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RESEARCH ARTICLE

Optimizing Sago Land Utilization by Intercropping with Eggplants, A Study at Tanjung Peranap Village, Meranti Island, Riau, Indonesia

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Abstract

Sago palms are the main food crops in eastern part of Indonesia. Sago productivity can reach 20 to 40 per ha per year, and the trees can be harvested when they are 10 years of age. Due to long duration before harvesting it is important that sago growers could grow annual food crops. The objective of study is to determine the growth of sago palm intercropped with eggplants, and how intercropping affects each crop grown as monoculture. The study was carried out from March to July 2018 at Tanjung Peranap Village, Meranti Island District, Riau Province, Indonesia. The experiment was organized in a completely randomized block design with two replications, with sago palm and eggplant as monoculture and as inter cropping. The results demonstrated that young sago palm did not suppress eggplant growth and vice versa. Therefore, eggplants can be planted between young sago palms.

Keywords: cropping pattern, sago palms, *Metroxylon sago, Solanum melongena*

Introduction

Sago (*Metroxylon spp.*) is the largest carbohydrate-producing plant in Indonesia. Potential production of sago dry starch is 20 to 40 tons per ha per year. Indonesia's carbohydrate needs are 30.2 million tons per year, and one million hectares of sago plantation can meet the food needs of all Indonesian people (Bintoro et al., 2010). Indonesia has the largest planting or sago forest area in the world that has the potential to be developed into industrial raw materials both food and non-food. There are abundant peatlands that have potentials to grow sago, and these area are relatively lacking government attention. The potential of sago as a local plant resource needs to be maintained and continued to be developed to provide food security, and for the welfare of the community, particularly in eastern Indonesia.

Sago plants can be harvested when they are 10 to12 years old. Long period of growth before sago harvesting causes sago farmers to need other sources of income to meet their daily foods, resulting the entanglement in the *ijon* system, i.e. the growers sell sago trees at very young age before harvest and paid very little amount of money. Many people from Tanjung Peranap Village even cut down natural forests and mangroves and sell the timbers due to lack of employment in these areas. Tanjung Peranap Village is located in a marginal area, mostly peatlands. Deforestation and canal construction to transport logged timber have cause forest fires and ecosystem imbalances in this area. Mangrove removal along the coastline can result in abrasion of land areas. Other income can be obtained by optimizing the use of sago land. According to Bintoro et al. (2017) sago can be combined with mina sago, or intercropped with annual food crops. The sago mina system can be done by making a tarpaulin pool between the sago tree stands. In addition to the mina sago system, it can also be intercropped with vegetables or food crops between sago stands. Vegetables that can be planted includes corn, chili, water spinach, eggplant, beans, cucumber, spinach, and tomatoes. Mina sago and intercropping activities have been started and examined to evaluate its potentials to increase the income of sago growers.

Agricultural cultivation techniques are needed to improve the efficiency of land use (Beets, 1982).

Land use for farming can be more productive, among others by cultivating several types of crops on the same plot of land. Planting systems that can be done includes intercropping, alley cropping, and relay cropping. Alley cropping contributes to improving the microclimate of fertile agricultural land conditions and can increase crop yields, more efficient use of water resources and increased nutrient use efficiency. Low input requirements for fertilizers, pesticides and labor, have the potential to increase the economic value of fertile land (Quinkenstein et al., 2009). Intercropping patterns can reduce pest populations in the main crops, hence increase crop productivity (Subhan et al., 2005). In line with this, the results of research by Setiawati and Asandhi (2003) showed that intercropping provides higher productivity (91-94%) than in monoculture. This study was conducted to determine the growth of sago and eggplant as intercrop as compared to monoculture.

Materials and Methods

The study was carried out in Tanjung Peranap Village, Kepulauan Meranti Regency, Riau Province, Indonesia, from March to July 2018. The plant materials used were sago seedlings that were ready to be transplanted to the land, purple eggplant seeds (*Solanum melongena* L.), urea fertilizer, SP-36, KCl, sago ash, and agricultural lime. This experiment was set up as a completely randomized block design two replications. The treatment consisted intercropping of eggplant and sago, and compared with monoculture eggplants and monoculture sago.

The trial was started by clearing the 5000 m2 of land from weeds and wild ferns using lawn mowers, followed by preparing plant beds in the cleared land. The eggplants were sown in polybag of 5 cm x 10 cm in a nursery. The nursery is shaded with a paranet covering an area of 1.5 m x 10 m. The media used for sowing eggplants is a mixture of soil and ash. Sago planting holes of 60 x 60 x 60 cm (length, width and depth) were prepared in the plant beds.

Sago planting is done by transferring the sago seedlings from the canal to the field using a cart. Sago seedlings are cleaned by cutting the tip of a spear or a dry leaf a dry leaf (Figure 1). Sago is grown by covering sago seedlings to the point where sago grows. Dolomite and ashes of 1.3 ton and 0.9 ton per ha, respectively, was applied at two weeks before planting. Fertilizer was given three days before planting at 160 kg of urea.ha^{-1}, 311 kg of SP36.ha^{-1}, and 90 kg of KCl.ha^{-1}.

Eggplant planting is done after the sago seedlings are six weeks after planting. Planting distance of eggplants is 70 cm x 70 cm. Each hole is planted with one selected seedlings from the nursery. Eggplant fertilization is by giving 80 kg of urea.ha^{-1} and 45 kg of KCl.ha^{-1} at 2, 5, 7 weeks after planting.

Figure 1. A sago seedling ready for transplanting to the field

Maintenance activities include cleaning sago plant beds from weeds, pests and diseases. Control of pests and diseases and weeding was conducted manually. Observation of the crops was carried out every two weeks on sample plants in each plot. The variables observed in sago in this experiment were petiole length, petiol width, number of leaves, number of spear leaves and leaf area increase. The length of petiole was measured from the base of the midrib to the first leaflets. Petiole width was measured at the base of the petiole. The length and width of leaflets selected were the longest in the first leaf. Measuring the length of the leaves of the leaflet is done from the base of the leaf to the tip. The leaf width is measured in the middle part of the leaflet perpendicular to the leaf bone. Scoring on the eggplant was conducted on plant height, number of leaf, and plant stem diameter. Calculation of the area of sago leaflet used a formula based on Nakamura (2005) as follows:

S (e) = 0.785 Lleaflet x Wleaflet

where

S (e) is the area of the leaflet
Lleaflet is the length of the leaflet
Wleaflet is the width of the leaflet

The data were analyzed using ANOVA using SAS 9.1.3. Mean separations was conducted using DMRT (Duncan Multiple Range Test) at 5% level of significance.

Results and Discussion

Tanjung Peranap Environment

Tanjung Peranap Village is located 102 °24 '36 to 102 °47' 48" North latitude, 0° 45'7" to 1°00' 7" East longitude. Tanjung Peranap village generally has organosol soil type. Organosol has the characteristics of blackish color, has a high water and organic matter content (peat), low pH (around 4 or less), low nutrients, poor drainage, and is generally in infertile. Peat soil management can be done by applying P fertilizer and agricultural lime or manure to provide more optimal soil environment, hence increase crop productivity. Lime applied in the experiment only raises the pH to 5, so that the growth of eggplant plants did not grow as expected. The depth of groundwater surface in April to August 2018 were 75 cm, 55 cm, 52 cm, 60 cm and 75 cm, respectively.

The transfer of sago seedlings to the field had problems with seedling establishment after planting, particularly due to pest and pig attacks. Wild boar damaged seedlings at 4 and 8 weeks after planting. Percentage of surviving seedlings in the intercropped and monoculture at 8 WAP is 53.33% and 50%, respectively. Grasshopper (*Sexava* spp.) attacks cause the leaves to not fully bloom. The wild boar (*Sus barbatus*) attacked sago young plants in the field in the evening and caused sago plants to die.

Table 1. Percentage of survived sago seedlings

Treatments	Week after planting			
	2	4	6	8
Monoculture	100	100	66	50
Intercropping	100	93	73	53

Percentage of Survived Sago Seedling

One of the main problems in sago plantations are the low survival of the seedlings after transplanting to the field. The life percentage of sago seedlings dropped dramatically in the sixth week, particularly due to pig attacks and lack of water (Table 1). The depth of ground water measured at planting is as deep as 52 cm. Groundwater surface depth at week six was 60 cm. The distance between sago seedlings and the groundwater level at six weeks is around 30-40 cm so the seeds lack water for growth. If the depth of the water surface is more than 30-50 cm from the surface of the soil, sago plants will lack water. Optimal sago plant growth can occur if the availability of water is sufficient i.e. the ground water depth is less than 20 cm. (Bintoro et al., 2010). Young sago plants that have two strands or more show the best growth in the field (Nurulhaq, 2012).

Sago Leaf Growth

The spear leaf is a true leaf primordia that has not yet expanding. The success of spear leaves into true leaves depends on environmental conditions and the quality of sago seedlings. Dry environmental condition, pest and disease disturbances on the leaf spear can cause the tip of the spear to dry out, so that it cannot develop into true expanding leaves. Monoculture sago has new spear leaves at 4 and 8 WAP, whereas intercropping sago has new spear leaves at 6 WAP Flach (1997) reported that the appearance of leaves on sago young plants is only 2 per month, whereas according to Irawan (2004) it is one leaf per month. Until the observation ended (8 WAP) there was only one new leaf produced, and until the last week there were still plants with spear leaves that had not yet fully expanded.

Our study demonstrated that intercropping of sago with eggplant has no significant effect on the addition of sago leaves; both treatments resulted in one new leaf per month. Eggplant shoots did not cover the sago trees, so that sago growth is not disturbed by the presence of eggplant.

The cropping system did not give a significant effect on the growth of the sago leaf petiole (Figure 1). The growth of sago leaf petiole of each treatment increased every week and reached 48 cm. Intercrops did not affect the width of the sago leaf petiole (Figure 2). The width of the sago leaf petiole had rapid growth of up to 2 WAP. The width of the sago leaf petiole reached 2.91 cm on average until the end of the observation (8 WAP). Sago food reserves in buttress are widely used in leaf formation rather than root formation (Flach, 1997). The growth of sago leaves is not affected by the presence of eggplant as intercrop.

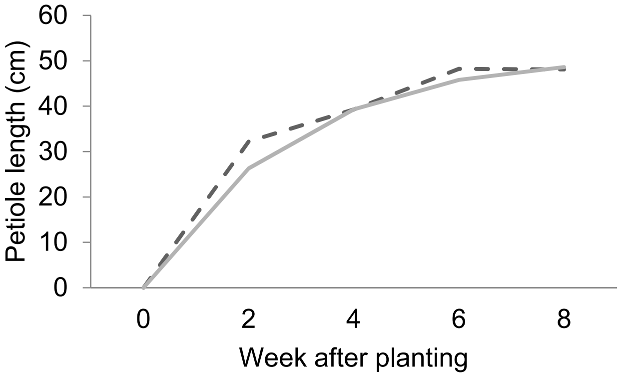

Figure 1. Growth of sago length as monoculture (**----**) and intercropped (–) with eggplants

Table 2. Sago leaf area increments as monoculture and intercropped with eggplants

Treatments	Leaf area increments (cm^2) at week		
	4	6	8
Monoculture	0.6692	1.0676	0
Intercropping	0.4985	0.3847	0
F value	ns	ns	ns

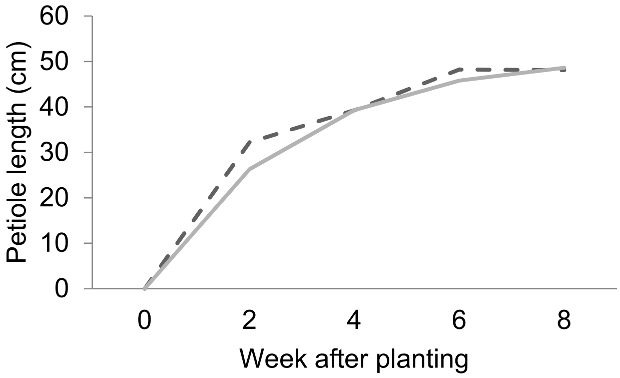

Figure 2. Growth of sago petiole width as monoculture (**----**) and intercropped (–) with eggplants

Sago Leaf Area

Plants with wider leaf area can potentially conduct more photosynthesis. The analysis of variance showed that the growth of sago palm leaf area was not affected by the presence of eggplant as intercrops (Table 2).

The growth of leaf area of the seedling started to decline from the sixth week until it stops growing at 8 WAP (Figure 5). Food reserves in the buttresses are used in leaf formation more than for leaf expansion. Leaf growth will decrease more quickly if sago plants lack nutrients, while leaf formation speed will remain constant (Flach, 1997). Eggplant canopy do not cover the sago seedlings that have just been transferred to the field. The growth of the sago leaf width was not disturbed by the presence of eggplant as an intercrop.

Eggplant Vegetative Growth

Eggplant growth is not affected by the presence of sago plants (Figure 6). The normal eggplant height in monoculture ranges from 60-240 cm (Balitsa, 2018). In our study, at this stage of development the sago tree stands did not cover eggplant. Sago trees have no significant effect on the growth of eggplant leaf number; both monoculture and intercropped eggplants height was about 22 cm (data not presented), which is shorter than those reported by Balista (2018), likely because of the different environment, particularly soil fertility levels. The photosynthetic rate of short plants was lower than the photosynthetic rate of plants that grew normally (Fisher and Palmer, 1992).

Eggplant grows to produce 15 leaves at 8 WAP, and there were no significant differences between monoculture and intercropping in affecting leaf growth (Figure 3).

The pH of the peat soil after liming in the field increased from below 4 to pH 5. Peat soil has low nutrient content (Yonebayashi, 2006). Low pH, particularly of <3.5 highly reduced or affected nutrient absorption from the applied fertilizers as the nutrients became unavailable to the crops. Peat soils are known to have low bulk density (Tie et al., 1991). The unavailability of nutrients in the soil causes reduced nutrient absorption by the roots (Maulana, 2011). The bulk density of peat soils ranges from 0.01-0.20 g per cm3, depending on the level of peat maturity. The low weight of peat soil contents characterizes the low carrying capacity of the soil (Bintoro et al., 2010).

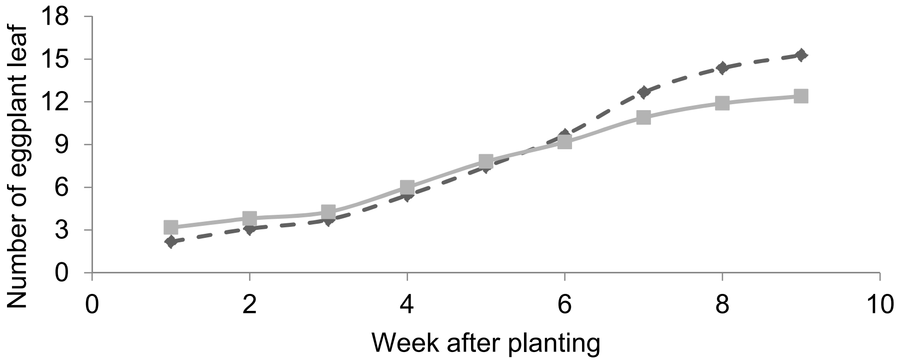

Figure 3. Number of eggplant leaf as monoculture (**----**) and intercropped (–) with sago

The intensity of sunlight is strongly correlated with the rate of photosynthesis of plants. Plants will show differences in photosynthetic characteristics when in low light intensity environment (Jumin, 1992). In this study, sago plant shoots do not cover or reduce light intensity in eggplant, indicated by the eggplant growth as an intercrop is not significantly different from monoculture eggplant.

Sago also did not affect eggplant diameter growth (data not presented), which was around 71 mm in monoculture and intercropping. Eggplant root lengths ranged from 15-20 cm. The average depth of ground water in the area is 63.4 cm and caused the plants to lack water. Low rainfall during growth is indicated by small eggplant stems and cracked bark; low water availability reduced enlargement and division of cells (Salisbury et al., 1992), resulting the eggplants to be shorter and smaller than those reported by Balitsa (2018).

Conclusion

Intercropping of sago trees with eggplant did not significantly affect the growth of sago or eggplants when compared to monoculture, therefore eggplant can be grown as an intercrop amongst young sago palm. Further research should be directed on the optimal dose of lime and fertilizer in Tanjung Peranap Village to optimize growth of both sago and vegetable intercrop. It is necessary to regulate water in sago fields because water has important roles in the sago plantation.

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