Gap Planting In Conifer Pure Stand In Japan

Y. Ochiai, M. Ishizuka

Forestry and Forest Product Research Insititute, 1 Matsunosato, Tsukuba, 305-8687, Ibaraki, Japan

Introduction

Gap planting was introduced in Negara Brunei Darussalam for enriching the secondary forests degraded by a logging operation[1]. Gap planting resembles the regenerating process in the natural forests. In the cases of the natural forests, when a large mother trees falls, a gap is created and the seedlings in the gap start to grow quickly.[1)2)3)]

One of the advantages of gap planting is the flexibility of the site. The site for gap planting can be selected at the site suitable for the quick growth. Each species has the site preference according to their own characteristics. In other words, the ecological site preference is closely related to the silvicultural site preference. If the site is properly selected, the seedlings grow quickly. Another advantage of gap planting is the micro-climate in the gap. The sunlight and soil water is more preferable in the gap than those in the surrounding forests. The seedlings in the canopy gap can grow faster than those under the forest canopy.

In Negara Brunei Darussalam, the gap planting is aimed to enhance the quality of the forests. In this report, the gap planting is carried out for enhancing the biodiversity of artificial forests of pure conifer stand. The four broad-leaved species are planted on the ridge, middle and lower slopes in both of gaps and forests. The gap planting as the method of under-planting and the silvicultural site preference of planted species will be discussed.

Experimental Site and Method

The experimental site is located in Tengakura experimental forest of Forestry and Forest Product Research Institute in Ibaraki prefecture, Japan (Fig.1). The altitude of the site is about 250m above see level. The upper trees were *Chamaecyparis obtusa* (Hinoki) on the ridge and upper part of the slope and *Cryptomeria japonica* (Sugi) on the lower part of the slope.

Three plots were set inside the site, March 2003. Those three plots were located on the different topography such as the upper, middle and lower plot (Fig. 2). The upper plot is located on the wide and flat ridge, the lower plot is at the foot of the slope and the middle plot is on the slope between the former two plots. The topography of the upper, middle and lower plot is flat, very steep and relatively flat. The size of each plot is 10 m x 20 m. Each plot contains a canopy gap and forest canopy. The seedlings of four species (*Quercus myrsinaefolia,*

Figure 1. *Location of experimental site in Japan.*

Figure 2. *Tengakura experimental forest and plots.*

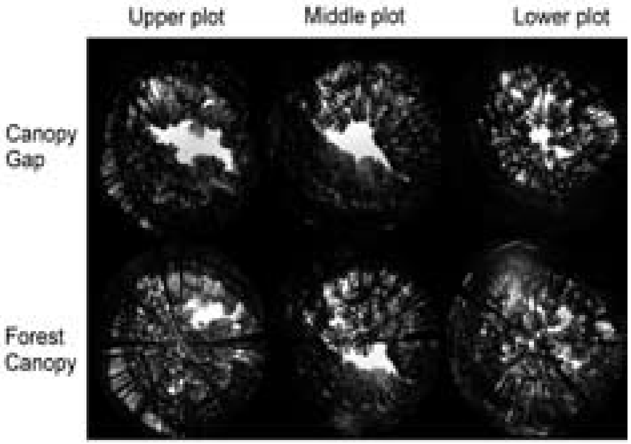

Figure 3. *Hemispherical pictures of canopy gap and forest canopy of three plots.*

Quercus serrata, Zelkova serrata and Zelkova serrata 'Musashino') were under-planted in each plot. In each plot, twenty seedlings of *Quercus myrsinaefolia, Quercus serrata* and *Zelkova serrata* and fifteen seedlings of *Zelkova serrata 'Musashino'* were under-planted with the spacing of 2 m. The diameter at breast height (DBH) and tree height of all trees inside each three plot. The diameter at ground level and height of all under-planted seedlings were measured March 2003, December 2003 and November 2004.

Results and Discussion

a. Upper trees

The DBH and height of the upper trees are shown in Table 1. The upper trees in the upper plot are *Chamaecyparis obtusa* of 57 years old. The average DBH and height are 22.6 cm and 16.1m. The upper trees in the middle plot are mixture of *Chamaecyparis obtusa* of 33 years old and *Cryptomeria japonica* of 57 years old. The average DBH and height of *Chamaecyparis obtusa* are 18.2 cm and 13.0 m and those of *Cryptomeria japonica* are 17.8 cm and 13.4 m. The upper trees of the lower plot are *Cryptomeria japonica* of 57 years old with 31.1 cm and 21.4 m of DBH and height. The growth of upper trees is not different from the trees growing the surrounding area.

b. Diameter growth of seedlings

The diameter increment of four species is shown in Fig. 4. The seedlings are divided into six categories of canopy gap and under forest canopy, in upper, middle and lower plot. The seedlings of *Quercus myrsinaefolia* show the least increment. The seedlings are assumed to have lower quality compared to the other three species. The seedlings of this species in canopy gap of upper and middle plots show the fastest growth in diameter.

Table 1. *Average diameter and height of upper trees in experimental site.*

Location	Species	DBH (cm)	H (m)	Age (year)
Upper	*Chamaecyparis obtusa*	22.6	16.1	57
Middle	*Chamaecyparis obtusa*	18.2	13.0	33
	Cryptomeria japonica	17.8	13.4	57
Lower	*Cryptomeria japonica*	31.1	21.4	57

Quercus serrata shows the largest increment in the canopy gap of the middle plot followed by the seedlings in the canopy gap of the upper plot. This species shows the least increment under forest canopy both of the middle and lower plot. This species is distributed on a ridge and upper part of the slope in undisturbed conditions. The ecological preference of this species is reflected to the silvicultural preference.

Zelkova serrata is famous for its high quality timber in Japan. The diameter growth shows the largest increment in the canopy gap both of the middle and lower plots. This species is distributed in the middle and lower part of the slopes. The ecological preference of this species is also related to the silvicultural preference.

Zelkova serrata 'Musashino' is one of the varieties of *Zelkova serrata*. Although *Zelkova serrata* has high quality timber, its defect is its multi-shoot. This subspecies has a up-straight trunk. *Zelkova serrata 'Musashino'* is planted for the possibility of straight timber. *Zelkova serrata 'Musashino'* shows the largest diameter increment in the canopy gap of the middle and upper plots.

c. Height growth of seedlings

The height increment is less stable (Fig. 5) than the diameter increment because the small animals disturb the growth, especially in the lower plot. They cut the trunk of planted seedlings. As the result, many seedlings decrease in height. Most of *Quercus myrsinaefolia* seedlings decreased in height during two years after planting. The only exception is the seedlings planted in the canopy gap of the middle plot. One of the reasons of decrese is low quality of the seedling.

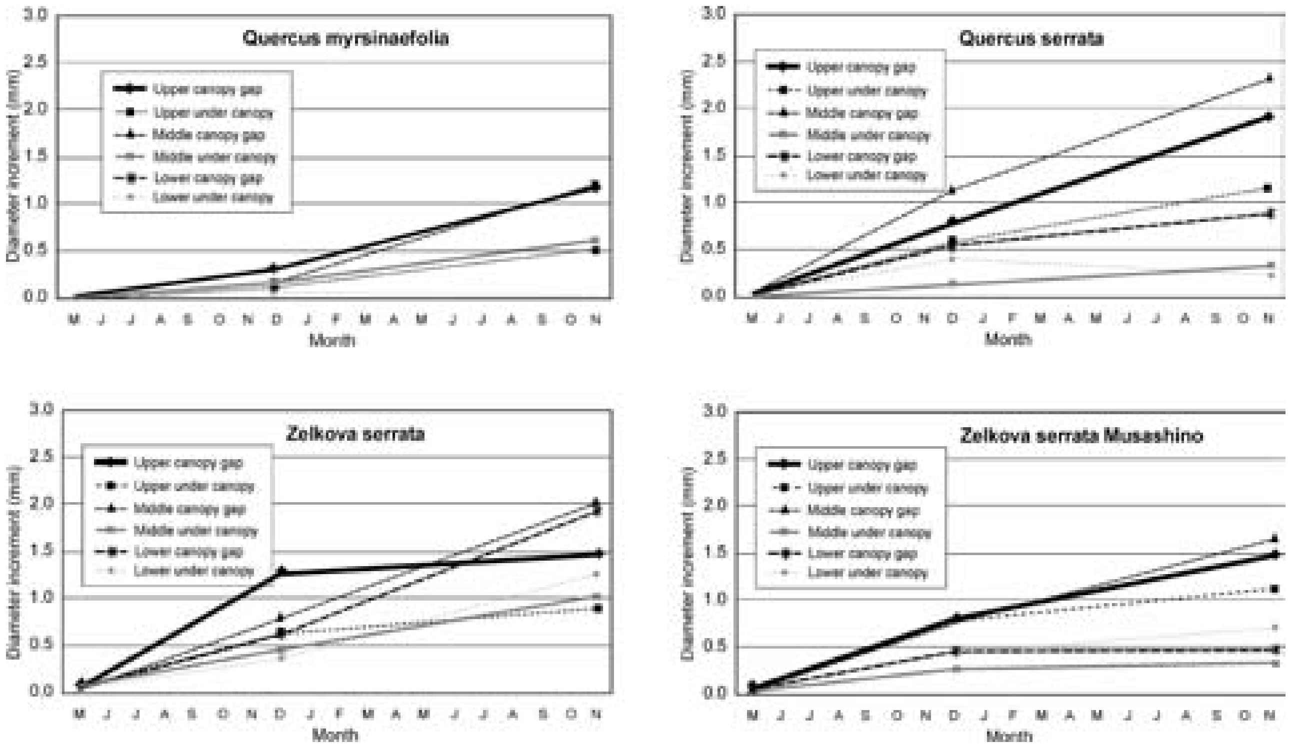

Figure 4. *Diameter increment.*

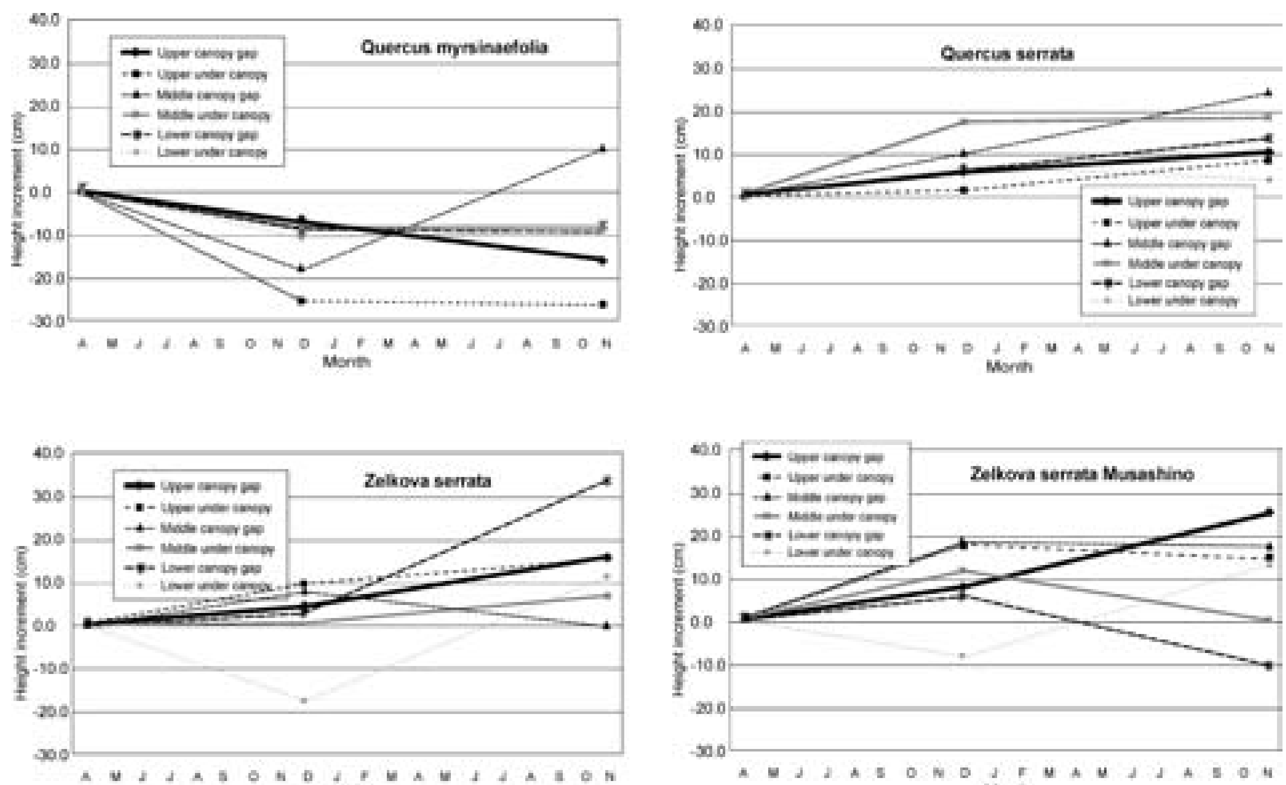

Figure 5. *Height increment.*

Most of seedlings of *Quercus serrata* show constant growth. The seedlings in canopy gap of the middle plot have the largest increment. The seedling height of *Zelkova serrata* decrease in the forest canopy of the lower plot first year because of the damage by the animal. The seedlings in the canopy gap of the lower part show the greatest height increment. *Zelkova serrata 'Musashino'* decrease in height in the lower plot. The height increment of this species is larger on the upper part of the slope.

The relationship of the height increment between the siilvicultural and ecological site preference is less clear than that of the diameter increment. The silvicultural site preferences of four species are slightly related to the ecological site preferences.

d. Site preference

These results are similar to those in Brunei Darussalam. *D. aromatica* which is distributed on the top of the ridge grow quickly on the upper and middle of the slope, *D. lanceolata,* which is distributed on the middle of the slope grow quickly only on the middle of the slope and *D. beccarii,* which distributed both on the ridge and middle of the slope grow quickly on the upper, middle and lower part of the slope. In this experiment, although more years of observation are necessary, it is obvious that when the site is decided, the silvicultural and ecological site preferences should be considered.

Although these are only second year results, the gap planting seems to be effective in enriching the biodiversity of the pure conifer stand in Japan. When carrying out the gap planting, the location of canopy gap is important. The ecological site preference should be considered at the decision of the location.

Literature cited

1) Ochiai Y., M. Alimanar and A.R. Yusop; Natural distribution and suitable method for plantation of two *Dryobalanops* species in Negara Brunei Darussalam, Bul. FFPRI, 31-56, 1994

2) Ochiai Y., Okuda S. and Sato A.: The influence of canopy gap size on soil water condition in a deciduous broad-leaved secondary forest in Japan, J.Jpn. For.Soc., 76(4), 308-314, 1994

3) Ishizuka M., Ochiai, Y., Utsugi, H.; Microenvironments and growth in gaps, Ecological Studies, Vol.158, 229-244, 2002.