

Influence of Intercropping System in Unmatured Agarwood Plantation

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ABSTRACT

The study was conducted to investigate the effect of intercropping system between short-term crops and karas trees on the growth of karas trees and the side income made by the karas planters after implementing the intercropping system. There were four treatment groups implemented in this study which include monoculture of karas(control), karas with chilli (T1), karas with okra(T2) and karas with corn (T3). The karas tree growth parameters measured were height (cm), circumference (cm) and leaves count. The production yield of selected short-term crops was weighed in kilogram and the net profit analysis was made based on the market price of chilli, corn and okra. The data collection for the growth of karas tree was done 'before' and 'during' the plantation of short-term crops in the study site as well as 'after' the short-term crops were removed from the study site. Data analysis showed that there was a significant difference ($p < 0.05$) on the tree circumference after okra and chilli were removed from the study plots when compared to the control group. Besides, chilli was recorded with the highest net profit of RM 1857.60. Therefore, the intercropping of karas tree with short-term crops can generate profitable side income to karas planters and these intercropping practices are proven to have no negative impact on the growth of karas trees in the study site.

Keywords: Intercropping system, karas plantation, karas growth, yield of short-term crops.

INTRODUCTION

Plantation of karas trees is becoming more popular among karas planters in Malaysia. The high value of agarwood produced by injured karas tree in global market entices people to be involved in larger scale of karas plantation to earn high income besides reducing the extinction threat of this wild species in the forest [1]. Agarwood, well-known since the era of Pharaohs is a type of resin from karas tree which is formed naturally from a reaction of karas tree to fungi/bacterial attack [2]. Karas tree belongs to Thymelaceae family under *Aquilariagenus* [1] and is found in 14 countries globally including Bangladesh, Bhutan, Brunei, Cambodia, China, Philippines, Indonesia, India, Laos People's Democratic Republic, Myanmar, Malaysia, Papua New Guinea, Singapore and Thailand [3].

However, karas tree takes longer period to be matured which is about 5-6 years [4] and must undergo an induction process to obtain agarwood (resin). Hence, to cover the planting cost and maintenance, intercropping or poly culture is encouraged and this practice is not new in the agricultural sector in Malaysia. Intercropping practices of karas trees together with other forest trees and plants were also reported by [5]. This approach is actively practised in Southeast Asia and most of the karas trees is commonly planted with rubber, teak, banana, corn, black pepper, pineapple and lemongrass [5].

Thus, karas planters need to find other alternatives to generate side income to support their living and maintenance cost of their karas plantations. On top of that, the planters can generate interim income by planting short-term crops such as chilli, corn and okra on their karas plantation. Recently, short-term crops are planted together with main crops such as rubber, oil palm and karas. For example, rubber was planted with banana [6], oil palm was planted with corn and cassava [7] and coconut planted with sugar cane [8]. The intercropping practice with short-term crops is basically able to generate source of income for the farmers in a short span of time while waiting for the main crops to grow and produce yields.

In this study, intercropping practice with short-term crops like chilli, corn and okra was conducted on an un-matured karas plantation. A few important parameters were studied such as the growth of karas tree height (cm), the circumference of karas tree (cm), leaves count of karas tree and also interim income earned from intercropping in karas plantation.

RESEARCH METHODOLOGY

Experimental Site

The study was conducted in Karas Plantation Kampung Tambak, Slim River, Perak, Malaysia. The study comprised of four treatment groups which were monoculture of karas (control), karas with chilli (T1), karas with okra (T2) and karas with corn (T3). The total area of the study plot is 0.25 acres, which can fit around 770 karas trees.

Measuring the Growth of Karas Tree

In this study, 30 karas trees in each treatment group were randomly selected for karas growth measurement. The growth measurement of the karas tree was performed three times which were before, during and after the short-term crops were removed from the study plots. The parameters measured were the height, the number of leaves and the circumference of the karas tree.

Intercropping System

The cultivation of short-term crops started from 15th June 2017 to 15th May 2018. The selection of the right type of short-term crops is essential for the growth of the karas tree as well as for the optimal return for karas planters in the future. Good market demand for chilli,

okra and corn as reported by [8], [9] and [10] also became the main reason in the selection of those crops to be planted in the study plot.

Short-Term Crops Cultivation Cost

Short-term crops cultivation cost for chilli, okra and corn is shown in Table 1. The calculation of the cost involves the cost of seedlings and organic fertiliser (cow dung). The application of organic fertilizer for short-term crops was performed only once during the entire experimental period.

Table 1. The Calculation of Short-term Crops Cost

Item	Cost
Chilli (T1)	
- Seedling cost	RM 140.00
- Organic fertilizer (cow dung)	RM 34.00
Total	RM 174.00
Okra (T2)	
- Seedling cost	RM 250.00
- Organic fertilizer (cow dung)	RM 34.00
Total	RM 284.00
Corn (T3)	
- Seedling cost	RM 450.00
- Organic fertilizer (cow dung)	RM 34.00
Total	RM 484.00

For the calculation on the sales of the short-term crops, the price of chilli, okra and corn was based on the market price which are RM10.00/kg [12], RM7.00/kg [12] and RM2.00/kg [13] respectively. The calculation of the net profit for short-term crops is based on the following formula:

$$\text{Net profit} = [\text{Total harvest (kg)} \times \text{market price}] - \text{Planting cost}$$

Data Analysis

Data analysis was carried out using Statistical Package for Social Science (SPSS) Version 20.0 software. The findings were analysed using descriptive statistics (mean and frequency) and inferential statistics (One Way Analysis ANOVA). The results were expressed as mean \pm SEM ('Standard Error Mean'). The values were considered significantly different when the p value is less than 0.05 ($p < 0.05$).

RESEARCH FINDINGS

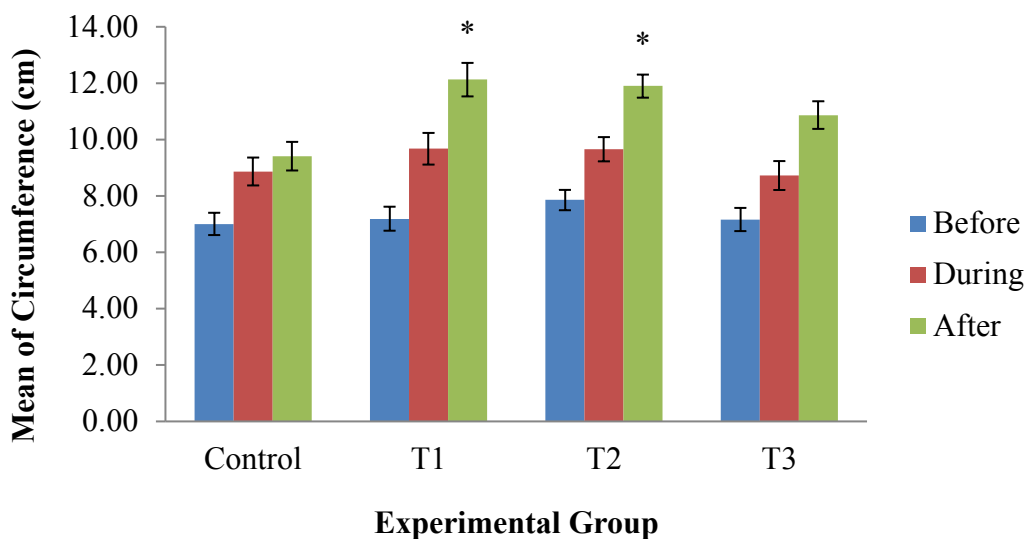
Analysis of Karas Trees Growth

Table 2 shows the results for the growth of karas tree before and during the short-term crops were planted as well as after the short-term crops were removed from the study site. Results were expressed in mean and 'standard error mean' (SEM). There was no significant difference ($p < 0.05$) found except for the parameter of karas tree after the okra and chilli were harvested and removed from the study site.

Table 2. Karas tree growth mean before and during short-term crops were planted as well as after the short-term crops were removed from the research plot

Parameter Karas Tree	Type of Crops (Mean ± SEM)			
	Control	T1	T2	T3
Before				
Height (cm)	164.64±52.00	159.21±58.00	168.89±43.85	163.94±60.35
Circumference (cm)	7.00±3.06	7.19±3.30	7.85±2.79	7.16±3.19
Leaves count	120.62±100.94	137.64±125.89	133.28±82.21	111.88±90.59
During				
Height (cm)	190.36±61.82	198.68±70.08	199.52±57.22	187.93±73.17
Circumference (cm)	8.87±3.83	9.67±4.35	9.66±3.33	8.72±3.97
Leaves count	174.75±158.34	204.25±196.96	209.65±143.37	182.13±138.86
After				
Height (cm)	212.13±61.05	222.49±64.69	223.90±52.68	216.60±74.51
Circumference (cm)	9.41±3.93	12.13±4.60*	11.90±3.17*	10.87±3.80
Leaves count	224.77±180.30	242.95±205.10	245.88±152.89	222.90±151.75

Note, * Mean difference is significant at $p < 0.05$, $n = 30$ karas trees in each treatment group, T1= karas with chilli, T2 karas with okra, T3= karas with corn.



*The mean difference is significant at $p < 0.05$ level, $n = 30$ karas trees in each group
Figure 1 Mean of circumference of karas trees in four experimental groups.

Analysis of Plantation Returns

Table 3 shows the harvesting yield of short-term crops in kilograms obtained in karas plantation. Based on these results, corn produced the highest weight (343.5 kg), followed by chilli (135.44 kg), and okra (129.12 kg).

Table 3 The harvesting yield of short-term crops in kilogram

Short term crops	Harvesting yield(kg)
Chilli (T1)	135.44
Okra (T2)	129.12
Corn (T3)	343.50

Table 4 presents the results of the net profit for the sale of short-term crop yields implemented at the study site. The net profit for the sale of short-term crops for chilli, okra and corn was RM 1180.60, RM 619.84 and RM 203.00 respectively.

Table 4 Net profit calculation of short-term crops yield in Karas Plantation

Short-term crops	Index	Cost
Chilli (T1)	Sale (135.44 kg x RM 10.00)	RM 1354.40
	Cultivation cost	RM 174.00
	Net profit	RM 1180.40
Okra (T2)	Sale (129.12 kg x RM 7.00)	RM 903.84
	Cultivation cost	RM 284.00
	Net profit	RM 619.84
Corn (T3)	Sale (343.50 kg x RM 2.00)	RM 687.00
	Cultivation cost	RM 484.00
	Net profit	RM 203.00

DISCUSSIONS

The agricultural sector is one of the key sectors in generating the economy of the local community [13]. Intercropping practice is often used in the agricultural sector due to the capability of this practice in generating side income for the farmers. However, the effect of this practice towards the growing condition of the main crops especially karas tree must be considered because healthy growth of karas could generate substantial revenue for the future of karas planters.

In general, intercropping involves the cultivation of two or more species in one area [3]; [15]. Intercropping practice in a single area will not only maximize the use of the land, but it may also provide maximum net return to the planters and farmers depending on the appropriate crop selection [15]; [16] and [6]. According to [17], this cultivation method is also vital to stimulate the growth of the main crops compared to monoculture practice.

Based on Table 2, karas plots that were intercropped with okra showed the highest mean value for almost all karas growth parameter investigated when compared to the control, chilli and corn. In addition, the karas tree growth parameter showed significant difference in circumference after the removal of okra and chilli from the study sites compared to the control group. However, there are no significant changes in the karas height and the number of karas leaves as compared to the control group.

In the present study, there was no negative impact recorded on the growth of karas trees although fertilization was not applied throughout the experiment. This finding is also supported by [19] while implementing intercropping system between rubber and banana. Their findings showed that the intercropping system is capable of enhancing the growth of rubber trees compared to the rubber monoculture system. In addition, the intercropping system might enhance the use of the nutrients present in the soil effectively rather than crops cultivated in monoculture system [17]. Thus, the cultivation of short-term crops can be helpful in supplying nutrients to the soil such as nitrogen, phosphorus and potassium by the decomposition of falling leaves which can then be fully utilized for crop growth [19], especially karas tree.

Different findings were obtained in the treatment group of karas with corn because this group showed unfavourable growth for most parameters investigated such as the height (during),

circumference (during) and the number of leaves (after) of karas tree as compared to the control group. This situation was probably due to the high nitrogen requirements during the corn fruit formation [21] and simultaneously caused nitrogen deficiency to stimulate karas growth in the study site.

In the present study, the harvesting yield of chilli, okra, and corn intercropped with karas tree was considered as the main factor in assessing their potential to generate side income to the karas planters. Although the harvesting yield for chilli and okra has no significant differences in weight (kg), the lower cultivation cost and the higher market price of chilli made it more valuable to be planted in the intercropping system with karas trees. The net profit for the sale of short-term crops for chilli, okra and corn was RM 1180.60, RM 619.84 and RM 203.00 respectively.

The lowest market price and the high cultivation cost of corn resulted in lowest profits obtained in the present study even though the weight of the harvested corn was high. However, based on the study conducted by [22], the intercropping of oil palm with corn is proven to deliver good profit which is around RM 4042.50/ hectares per season. [23] also reported that the intercropping of oil palm with banana had a positive impact on yield productivity as well as increasing the income of farmers compared to the monoculture practices that were also implemented.

In a study conducted by [24], a 6.25-year-old rubber plants which were intercropped with some other crops such as chilli, long beans, groundnut, spinach, sweet potatoes, corn and banana on 2.02 hectares of land yielded a revenue of around RM 386 per month for planters. Meanwhile, the young rubber trees that are about 2.5 years old were grown with chilli, long beans, cucumbers, melons and lemon trees on 0.57 hectares of land could generate about RM 579 per month for planters. This situation proved that the area of land, plant species and age of the main crops also affect the yield and income obtained by planters. Thus, the young age of the main crop was found to give a positive outcome for the short-term crops yields, thereby generating more lucrative income for the planters. This is in correlation with the present study that chose to intercrop short-term crops with the youngest karas trees of the age of almost one year.

In conclusion, the intercropping of karas tree with short-term crops can generate profitable side income for karas planters and these intercropping practices are proven to have no negative impact on the growth of karas trees in the study site. Chilli was found to have the most potential to be planted with karas tree due to the highest net profit obtained and it gives no negative impact on karas tree growth.

CONCLUSION

Appropriate selection of short-term crops in the intercropping system should be emphasized by karas planters. This is because this selection will affect the process of growing karas trees as well as generating more lucrative side income for the karas planters while waiting for the karas trees to be harvested.

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