

FRUIT PRODUCTION OF A SIX-YEAR OLD *SHOREA STENOPTERA* PLANTATION AT HAURBENTES, BOGOR, INDONESIA

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ABSTRACT

A six-year old plantation of *Shorea stenoptera* at Haurbentes, Bogor flowered for the first time on October, 1987. In plots of 270 m², 12 of the 32 trees had opened flowers. The average heights of flowering and non-flowering trees were 400 cm and 270 cm, respectively. The flowers and fruits were counted four times from October 28, 1987 until February 17, 1988. In October, a total of 24313 flowers existed and 1.9% of them became mature fruits on February, 1988. The fruit production was 308 kg/ha and 133 kg/ha in fresh and dry weights, respectively.

INTRODUCTION

Shorea stenoptera Burck produces large and oil-rich fruits called illipe nuts. Many *Shorea* plantations are found in West Kalimantan where fruits are collected for oil. There are many studies about the phenology of Dipterocarpaceae (Burgess 1972, Cockburn 1975), mast flowering (Ng 1977, Yap 1987) and pollination (Appanah 1981, Appanah and Chan 1981). There are, however, no quantitative studies on the change of the number of flowers that mature to fruits in Dipterocarpaceae. There are only a few records on the age at sexual maturity of Dipterocarpaceae (Foxworthy 1932, Ng 1966 and 1977) but none exists for *S. stenoptera*. Thus, when a six-year old plantation of *S. stenoptera* in Bogor began to flower, it was deemed interesting to trace the number of flowers that mature to fruits.

STUDY SITE AND METHODS

Shorea stenoptera and other Dipterocarp species have been planted in an experimental forest at Haurbentes, Bogor (6°32'-33'S, and 108°26'E, and 200 m above sea level) which was established in 1940 by the Center for Forestry Research and Development. The total of monthly average precipitation from 1957 to 1965 was 4196 mm.

Plots P-1 to P-3 and P-4 were made in a 6-year old and 18-year old plantation of *Shorea*, respectively. *S. stenoptera* seedlings had been planted every 3 m x 3 m. The plot sizes were 10 m x 10 m, 12 m x 15 m, 12 m x 15 m, and 20 m x 25 m, for P-1 to P-4, respectively. P-1 was a few meters distant from P-3 and about 20 m from P-2. P-2 was on a 16° slope with a north aspect while the others were on gentle slopes of less than 10°. The tree height (H) and trunk diameter at the 1.3 m height (DBH) were measured. It was noted whether the faces were in flowering or not. In P-1 and P-2 all the panicles were tagged with numbered tapes and a stapler. The length of the panicles was measured and the number of flower buds, flowers, young fruits, flower scars was counted. After the flower fell, two bracteoles and the scar of the peduncle remain at the point of the panicle where the peduncle was attached. Later the bracteoles also fell. A few trees were in blossom earlier than others and lost many small branches of panicles. The flower number of the former trees was therefore underestimated.

On 8 December, 1987, 8 January, and 17 February, 1988 the fruits were counted again. One tree had a few new panicles in December and January. They were counted as in the above process.

On 17 February, 337 fruits were collected randomly, their length, diameters and weight were measured. The calices were separated from 57 fruits and the fruits were weighed. The calices and fruits were cut into small pieces and oven dried at 105°C for 16 hours, and weighed.

RESULTS AND DISCUSSION

The first trees of *Shorea stenoptera* in Haurbentes were grown from seeds which came from Pontianak, West Kalimantan about 40 years ago (Masano *et al.* 1987). Table 1 shows the amount of illipe nuts, group of *Shorea* species, called Teng-kawang in Indonesia, *S. stenoptera*, *S. pinanga* Scheff., and *S. seminis* Sloot, harvested in West Kalimantan from 1983 to 1987. The annual crop fluctuated greatly.

Tengkawang species have a characteristic of mast flowering as many other *Shorea* species. In 1987, *S. stenoptera* began to flower in April in West Kalimantan

Table 1. Annual crop of illipe nuts harvested from plantations and natural forests in West Kalimantan from data of the Department of Forestry of West Kalimantan at Pontianak.

April 1983 - March 1984		Fresh weight 10 640 500 kg
1984-	1985	0
1985-	1986	396 900
1986-	1987	1 982 980
1987-	1988	7 822 480

while at Haurbentes, it was in September. The flowering season in different localities is not the same. Twenty three species of Dipterocarpaceae are planted at Haurbentes, and most of them were flowering in September or October of 1987. In Mt Palung, West Kalimantan, 22 species of Dipterocarpaceae flowered in April of 1987 (Simbolon at Herbarium Bogoriense, personal communication).

The tree sizes and basal area (BA, summed area of stem cross sections at 1.3 m height) of 5. *stenoptera* in P-1 to P-3 are shown in Table 2. The trees were rarely shaded by neighboring trees and the areas were manually weeded. The flowering trees were significantly bigger in DBH and taller than the nonflowering ones. They began to flower after 6 years from germination. The ages at first flowering of 65 species of Dipterocarpaceae in the Arboretum at Kepong, near Kuala Lumpur were from 17 to 45 years (Ng 1966 and 1977), *Dipterocarpus baudi* flowered at 6.5 years old (Foxworthy 1932). 5. *stenoptera* is one of the earliest flowering species in Dipterocarpaceae. In P-4 which is an 18 year-old-plantation all trees flowered.

Table 2. Tree size and area of *S. stenoptera* in P-1, P-2 and P-3 (450 m² in total), and P-4 (500 m²).

	P-1, P-2, and P-3 (6 yr old)			P-4 (18 yr old)
	Flowering tree	Non-flowering	All trees	
No.	20	25	45	20
Mean DBH (cm)	4.36*	2.59*	3.37	20.02
Standard deviation	1.47	1.10	1.54	7.99
Mean height (cm)	400*	270*	328	1568
Standard deviation	105	90	116	428
Basal area (m ² /ha)	0.74	0.34	1.08	14.5

* The difference is significant at the level of P = 0.01.

Shorea stenoptera is a small tree, but is a remarkably variable species (Ashton 1982). Gadrinab (1984) has found two genetic types, big and small types. The big type becomes 40 m or more in height while the small type is usually shorter than 20 m. They can be distinguished even when still young and small because branches of the big type are usually thick and extended upward while those of the small type are slender and hanging down. The trees in P-1 to P-3 seemed to be of the small type. A few trees in P-4 are of the big type.

The changes in number from flowers to mature fruits of 12 flowering trees in P-1 and P-2 are shown in Table 3. The flowering season of *Shorea stenoptera* at Haurbentes started in September, and was nearing its end at the time of study which was October 28-30. *S. pinanga* bore fruits but no more flowers at that time.

Eighty four percent of all flowers (24 312) had already fallen by October 30. Thirteen percent of all the flowers were lost from November 1 to December 8, 1987. Two trees which had only 74 flowers lost all flowers by December 8. From December 9 to February 17, 1988, 1.3% of all the flowers were lost. The mature fruits in February were 1.9% of all flowers in October, and there were only 1.7 fruits/m². One tree which had 47 fruits on January 8, 1987 lost all of them by February 17. The fruits of many trees were nearly mature on January 8. Hence, the real fruit set ratio (fruit no./flower no.) was from 1.9% to 2.6%. The mean fruit set ratios of 187 species of self-incompatible and 129 self-compatible hermaphroditic plants were 22.1% and 72.5%, respectively (Sutherland and Delph 1984). They, however did not include Dipterocarpaceae. This ratio in *S. stenoptera* was very low. Many flowers fell soon after their opening. They might not have been pollinated.

Table 3. Change of flower and fruit number of *S. stenoptera* in P-1 and P-2 (270 m²) and fruit weight.

		No.	%	Later	Flower
Oct. 28-30	No. of Panicle	337			
1987	Bud	779	3.2		
	Flower & fruits	3 181	13.1		
	Flower scar	20 352	83.7		
	Total	24312	100		
Dec. 8	Young fruits	777	3.2	200	
Jan. 8'88	Almost mature fruits	643	2.6	2	141
Feb. 17	Mature fruits	458	1.9	0	0
Feb. 17	Mean length of fruits			42 mm	
	Mean diameter of fruits			28 mm	
	Fresh fruit weight without calyx			18.16g	
	Dry fruit weight without calyx			7.84g	
	Fruit production (fresh)			308 kg/ha	
	(dry)			133 kg/ha	

One tree continued to produce new panicles and flower until January 1988. The flowers in December and January were, however, 1.4% of all flowers in October. They did not contribute to fruit production in February. Some trees outside the plots also continued to make a few flowers in December and January. In West Kalimantan, we found a tree bearing a few flowers in November. There seemed to be some variation in the flowering period among individuals. Ng (1977) has reported that *S. stenoptera* flowered frequently for very extended periods in Kepong.

The fruits without calyx were 42 mm and 28 mm in mean length and diameter respectively, and 18.16 g in fresh weight. There were significant variations among some trees in the mean length and diameters of fruits from each tree (Figure 1).

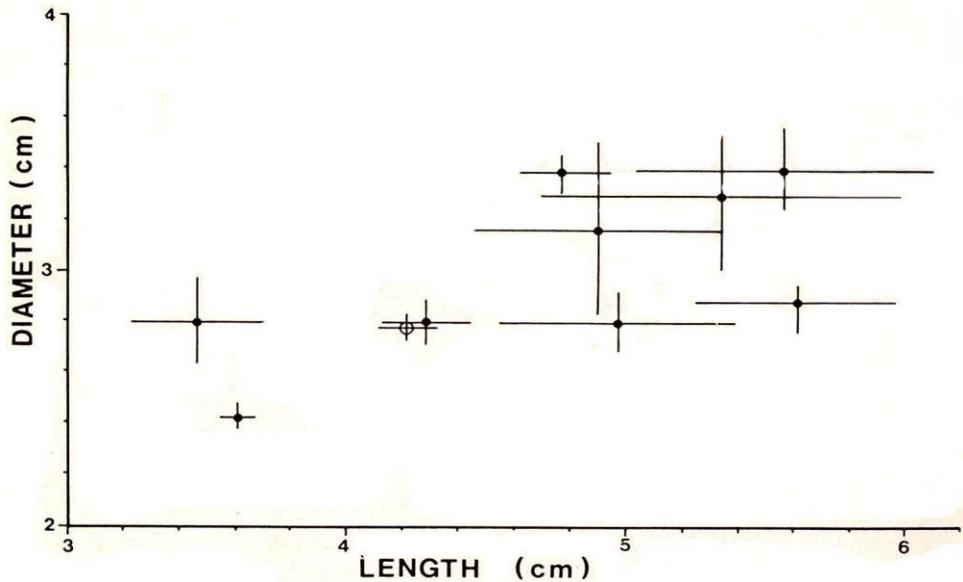


Figure 1. Relationships between mean length and diameter of fruits from each tree (solid circle) and all trees (open circle). Cross lines show the confidence limits of the means ($P = 0.05$).

The shape and length of five wings of calyx were also different among trees. The wing length varied from one third to 2 from that of fruit length. As a result, the wings have no role in wind dispersal. The productivity of fruits was 133 kg/ha in dry weight.

The relationships between tree sizes and number of flowers in October are shown in Figure 2. There was a rough correlation between them. The tree with the least flowers was shaded by a big tree outside the plot. The trees in P-1 tended to make more fruits than trees in P-2 of the same size. Only the relationships between height of the tree in P-2 and number of flowers was significantly correlated at 5% level as shown by a straight line in Fig. 1 (correlation coefficient = 0.750).

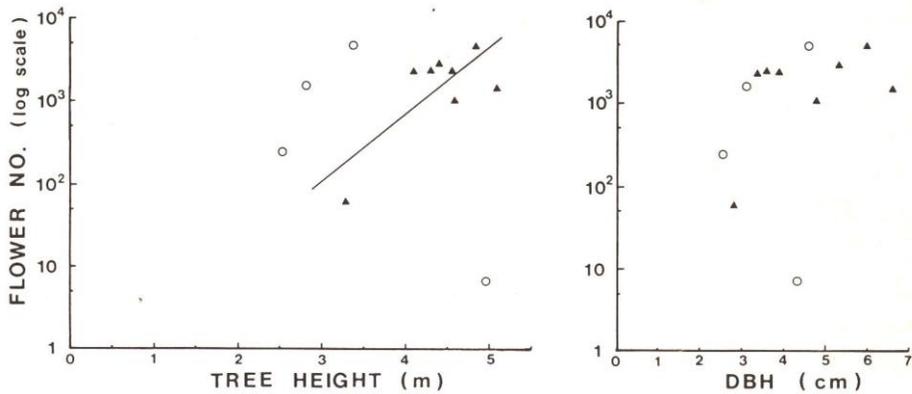


Figure 2. Relationships between flower number of a tree and tree height (left figure), and DBH (right figure). The flower number is the sum of buds, flowers, young fruits, and scars in October. Circle, trees in P-1. Triangle, in P-2.

CONCLUSION

The age at first flowering of *S. stenoptera* trees which are being grown at the experimental forest at Haurbentes was 6 years old. Two months after the start of flowering, 84% of flowers counted (24 312 flowers from 12 trees in a 270 m² plot) had already fallen. Then after another month, 97.1% of all the flowers had fallen and by the end of another month, 98.4% of the total flowers were lost. Mature fruits at this time were 1.9% of all flowers found in the first months of flowering. The productivity of fruits was 133 kg/ha in dry weight.

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