Effect of Silvicultural Treatments on the Growth of *Thyrsostachys siamensis* Gamble at Wetland Putrajaya, Malaysia

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Abstract

Thyrsostachys siamensisis Gamble is considered as one of the commercial species whose shoots can be utilized as food. Its culms are used for multiple purposes, such as for building materials, furniture, farm implements, mats and baskets. In addition, it can be used as an ornamental plant to reduce soil erosion and provide shade. This species also has the potential to be used for pulp and paper production. In Malaysia, there has been no study on the silvicultural options for this species. A study of the silvicultural treatments on the growth of *Thyrsostachys siamensis* at Wetland Putrajaya was carried out to determine the effect of organic fertilizer (goatgro) and thinning on the growth performance of *Thyrsostachys siamensisis*. Six different treatments were applied. A constant goatgro fertilizer rate of 2 kg using a pocket system combined together with three thinning regimes of 0, 15 and 30% were applied to various assigned clumps. Each replicate was assigned to four clumps and there were six replicates altogether comprising a total of 24 clumps. The data was collected three times per week. The parameters measured were: the number of shoots and culms, shoot height and culm height. Results from this research showed that there was a positive effect on the growth performance of this species due to the treatments. Thinning 30% of the culms of *Thyrsostachys siamensis* produced an effect on new shoots sprouted. Applying organic fertilizer gave a positive effect on both shoot and culm height.

Keywords: *Thyrsostachys siamensis*, silvicultural treatments, organic fertilizer, thinning, parameter

Introduction

Thyrsostachy siamensis Gamble is important in Myanmar and Thailand (Thammincha, 1990). The culms are used for multiple purposes, such as building material, furniture, farm implements, mats, baskets and shoots are used as food. *T. siamensis* is well known in Thailand for paper making and other utilization purposes. The shoots of *T. siamensis* are used as food in Thailand and exported to Taiwan and Japan (Smitinand and Ramyarangsi, 1980). *T. siamensis* can also be used as an ornamental plant and for shade.

Due to the importance and potential of *T. siamensis* shoots as food, a trial on the growth of these species was carried out. In addition, in Malaysia, there have been no trials on the silvicultural aspects of this exotic bamboo species.

To ensure an adequate supply of bamboo shoot resources of *T. siamensis* in the future, systematic plantation management principles should be promoted in Malaysia. With the application of systematic management principles to natural stands of bamboos, the production of bamboo stock could be increased (Fateh Mohammad, 1931; Numata, 1979 and Liese, 1985). The application of fertilizer to bamboo plantations has been tried in other countries such as China and India and found to have positive results.

Compound fertilizer has been found to increase bamboo yield (Azmy, 2000). Fertilizer application was very important for the management of bamboo stands (Fu *et al.*, 1988), with shoot bud differentiation and leaf renewal the best times to apply fertilizer (Qiou and Fu, 1985). The most important nutrient for bamboo is nitrogen (N) followed by phosphorus (P) and potassium (K). The rate of application of NPK to bamboo stands depends on soil conditions. Studies showed that NPK fertilizer should be applied three times annually and application was best after rain or after hoeing out weeds (Tang *et al.*, 1987; Zhao and Liu, 1987; Chen, 1988 and Guo, 1988). In India, the application of fertilizer to *Bambusa arundinacea* and *Dendrocalamus strictus* produced a significant increase in bamboo yields (Kinhal, 1985; Lakshmana, 1990). In Peninsular Malaysia, the preliminary application of NPK fertilizer at Nami, Kedah showed that for every 2 kg of NPK fertilizer applied to each natural stand clump of *G. scortechinii*, regardless of its culm density, a 30% increase in shoot sprout could be expected (Azmy, 1995; Azmy *et al.*, 1997). In order to have a sustainable supply of bamboo shoot material in Peninsular Malaysia, and as there has been no such study conducted before on *T. siamensis*, a trial study was carried out to see the effect of silvicultural treatments on the growth of *T. siamensis* at Taman Wetland Putrajaya, Malaysia.

Materials and Methods

A study on the silvicultural treatments on the growth of *T. siamensis* at Wetland Putrajaya was carried out (Figure 1) using clumps that were five years old and planted by the Putrajaya Taman Wetland Authority. There were between 15-40 culms within each clump. Six different treatments were applied using organic fertilizer (goatgro) and thinning. A constant goatgro fertilizer rate of 2 kg using a pocket system combined together with three thinning regimes of 0, 15 and 30% were applied to various clumps. Two fertilizer treatments were applied with the thinning regimes. The first treatment was applied on 29 September and the second on the 4 November 2004. If 30% thinning per clump was to be carried out on 10 mature culms of more than three years age available per clump from a total of 30 culms, then nine culms of these mature culms were cut and selected evenly within the clump. Each replicate was assigned to four clumps and there were six replicates altogether comprising a total of 24 clumps. The data was collected three times per week. The parameters measured were: the number of shoots and culms, shoot height and culm height. Culm height was measured starting from ground level to the maximum height at which the shoot started to droop. All shoots with a height greater than 30 cm were measured during the 18 weeks of the study period from September 2004 until January 2005. The climatic data for the Taman Wetland Putrajaya and the fertilizer content of the goatgro were also recorded, including the pH level of the soil within the study site.

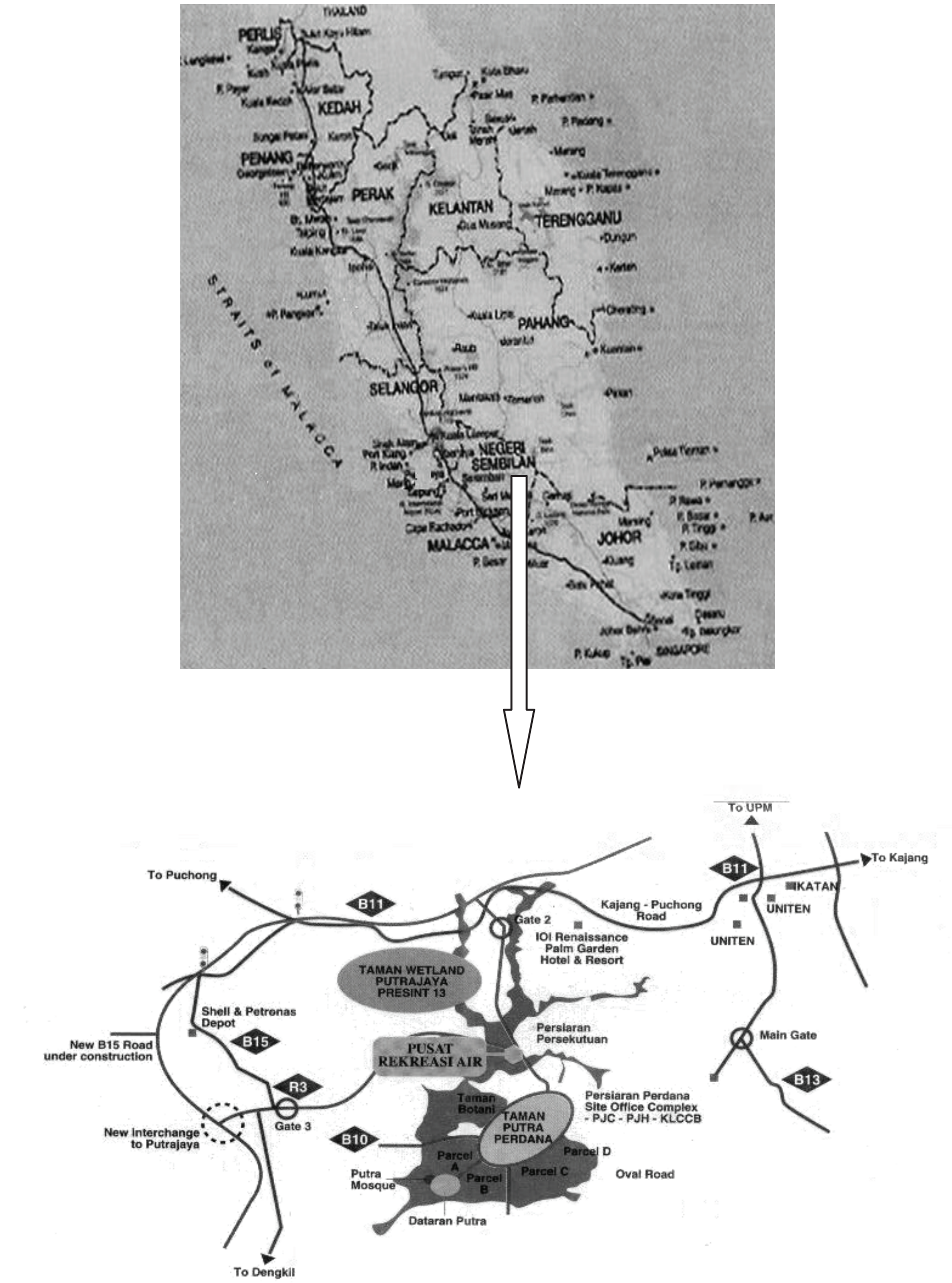

Figure 1 Study plot location at the Taman Wetland, Putrajaya.

Results

Culm Height

There was a significant difference in the mean culm height before and after treatment with an F value of 5.022 at 0.05 level (Table 1). Multiple comparisons showed that there were no significant differences between Treatment 2 (fertilizer) and Treatment 3 (fertilizer and thinning 15%).

Both Treatment 3 (fertilizer and thinning 15%) and Treatment 6 (thinning 30%) achieved maximum culm height in October 2004 (Figure 2). In November and December 2004, Treatment 6 (thinning 30%) reached its highest culm height. Finally, on January, Treatment 4 (fertilizer and thinning 30%) reached its highest culm height.

Table 1 ANOVA of culm height before and after treatment.

Treatment	**Culm height (m)**				
	n	**df**	**Mean**	**MS**	**F value**
		5		**0.052**	**5.022***
Treatment 1 (Control)	4		3.9425*		
Treatment 2 (Fertilizer)	4		3.7025ns		
Treatment 3 (Fert. and thin 15%)	4		3.8175ns		
Treatment 4 (Fert. and thin 30%)	4		3.955*		
Treatment 5 (Thin 15%)	4		3.97*		
Treatment 6 (Thin 30%)	4		3.9975*		
Error		**18**		**0.010**	
Total	**24**	**23**	**3.8975**		

Note: * The mean difference is significant at the 0.05 level.
ns The mean difference is not significant at the 0.05 level.

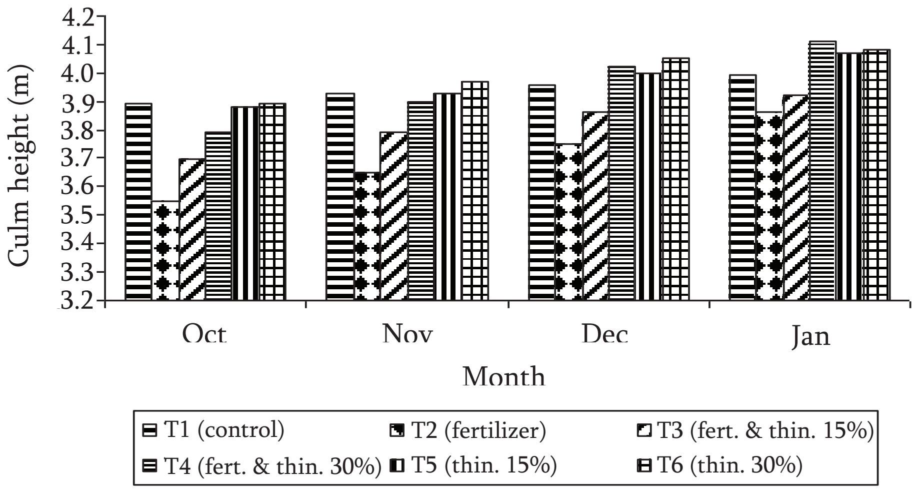

Figure 2 Culm height before and after treatment (4-month period).

For Treatment 2 (fertilizer) from October to November the increment in culm height was 0.10m (Figure 3). From November to December the culm height also increased by 0.10 m. Lastly, from November to December the increment in culm height was 0.11 m.

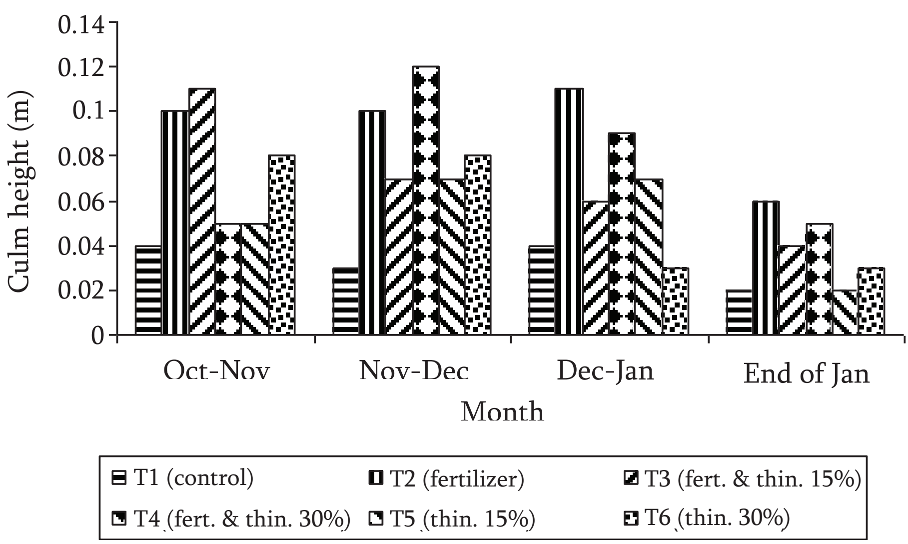

Figure 3 Culm height increment before and after treatment (4-month period).

Treatment 4 (fertilizer and thinning 30%) was the best treatment to increase culm height. From October to December, the increment in culm height was 0.11 m. From November to December, the increment was 0.12 m and finally, from December to January, culm height increment was 0.09 m. This showed that there was not much difference in the height increment for all the treatments even though there significant differences for all the treatments are shown in the ANOVA table.

Number of Culms

There were no new culms produced after thinning activities for both treatments as shown in Figure 4. Thus, there was no significant difference for both activities. There were only two increases in the number of culms as shown in Figure 5, with Treatment 2 (fertilizer) and Treatment 6 (thinning 30%) each having an increase of one. There were no other increases because the period was too short for new culms to form from the young shoots that had sprouted within the period of the study.

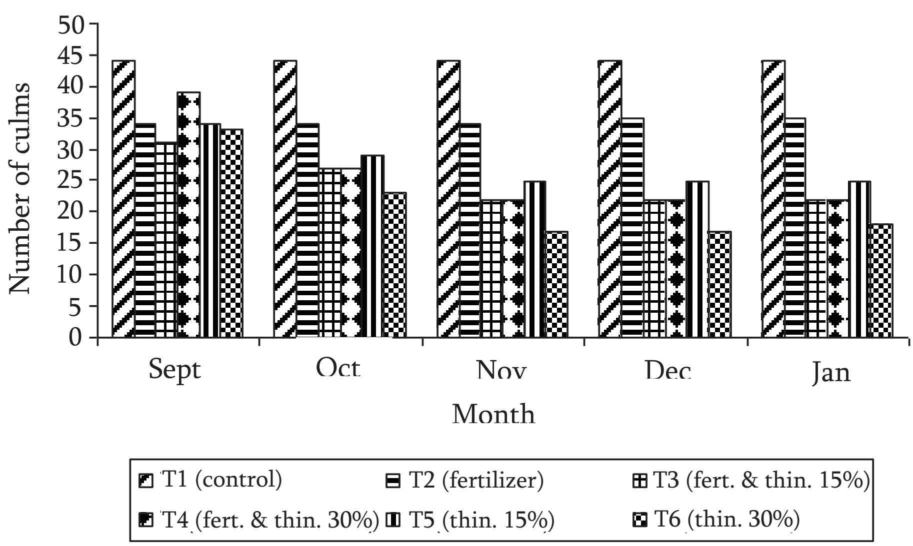

Figure 4 Number of culms before and after treatment (4-month period).

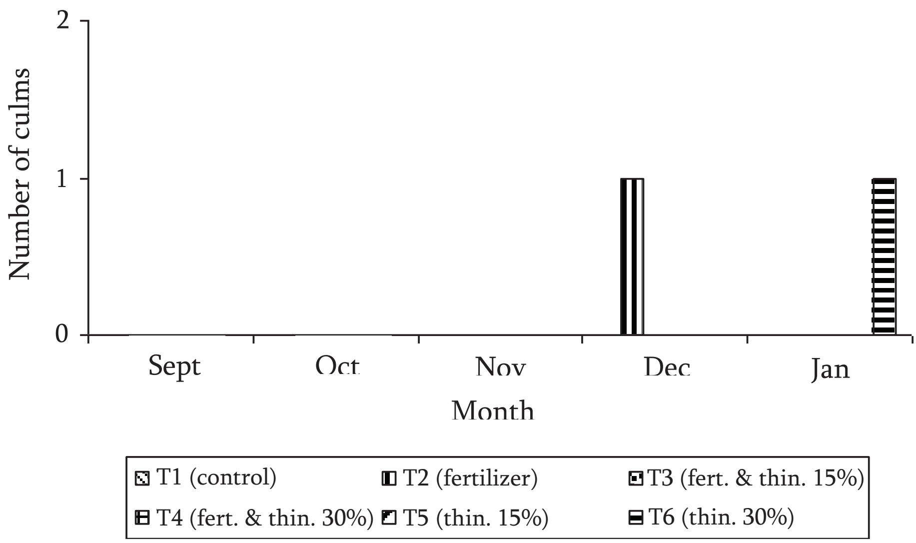

Figure 5 Increase in the number of culms before and after treatment.

Number of Shoots

From Table 2, there was only one significant difference detected in Treatment 6 (30% thinning only) with an F value of 6.427 at 0.05 level. Based on Figure 6, no shoots sprouted in the first week. In the second week, there was only one shoot sprout in Treatment 2 (fertilizer) and Treatment 6 (30% thinning), once the fertilizer was applied. In Treatment 4 (fertilizer and 15% thinning), one shoot sprouted at week four, while Treatment 5 (thinning 15%) and Treatment 6 (thinning 30%) only showed one shoot sprout after the application of the second treatment.

This showed that probably Treatment 6 (thinning 30%) gave a good response in the number of the new shoots sprouted (Figure 6).

Table 2 ANOVA of number on new shoots.

Treatment	No. of shoot				
	n	df	Mean	MS	F value
		5		**0.511**	**6.427***
Treatment 1 (Control)	18		0.0000 ns		
Treatment 2 (Fertilizer)	18		0.1111 ns		
Treatment 3 (Fert. and thin 15%)	18		0.0000 ns		
Treatment 4 (Fert. and thin 30%)	18		0.0556 ns		
Treatment 5 (Thin 15%)	18		0.0556 ns		
Treatment 6 (Thin 30%)	18		0.4444(*)		
Error		**102**		**0.080**	
Total	**108**	**107**	**0.1111**		

Note: * The mean difference is significant at the 0.05 level
ns The mean difference is not significant at the 0.05 level

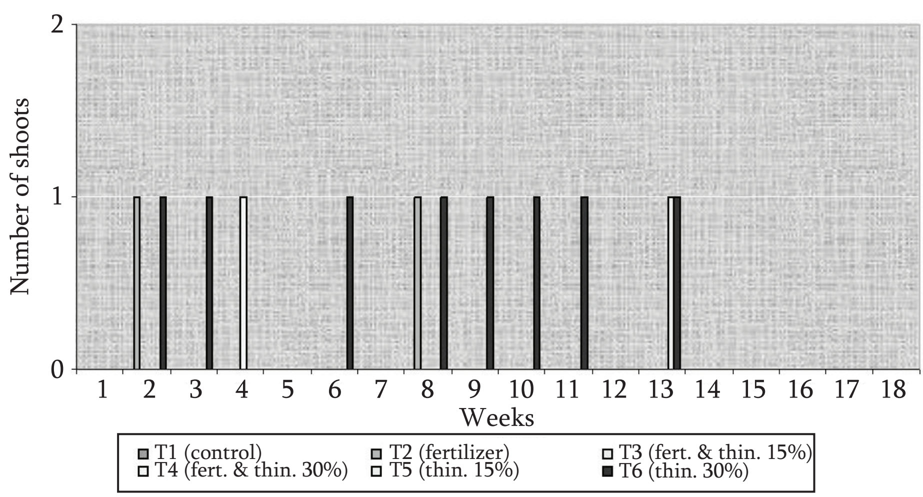

Figure 6 Number of shoot sprouts within the 18-week period of study.

Shoot Height

Based on Table 3, there were significant differences in the shoot heights for Treatments 2, 4 and 6 with an F value of 35.389 at 0.05 level. The mean values were 1.1567, 1.0067 and 0.7157 m respectively. Multiple comparisons showed that there were no significant differences in the other treatments.

From Figure 7, Treatment 2 (2 kg fertilizer only) showed an effect on shoot height at week two after the application of fertilizer. Shoot height increased up to 1.56 m at the end of the study. The height of shoots achieved was around 0.1-1.56 m.

Treatment 4 (fertilizer and thinning 30%) showed an effect on shoot height at week four. The highest shoot height was 1.23 m. The shoot heights achieved ranged from around 0.33-1.23 m.

Table 3 ANOVA of shoot height.

Treatment	**Shoot height (m)**				
	N	**df**	**Mean**	**MS**	**F value**
		5		**5.173**	**35.389***
Treatment 1 (Control)	18		0.0133 NS		
Treatment 2 (Fertilizer)	18		1.1567*		
Treatment 3 (Fert. and thin 15%)	18		0.0000 NS		
Treatment 4 (Fert. and thin 30%)	18		1.0067*		
Treatment 5 (Thin 15%)	18		0.0689 NS		
Treatment 6 (Thin 30%)	18		0.7157*		
Error		**102**		**0.146**	
Total	**108**	**107**	**0.4193**		

Note: *The mean difference is significant at the 0.05 level.
NS The mean difference is not significant at the 0.05 level.

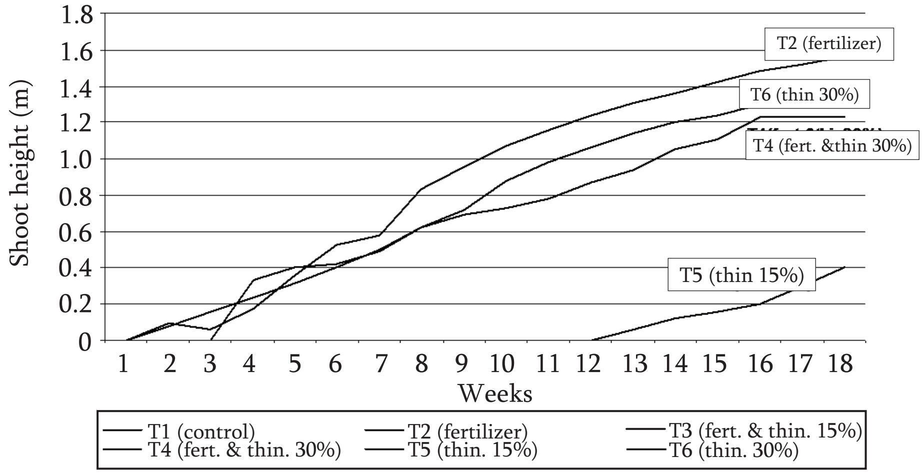

Figure 7 Shoot height within the 18-weeks period of study.

Rainfall

The total rainfall for 2003 was 2843.1 mm, while the total rainfall for 2004 was 2775.6 mm. During 2001, the total rainfall was 2651.5 mm and the total rainfall for 2002 was 2694.5 mm (Figure 8).

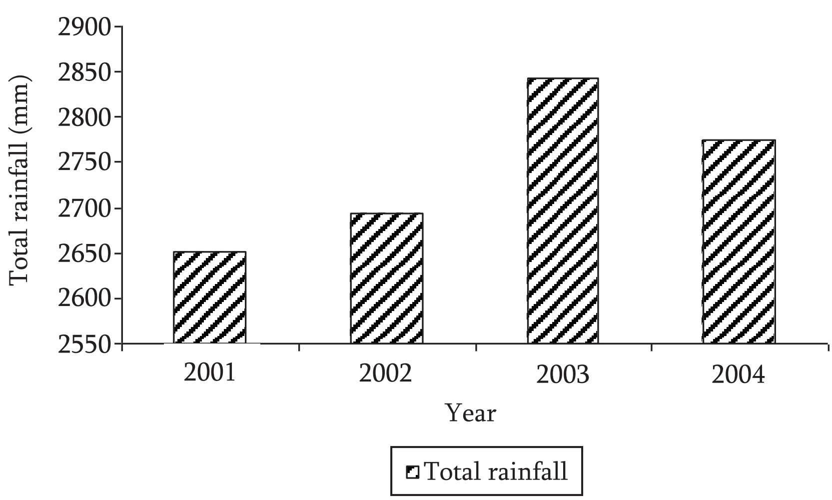

Figure 8 Annual rainfall at the study site at the Taman Wetland Putrajaya.

Discussions

T. siamensis has been a popular plant in Thailand and has been exported as a food item. As a plantation species, it was expected to be a fast growing species but since the application of fertilizer in September, there was not much rain experienced during the month of October, while later in November, there was a lot of rain at Taman Wetland Putrajaya. The highest fall was 428.7 mm in November. Starting in December, the rain decreased until January 2005. The lowest rainfall received was in June 2004 (Figure 9).

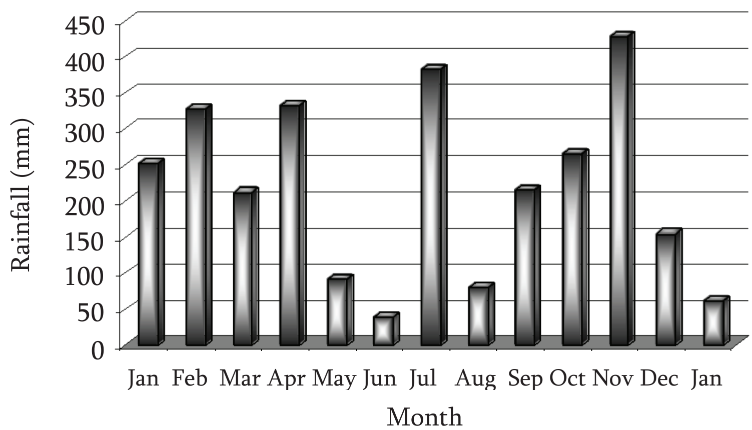

Figure 9 Annual rainfall at study site at the Taman Wetland Putrajaya.

In order to have a many shoot sprouts, a lot of water is needed constantly, especially during the establishment stage. Due to the short period over which the thinning regimes were applied, this might have caused the shoots to sprout less than expected, compared to other treatments applied during the fertilizing time. Thus, as the fertilizing and thinning activities were carried out within a few months, possibly this caused a delay in shoot sprouting. In addition, the remainder of the cut shoots formed into 'witches brooms' with bushy leaves. Although 30% thinning produced many 'witches brooms', it helped to open up new space, so there was less competition for water, nutrients and sunlight among the remaining culms.

Treatment 5 (thinning 15%), appeared to have no effect on any growth parameter measured.

Probably, most new shoots were dead by December due to the lack of rainfall. The newly emerged shoots dried up inside and later were infested by termites. In addition, monkeys seemed to be another cause of deterioration in the young shoots, as the bamboo clumps with young shoots were a food source for the monkeys in the Taman Wetland, Putrajaya. This caused shoots to die and not develop into new culms.

The soil at the study site was red loam, with an average range from 4.7-5.3 for the pH. The soil temperature was between 28.7 °C- 28.8 °C. The soil moisture content was between 3.34%- 6.73% (Table 4). Bamboo does not like waterlogged conditions and is very seldom found in swampy areas. It thrives best on well-drained, sandy-loam to clay-loam soils based on underlying rock with a pH from 5.0 to 6.5 (Azmy and Abd. Razak, 1991).

The shoot height showed a good response to the fertilizer treatment because organic fertilizer was used to maintain soil fertility, which helped to increase height increment. Organic fertilizer helped to trap moisture and provide available N, P and K in the soil. The nitrogen, phosphorous and potassium content in the organic fertilizer used in this study was 3.21, 0.96 and 1.79%, respectively (Table 5).

Table 5 Fertilizer content used in this study.

Fertilizer	Content
Nitrogen	3.21%
Phosphorous	0.96%
Potassium	3.62%
Sulphur	0.64%
Magnesium	0.73%
Calcium	1.79%
Manganese	554 ppm
Zinc	110 ppm
Boron	30 ppm
Molydenum	1.9 ppm
Net Weight	400 g

The best treatment for growth in culm height was the application of 2 kg fertilizer. This treatment not only opened up more space for the clump but also decreased the competition for food, nutrients, water and sunlight within the culm. Furthermore, this fertilizer treatment helped to supply nutrients such as nitrogen, calcium and phosphorous which are needed for bamboo growth.

Conclusions

In this study, fertilizer treatments gave better results compared to the control. Fertilizing produced a positive effect on the growth of shoots and on culm height. The period between the application of the first and second treatments should be more than 4-6 months, in order for the first treatment to have an effect on the bamboo's growth performance. According to Azmy and Hall 2004, the application of organic fertilizer of goatgro, chicken dung and palm oil mill effluent (POME) tended to increase shoot sprouting.

Thinning at a rate than 30% caused the growth of "witches brooms" and no new shoots were able to sprout. It was found that cutting the culm close to the ground helped to increase shoot production. Fertilizing produced a positive result on shoot sprouting and on culm height.

Soil moisture, soil content, rainfall and animal attacks by monkeys and termites were factors that affected bamboo growth performance.

Based on this study, the application of 2 kg of organic fertilizer was the most suitable treatment for *T. siamensis* to enhance the shoot and culm height. A silviculture treatment of 30% thinning was most suitable to encourage more shoots for commercial purposes. Future managers and entrepreneurs should take into consideration fertilizing and thinning of bamboo plantation clumps to improve shoot production for export purposes.

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References

Azmy, H.M. 1989. Venture on the making of fish or vegetable and charcaoal baskets. (FRIM Technical Information No. 8. Forest Research Institute Malaysia, Kepong. (In Malaysia)

Azmy, H.M. 1991a. Three Malaysia wild bamboos. Nature Malaysiana 16(4): 130-135.

Azmy, H.M. 1991b. The structure and demography of *Gigantochloa scortechinii* Gamble natural stand. Bamboo Journal 9: 21-26.

Azmy, H.M. 1995. Effects of fertilizing and harvesting intensity on natural stands of *Gigantochloa scortechinii*, pp. 86-95. *In* I.V.R. Rao and C. B. Sastry and E. Widjaja, eds. Bamboo, People and the Environment Volume 1: Propagation and Management. Proceedings of the 5th International Bamboo Workshop and the IV International Bamboo Congress, Ubud, Bali, Indonesia, 19-22 June 1995.

Azmy, H.M., H. Norini and W.M. Wan Razali. 1997. Management guidelines and economics of natural bamboo stands. FRIM Technical Information handbook No. 15. 40 pp.

Azmy, H.M. and J.B. Hall. 2000. Effect of compound fertiliser and soil mounding on natural stand bamboos of *Gigantochloa scortechinii* in Peninsular Malaysia. Journal of Tropical Forest Science 14(3): 401-411.

Azmy, H.M. and J.B. Hall. 2004. Application of organic fertilizers on natural stand bamboos for sustainable management in Peninsular Malaysia. Journal Bamboo and Rattan 30: 309-317.

Chen, R. 1988. Several suggestions on the development of bamboo grove for shoot production in Xiyang Town. Forest Science and Technology in Yongan (Fujian) 2: 7-9.

Duriyaprapan, S. and P.C.M. Jansen. 1995. *Thyrsostachys siamensis* Gamble, pp. 145-147. *In* S. Dransfield and E.A. Widjaja, eds. Bamboos. Plant Resources of South–East Asia. 7. PROSEA.

Guo, Q. 1988. Applying fertilizer in bamboo forest. Modern Agriculture (Shanghai) (6): 1-54.

Fateh Mohammad, M. 1931. The bamboo forest of Hoshiarpur District Punjab. Indian Forester LVII: 491-510.

Fu, M.Y., J. Xie and M. Fang. 1988. Fertilizer application studies in bamboo stands with different uses. Forest Research (Beijing) 1(5): 54-57.

Kinhal, G.A. 1985. Use of biofertilizer in bamboo plantations. Indian Forester 3(2): 503-504.

Lakshmana, A.C. 1990. New management techniques for natural stands of *Bambusa arundinacea* in Karnataka–A preliminary report. Myforest 26(1): 1-7.

Liese, W. 1985. Bamboo–Biology, Silvics, Properties, Utilization. GTZ, Eschborn, Germany. 132 pp.

Numata, M. 1979. The structure and succession of bamboo vegetation, pp 222-236. *In* M. Numata, ed. Ecology of Grasslands and Bamboo Lands in the World. The Hague.

Qiou, F.G. and M.Y. Fu. 1985. Fertiliser application and growth of *Phyllostachys pubescens*. Recent Research on Bamboos, pp. 114-120. *In* A.N. Rao, G. Dhanarajan and C.B. Sastry, eds. Proceedings of the International Bamboo Workshop 6-14 October 1985. Hangzhou, People Republic of China.

Smitinand, T. and S. Ramyarangsi. 1980. Country Reports: Thailand, pp. 85-90. *In* G. Lessard and A. Chouinard, eds. Proceedings of a workshop "Bamboo Research in Asia", Singapore, 28-30 May 1980.

Tang, R., L. Sun and F.C. Zhou. 1987. Studies on high-yield *Phyllostachys pubescens* groves in the practice forest farm of Nanjing Forestry University. Bamboo Research (1): 59-62.

Thammincha, S. 1990. Some aspects of bamboo production and marketing, pp. 320-327. *In* I.V.R. Rao, R. Gnanaharan and C.B. Sastry, eds. Bamboos Current Research. Proceedings of the International Bamboo Workshop. 14-18 November 1988. Cochin, India.

Zhao, P. and D. Liu. 1987. Experiments on rejuvenation of damaged *Phyllostachys pubescens* grove. Chinese Forestry (8): 1-39.