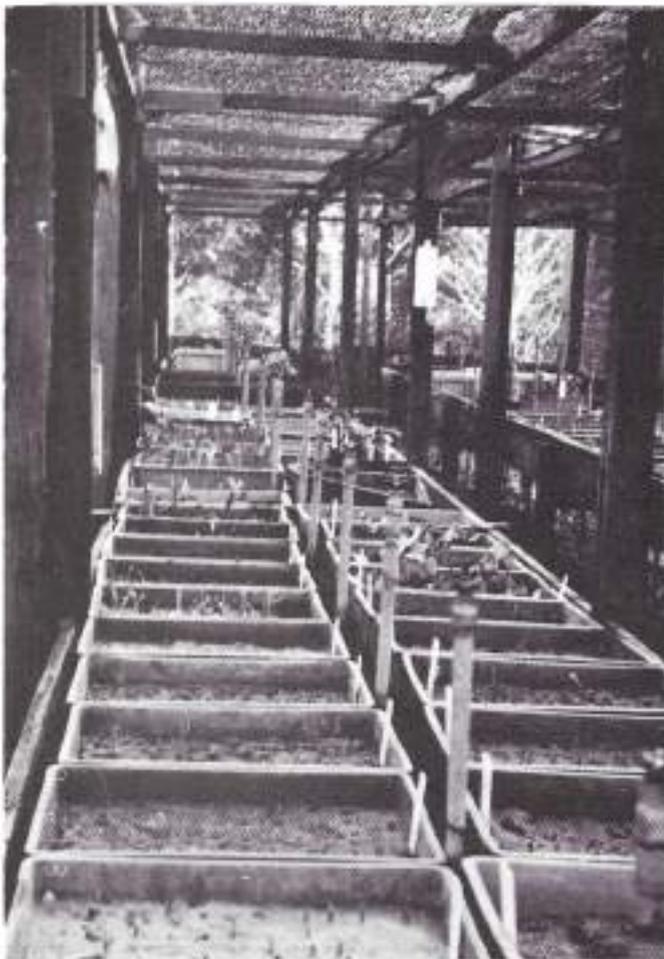
Boxes of 35cm x 40cm x 17cm are filled with sterilized sand and are arranged in the bed frame between jet-nozzles that can produce a fine mist spray.

2.4 Various steps against rooting of cutting

Water temperature and the rooting medium are required to be further worked into to promote the rooting of cutting.



Picture 1 misting house



Picture 2 cutting beds

(a) **Light Intensity**

Light Intensity is one of the techniques for the rooting of cutting, thus how to prepare the cutting of scions.

Comparison between cut leaves and non-cut leaves on the scions had been done previously. The results showed that rooting with non-cut leaves is very poor.

The following trials were carried out; a black shading sheet of 50% transmitted sunlight was brought in from Japan and set up over the bed frame as a ceiling. The second trial is made but the results were also poor with an increase of 2% - 3% of rooting rate. Our scions were collected from over 5 years old trees. In the next trial, the surrounding bed medium is covered with a transparent white vinyl sheet in order to keep a higher temperature and moisture but it was darker with illumination reading under 3 000 lux. The result of this trial was good when compared to our previous two trials.

The misting house at Kinarut is located about 25km South of Kota Kinabalu with a latitude of 5 degree North. The maximum intensity of sunlight during the day was 120 000 lux but it depended on the daily weather. Generally at 0800 am to 1000am, the reading was approximately 10 000 lux to 30 000 lux respectively. The illumination inside the misting house is proportionate to the outside reading.

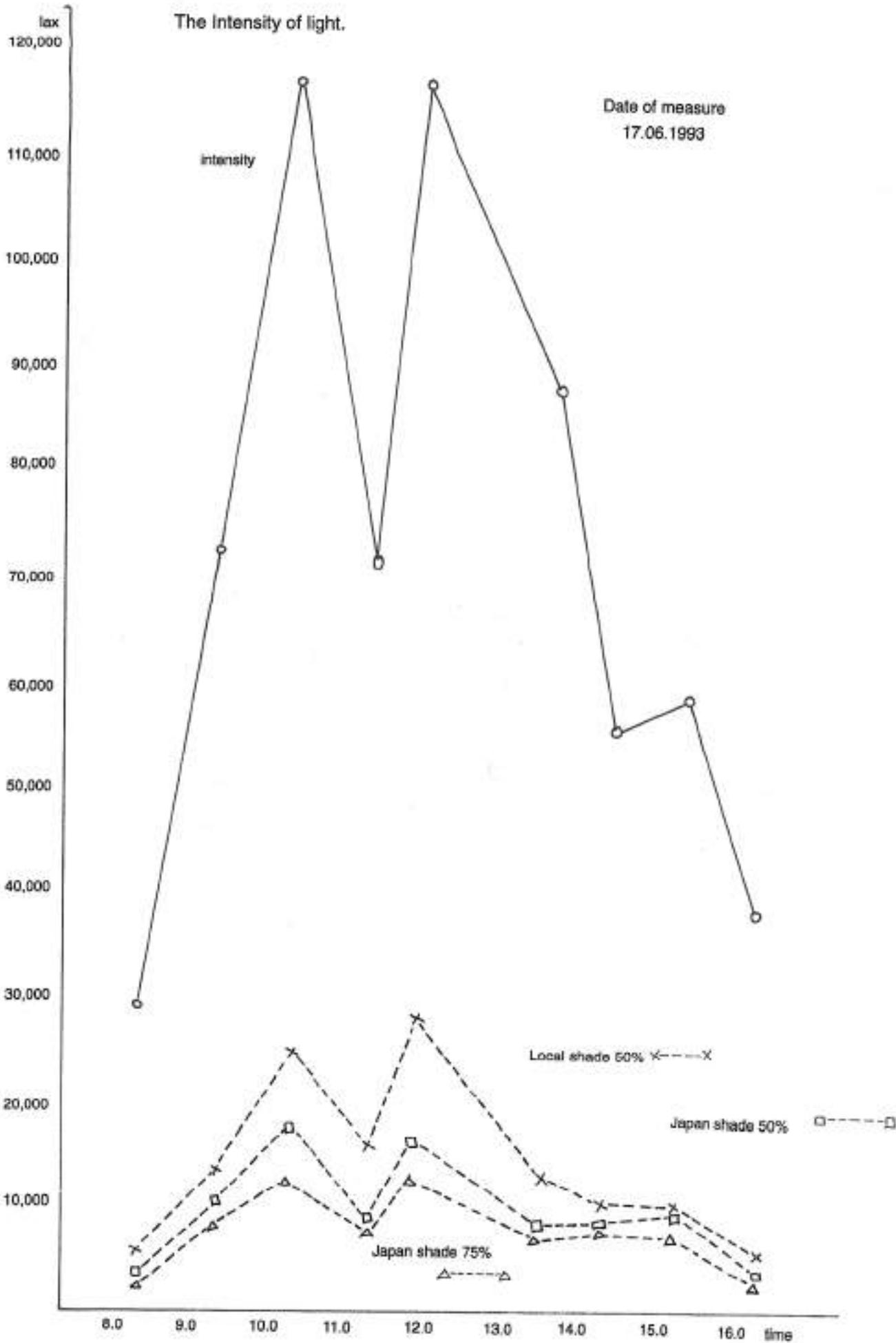
After investigating the light intensity, several steps were taken to find the most suitable conditions for cutting cultivation in a misting house. Shading sheet at the top was changed to a black vinyl sheet with different light penetration of 75% and 50%. Vinyl sheet with 50% light penetration shown 17% - 24% value against the intensity of outside radiance as shown in the graph attached.

It seems very difficult to control the illumination inside the misting house. We carried out another cutting trial with shading sheets allowing different amounts of light through as mentioned above, and the results are as shown:-

Table 6: Comparison of rooting rate on different light intensity.

Date planted	(Taito -Seiko Company) Black vinyl sheet from Japan						(Black Polythene Sheet) Local vinyl sheet		
	75%			50%			50%		
	Q	S	R	Q	S	R	Q	S	R
22.12.92 16.02.93	124	5	3.5%	83	7	8.4%	222	22	9.9%
02.02.93 07.04.93	84	7	8.3%	84	4	4.8%	84	17	20.3%

Note: Q - quantity
S - survival
R - rate



Result:

We repeated this trial twice and the result shows no difference, but with local vinyl shade of 50%, it gave a better rooting rate of the cuttings than other materials used.

This trial indicates that the rooting rate is probably related to intensity of light. At the moment, only a few could be changed and renovated inside to allow more sunlight to pass through.

Below is the result of analysis of variance which was conducted to determine the significant difference of the various of shading sheets used in the trial.

Table 7: Analysis of variance in comparison of rooting rate on different shading used.

Factor	SS	DF	Ms	F	
between	189.42	2	94.71	1.70	ns
inside	555.05	10	55.50		
total	744.47	20	150.21		

No significant difference at 5%.

SS = Sum of square

DF = Degree of freedom

F = Variance-ratio

Ms = Mean square

(b) Water

In marcotting, while the marcot is still attached to the tree, it is not necessary to water it like in cutting propagation.

For cutting cultivation in the misting-house, watering is very important and should be done many times a day to keep the humidity and moisture constant because if insufficient water is received by the cuttings, they will wilt.

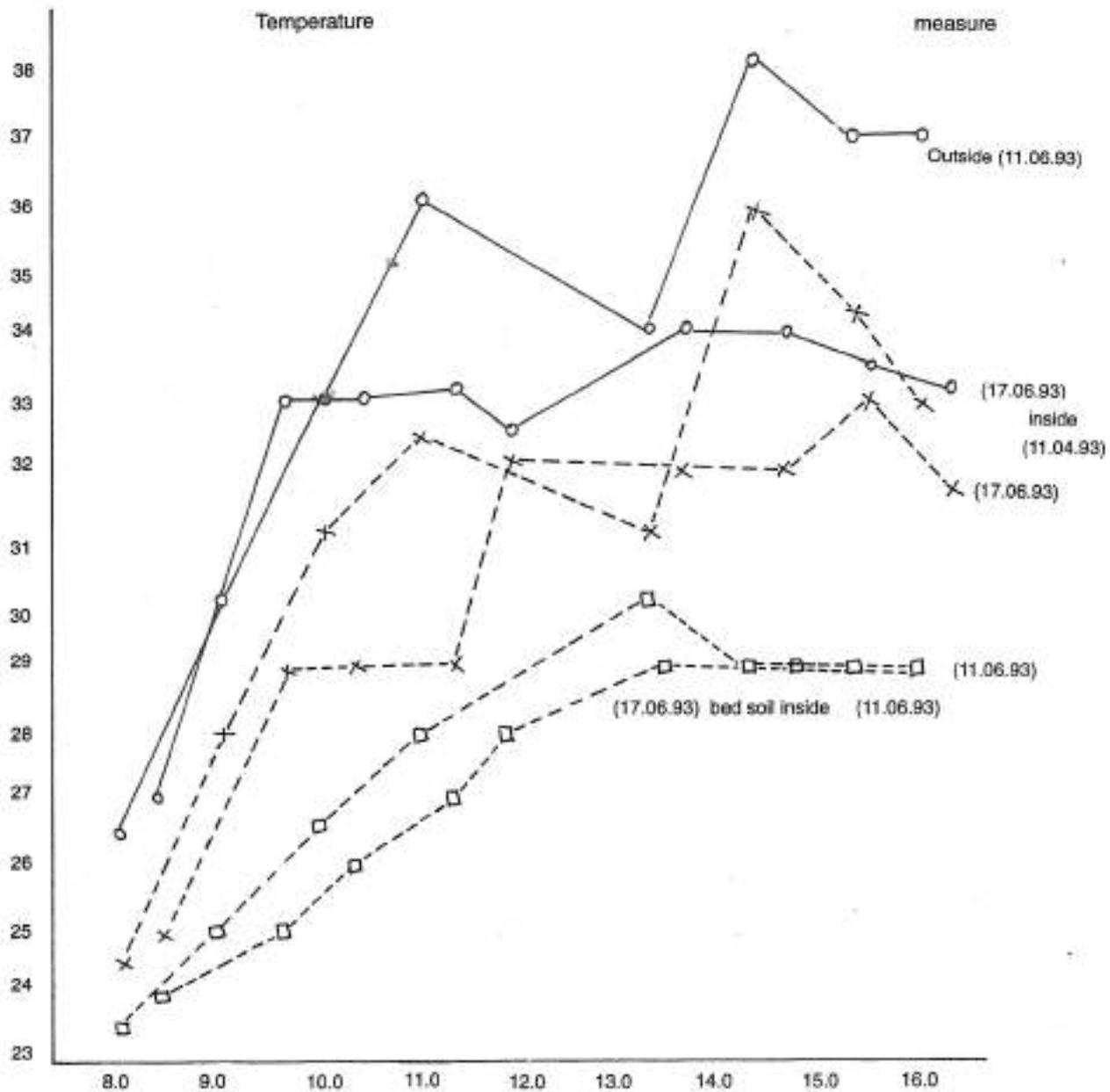
The use of a moisture control timer is necessary to give high survival of cuttings. Water has to be supplied in quantity for root development. Seven nodes of cuttings were dipped in a flask with diameter of 7 cm and the rate of transpiration observed. Observation was done for a week and it was found that the water has decreased about 17.03g or an average of 0.064g per hour.

The above experiment was carried out in the laboratory room but the same experiment was also repeated in misting house. It is observed that decrease of 0.745g was by evaporation with an average of 1.193g per hour. The decrease in volume of water (same volume) was higher in a misting house. This was due to high humidity and temperature in a misting house compared to the experiment done in the laboratory room. Absorption by the cuttings and evaporation occurred continuously.

The third experiment was done by putting a flask at the nozzle of the misting head. It was observed that 0.75g of water per second pumped from the nozzle into the flask. A misting head can supply to an area of about 7cm which is equivalent to 3.75g of water in 5 second every 30 minutes. The exact amount of water needed by cuttings for rooting is yet to be known, since it always depend on the degree of humidity as weather changed all the time, resulting in wilting of some of the scions.

(c) **Temperature**

But by keeping cuttings in a misting house which is covered with vinyl sheet and transmitting 50% sunlight, this reduces the temperature of the bed medium. The outside temperature and the temperature in the misting house are in a proportion 2-1 respectively. If outside temperature has increased, the inside temperature of the bed medium will also increased. Soil temperature that we observed is about 30 degree.



(d) **Bed medium**

In cutting propagation, medium suitability has great influenced in the development of roots. A cutting medium should be chosen based on several factors:-

- (a) Good air permeability
- (b) Good water retention
- (c) Correct species
- (d) No fertilizer or other organic matter
- (e) Easily and cheaply obtainable

In Sabah river sand is cheap and easily obtainable. The base rocks in much of Sabah, is tertiary sand stone, silted stone, mud stone and shale. River silt has the smallest grain and therefore has poor air permeability, but coarse river sand is a good medium, since it has good air permeability for cutting propagation.

For our trial, we collected sand from rivers flowing into the West China Sea and analysed them. One kilogram of sand was collected from each river and sieved to remove all debris. All samples contained over 65% of pure sand under 4.25 PU. Sand from Tuaran and Beaufort rivers contained 20% of over 300cm or 200mm of the smallest grain of less than 200mm diameter.

Sand from the Kota Marudu River is more even in size and with good drainage. Ph is strongly acid and is suitable for Acacia species in rooting of cuttings.

Table 8 shows a different content of acidity.

Table 8: Rate by different bed medium grading

Sieve size PU	K. Marudu river %	Tuaran river %	Beaufort river %
1.06	5.3	3.0	12.0
2.5	17.7	7.2	26.2
4.25	38.8	50.8	38.2
8.5	31.0	20.5	6.2
200mm	8.0	18.5	17.2
PH	7.5	7.0	6.0

Note:

Date trial checked: Jan 12, 1993

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Table 9: Survival of cuttings: Comparison between medium used on different species of Acacias

Medium	K. Marudu	Tuaran	K. Belud
Species			
A. hybrid	40.0%	20.0%	20.0%
A. mangium	6.7%	10.0%	6.7%
A. auriculiformis	56.0%	10.0%	16.7%
	34.0%	13.3%	15.0%

Note:

Date of trial : 13.05.93 - 07.07.93

Source of variety : Scion collected from scion garden at Kinarut.

Result

Coarse sand from Kota Marudu river gave the best performance among the three media tried.

Statistical treatment indicated no significance at 5% of probability as shown below.

Table 10: Analysis of Variance

Factor	ss	df	Ms	f
between	603.63	2	301.815	1.095
within	1652.91	6	275.485	

Not significant at 5%.

The other media included in this trial are as follows:-

Table 11: Survival of cuttings comparison between medium.

Bed medium	Kanomado 50% + Sand 50%	Kanomado 100%	Jiffy - 7
Survival %	33.0	23.0	33.0

Note: Trial conducted was on Sept. 5 to Oct. 18 1991

Result

- River sand - The smallest grains have poor drainage.
- Kanomado - Brought from Japan. Of volcanic origin which contains aggregated soil structure, excellent air permeability and is water retentive. Cutting of Acacias could not stand firmly in the medium, since the structure of soil is very coarse.

The best result among these mediums is Kanomado 50% + sand 50% and Jiffy -7 with 33.0% survival in both cases. Jiffy-7 retains water for a long time resulting in growth of green moss.

It is concluded that medium of coarse sand with 5 PU = 1mm of diameter is considered better since the cutting could be planted, fixed strongly into the medium and has air permeability.

2.5 Various factors affecting survival of cutting.

(a) Tree age

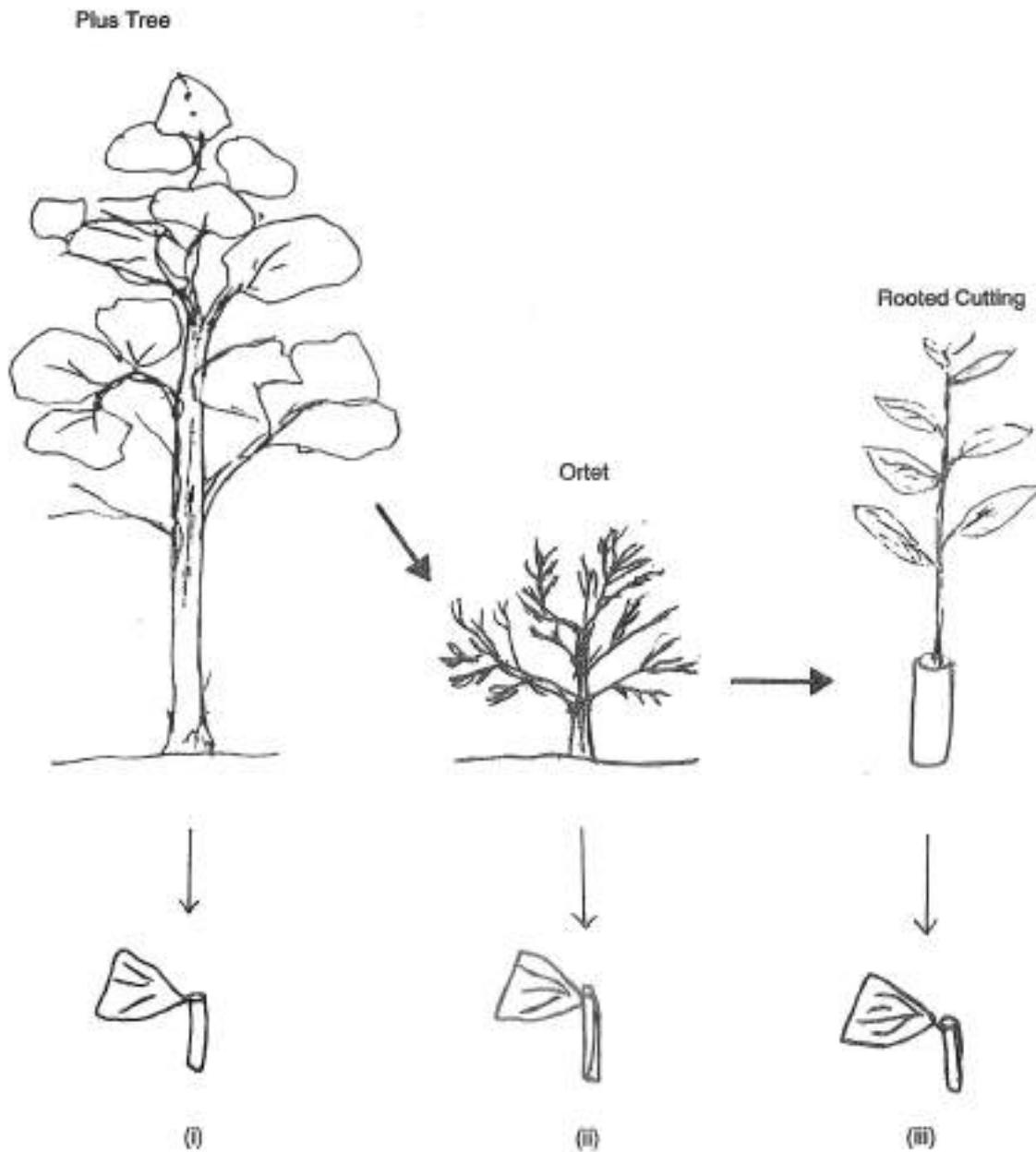
Generally, rooting and survival of cuttings from young trees is better than from old trees. The rooting of cuttings from *Acacia mangium* trees of different ages were investigated.

Table 12: Rooting of cuttings from trees of different ages.

PT No.	Tree age	Quantity	Survival	Rate %
* 3	3 months	80	75	94.0
82	4 years	24	12	48.0
MA-5	5 years	70	3	7.8
62	8 years	54	5	1.6
96	10 yrs. +	33	4	7.5

* This plus-tree was collected according to the age of scion taken from a marcot and from old trees for comparison on survival rate of cutting. The result indicated that scion or branch tip of plus-tree between 5 to over 10 years has very poor rooting of 3 - 5%. But scion from coppice of marcots that sprouted even before 3 months has shown a higher rate of 94.0%. Trees of 4 years has a 48.0% survival. In conclusion, scions from marcotted trees is a good scion source for cuttings.

(b) Different sources of cutting



1. Our next trial is to compare rooting of cutting of scion from different sources and positions.

- (i) Scion taken from parent tree at Ulu Kukut.
- (ii) Scion taken from the ortet of marcotted tree.
- (iii) Scion which sprouted from the ortet.

Table 13: Different sources of cuttings

Plus-Tree	Classification of scion source	Age	No.	Rooting	Rate %
PT 23	Plus tree	18 yrs	120	11	9.2
PT 23	Orter scion	13 mths	30	12	15.0
PT 23	Sprouted scion	5 mths	119	43	36.1

Note: Period of trail: 04.12.92 to 18.01.93.

Result

Sprouted scion from ortet of 5 month old gives a higher performance in rooting of cutting.

(c) Scion collection from different heights of a plus tree

In propagation of cuttings, the survival rate of a scion from matured trees was found to be very low. An experiment was done to examine which position of the crown produced scions with best rooting. Our trial consisted of 4 collecting scions from different heights. A 4 year old plus tree of height 13m was chosen. The levels are as marked below:-

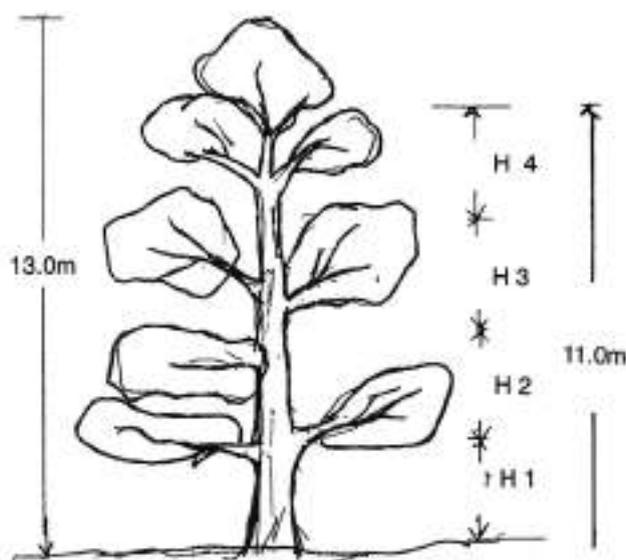


Table 14: Cutting on different source of scion.

Division	Coppices		Branch tip		Average
		%		%	
H 1 (4m)	5/133	3.8	4/69	5.8	4.4 %
H 2 (7m)	2/53	3.8	2/53	3.8	3.8 %
H 3 (9m)	0/52	0	2/64	3.1	1.8 %
H 4 (11m)	0/25	0	0/52	0	0 %

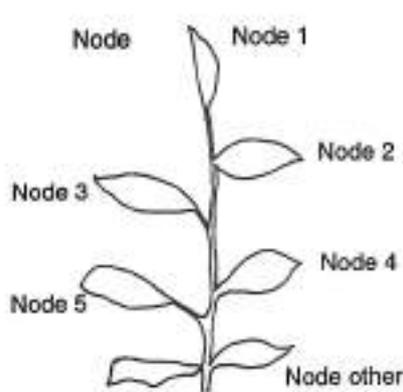
Note: Date of trail: Sept. 05 to Oct. 06 1992.

Result

The rooting rate was very poor. The results, however showed that the best results were from scions from the basal part of the tree. With marcotting, rate of rooting is the same but the higher you marcot the better is the survival.

- (d) Scion from different position of the leaf nodes.
The rooting of scions from different positions of nodes were examined.

Table 15: Cuttings of different position of nodes.



Node	Quantity	Rooting	Rate
1	72	0	0.0%
2	67	9	13.4%
3	66	16	24.2%
4	50	7	12.1%
5	59	7	12.0%
Other	345	3	0.9%

Note:
Date of trial : May 03 to June 05, 1991.
Variety : *Acacia mangium*
Tree age : 4 (estimated)

Result

The third leaf node gave the highest rate of rooting. The first nodal was too small and soft and the sixth node too matured to give good rooting results.

- (e) **Coppice of pollarded tree**

Four year old trees were pollarded, 2 trees each at 30cm, 50cm, 100cm, and 150cm.

Table 16 Production of *A mangium* coppice took 3 month to sprouting.

Pollarded height (cm)	Diameter cm	Height m	Prod. coppice	Cutting	Rooting	Rate %
30	10	6	57	38	19	50.0
30	8	5	23			
50	9	5	62	24	16	66.7
50	16	6	39			
100	8	5	39	44	32	72.3
100	10	5	57			
150	12	5	73	61	32	52.0
150	8	8	13			

Note:
Pollarding date : September 04, 1992.
Collected scion : October 05 to November 26, 1992.
Planted date : November 14 and November 26, 1992.

Result

No comment about this trial. However, scion from the lowest pollarded trees gave the lowest result. Rooting rate increased at 50cm and at 100cm giving 66.7% and 72.3% respectively. It gradually decreased in rooting percentage at height 150cm with 52% but is still good compared to the pollarded height of 30cm with 50% rooting.

This technique should not be applied to plus-trees, as it might die instead of producing coppice and thus the loss of a source of genetic value.

2.6 Making scions

Generally, we prepared scions by cutting the internodes and above and below one or 2 nodes cutting the leaf or 2 leaves in half. The internodal lengths of *Acacia* species is 2cm to 5cm on average. We had started our trial without leaf but failed. All plants including cuttings need light for photosynthesis for survival.

(a) Making scion with two leaves

We examined the rooting of one and two leaved cuttings as shown below:

Table 17: Cutting of different leaf cut.

No. of leaf	Young tree	ortet	Average %
one	20.7	18.5	19.3
two	12.1	19.2	15.3

Note:

Variety : *Acacia mangium*

Young tree : 3 years old

Ortet : 3 months old

Planted date : March 12 to April, 1992.

Result

One leaf per scion from a young tree gives 20.7% result on average compared to 12.1% two leaved scion from a young tree.

From this trial we could conclude that there is not much difference between one and two leaved cuttings, but there is a difference with a leafless scion.

Below is another result of trial on different leaf cuttings.

Topic: Trial of PT scion cutting using different types of cutting medium and leaf position (uncut leaf).

Material: Scion of PT 3, Hybrid (3 month), sterilized sand 50% + Kanomado 50%, and sterilized sand 50% + gravel 3mm - 5mm 50%.

Date of trial : 25/09/1991

Distance rate : 18/10/1991

Table 18: Cuttings and size of leaf retained.

Soil Type	Pcs.	Scion	Leaf			Total
			1/3 uncut	1/2 uncut	2/3 uncut	
Sand (100%)	20	CPT 3	5%	25%	0%	10%
	10	Hybrid (3 month)	100%	90%	90%	97%
Sand 50% + Kanomado 50%	20	CPT 3	20%	35%	50%	35%
	10	Hybrid (3 month)	100%	100%	100%	100%
Sand 50% + Gravel 3mm - 5mm 50%	20	CPT 3	25%	15%	10%	17%
	10	Hybrid (3 month)	90%	90%	90%	90%
Total			43%	47%	47%	

From our observation, there is no significant differences in rooting between 1/3 leaf, 1/2 leaf and 2/3 leaf lamince retained.

The best medium for rooting of scion was sterilized sand + kanomado (ratio 1:1). The effect of leaf cutting position (horizontal) showed no differences.

After identifying the problems and rectifying the technical aspects, we expect to get a better results which is comparatively similar to what we have achieved when doing cutting trials with young seedlings.

(b) Length of cutting

Rooting of cuttings can be improved with a suitable leaf cut and length of scion. We conducted the trial to find out the most suitable length of cutting. We cut the scions into 3cm, 6cm, and 10cm lengths from the ortet of *Acacia mangium*.

Table 19: Cuttings with different length of scions.

Length	Quantity	Rooting	Rate
3cm	279	59	21.1%
6cm	248	45	18.0%
10cm	239	25	10.5%

Date planted : Sept. 08, 1992 to Nov, 1992

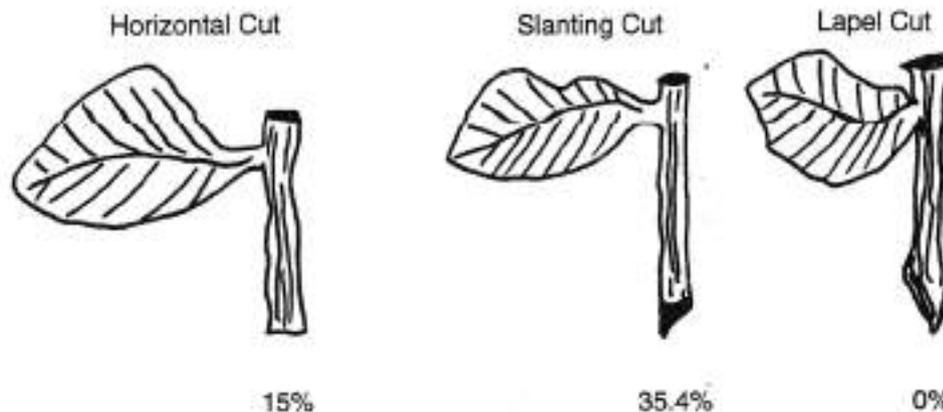
Variety : *Acacia mangium* plus-tree from Bongkol Project.

Result

Cuttings 3cm in length gave good results. On average, the suitable in length of *Acacia* cuttings is about 3cm to 5cm.

(c) Basal cutting of scion

Roots developed from the callus of basal cuttings. We carried out this trial to find out which type of basal cuttings would root best. Three types of cuts were carried out as follows:-



Note:

Variety : Hybrid ortet

Trial date : 12.10.1992 to 23.11.1992

Result

A slanting cut gave the best result since the basal face for callus development is larger than the horizontal cut.

The larger cut surface in contact with the sand is better for water absorption. In case of lapel cut, we cannot get good result because cut top of the scion was destroyed when the scion had been planted in the sand.

2.7 Cutting practice

(a) Bed preparation

Our bed shelf in the mist-house is raised 70cm from the ground and is 1 meter in width. Adjustable jet nozzles are installed along the mid of bed shelf. For ease of work and smoothly operation, a box 30cm x 45cm x 17cm is recommended. Sterilized sand is poured into the box and arranged along the bed shelf. One box can hold about 200 ramets of cuttings the bases of which are planted in the medium to avoid toppling over during watering.

(b) Method of cutting

The cuttings were prepared by using the slanting cut method at the base of the ramet and plant in a row. Distance of each planted ramet was about 3cm. The suitable depth for planting of cutting is 1cm to 1.5cm if a single node of cutting is propagated.

2.8 Rooting promotion

(a) Auxin treatment

We conducted a trial on the rooting effect of auxin on Acacia cuttings which seldom resulted in good or bad performance.

Table 20: The rooting effect of Auxin.

Auxin	Survival
Seradix 1	13.6%
Seradix 2	14.3%
Seradix 3	16.6%
Oksiberon	12.5%
Moreroot	0.0%

Note:

Variety : Acacia hybrid of 1 year old.

Examined period : 10.9.92 to 01.11.92

Result

No difference were observed between auxins used but Moreroot failed to stimulate root production. The effect of using rooting hormone is that it promoted a large number of roots. In this trial survival rate was too low, however, we were unable to find out its cause.

(b) Water and Silver Nitrate treatment.

- a. Collected scions are soaked in the water to prevent wilting and to wash out the resin from the cut end as they hinder the absorption of water.
- b. The scions which were collected from mature trees were soaked over night in Silver Nitrate solution at concentration of 3000ppm.

Table 21: Trial of Silver Nitrate treatment.

Method/Treatment	Quantity	Survival	Rate %
Control	1245	52	4.2
Silver Nitrate	510	58	11.20

Note:

Date of trial : November 22, 1992 to December 1993.

Result

Silver Nitrate treatment gave a much better result than the control which was just soaked in water.

2.9 Medium sterilization

Using the same medium several times in vegetative propagation could affect the rooting of cuttings and also seed germination. Medium which are used several times turn green on the surface and also become a source of pathogen which could be harmful to rooting of cuttings.

(a) Medium sterilization

Sand medium for cutting bed are used in the trial

Table 22: Rooting effect of medium.

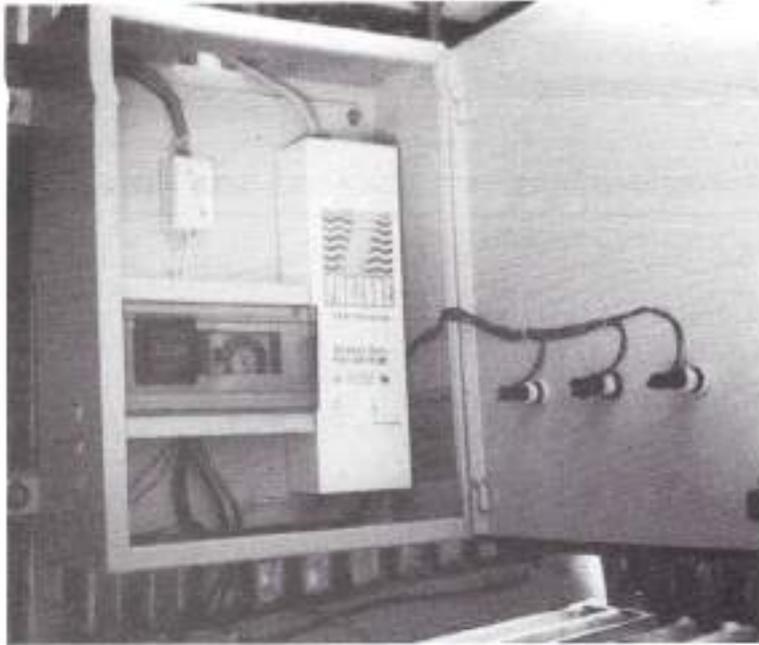
Method	Quantity	Survival	Rate %
Sterilization	100	23	23.0
Non-sterilization	100	0	0.0

Note:

Date of trial : 26.02.92 to 19.04.93

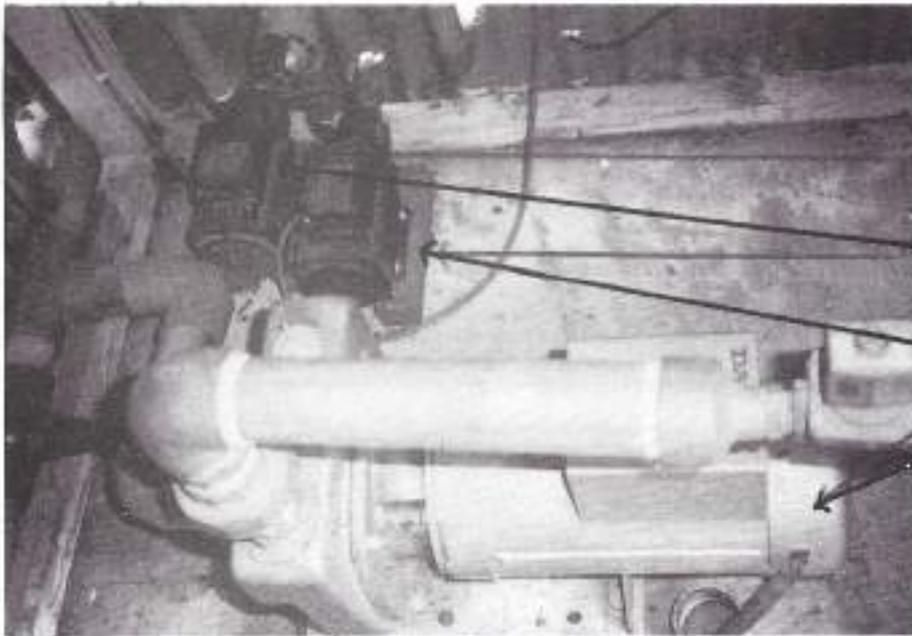
Variety : *Acacia hybrid*

Medium : River sand



Electricozone
equipment

Picture 3



Water pump

a. Sterilizer water
pump

b. Pump up water
from main tank

c. Main water pump.

Picture 4



Main tank

Sterilizer tank

Picture 5

Result

All cuttings which are planted in control medium (non-sterilization) died three weeks after planting. The sterilized medium was heated at 250 Celcius for 3 to 4 hours in the oven.

Another trial was conducted by sterilizing the media under sunlight. The sand was spread on a concrete floor and exposed to sunlight for 2 or 3 days. However, the cuttings all died.

(b) Water sterilization

The purpose is to kill any bacterium source, since all vegetative materials die easily in dirty and infected water. The most suitable water source is rain water. But during dry season, water is taken from river, pond or from other water sources. The water is ozonized.

The Fishery Agency reported that before sterilization took place, water content of bacterium is about 1363 organisms per 1cc and decreased to 3 per 1cc after sterilization. The Water Department, Kota Kinabalu, reported that water content of bacterium after passing through sterilization equipment contained is under 100 bacterium per 1cc.

In trial cuttings, we had tried to find out how rooting of cutting influenced by disinfected water, but we could not exactly know the result.

2.10 Rooting and growth of cutting

(a) Rooting

Rooting seems to differ for different *A. mangium* genotype. Cuttings from some trees root as early as nineteen days but others take about one and a half month for rooting.

(b) Growth process

We had conducted a trial on the growth process of rooted cutting seedling after potting. In the early stage of cutting seedling, it shown a slow growth. Because the roots are not enough to support any nutrients to the upper part and photosynthesis function is not enough compared to the seed seedlings. But cutting seedling will become normal in growth as their enough leaves and roots grow at later stage.

(c) Time of cutting

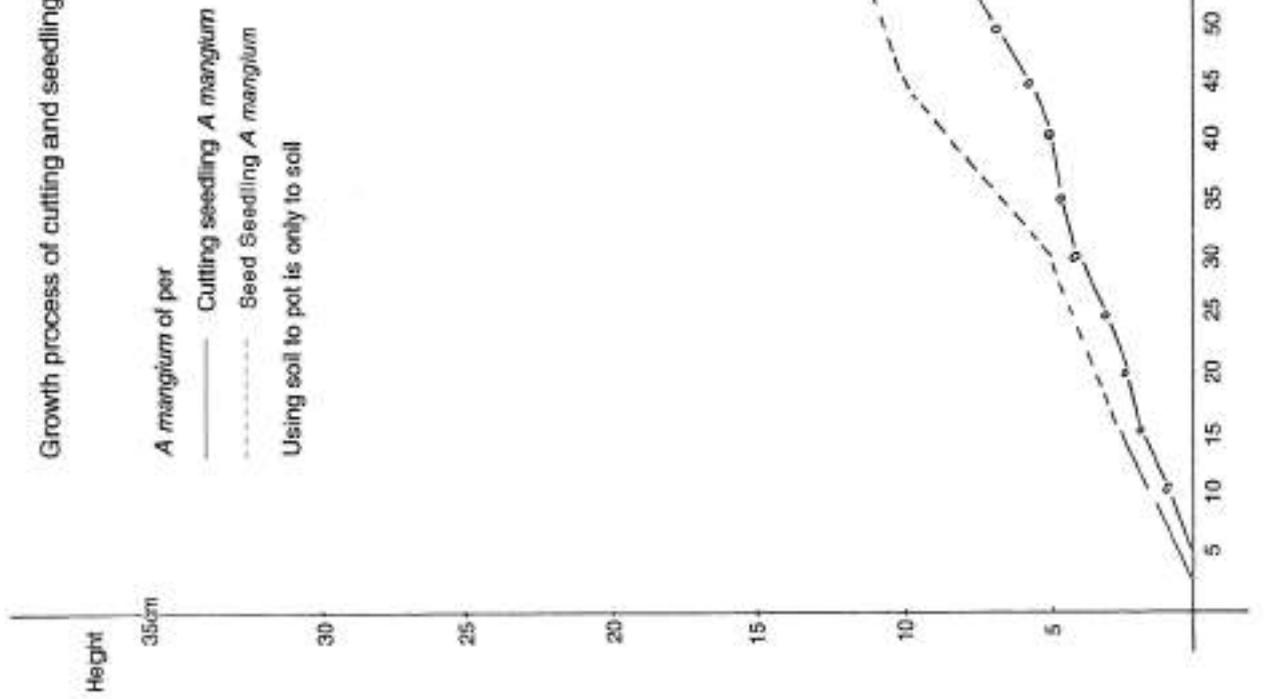
Sabah has a dry season. In Kota Kinabalu, flowering occurs twice a year. Firstly from late June until August and the second time from late November to January.

Because scions from matured tree during the flowering time, gave poor rooting success we observed the rooting of cuttings versus month of cutting from scions from our scion garden tree.

Result

We always propagate cutting from new sprouts of marcots. According to our trial, rate of success was in late September to February than in March to August.

Growth process of cutting and seedling *A. mangium*.



2.11 Final trial

We carried out various cutting trials with significant results. In January 1993 we conducted a final trial based on experience of our various experiments.

Table 23: Final cutting trial

PT number	5	10	17	27	34	Total	Rate %
	21/30	14/30	15/30	14/30	18/30	82	54.7
Rate %	70.0	46.7	50.0	46.7	60.0		

Variety : *Acacia hybrid*

Date of trial : January 1993

Result

Progress so far was 60% survival. Further trials are required in connection with light intensity, water and so on.

2.12 Conclusion

- (a) Cutting from seedling have a higher rooting rate success than cutting from other trees.
- (b) There this same observation can be applied to other tree species. The procedure is as follows:-
 - (i) Establish a scion garden from plus trees by marcoting.
 - (ii) Carry out cuttings using scions from marcots of scion garden.
- (c) To obtain good rooting of the cutting, the usual technique and care given to *Acacia* cutting must be exercised.

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