Seed selection of Tectona grandis for Eastern South Vietnam and the Central Highland

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Due to various causes, the natural forest area in our country is diminishing day by day, thus reforestation work is of significant and urgent importance. Besides the traditional native tree species planted by our people such as bamboos, pines, dipterocarps, etc… some species of origin from other countries have also been introduced into our country and Tectona grandis is one of them.

Teak is a large timber species with rather fast growth rather wide ecological range and is naturally distributed in many countries such as India, Myanmar, Thailand and Laos. Tectona grandis wood is used for various purposes such as ship-building, household utensils. Specially Teak timber has high export value and this species was introduced rather early in our country (about 1930- 1940) in Tay Ninh, Binh Duong, Binh Phuoc, Dong Nai, Daklak, Hanoi, Son La, Lai Chau, Tuyen Quang and Bac kan. Today the area of concentrated Teak plantations in Eastern south Vietnam and the Central Highland is about 4,200ha.

However as the seed selection has not previously been paid attention to and adequately invested, the seed supply for forest planting has been from mass collection at the same time all-sided technical measures for intensive management have not been applied, productivity of forest plantations is still low (9- 12m^3/ ha/ year) and the quality of the plantations is not uniform. Prompted by the demand of production, the Eastern South Viet Nam Forest Scientifis and Production Centre has conducted a research subject: "Seed selection of Teak for the Eastern South Vietnam and the Central Highland" with main objective of plus tree selection and establishment of seed orchards for these two regions.

I. Research methodology

1. Method of experiments laying out

* Seed orchard from grafts: Laying out in complete random. In Bau Bang: 3-time replicated: each replicate 5 blocks, each block 24 squares, each square a tree (a plus tree clone). In Kon Ha Nung: 4- block replicated, each block 25 squares, each square a tree.
* Seed orchard form seedlings: laying out in alpha design, 15-time replicated, each replicate 24 squares, each square a tree.
* Rooting of cuttings: each experiment is 3-time replicated (3 trays), each replicate 30 cuttings.

Each experiment is carried out twice and all experiments are carried out under mist spraying in green-house.

2. Method of data collection

Pole is used for height measurement, tape- measure is used for diameter measurement and all planted trees in the experiments are measured in diameter at tree base, total tree height and other indices concerning tree quality in December every year.

3. Data processing method.

After data collection and treatment in the field the data are stored in computer. Data processing is done with statistical analysis programmes Stagraphic, Genstat.

II. Locations of the research

Survey was conducted to select plus trees representing different sites in all Eastern South VietNam and Central Highland provinces planted with Teak. Experiments afterward were laid out at two location:

- Bau Bang Forest Experimentation Station, Ben Cat, Binh Duong province: 4 ha.
- Kon Ha Nung Forest Experiment Centre, Gia Lai province: 1 ha.

III. Research results

1. Plus trees selection

Large –scale plus trees selection was carried out in both Eastern South Vietnam and Cetral Highland regions. Selected trees are typical representation for each and every sites. 31 plus trees were selected in various locations

Table 1. Data from measurement of plus trees in Eastern South Viet Nam and the Central Highland.

Location	Code of plus trees	D1.3 (cm)				Total height (m)				Height of bole (m)			
		Plus trees	Forest stand		Excess d	Plus trees	Forest stand		Excess d	Plus trees	Forest stand		Excess d
			X	d			X	d			X	d	
§Þnh Qu¸n	3DQ	63.6	45.13	5.99	3.08	27.0	24.00	1.49	2.01	13.5	11.76	2.19	0.80
	30DQ	63.5	46.60	5.48	3.08	27.5	23.64	1.751.79	2.21	13.5	11.42	1.79	1.16
	4DQ	62.1	45.13	5.99	2.83	26.5	23.49	3.98	1.68	14.0	11.89	1.88	1.12
	33DQ	61.5	49.50	6.36	1.89	28.929.7	21.64	3.16	1.82	14.5	12.56	2.32	0.84
	7DQ	56.8	47.84	5.94	1.50	26.4	23.27	1.49	2.04	14.2	11.96	1.94	1.16
	22DQ	56.0	43.08	5.99	2.16	26.7	24.00	1.79	1.61	14.013.3	12.76	2.19	0.57
	2DQ	55.8	45.13	5.13	2.08	26.5	23.49	1.75	1.79	14.8	11.89	1.88	0.75
	29DQ	55.5	46.60	5.48	1.62	26.4	23.64	1.49	1.63	13.5	11.24	1.79	1.88
	24DQ	55.0	43.08	5.99	1.99	29.0	24.00	1.49	1.61	15.2	12.76	2.19	0.34
	24DQ	54.8	43.08	5.99	1.96	27.5	24.00	1.49	3.36	15.0	12.76	2.192.19	1.11
	20BD	54.5	43.08	5.99	1.91	26.0	24.00	1.79	2.35	15.0	12.76	1.88	1.02
	5DQ	54.1	45.13	5.13	1.75		23.49		1.40		11.89		1.65
La Ngµ	35LN	33.7	20.32	4.91	2.73	19.0	15.47	2.34	1.51	9.7	7.22	2.50	0.99
	S3LN	33.0	22.42	4.15	2.55	20.8	16.40	2.79	1.58	10.6	7.84	2.36	1.17
	34LN	28.5	19.16	3.95	2.25	22.5	15.30	3.09	2.33	12.4	7.82	2.40	1.91
	S2LN	25.8	19.55	4.13	1.51	19.0	15.19	2.55	1.50	9.5	6.48	2.19	1.38
	36LN	25.8	18.35	4.67	1.60	19.0	14.56	3.04	1.46	10.5	6.57	2.32	1.69
	45LN	25.5	18.16	4.45	1.65	19.5	16.22	2.15	1.53	11.4	7.86	2.37	1.49
	S1LN	25.3	17.55	3.00	2.03	22.0	16.70	3.19	1.66	12.0	8.15	2.72	1.42
	48LN	25.3	17.66	3.50	2.18	18.5	13.64	2.29	2.12	9.4	7.08	2.04	1.14
	43Ln	25.0	18.16	4.45	1.54	20.0	16.22	2.15	1.76	13.1	7.86	2.37	2.21
	46LN	24.4	17.04	3.89	1.90	19.0	14.12	1.68	2.90	12.0	6.66	1.74	3.07
Léc Quang	1LQ	58.0	48.48	5.36	1.78	25.5	18.78	2.68	2.51	15.0	7.93	2.16	3.27
	2LQ	56.5	48.48	5.36	1.50	24.6	18.78	2.68	2.17	12.8	7.93	2.16	3.26
	3LQ	28.0	27.03	2.94	1.69	21.9	17.13	1.83	2.61	13.6	8.75	1.90	2.55
	4LQ	27.6	23.03	2.94	1.55	19.8	17.13	1.83	1.46	12.2	8.75	1.90	1.82
Eakm¸t	2EAK	44.0	29.52	5.50	2.63	28.5	21.29	2.52	2.86	15.0	10.60	1.85	2.37
	1EAK	42.8	28.44	5.39	2.66	26.5	22.83	2.30	1.60	14.9	12.84	3.54	0.58
M· §µ	3MD	27.9	18.60	3.02	3.08	20.8	17.10	2.04	1.81	13.0	11.03	1.85	1.07
	1MD	27.0	16.82	3.57	2.86	20.7	15.97	2.97	1.59	13.7	11.00	2.49	1.08
	2MD	24.2	16.82	3.57	2.07	20.5	15.97	2.97	1.52	13.9	11.00	2.49	1.16

2. Seed orchard from grafts

a. Seed orchard from grafts in Bau Bang

* As regards diameter at tree base: At 3 years of age there is not as yet big difference between the clones in diameter at tree base. Clones 24 DQ, 01 MD and 34 LN have smallest average diameter at tree base (6.10cm, 6.40cm, 6.42 cm) and clone 24 DQ has largest average diameter at tree base (9.537cm). The difference in diameter between largest- diameter clone and smallest diameter clone is 3.437cm or 56.34%.
* AS regards height: There is a difference between the clones. Clones 34 LN (H = 2.440m) and 04 DQ (H= 2.114m) have smallest average height; two clones of biggest height are 22 DQ (H= 3.960m) and 03 Md (H= 2.987m). The difference between the best and poorest clones is 1.846m or 87.32%.

b. Seed orchard from grafts in KonHa Nung

* As regards diameter: There is a difference between the clones although not big. Clone 02 MD (D = 13.000cm) has largest diameter, clone 04 DQ (D = 9.000cm) has smallest diameter. The difference between the best and poorest clones is 4.000cm or 44.00%.
* As regards height: There is not yet a marked differentiation between the clones. Clone 43 LN (H= 7.75m) has best height growth, clone 24 DQ (H= 5.933m) has poorest height growth. The difference between clones of best and poorest height growth is 1.767m or 29.78%.
* AS regards growth: There is not as yet a marked difference between the clones. The differentiation of the clones is still at initial stage. However there are still clones that early express their superiority in diameter and height in the first three years (clones 22 DQ in BauBang, clone 01 MD, 43 LN in Kon Ha Nung). Some clones already manifest their poorer growth in the first three years and also in 2 different locations (Bau Bang, Kon Ha Nung), such as clone 04 DQ in both height and diameter.

Comparison made between growth of the planted clones in the experiment and table for plus tree selection does not yet show any relation between growth of clonal progeny with their absolute values of diameter or the excesses and mean values of the forest stand. Even with some mother trees of bigger size, their clonal progenies do have smaller size and poor growth. For example, clone 04 DQ grows poor than clone 22 DQ although the former mother tree has $D_{1.3}$, H and excess far better. Comparison of clone 01 MD with clone 03 MD planted in Kon Ha Nung provides similar remark. Therefore there must be further monitoring, measurement, analysis of seed orchard from grafts at higher ages so that accurate remarks might be made.
- Comparison of growth between seed orchard form grafts in Bau bang and that in Kon Ha Nung shows that seed orchard from grafts of Teak experimentally planted in Kon Ha Nung has the diameter and especially the height far better.
- As regards quality, Teak planted in Kon Ha Nung has straight bole, few branches and better growth. Teak planted in Bau Bang is on the contrary: many big and horizontal twigs, poor growth manifested through sparse, dried trees in the orchard. As having been analyzed, the Bau Bang site is not suitable for the biological characteristics of Teak therefore the trees have poor growth and the sign of gradual dying is noticed at some trees. As it is not yet late now we need have timely measure to maintain this precious gene source by choosing a new area of suitable site conditions to the biological characteristics of Teak to move it.
- Between height and diameter there is a rather close linear correration:
+ In Bau bang: H = 1.262 + 0.260D (at 3 years of age) with a correlation coefficient R = 0.538.

3. Teak seed orchard from seedlings:

- As regards diameter. There is not as yet any marked difference between the clones when the trees are 2 years and 6 months of age in Bau Bang (P= 0.283). Clone 34 LN (D = 9.253cm) has largest diameter, clone S 3 LN (D= 5.781 cm) has smallest diameter.
- As regards height: The data show no difference between the clones (P= 0.342). Clone 24 BDQ has biggest height (H= 3.423m), clone 07 DQ (H= 2.423m) has smallest height.

Thus Teak planting for progeny testing at 2 years 6 months of age established in Bau Bang does not yet show the superiority handed down by the parents to next generation. There need be further and long-term monitoring, measurement and analysis so that accurate conclusions might be drawn.

4. Experiments on rooting of Teak cuttings

a. Ability of rooting of Teak cuttings.

Results of experiments with various forms of a chemical are shown in table 2.

Table 2. Ability of rooting of Teak cuttings treatment with various forms of a chemical

Indices tobe studied	Control	Powder (%)				Solution (ppm)			
		0.5	1.0	1.5	2.0	50	100	200	300
Ratio of rooted cuttings (%)	16.60	20	6.7	3.3	0	10	6.7	3.3	3.3
Number of roots (c_2i)	2.80	3.3	2.0	1.0	-	3.5	3.3	3.0	2.5
Length of roots (cm)	4.05	5.61	1.93	2.40	-	7.16	4.50	2.42	5.04

* Remarks:

IBA concentration in powder form.

Treatment of 4 months old Teak cuttings with powder at 6.5% concentration gives highest ratio of rooted cuttings, number of roots is 3.3/ cutting, average length of root 5.61cm. This concentration gives the results 20.48% better than control.

- The higher the concentration the lower the ratio of rooted cuttings is observed.
- Immersion of Teak cuttings in 50 ppm solution in 3 hours gives highest ratio of rooted cuttings but this ratio is still 147.76% lower than in control.
- Similarly to the case of IBA powder, the higher the concentration of the solution the lower the ratio of rooted cuttings; the number of roots is also gradually reduced.

b. Most suitable concentration for Teak cuttings

* Results of experiments with various concentration levels are shown in table 3.

Table 3. Ability of rooting of Teak cuttings treated at different concentrations (powder form)

Indices tobe studied	Control	0.2%	0.4%	0.6%	0.8%	1.0%
Ratio of rooted cuttings (%)	13.3	16.6	21.4	22.6	15.7	13.3
Number of roots	2.76	4.00	3.33	4.30	3.40	2.50
Length of roots (cm)	6.74	5.64	5.68	12.13	9.50	2.07

* Remarks:

- Concentration 0.6% gives highest ratio of rooted cuttings (22.6%), 69.92% in excess of control. It is noteworthy that the root develop very well in length (12.12cm), 77.97% in excess of control. Average number of roots is 4.30 roots/ cutting.
- Concentration 0.4% also gives rather good result: Ratio of rooted cuttings is 21.4%, 60.8% in excess of control; average number of roots is 3.33 roots/ cutting, average length of roots is 5.68cm, lower than in control but the result is relatively good as compared with the remaining concentration levels.
- High concentration levels: 0.8%, 1.0%: Ratio of rooted cuttings is gradually reduced and sometimes equal to control, roots length and number of roots per cutting are even smaller.

Thus most suitable concentration level for rooting of Teak cuttings is 0.4% - 0.6% in powder form.

Increasing or decreasing concentration from this range all result in smaller ratio of rooted cuttings, smaller number of roots per cutting as well as smaller length of root.

c. Type of Teak cutting

* Results of the experiments on different type of Teak cuttings are shown in table 4.

Table 4. Ability of rooting of different types of Teak cuttings

Indices tobe studied	Top section	Middle section	Base section
Ratio of rooted cuttings (%)	20.3	24.5	24.3
Number of roots	2.67	3.75	4.25
Length of roots (cm)	8.55	11.77	6.15

Remarks: There is not as yet great difference in ratio of rooted cuttings between different types of cuttings. However the cuttings from the middle section have highest ratio of rooted cuttings (24.5%) with average length of root being 11.17cm. Thus all cuttings from 4 month old shoots can be used for rooting as all cuttings give similar results.

IV. Conclusions and recommendations

1. Conclusions:

a. Plus tree selection

Although it has been much limited in area, tree age, seed sources but 31 plus trees have been selected from different sites such as in Dinh Quan, La Nga, Loc Quang, Ma Da and Eakmat. These plus trees all exceed mean values of the forest stand in $H_{1.3}$ and total height (>=1.5 SD) and the length of bole is greater than 1/ 2 total height. In addition, plus trees also have better quality such as bole: Straight and cylindrical; crow: proportioned; little or no disease and insect attack.

b. Seed orchard from grafts

Through 2 seed orchards in Bau Bang Eastern South Vietnam and Kon Ha Nung Central Highland, there has not been found great difference between the clones in diameter and height. Some clones however do early show their superiority in diameter height (clones 22 DQ, 01 MD and 43 L). Analysis of data does not yet provide a correlation between growth of clonal progeny and absolute values of their diameter size and excess with mean values of the forest stand at the stage when the trees are still young.

As regards the seed orchard in Bau Bang, teak trees gradually died due to the site chosen is not suitable to the biological characteristics of the trees. Thus we need have timely measure to maintain this precious gene source.

c. Seed orchard from seedlings

The trees are still young, only more than 2 years of age, thus between the clones there is not yet marked difference. However due to the location chosen being not suitable, the trees of Tectona grandis here begin growing slower and in dry season dead trees are seen here and there.

d. Rooting of teak cuttings

Rooting of Teak cuttings is relatively less successful (24.5%). If method of rooting of cuttings is used, the cutting (4-month old) should be treated with IBA (powder) at concentration level 0.4 – 0.6%.

2. Recommendations

a. To maintain the gene source with the plus trees having been selected and scientifically evaluated, the existing gene source remained now in the Bau Bang experimental site must be moved to a new place with ecological conditions suitable to teak by vegetative propagation (grafting).

b. There need be early trial of provenances at various sites especially the valuable teak provenances from Myanmar, Thailand, Indonesia obtained through international cooperation.

c. Teak is a species of superiority with fast growth, high productivity and economic value but the management age is relatively long (50 years) thus there must be further monitoring, data collection of the results from experiment.

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