A preliminary result of coppicing trials in teak plantations in Kanchanaburi, Thailand

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Abstract

The present study was carried out at Thong Pha Phum Plantation, Forest Industry Organization in Thong Pha Phum district, Kanchanaburi province. The objective was to study the growth parameters of coppice teak sprouts from stumps of thinning and final cutting which grew in the same area with the additional seedling. One-year-old teaks from coppices and seedlings that additional planting were measured at diameter at 10 cm above ground level (D_{10}), diameter at 30 cm above ground level (D_{30}) and diameter at breast height (DBH). The height growth of teak was also measured. The growth characteristics were compared between coppice sprouts and additional seedling.

Result indicated that the growth ability of coppice sprout of teaks was affected by origin of teak. The coppice sprouts from stump of final cutting were better than from stumps of thinning and additional seedling, while the coppice sprouts from stump of second thinning were better than from stumps of first thinning. The results showed that highly significant difference in all the size parameters among origin of teak trees was found (p<0.01). The coppice is one of the alternative regeneration systems not only by low cost, but also by enhancing the short rotation and productivity of plantation.

Keywords: growth, coppice, teak, plantations, Kanchanaburi

Introduction

Teak is the important indigenous tree species in Thailand. The first teak plantation in Thailand was established in 1906 in Phrae Province, northern Thailand so as to seek the possibility of producing teak to meet the demand. The planting area has been extended to the other parts of the country at present. In 1945, a national large scale teak planting program was initiated by the Royal Forest Department (RFD) and teak has become a top priority species since then. To improve the teak wood quality and yield of the plantation, intensive improvement programs including breeding, silviculture and nursery researches were conducted in Thailand in early 1965 (Keiding 1966). At present, teak is widely planted in many forms of planting by several agencies. The main agencies responsible for teak planting in Thailand are RFD, Forest Industry Organization (FIO) and Thai Plywood Company (TPC). Moreover, teak is one of the most widely cultivated hardwood timber species in tree plantation in Thailand. The planting program was launched with the financial support from RFD's Reforestation Fund. Thus, teak planting had provided more growing stock of teak for future uses. In the past, almost all teak plantations were owned by the state with only few small scale plantations owned by the private sector. At present, tree farmers have increasingly planted teak as tree farming, homestead, mixed with other crops along boundaries and other planting system. Teak is somehow still remained as a promising economic species of the country.

FIO is the biggest and oldest company that owns teak plantations for the economic purpose in Thailand. FIO started growing teak in 1968 and the rotation length were 30 years in the good site and 40 years in the poor site, respectively. The interval of thinning cycles at 10, 15 and 20 years of age are practiced for good sites, while such intervals would be 15, 22 and 30 years of age for poor site.

In 1995, 2:2 mechanical thinning (2 lines cut and 2 lines remained) was conducted in FIO teak plantations for improvement the remained teaks. The coppice sprouts were

occurred after thinning, but the growth was not well (Vacharangkura and Viriyabuncha 2003). The coppiced system was used after teak plantations were clear-cut in 2001. Some coppice sprouts regenerated combined with the additional planting for 80-90 trees/rai. In the past, FIO did not have the system for management the coppiced teaks, so they remained one or two coppice sprouts after coppiced. Since 2003, the best sprout in term of highest, strongest and nearest surface ground was remained. It was found that the sprout grow better than the additional tree. However, some plantations with intensive care were found that some additional tree could grow equal to sprout and the growth was not different in around 3 years. The primary advantage of coppice system was saved the costs of labor, stump and land preparation. The coppiced system was extensively employed in most of FIO's teak plantations. In present, there are few studies about the coppiced system.

This study aimed to examine the growth of coppiced teak for alternative management, expecting early incomes from fast-growing stems as well as cost-cutting in management. This system may allow farmers to improve the manner of combined management of agriculture and forestry that can be practiced by as many farmers as possible will be developed.

Materials and methods

This study was conducted at Thong Pha Phum Plantation belong to FIO in Thong Pha Phum district, Kanchanaburi province, western Thailand at the latitude of 14º8'-14º46'N and the longitude of 98º37'-98º46'E. It was considered a relatively superior site for teak plantation because its elevation of about 400 m. It was about 300 m below the upper limit for growing teak in Thailand. Thong Pha Phum Plantation's landform surrounded by limestone mountains. The climate of Thong Pha Phum Plantation is generally affected by monsoons and can be divided into hot, rainy and cold seasons. April is the hottest month with the average temperature of 36.7ºC, while January is the coldest with average temperature of 15.8ºC. However, critical minimum and maximum temperature might range between 6-42ºC. Rainy season starts from early May and end in late October with mean annual rainfall of 1,765 mm. Dry periods cover about 6 months, from early November to late April having only 187 mm of rainfall equivalent to 10.6% of the annual rainfall during such period.

The investigation was started in February, 2010 to December, 2010 at the teak plantation planted in 1980 with the original spacing of 4 x 4 m where the first thinning (50%) and second thinning (30%) were conducted when teaks were 15 years old and 22 years old, respectively. After the final cut in December, 2008, every coppice sprouts regenerated from stumps of first thinning, second thinning and final cutting in February, 2009 after they got the sufficient light. The best sprout (healthy, best growth rate and occurred from the lowest position of stump) was selected for retention in each tree after approximately 3 months. The additional planting by stump was done in around April to the beginning of May.

Three plots of 40 x 40 m size were laid out by using completely randomized design with 2 sites (Fig. 1). One-year-old teaks from coppices and seedlings that were additionally planted measured size parameters i.e. diameter at 10 cm above the ground level (D_{10}), diameter at 30 cm above the ground level (D_{30}) and diameter at breast height (DBH) every two months from February, 2010 to December, 2010. The heights of samples were also measured. The growth characteristics were compared between coppice sprouts and additional seedling was analyzed by Multiple Comparisons of Means: Tukey Contrasts (95% family-wise confidence level). Total initial number of coppices and planted seedlings measured were 54 sprouts and 26 seedlings in Site 1 and 66 sprouts and 13 seedlings in Site 2.

Fig. 1. Study sites

Results and discussion

1. Growth parameters of teak trees

Most of coppice sprouts grew after final cutting, because they can get the sufficient light. The seedlings were additionally planted at where the coppice sprouts couldn't grow. There was no coppice sprouts from first thinning stump in Site 1, but were found in Site 2.

(1) The share of coppices and seedlings

The sprouting of teak in this study were 59 % and 69 % in Site 1 and Site 2, respectively. The coppicing ability was less than in Mixed Deciduous Forest, Ngao District, Lampang (Chaweepuk 1999). The share of seedling

Table 1. The share of coppices and seedlings in the teak plantations in Thong Pha Phum

Sources	Site 1		Site 2	
	Number (tree/ha)	%	Number (tree/ha)	%
First thinning	0	0	100	17
Second thinning	125	22	156	26
Final cutting	213	37	156	26
Additional seedlings	181	31	81	14
Dead	56	10	106	18
Total	575	100	599	100

additionally planted was higher than coppices in Site 1. The number of sprouting from the stumps of second thinning, the stumps of final cutting and additional seedlings occupied 22 %, 37 % and 32 %, respectively. In contrast, share of additional seedlings were smaller than coppices in Site 2. The share of sprouts from the stumps of first thinning, second thinning, final cutting and additional seedlings were 17 %, 26 %, 26 % and 14 %, respectively, as showed in Table 1.

(2) Diameters

The tree size of seedlings additionally planted was the smallest among all categories, following those of coppice sprouts from second thinning and final cutting stumps. As same as in Site 2, teaks from seedlings additionally planted was the smallest and coppice sprouts from first thinning, second thinning followed and final cutting was the largest. The two years old additional seedling was the smallest.

1) D_{10}

The D_{10} of additional seedlings in site 1 increased from 0.76 cm in February, 2010 to 2.49 cm in December, 2010. The D_{10} of coppice sprouts from stumps of second thinning and final cutting increased from 1.68 cm to 4.30 cm and from 3.49 cm to 5.96 cm, respectively. In Site 2, D_{10} of additional seedlings (0.52 cm to 1.85 cm) were smaller than those in Site 1. On the other hand, D_{10} of coppice sprouts from stumps of both second thinning (4.93 cm to 7.16 cm) and final cutting (5.66 cm to 8.55 cm) were larger than those in Site 1. In both sites D_{10} of coppice sprouts from stumps of final cutting were the largest and coppice sprouts from stumps of second thinning and additional seedling followed it. D_{10} of coppice sprouts from first thinning stump could find only in Site 2, and their D_{10} increased from 3.40 cm to 6.26 cm. Those were smaller than other coppice sprouts, but larger than additional seedlings.

2) D_{30}

The results in Site 1 showed that D_{30} of additional seedling increased from 0.84 cm in February, 2010 to 2.13 cm in December, 2010. The D_{30} of coppice sprouts from stumps of second thinning and final cutting increased from 1.42 cm to 3.47 cm and from 2.94 cm to 5.13 cm, respectively. In Site 2, D_{30} of additional seedlings (0.56 cm to 1.74 cm) were smaller than those in Site 1. On the other hand, D_{30} of coppice sprouts from stumps of both second thinning (4.43 cm to 6.20 cm) and final cutting (4.77 cm to 7.42 cm) showed bigger than those in Site 1. D_{30} of coppice sprouts from stumps of thinning and final cutting were bigger than additional seeding in both sites. D_{30} of coppice sprouts from first thinning stumps could find only in Site 2 increased from 3.05 cm to 5.35 cm were smaller than coppice sprouts from stumps of second thinning and final cutting, but bigger than additional seedlings.

3) DBH

Because the additional seedlings were very small, few seedling could be measured DBH. DBH of additional seedling increased from 1.77 cm in August, 2010 to 2.27 cm in December, 2010 in Site 1 and 1.00 cm to 3.30 cm in Site 2. The DBH of coppice sprouts from stumps of second thinning and final cutting were 1.95 cm to 2.59 cm and 2.57 cm to 3.89 cm, respectively in Site 1. In Site 2, the DBH of coppice sprouts from stumps of first thinning, second thinning and final cutting were 2.87 cm to 4.20 cm, 4.05 cm to 5.35 cm and 3.70 cm to 5.73 cm, respectively. The same trend as D_{10} and D_{30}, coppice sprouts from stumps of final cutting were biggest followed by those from stumps of second thinning, first thinning, and additional seedling. DBH of coppiced teak at TPC Clone Bank, Uthai Thani Province was 4.58 cm at the age of 12 months (Thueksathit 2006) showed bigger than those in Site 1 but smaller than those in Site 2. Comparison the DBH of coppice sprouts between sites showed that in Site 2 were bigger than in those in Site 1.

(3) Height

Total height also showed the same trend of diameter. The height of additional seedlings was 0.24 m to 0.96 m in Site 1 which showed higher than in Site 2 (0.16 m to 0.51 m). On the other hand, height of coppice sprouts from stumps of second thinning and final cutting in Site 1 were 0.53 m to 1.80 m and 1.39 m to 2.95 m showed smaller than those in Site 2. The height of coppice sprouts from final cutting showed highest in both sites and higher than the height of 1-year-old coppiced teak at TPC Clone Bank, Uthai Thani Province (2.25 cm)

The results indicated that coppice sprouts grew faster than seedlings as showed in Fig. 2-3.

2. Growth parameters comparison

The size parameters among by the origin in Site 1 and Site 2 shown in Tables 2 and 3.The coppiced teak grew from the stump of second thinning and from final cutting showed the growth in term of D_{10}, D_{30} and height better than those of additional seedling in Site 1. In Site 2, the growth parameters showed highest in coppice from stumps after final cutting and lower in coppice from stump after thinning (first and second thinning) and additional seedlings, respectively. The results from comparison the growth parameters of coppice sprouts from stumps after thinning, stumps after final cutting and additional seedling in both

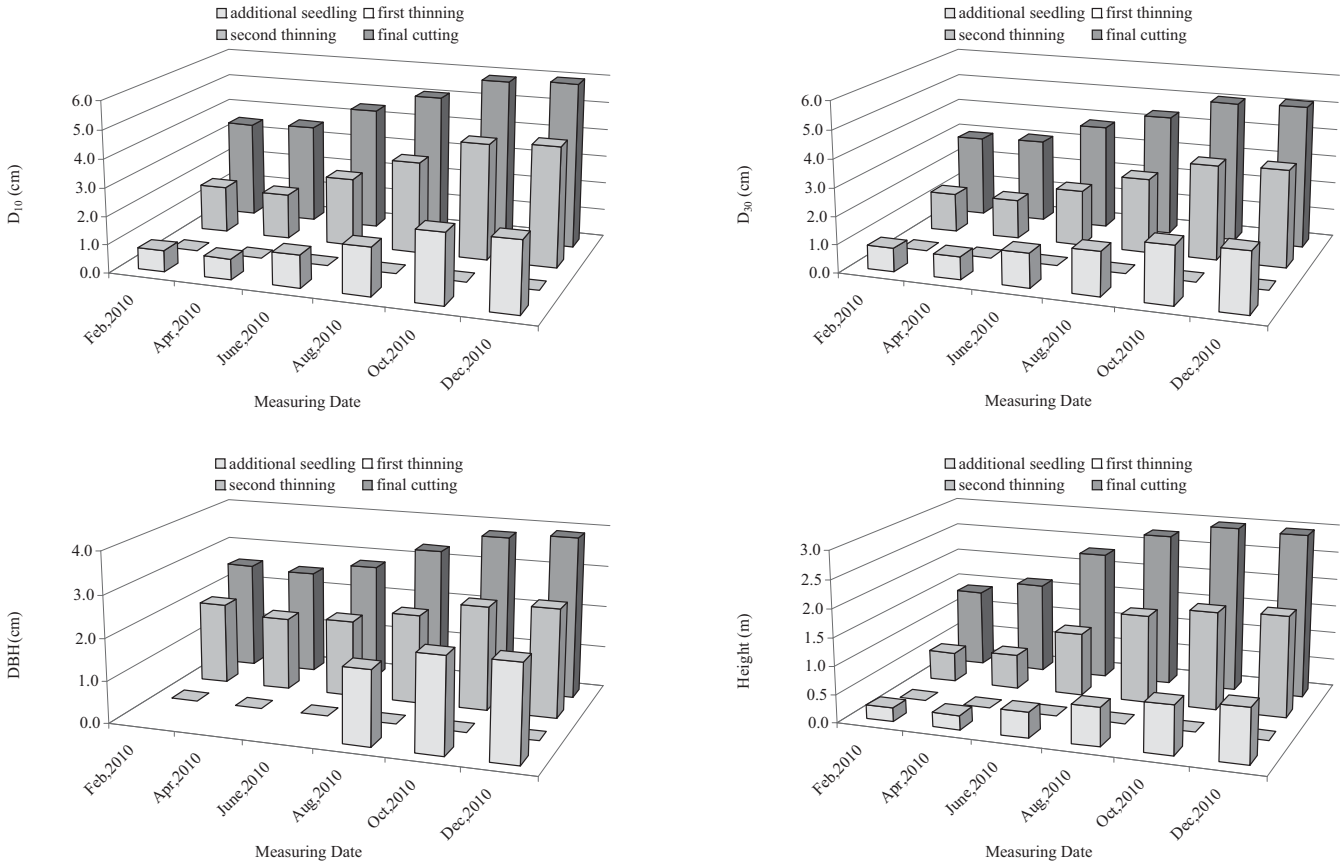

Fig. 2. Growth parameters of coppice sprouts and additional seedling in Site 1

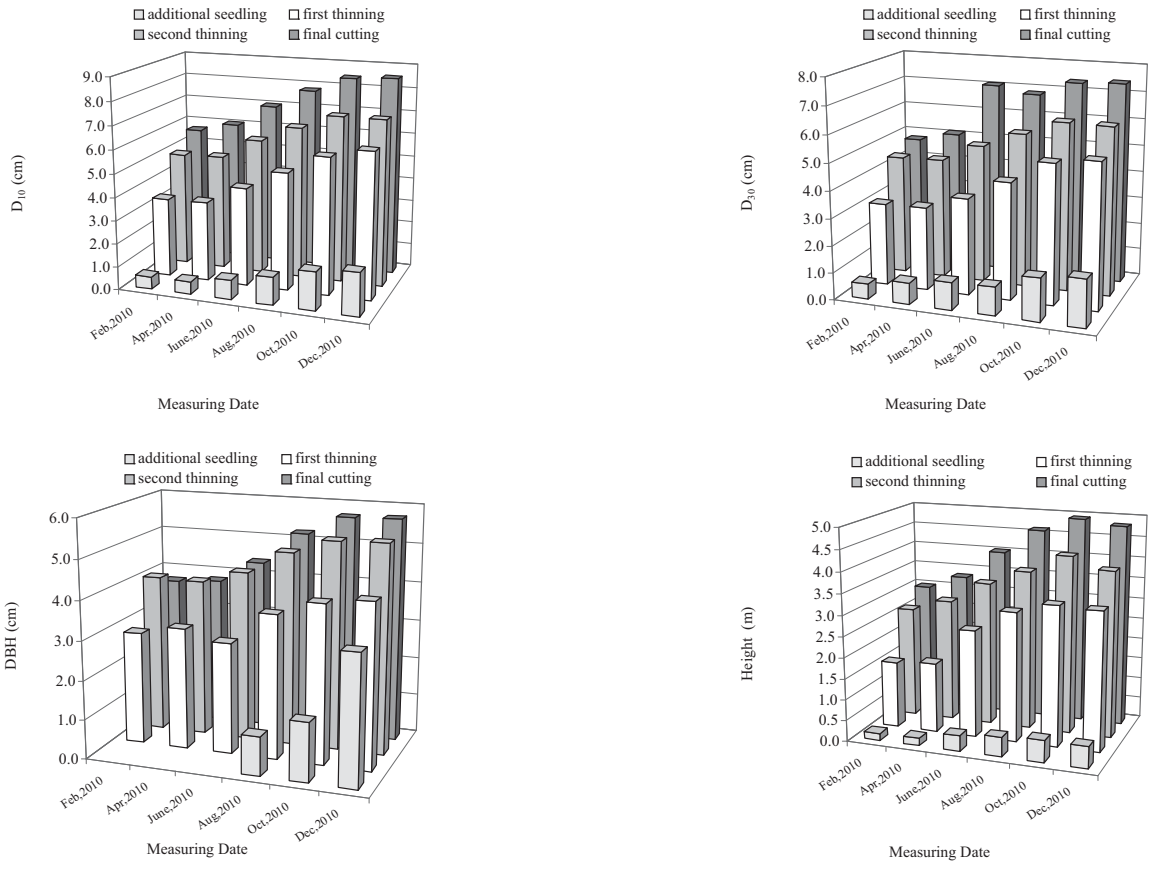

Fig. 3. Growth parameters of coppice sprouts and additional seedling in Site 2

Table 2. Comparison growth parameters among the sources of teak in Site 1

Parameters	Sources	Mean	S.D.	F value	*p* (>F)
D_{10} (cm)	Additional seedling	1.55 a	1.10	570.00	0.0000
	Second thinning	2.91 b	1.52		
	Final cutting	4.73 c	1.97		
D_{30} (cm)	Additional seedling	1.67 a	0.90	328.96	0.0000
	Second thinning	2.47 b	1.17		
	Final cutting	4.06 c	1.75		
Height (m)	Additional seedling	0.56 a	0.56	498.78	0.0000
	Second thinning	1.23 b	0.78		
	Final cutting	2.33 c	1.28		

All difference are significant at the 0.01 level ($p < 0.01$)

Table 3. Comparison growth parameters among the sources of teak in Site 2

Parameters	Sources	Mean	S.D.	F value	*p* (>F)
D_{10} (cm)	Additional seedling	1.10 a	0.79	216.75	0.0000
	First thinning	4.71 b	2.47		
	Second thinning	6.11 c	3.78		
	Final cutting	7.25 d	2.72		
D_{30} (cm)	Additional seedling	1.41 a	1.06	72.23	0.0000
	First thinning	4.13 b	2.18		
	Second thinning	5.37 c	3.37		
	Final cutting	6.42 d	4.13		
Height (m)	Additional seedling	0.37 a	0.27	196.54	0.0000
	First thinning	2.59 b	1.60		
	Second thinning	3.51 c	2.41		
	Final cutting	4.12 d	1.83		

1. All difference are significant ($p < 0.01$)
2. Means followed by a different letter are significantly different ($p < 0.01$) (a, b).

Table 4. Size parameters comparison between the study sites

Parameters	Sites	Mean	S.D.	F value	*p* (>F)
D_{10} (cm)	Site 1	3.06	2.10	457.69	0.0000
	Site 2	5.32	3.44		
D_{30} (cm)	Site 1	2.96	1.74	349.47	0.0000
	Site 2	5.04	3.47		
Height (m)	Site 1	1.39	1.22	1908.5	0.0000
	Site 2	4.39	2.18		

All differences are significant at the 0.01 level ($p < 0.01$)

sites showed highly significant difference among the origin of young trees.

The results also indicated that the average D_{10} of coppiced teak trees were 3.06 cm and 5.32 cm in Site 1 and Site 2, respectively. The average D_{30} of coppiced teak trees were 2.96 cm in Site 1 and 5.03 cm in Site 2. As same as the average height of coppiced teak trees were 1.39 m in Site 1 and 4.38 m in Site 2. The coppice sprouts in Site 2 grew from the stumps of first thinning and second thinning, it meant that the coppice ability in Site 2 showed better than in Site 1. The results also indicated that D_{10}, D_{30} and height of teak trees in Site 2 were better than those in Site 2. Based on statistical analysis, D_{10}, D_{30} and height were found to be significantly different at 95% confidence level between two study sites. There were few data, DBH were not analyzed in this study. The mean of size parameters in both study sites are shown in Table 4.

The result showed that the coppice growth depended on light condition, because most coppices grew after the final cutting. Additionally, coppice ability depended on the age of the stump, because growth parameters (D_{10}, D_{30}, DBH, and Height) of coppices from stumps of final cutting

were higher than those from the thinned stumps. Moreover, the coppices grew faster than the additional seedlings perhaps due to the stock of dry matter in the stumps. However, the growth of coppices was faster than those of the additional seedlings in the same area, but the difference was smaller when teak was getting older. Himmapan (2008) indicated that the growth characteristics, including DBH, height, basal area, stem volume and biomass of teak coppices were dramatically increasing during 2-3 years old, while slightly increasing in the age of 8 years.

The coppiced teak is one of the alternative management. Coppice system may achieve early incomes from fast-growing stems, as well as cost-cutting in management. Teak stumps after clear-cutting could be left for self-coppicing which in turn will reduce the cost in both new seedling and site preparation (Akkhaseewon 2007). Himmapan (2008) found that coppice method at a teak plantation with 4 x 4 m spacing decreased the cost of land preparation, planting, first weeding, and fertilizing. It was estimated that management cost at the first year was reduced from the normal cost (3,960 Baht/rai) to 2,028 Baht/rai, if coppicing rate was 50 %, and it reduced to 2,203 Baht/rai, if coppicing rate was 70 %.

Conclusion

Growth of the coppices of teak varied by their origin e.g. from the stumps of thinning and final harvesting. Growth performance of the coppices from clear-cut stumps was better than those from the thinned stumps. Moreover, growth of the coppices from the second thinned stump was better than those of the first thinned stumps. Using coppice could be one of the alternative agents to promote regeneration which will achieve both low cost and early income.

Advantages of coppice silviculture were found not only in the higher growth rate than seedlings, but also in deceasing management cost. This system may reduce the burden of weed management, physical protection of the site and negligible risk of erosion.

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