BUDDING AND GRAFTING OF TEAK
(TECTONA GRANDIS)

by

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Before starting the discussion of vegetative propagation in teak a question will naturally arise: What is the purpose? Does vegetative propagation not require planting of teak and is it not easier and cheaper just to rely on natural regeneration in the mixed stands of existing teak forests? For a long term policy I think the answer will be No! With the great demand for teak, a demand which might still increase, the situation post war has changed considerably. One way of lowering the cost of production is to use improved planting material by which is meant faster growing teak of better quality. The vegetative propagation gives the plant breeder in general a possibility of analysing the genetic variation of the crop he is concerned with and thereby making way for improvements. When the question is about teak there are some special circumstances which make the budding of this species of more than general interest.

It is no secret that the reserve of natural teak forest in Thailand is rapidly decreasing mainly due to illegal cutting and destruction of the natural regeneration by fire. Dr. Loetsch from FAO who has made a survey of the teak forest in Thailand recently states that if the present rate of cutting continues the accessible teak of timber dimensions will be exhausted in 15 years. The illegal cutting may have another dexterious effect beside reducing the reserve in an uncontrolable manner. When the foresters have marked trees for girdling they leave a certain amount of the better trees as seedparents. These trees however are the most attractive for illegal felling and will disappear first, leaving only the second rate trees to produce seed for natural regeneration. There may thus be a possibility of a negative selection and the next generation of trees may be of poorer quality and growth than the former.

It was my impression from a 3 months' stay in Thailand and from my travels in the North that teak logs are becoming more and more laborious and costly to bring out to the sawmills as the teak along the main communication lines has been cut already. As to render the production of teak more economic for a long term policy the growing of teak in plantations is no doubt necessary.

It is especially here the forest tree breeder comes into the picture. By vegetative propagation the inheritable characters of the selected trees are transferred unaltered to the buddings or graftings, and thus trees of outstanding forestry value may be preserved also after the budparents have been felled. One of the purposes for the investigations was therefore to find a practical method for the vegetative propagation of teak and eventually to establish a clone collection. Such a clone collection gives the breeder and opportunity to study the individual trees' growth habit (flowering, branching, ect.) and to a certain extent compare their vigour. Later when the trees start flowering controlled pollination may be carried out—a procedure which otherwise would be very difficult with the selected trees scattered over vast areas. Vegetative propagation may also be employed in building up seedgardens for the production of high class strains of seed for plantations.

The budding.

a) Method:

From Indonesia it has been reported that budding of teak has been carried out with success (van Alphen De Veer, 1954, and Hellinga, 1956). The budding method was however not mentioned. Mr. Sa-ard of the Kasetsart University, Bangken, managed to bud a small number of teak on potted plants using the same method as with roses and certain forest trees, the so called shield budding. Unfortunately these buddings died when the nursery was flooded.

In the current investigations only the *forkert budding* method was employed. This method is used extensively for budding of rubber (Hevea brasiliensis) and it was assumed that it would also suit teak.

The forkert budding method is illustrated in the figures 1 and 2 and can be described shortly as follows:

Two vertical incisions forming a pointed arch are made on the rootstok. The rind flap thus made is lifted where the cuts meet exposing the cambium of the stock. A budpatch i.e. a rectangular piece of bark containing one bud from the selected tree is placed on the exposed cambium and the flap pushed back. The union is covered with a rectangular piece of palm leaf which is tied firmly to the stock beginning from below and going upwards. The budding is finally shaded with some bigger leaves fixed to the stock above the union.

The completed budding is left for a week or more depending on the species before opening takes place. After that time the budpatch and usually the flap has grown to the stock. At opening, the rind flap is cut off exposing the budpatch. Some time after opening when the callus has hardened and one is sure the budpatch is still alive the stock is cut back.

b) The experiment:

The actual budding took place in the days from the 19th April to the 8th May at Huey Tak Teak Plantation in the Lampang province. Two areas in a 1958-planting with a stand of seedlings as even and complete as we could find it were selected for the experiment. The two plots (no. 1 and 2) were fenced in to prevent water buffaloes from damaging the buddings. The planting distance was 2×2 m, and the seedlings were planted as 1 year old stumps. Thus the stocks for budding were 2 years old from seed and 1 year from planting. The size of the stocks varied considerably, but the average diameter at budding height was about 3 cm. All the seedlings had developed new leaves at the time the budding started.

Plot 1 measured 48 × 20 m = 960 m^2 and contained 230 points (10 rows of 23 points) of which it was possible to bud only 139. Plot 2 measured 30 × 24 m = 720 m^2 and had 168 points (12 rows of approx. 14 points) of which we could bud 103. In plot 1 and 2 were budded 5 and 6 clones respectively, most clones occupying 2 rows. Regarding details see table 1.

The procedure in budding the 11 clones was as follows: Budwood from selected trees situated at some distance from the plantation was usually cut in the afternoon, stored in bathroom overnight and used for budding the following morning. From the selected trees in the plantation we managed in most cases to cut the branches the same morning as the budding took place. The selected trees were in different degrees of leafing-out. Some appeared to be still resting while others, especially the younger ones, had fully developed leaves. From the branches of the latter the leaves were immediately cut off after the branches were brought down from the tree.

The budding operation in the field began with slicing off from the budwood a sufficient number of patches each containing a bud. The slice was cut deep enough to remove a small sliver of wood as well as the bark. The slices were collected, wrapped in paper and taken out one at a time when cuts were made on the rootstock. The wood was carefully separated from the bark in order not to break the latter. The budpatch was then trimmed in a rectangular shape to fit the cut on the rootstock. When placing the budpatch under the lifted flap care was taken not to rub the layers of cambium against each other or to make them dirty. The binding, shading and the opening of the budding has already been described.

Discussion of the experiment

The time of the year chosen for the budding is normally the hottest season in Thailand, and as regard to rainfall it is a transition period between the dry and the rainy season. The few showers in April are sufficient to start the flushing of the young seedlings which is essential for the budding operation.

Fig. 1. Budding of Teak. Insertion of budpatch on rootstock.

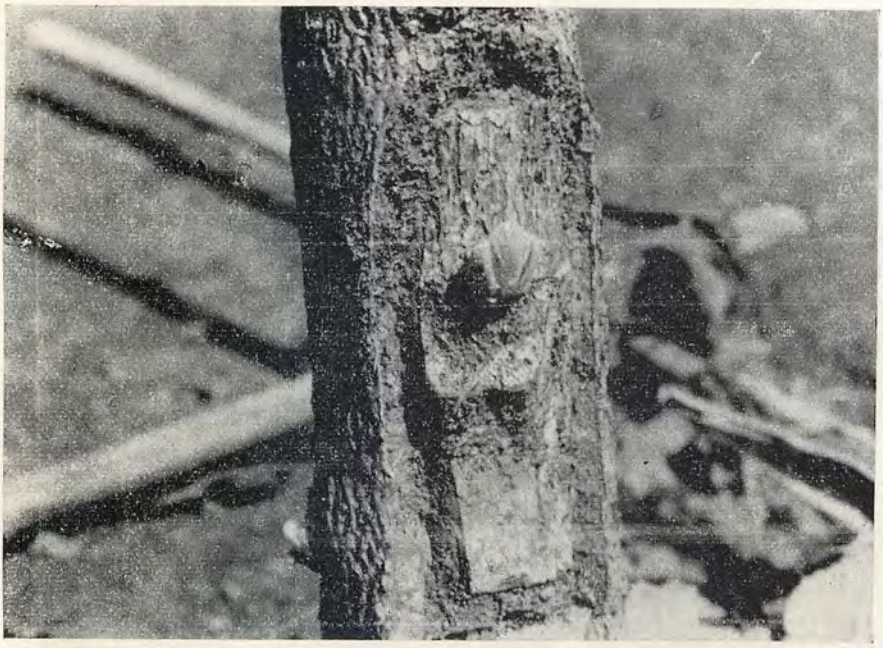

Fig. 2. Close-up of a sprouting budgraft. Note that the space between budpatch and sides of incision on the rootstock is completely covered with callus. The photograph is taken 16 days after the actual budding. Slightly enlarged.

Fig. 3. Sprouting budgraft. Budded 19th April–phot. 11th May. Callus formation less good as the budgraft was opened only 4 days after budding.

Fig. 4. Same budgraft as in fig. 3 photographed on the 25th May i.e. 5 weeks from budding. Shoot measured 25 cm.

Only after the leaves appear will the bark "go", which means that the cambium becomes sufficient active for the bark to be lifted without breaking.

The selected trees from which budwood was taken were, as already mentioned, in various stages of flushing, but in general less advanced than the seedling stocks. The stages of leafing-out including trees apparently still resting and trees with fully developed leaves did not in our experiment show any effect on the success of the budding. The budding period can no doubt be extended into the rainy season.

It soon became obvious that the callus formation on the stocks was very active. In order to find out how soon we could open the buddings, one was opened the 5th day after budding. Already then the budpatch had grown to the stock although the space between budpatch and the sides of the cut was not yet covered by callus. The same budding cut back 4 days after the opening began to sprout on the 16th day from budding. In comparison rubber may start sprouting 6 weeks after budding. To be on the safe side however most of the other buddings were not opened until 12 days after budding, which is probably a little too long to wait. We found several buddings in which the flap had grown completely to the stock after that period. Opening up after 8–10 days may be more satisfactory.

The time between opening and cutting back was tentatively fixed to 5 or 6 days. The criterion for cutting back is that the budpatch is still alive. If not, there is still a possibility of rebudding. We found, however, that all the budgrafts that were alive at the opening kept alive, and that cutting back immediately after opening as done for a number of stocks outside the experiment did not apparently do any harm. This observation is of interest and ought to be investigated further as the use of budded stumps in some cases might be more convenient. After cutting back the stocks normally "bleed" profusely for 4–6 days. When the bleeding stops, the bud begins to sprout or vice versa. Which one of the two causes the other we could not detect.

The sprouting of the budgrafts takes place mainly from the 4th to the 8th day after cutting back, but in some instances it may last as long as 2 weeks. In our experience early and late sprouting (as well as success and failure) to a large extent depends on the condition of the bud. It does not matter as far as we can see whether the buds come from 1, 2 or 3 years old shoots as long as the appearance is healthy and the colour of the buds greyish-green. The condition of the buds from shoots older than 3 years is a little difficult to judge and should generally be avoided. Late-sprouting buddings will often appear with 2 buds and correspond to an end shoot in which flowering has taken place, or in which the top bud in some way has been damaged. By removing one of the buds the budgraft will develop normally. To obtain healthy buds it is advisable to cut budwood from the upper part of the crown where the growth of the branches usually is the best.

The result of the budding was as a whole very satisfactory. In plot 1 the percentage of success was on an average for 5 clones 88 and in plot 2 the corresponding figure for 6 clones was 69. The last census was taken on the 25th of May. The recording of successful buddings in plot 2 lasted 7-9 days against 17-19 days for plot 1 due to the difference of 10 days in budding the two plots. This may account for the somewhat lower figure of 69% for plot 2 as not all buds had started to sprout within the 9 days. Details regarding budding of the individual clones can be seen in table 1.

In the case of the clones SG II and SG III in which the 1st round of budding was less successful the failures were rebudded, i.e. a new bud was inserted on the opposite side of the rootstock on which the original budding was made. Most of the rebuds succeeded thus making the stand of budgrafts more complete. Beside budding it was also tried to graft teak using almost the same procedure as with budding. The graft did not "take" nearly as well as the buddings, but we managed to get 5 successes out of 26 made. The scions are all taken from branches

which have recently flowered in the selected tree SG VIII. It will be interesting to compare buddings and grafts from the same clone, especially in the respect of flowering. It is possible that the trees developing from grafts will start flowering sooner than those developing from buddings. Finally 20 one-year-old seedlings were budded in the nursery. They were taken up, cut back and transplanted on the same day near the arboretum at Huey Tak Teak Plantation. These budded stumps were treated exactly as seedlings or ordinary stumps, the purpose being to test another way of establishing a clone collection or seedgarden. On the 6th day after planting, which was the last day of recording, all the budpatches were alive but had not yet started to sprout.

The selection of budparents.

The main purpose of the selection was to collect and preserve trees of good faenotypic appearance for comparison and further study in the clone collection. Trees both in natural stands of mixed teak forest and in pure stands on the plantation were sought out for straight axis, long clean bole, light spreading branching, well developed crown in good balance with the tree as a whole and last but not least vigour. It is the writer's impression that teak is strongly influenced by its environment and that a selected tree's fine appearance especially in mixed stands may be due to a fortunate position—a good upbringing so to speak. By multiplying the tree vegetatively it may be revealed whether its good faenotype is also genetically determined or perhaps which characters of the tree give it a preference for others. In this connection K. Gram and C. Syrach Larsen made some very interesting observations on the flowering of teak and its influence on the branching. In order to investigate these observations further two pair of trees from Huey Tak Teak Plantation were cloned for comparison of flowering early and late in life. The two trees of each pair grew near each other under the same external conditions. In each case one of the trees had flowered once or twice only and had a straight axis running through to the top while the other had flowered many times and

consequently branched out low down (figs. 6,7 and 8). Flowering had thus reduced the forestry value of the latter. It is of importance therefore to find out whether the tendency to flower early and late in life is inheritable.

In two instances (SG V and SG VI) buddings made from low and high branches from the same tree have been kept separate in the hope of producing juvenile and mature forms for further study.

In all 11 trees have been selected and budded in the 2 plots. Of these 4 are mature trees from mixed teak forest in the area between Mae Huat and Lampang and the rest from the Huey Tak Teak Plantation. Details of the selected trees marked SG I-XI can be seen in table 2.

Summary.

In the introduction the need for improvement work of teak is pointed out with a reference to the special circumstances in Thailand. Due to the abundant illegal cutting and extensive forest fires the productivity and quality of the natural teak forest is rapidly decreasing and the necessity of building up plantations of teak becomes of current interest. The planting of teak in plantations makes it possible for the forest tree breeder to make improvements. The vegetative propagation is of great importance to the breeder in respect of preserving the good faenotypes for closer study and comparison and for the establishment of seed-gardens.

The method of budding is termed the forkert budding method. It is used extensively in rubber (Hevea brasiliensis). The method is described in general first and later in detail for teak. Then follows a description of the experimental procedure, the lay-out of the two clone collections and the result of the budding. The present investigation shows that teak is very well suited for budding when using the same method as in rubber. At the last day of recording the 2 experimental plots contained 194 successful buddings distributed on 11 clones. The average percentage of success for both plots was 80.

Fig. 5. S.G.I. Selected tree in mixed Teak forest in the Lampang district. Approx. 80 years old. Note man in middle of crown on his way to the top for cutting down budwood.

Fig. 6. Sample plot no. 1 at Huey Tak Teak Plantation. Trees 13 years of age. Note variation in height and branching. Two trees, S.G.VII and S.G.VIII, selected and budded for comparison of late and early (in life) flowering.

Fig. 7. Top of S.G. VII, the late and sparse flowering tree. Only a few, withered inflorescences can be seen. Axis just beginning to fork at 17 m's height.

Fig. 8. Top of S.G.VIII, the early and prolific flowering tree. Many dead stalks from inflorescences can be seen. Forking started at 12.7 m.

From the discussion of the experiment it follows that the time between the budding and the sprouting in teak is 2-3 weeks, which is less than half the time used in rubber. It is also stated that the rootstocks are budable only when the leaves have developed, i.e. when the resting period during the dry season has passed.

About 2/3 of the budparents were selected in stands of planted teak in the age from 13-17 years, while the rest was selected in mixed teak forest of mature trees (60-90 years of age). In general vigorous trees with straight axis, clean bole and light branching were sought out, but special attention has been paid to the investigation of the inheritance of flowering characteristics.

References:

A more detailed illustration of the budding procedure as well as photographs of the selected trees can be seen in a special album produced for the Committee and remaining with the Secretary for Thai-Danish Botanical Studies.

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TABLE 1.

plot no. 1

clone no.	row no.	no. of buddings per clone	date of budding 1959	date of opening	days between budding opening	no. of growing	date of cutting back	days between opening & cutting back	no. of sprouting 25.5.59.	percentage of success
SG. I.	1 2	14	19.4.	3.5.	14	14	7.5.	4	14	100
SG. II.	3 4	25	20.4.	4.5.	14	17	10.5.	6	19*	76
SG. III.	5 6	29	21.4.	5.5.	14	25	11.5.	6	27*	93
SG. IV.	7 8	27	24.4.	7.5.	13	26	12.5.	5	24	89
SG. V.	9 10	44	26.4.	8.5.	12	44	13.5.	5	39	89
total		139				126			123	
percentage						91			88	

* includes rebuds.

plot no. 2

clone no.	row no.	no. of buddings per clone	date of budding 1959	date of opening	days between budding opening	no. of growing	date of cutting back	days between opening & cutting back	no. of sprouting 25.5.59.	percentage of success
SG. VI.	1 2	19	28.4.	11.5.	13	19	16.5.	5	14	74
SG. VII.	5 6	17	29.4.	11.5.	12	17	16.5.	5	12	71
SG. VIII.	3 4	21	29.4.	11.5.	12	20	16.5.	5	11	52
SG. IX.	7 8	20	30.4.	12.5.	12	20	17.5.	5	14	70
SG. X.	9 10	15	30.4.	12.5.	12	15	17.5.	5	15	100
SG. XI.	11 12	11	4.5.	13.5.	7	11	18.5.	5	5	45
total		103				102			71	
percentage						99			69	
rebudding										
SG. II.	2 3	8	5.5.	15.5.	10	8	17.5.	2	7	88
SG. III.	4 5	4	8.5.	17.5.	9	4	19.5.	2	4	100
total		12				12			11	
percentage						100			92	

TABLE 2.

List of Selected Trees.

clone no.	height m.	girth at breast h. cm.	height of clean bole m.	age years	purpose of selection
SG. I.	25.0	160	16	80	Forestry value (see p. 5 of the report) Tree from mixed teak forest.
SG. II.	17.5	68	–	17	Forestry value. Plantation tree. It has flowered but relatively late in life.
SG. III.	18.0	65	–	15	Forestry value. Plantation tree. Straight axis - light branching-late (in life) flowering.
SG. IV.	33.4	264	18	80–90	Forestry value. Tree from mixed teak forest. Very fine faenotype. Near-by young trees (offspring?) of good appearance too.
SG. V.	29.0	172	–	60	Forestry value. Tree from mixed teak forest. Budwood taken from high and low branches for investigation of mature and juvenile forms.

SG. VI.	28.0	209	–	70–80	Moderate forestry value. Budwood taken from 22 m and 4 m's height for comparison of development stages.
SG. VII.	17.3	91	–	13	Forestry value. Plantation tree. Flowering late-in-life. Comparison with SG. VIII.
SG. VIII.	15.6	96	–	13	No forestry value. Plantation tree. Flowering early-in-life. Comparison with SG. VII. First serious fork at 12.7 m.
SG. IX.	17.0	61	–	15	Little forestry value. Plantation tree Flowering early-in-life. Comparison with SG. X. First serious fork at 5-6 m's height.
SG. X.	17.5	56	–	15	Forestry value. Plantation tree. Flowering late-in-life. Comparison with SG. IX.
SG. XI.	19.5	64	–	15	Forestry value. Plantation tree. Flowering late-in-life.