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Effect of Organic Fertilizers Application to the Growth of *Orthosiphon stamineus* Benth. Intercropped with *Hevea brasiliensis* Willd. and *Durio zibethinus* Murr.

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ABSTRACT

The aim of this study was to determine the suitable application rate of different organic fertilizers in relation to growth and yield of *Orthosiphon stamineus*. A Randomized Complete Block Design (RCBD) was used and *O. stamineus* seedlings transplanted with spacing 1.5 m between rows and 0.45 m within rows of plants both under rubber (6×4 m) and durian (15×10 m) canopies with light intensity equivalent to 50% of light intensity after measured. Each site was divided into three blocks or replicates. Each block contained four treatments and 20 pants of *O. stamineus* for each treatment. Three organic fertilizer treatments were applied to each block. The selected fertilizers or organic material were namely chicken dung, cow dung, oil palm of Empty Fruit Bunch (EFB) and control treatment and each treatment was randomly allocated in each block. Fertilizers were applied once every six months for one year at two application rates were 0.9 and 0.6 kg plant^{-1}. The growth parameters measured were plant height and fresh and dry weight of leaves for shoot tips 30 cm and above. Chicken dung at rate 0.9 kg plant^{-1} resulted in the highest yield (135 kg ha^{-1}), followed by oil palm EFB, cow dung and control were 68, 54 and 32 kg ha^{-1}, respectively under rubber. The trend also same under durian were 253, 56, 43 and 31 kg ha^{-1}, respectively. The fertilizer response trend was found that the chicken dung was the better source of organic fertilizer followed by oil palm EFB and cow dung. Chicken dung applied at 0.9 kg plant^{-1} is the most suitable for *O. stamineus* intercropped with rubber and durian.

Key words: Agroforestry, interplanting, herbs, dry weight, soil amendment and compost

INTRODUCTION

Orthosiphon stamineus or known as Misai Kucing in Malaysia is a medicinal herb found mainly throughout South East Asia and tropical Australia. The species belongs to the family of Lamiaceae. Production of this crop does not meet the market demand for the preparation of the herbal product. Hence, there is an urgent need to practice intercropping extensively for future commercial supply of this plant to meet the market demand (Lee and Chan, 2004). It is a simple but inexpensive strategy and has been recognized as a potentially benefited technology for increase crop production (Rahman *et al*., 2009). *Orthosiphon stamineus* is believed to have

anti-allergic, anti-hypertensive, anti-inflammatory and diuretic properties. *O. stamineus* is used as a remedy for arteriosclerosis (capillary and circulatory disorders), kidney stones, diabetes and nephritis (Jaganath and Ng, 2000).

Acosta and Lergh (1984a) stated that a planting distance of 40 cm and cutting height of 20-25 cm gave the best yields of *O. stamineus*. Yields of *O. stamineus* were best at planting distance of 40 cm with cuttings every 30 rather than 20 or 40 days (Acosta and Lergh, 1984b). Similar results were also obtained by Zaharah and Salbiah (2005). They reported that the optimum planting distance for *O. stamineus* is 1.5 m between rows and 0.45 m within rows with a plant population of around 29,300 ha^{-1}. This population density yielded an average wet leaf and dry leaf yield of about 18.0 and 3.5 t ha^{-1}, respectively. Other than that, 50% of relative light intensity was the prominent highly than 70 and 100% of relative light intensities under artificial shade in terms of relative height growth rate and total biomass (Affendy *et al.*, 2010). However, information regarding suitable fertilizer rates for the satisfactory production of *O. stamineus* intercropping is lacking in Malaysia. This problem also supported by Gharineh and Moradi Telavat (2009) that the most important factors in selecting plants include their compatibility, having low competition and producing highest yield. This study was therefore undertaken to determine the suitable application rate of different organic fertilizers in relation to growth and yield. The selection of main crop like rubber and durian are based on the familiar crop in the western part of Sabah, Malaysia. So, this study attempt to the farmers to encourage them for agroforestry practice through *O. stamineus* cultivation under their crop.

MATERIALS AND METHODS

Description of the study area: This study was conducted on February 2007 to January 2009 in rubber plantation (8 years-old) and Durian plantation (20 years-old) owned by smallholders in Kampung Kogopon, Papar, Sabah which is approximately 30 km from Universiti Malaysia Sabah at coordinates N 05°42.987' E 116°03.391' and N 05°41.754' E 115°01.264', respectively. The soil series of this area belongs to Inanam family (Gleyic Acrisol) as it is characterized with a gleyic horizon.

According to Acres *et al.* (1975), the soils are formed on fine- to coarse-textured, rarely stony, alluvium occurring on floodplains, valley floors and terraces. They are imperfectly to poorly drain due to groundwater fluctuations. The soils have gleyic horizons below 50 cm and have A, E, B_t, B_{tg} or Cg horizon sequences. The argillic horizons, which occur above gleyic horizons commonly, have matrix colours of 7.5YR hue, with chromas of less than 4, or yellower hues; they generally have fine or moderately fine textures. Most of the surface horizons of these soils have higher cation exchange capacities and exchangeable cation values than the subsurface horizons. The percentage base saturation is usually below 20% with generally low levels of exchangeable cations. Soil pH ranges from 4.0 to 5.5 and generally increases with depth. The experiment for both sites covered an area of 0.5 ha. Based on data from the Malaysian Meteorological Department, the mean annual rainfall for ten years from 1996 to 2007 for both sites was 2686.02 mm. The rainy season occurs in October to December. The mean daily temperature is 23.5 to 33°C with a mean monthly relative humidity above 80% and slightly lower during rainy season.

Materials: A total of two thousand seedlings were established in a nursery. After 1 week in the sowing beds, the seedlings were transplanted into perforated polyethylene bags sized 6×9 inches.

The planting medium in the polyethylene bags was prepared using sand and soil in a ratio of 3:1 (soil: sand) (Aminah *et al*., 2002). After 2 weeks in the polybags the seedlings were transplanted to the field for intercropping with rubber or durian.

Experimental design: A Randomized Complete Block Design (RCBD) was used. *O. stamineus* was planted with spacing 1.5 m between rows and 0.45 m within rows of plants. The site was divided into three blocks or replicates. Each block contained four treatments and 20 plants of *O. stamineus* for each treatment. Three organic fertilizer treatments were applied to each block. The selected fertilizers or organic material were chicken dung, cow dung, oil palm of Empty Fruit Bunch (EFB) and control treatment and each treatment was randomly allocated in each block. Fertilizers were applied once every 6 months for 1 year. Two rates for each organic fertilizer were used (0.9 and 0.6 kg plant^{-1}) without any additional fertilizer based on previous recommendation by Zaharah (2005) in which 0.6 kg plant^{-1} consists 0.3 kg pure organic fertilizer and 0.3 kg additional organic based NPK (Kokei 10:10:10). This study only focused on 0.6 kg (base rate) and 0.9 kg (excess rate) pure organic fertilizer per plant constituting a minimum and maximum cost and management regime.

Data collection: The growth parameters measured were plant height and fresh and dry weight of leaves for shoot tips 30 cm above (Vimala *et al*., 2004). Data collection and harvest were taken every month for 12 months and translated into kg/ha/year (one year basis). The plant height was based on Relative Height Growth Rate (RHGR).

Statistical analysis: The data were subjected to one-way Analysis of variance (ANOVA) and Duncan Multiple Range Test (DMRT) using Statistical Package for Social Science (SPSS) software to evaluate the effects of fertilizer treatments on *O. stamineus* intercropped with rubber and durian. Independent sample t-test was used for evaluating the effects of the two fertilizer rates on *O. stamineus* RHGR and yield.

RESULTS AND DISCUSSION

Relative Height Growth Rate (RHGR) of *O. stamineus* intercropped with rubber and durian using different organic fertilizer treatments: Results as shown in Table 1 indicate that the RHGR of *O. stamineus* under rubber and durian were significantly different between the fertilizer treatment at 5% level ($p<0.05$). RHGR of *O. stamineus* under rubber was highest for chicken dung (0.140 cm/cm/week), followed by oil palm EFB (0.091 cm/cm/week), cow dung

Table 1: Mean RHGR of *O. stamineus* for rubber and durian intercropping with different fertilizer treatments

Intercrop	Treatment fertilizer	RHGR (cm/cm/week)
Rubber + *O. stamineus*	Chicken dung	0.140^{a}
	Cow dung	0.085^{b}
	Oil palm EFB	0.091^{b}
	Control	0.074^{b}
Durian + *O. stamineus*	Chicken dung	0.169^{a}
	Cow dung	0.095^{c}
	Oil palm EFB	0.131^{b}
	Control	0.100^{c}

Mean with different letters are significantly different at 5% level ($p<0.05$) using ANOVA and DMRT

Table 2: Mean RHGR of *O. stamineus* for the two fertilizer treatment rates

Intercrop	Rate (kg plant^{-1})	RHGR (cm/cm/week)
Rubber+*O. stamineus*	0.9	0.095
	0.6	0.099
Durian+*O. stamineus*	0.9	0.120
	0.6	0.128

Mean values were not significantly different at 5% level probability ($p>0.05$) using t-test

Table 3: Mean yield (Dry matter) of *O. stamineus* intercropped with rubber

Rate of fertilizer	Treatment	Dry matter (kg ha^{-1})
0.9 kg plant^{-1}	Chicken dung	135^{a}
(13.3 t ha^{-1})	Cow dung	54^{c}
	Oil palm EFB	68^{b}
	Control	32^{d}
0.6 kg plant^{-1}	Chicken dung	93^{a}
(8.9 t ha^{-1})	Cow dung	39^{c}
	Oil palm EFB	47^{b}
	Control	30^{d}

Mean values with different letters were significantly different at 5% level probability ($p<0.05$) using ANOVA and DMRT

Table 4: Mean yield (Dry matter) of *O. stamineus* intercropped with durian

Rate of fertilizer	Treatment	Dry matter (kg ha^{-1})
0.9 kg plant^{-1}	Chicken dung	253^{a}
(13.3 t ha^{-1})	Cow dung	43^{c}
	Oil palm EFB	56^{b}
	Control	31^{d}
0.6 kg plant^{-1}	Chicken dung	247^{a}
(8.9 t ha^{-1})	Cow dung	41^{c}
	Oil palm EFB	59^{b}
	Control	33^{d}

Mean values with different letters were significantly different at 5% level probability ($p<0.05$) using ANOVA and DMRT

(0.085 cm/cm/week) and control (0.074 cm/cm/week). The results were of a similar trend for durian with mean values for chicken dung, oil palm EFB, cow dung and control being 0.169, 0.131, 0.095 and 0.1 cm/cm/week, respectively.

From the results shown in Table 2, there were no significant differences at 5% level ($p>0.05$) for the two fertilizer rates for either rubber or durian intercropping.

Yield (dry weight) of *O. stamineus* for rubber and durian intercropped using different organic fertilizer treatments: The results in the Table 3 show significant differences at 5% level ($p<0.05$) for the fertilizer treatments and the two application rates for *O. stamineus* intercropped with rubber. Chicken dung resulted in the highest yield (135 kg ha^{-1}), followed by oil palm EFB (68 kg ha^{-1}), cow dung (54 kg ha^{-1}) and control (32 kg ha^{-1}). A similar trend resulted for 0.6 kg rate per plant (8.9 ton ha^{-1}), chicken dung was higher (93 kg ha^{-1}), followed by oil palm EFB (47 kg ha^{-1}), cow dung (39 kg ha^{-1}) and control (30 kg ha^{-1}).

As for the yield of *O. stamineus* under rubber, the results were also the same for durian intercrop as shown in Table 4. There were significant differences at 5% level ($p<0.05$) between the fertilizer treatments for the two rates used which were 0.9 and 0.6 kg plant^{-1}. Chicken dung

Table 5: Yield of *O. stamineus* for rubber and durian intercrops for the two fertilizer rates

Crop	Rate (t ha^{-1})	Yield (kg ha^{-1})
Rubber	8.9	53
	13.3	73*
Durian	8.9	93
	13.3	96

Mean values were significantly different at 5% level probability ($p<0.05$*) using t-test

produced a higher yield (253 kg ha^{-1}), followed by oil palm EFB (56 kg ha^{-1}), cow dung (43 kg ha^{-1}) and control (31 kg ha^{-1}). A similar trend was also observed for 0.6 kg per plant rate, chicken dung was the highest (247 kg ha^{-1}), followed by oil palm EFB (59 kg ha^{-1}), cow dung (41 kg ha^{-1}) and control (33 kg ha^{-1}).

Table 5 shows that there were significant differences in yield at 5% level ($p<0.05$) for the two fertilizers rates for the rubber intercrop. The 0.9 kg plant^{-1} (13.3 t ha^{-1}) fertilizer rate resulted in significantly higher yield compared to 0.6 kg plant^{-1} (8.9 t ha^{-1}) for all the fertilizers used under rubber. There was no significant difference for the durian intercrop.

The beneficial effects of nutrient improvement for both agriculture and forestry have been well documented by several researchers (Aminah and Hussin, 1989; Shamshuddin *et al*., 1987, 1992, 1995; Shamshuddin and Sharifuddin, 1995). The results from this study are in agreement with earlier findings that fertilizer applications promote better growth. However, response to fertilizers mainly depends on the type of fertilizers applied and other environmental conditions such as light and soil.

In this study, it was found that the 0.9 kg plant^{-1} for all types of fertilizers was better in terms of RHGR for both intercrops compared to rate 0.6 kg plant^{-1}. Organic fertilizer increases the organic matter content of the soil along with the major and minor nutrients (Islam *et al*., 2006). According to Acosta *et al*. (1986), early growth and development of *O. stamineus* was best at 75 kg ha^{-1} but in summer 100 kg ha^{-1} was better. This was because the climate and soil fertility were different and as such the fertilizer requirement by *O. stamineus* was different. This is supported by Hassan *et al*. (2007) wherein edaphic and climatic factors were different for the two sites. Another study done by Vimala *et al*. (2004) showed that optimum fertilizer rate in relation to yield was 2.59 kg m^{-2} or 25.9 t ha^{-1}. In the present study, 0.9 kg plant^{-1} (13.34 t ha^{-1}) was effective due to direct fertilizer application to the plant. However, Zaharah (2005) recommended that the optimum fertilizer of *O. stamineus* is 5 t ha^{-1} for six months using organic fertilizer such as chicken dung in alluvium soil and 10 t ha^{-1} in BRIS soil (sandy soil) and subsequent organic based fertilizer as a supplement. Nevertheless, consideration of fertilization rate to *O. staminues* should take into account economic returns.

The fertilizer response trend for the field study is similar to that of the nursery study for *O. stamineus*. It is clear that chicken dung is better than oil palm EFB and cow dung. This is because it has higher nitrogen content. According to Ismail and Zaki (2005), the biomass yield of tea plants increased when chicken manure was increased from 5.0 to 10.0 t ha^{-1} but remained unchanged at 15.0 t ha^{-1}. Zaharah and Vimala (1987) also reported that cucumber on bris soil treated with 10.0 t ha^{-1} chicken manure produced the highest yield.

Oil palm EFB was found to be the second best organic amendment. Yau *et al*. (2006) showed that 20 t ha^{-1} EFB compost with 0.3 t ha^{-1} inorganic fertilizer supplements resulted in a higher yield and lower disease incidence compared to 5 t ha^{-1} compost for cabbage cultivars (*Brassica oleracea* var. *capitata*) under plastic rain-shelter on mineral soils in the lowlands. This

was supported by Ismail *et al.* (2004), who reported that *Brassica campestris* var *chineses* grown in coconut dust with EFB compost resulted in a higher growth and yield (548 g plant^{-1}) compared to either coconut dust or coconut dust mixed with peat. A study done by Zaharah and Lim (2005) found that application of EFB parts to soil resulted in complete N mineralization and a suitable ameliorant in improving soil quality for sustainable oil palm production.

Experimental results reported by Yusoff (2006) indicated that on the inland soils and on some of the less fertile coastal soil, EFB use resulted in improved foliar nutrient levels and vegetative growth. In this study, cow dung treatment did not result in good *O. stamineus* performance but can be useful for other crops. Bwembya and Yerokun (2001) found that cow dung application to maize resulted in the lowest dry matter yield compared to a combination of cow dung with green manure. Troeh and Thompson (2006) mentioned that organic fertilizers such as manure have some slow-release characteristics but the effect is variable and difficult to control. This application of chicken dung was superior among the other organic fertilizers that used. The content of N in the chicken dung caused the high growth yield of *O. stamineus*. The combination of amount of the light under tree canopy, nutrient supplement and root density below ground were affected to the growth of *O. stamineus*. Moreover, the amount of the nutrient elements for each fertilizer also unpredictable. Sometimes, it also depends on the location and source of material of the organic fertilizer. As a result, application of chicken dung showed the better growth performance to the O.stamineus especially when intercrops under rubber and durian or any forest canopy.

CONCLUSION

It was found that the higher fertilizer rate resulted in higher yields of *O. stamineus* but the yield varied between fertilizer types. The fertilizer response trend was found that the chicken dung was the better source of organic fertilizer followed by oil palm EFB and cow dung. Chicken dung applied at 0.9 kg plant^{-1} is the most suitable for *O. stamineus* intercropped with rubber and durian.

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