Organic Alternative of Activated Biomass from Palm Wastes on Vegetative of Coconut (Cocos Nucifera) in Bris Soil

Khairol Ismail*[1], Ahmad Arif Ismail[2], and Mohamad Asyraf Husin[3]

[1,3]Industrial Crop Research Centre, MARDI Bagan Datuk, 36307 Sg. Sumun, Perak, Malaysia

[2]Industrial Crop Research Centre, MARDI Jerangau, 21820, Ajil, Terengganu, Malaysia

Email: [1]khairol.mardi@gmail.com

***Abstract*—** The research work was initiated to study the impact of activated biomass from palm wastes on the growth of coconut planted on marginal bris soil. The experiment was carried out at MARDI Cherating, Pahang. Coconut plants of Ceylon tall at the age of 10 years old used. The activated biomass was derived from coconut fronds (CF) and empty fruit bunch (EFB) which were air-dried and carbonized in a stainless steel fabricated kiln at a temperature between 250oC - 350oC for 4 h to develop the activated biomass. Seven rates of activated biomass were applied in the experiment and it was combined with 4.50 kg/palms of NPK Blue 12:12:17:2 compound for each plant. The data was gathered for the different before and after treatment applications for the time of 2 years. Data of the palm as a measurement of vegetative growth (stem height, stem diameter, stem parameter, fronds number, fronds length, and chlorophyll content) was recorded. The results also showed the excellent effect of plants grown with different activated biomass types and rates per palm. T6 indicates the highest significant reading of stem height. Fronds number, stem diameter, and stem perimeter were indicated from parameters recorded highest at T3. The highest chlorophyll level and fronds number were observed at T4. Further field evaluations are needed to determine the relationship of level of biomass organic with the total amount of NPK supply in inducing the growth of coconut planted in marginal soil.

***Keywords*—** Activated biomass, palm waste, coconut fronds, empty fruit bunch, plant growth.

I. INTRODUCTION

Malaysia is one of the producers of coconut (Cocos nucifera L.) and is mainly cultivated in the coastal belt of the west and east coast. Perak, Selangor, Johor, Pahang, Terengganu and Kelantan account for more than 90% of the area and production. The annual nutrient export by various parts of the palm viz. nuts, fronds, trunk, bunch, and spathe reported by different workers vary from 20 to 174 kg N, 2.5 to 20 kg P, and 35 to 249 kg K ha-1 (Pillai and Davis, 1963; Ramadasan and Lal, 1966; Ollangnier and Ochs, 1978), but there appears to be a general agreement on the ratio of N and K removed by the palms (1: 1.44 - 1.75). If the soil is not replenished with the soil. it will adversely affect the nut yield. Organic manure can meet only 15% of the total nutrient requirement. Unlike inorganic fertilizers, the nutrient supply from organic manure is slow and steady apart from very low nutrient loss. Organic manure also has the added advantage of improving soil physicochemical and biological properties. Plantation crops produce a huge amount of biomass for recycling in the form of suitable organic manure.

Plantation crops have sufficient potential to benefit from natural farming and sustain their yield with low external input as they produce considerable quantities of biomass. (Nampoothiri, 2001). The palm is predominantly grown in acidic nutrient-poor laterite, sandy loam, or sandy soils in the coastal region. Being a perennial crop, the coconut palm produces huge quantities of organic wastes throughout the year. The availability of organic recyclable biomass from a hectare of well-managed coconut garden has been estimated to be about 14–16 tons annually in the form of leaves, spathe, bunch waste, and husk. The use of these waste materials as domestic fuel and thatching material is now limited due to the change in the lifestyle of the rural population. Hence, enormous possibilities exist to recycle these wastes into organic manure to meet the nutrient demand of the crop. As the wastes are lignin-rich materials, their decomposition is slow under natural conditions, and utilization of biopolymer degrading organisms becomes important for the bioconversion of these valuable resources into agriculturally usable organic manure. The waste biomass from coconut palm differs significantly in the chemical composition (Thomas et al., 1998). The application of biomass organic integrated with NPK will enhance for best growth performance of coconut. The application of biomass organic from coconut waste will increase the nutrient contents for plants uptake (Khairol. I and Mohammad. A. H., 2019). The research work was initiated to study the impact of activated biomass from palm wastes on the growth of coconut planted on marginal bris soil.

II. METHODOLOGY

A. Experimental site

The experiment was carried out for one year in a plot of 10 years old coconut palm of Ceylon tall cultivar at MARDI Cherating, Pahang, Malaysia. The site was located at 4°07'45.202' N latitude and, 103°38'45.449' E longitude. The daily temperature during the experiment was in the range of 30–40°C. The research station received an annual average rainfall of 600 mm on 30 rainy days distributed from September to November. The soil was Beach Ridges Interspersed with Swale (BRIS) with low pH and low availability of Nitrogen (N), Phosphorus (P), and Potassium (K).

B. Planting materials

Ceylon tall of coconuts at the age of 10 years were used in a fully randomized design horizontally on raised plots at a spacing of 9.0 m between seedlings and 9.0 m between rows triangularly.

C. Activated biomass development

The activated biomass was derived from coconut fronds (CF) and empty fruit bunch (EFB). Raw of CF was collected from MARDI Bagan Datuk Field and EFB biomass was collected from Sg Sumun Oil Palm Mill, Sime Darby Bhd, located in Bagan Datuk, Perak, Malaysia. The Biomass samples were air-dried for one week to eliminate excessive moisture. The biomass was then chopped in the size of < 50 mm. The biomass sample was carbonized in the stainless steel fabricated kiln at a temperature between 250oC - 350oC for 4 h to develop the activated biomass. Then, the activated biomass was shredded to the size < 5 mm before apply in the experimental plots.

D. Treatments

Seven rates of activated biomass were applied in the experiment and it was combined with 4.50 kg/palms of NPK Blue 12:12:17:2 compound for each plant. The activated biomass was applied at the basin of palm within 2 meters from the stem of coconuts. The NPK was applied above the activated biomass that was applied before. The treatments are as follows:

- T1- Control (NPK only),
- T2- CF 3.0kg/plant + 4.5 kg/plant of NPK,
- T3- CF 6.0kg/plant + 4.5 kg/plant of NPK,
- T4- CF 9.0kg/plant + 4.5 kg/plant of NPK,
- T5- EFB 3.0kg/plant + 4.5 kg/plant of NPK,
- T6- EFB 6.0kg/plant + 4.5 kg/plant of NPK,
- T7- EFB 9.0kg/plant + 4.5 kg/plant of NPK.

E. Data of growth characters

Data of the palm as a measurement of vegetative growth was recorded. The data was gathered for the differences before and after treatment applications for the time of 2 years. The parameter of stem diameter and perimeter of the stem was collected at the height of 1 meter from the bottom of the stem using a calliper and measuring tape. The stem height was measured from the base to the tip of the lowest frond by using a steel ruler. The number of fronds per plant was counted and recorded. The chlorophyll content of the leaves was measured by using a portable SPAD chlorophyll meter with three leaf samples were taken from each plant. The length of fronds was measured from the 11th fronds of each plant by using a measuring tape.

F. Experimental design and data analysis

The experimental design was a Complete Randomized Design. Analysis of variance tests was carried out to detect significant differences between the parameters collected with 2 replications. Means of the measured variables were compared by using the appropriate ANOVA procedure (SAS Institute 1989) and the Duncan test ($P<0.05$).

III. RESULTS AND DISCUSSIONS

A. ANOVA analysis of parameters

The ANOVA analysis suggested that stem height and fond number were significantly affected by treatment (Table 1). On the other hand, stem diameter, stem perimeter, fond length, and chlorophyll content were not significantly affected by the treatment. It can be concluded that the activated biomass applied did not contribute to the difference among treatments to the parameter difference of fronds length, stem diameter, stem perimeter, and chlorophyll content.

B. Effect of activated biomass on stem height of palm

The stem height of the plant was measured to justify the effects of activated biomass on plant height (Figure 1). It shows that T6 indicates the highest significant reading with 63.9 cm compared to other treatments, while T1 showed the lowest effects on stem height with 24.8 cm respectively. In contrast, T3 exhibits statistical parity with that of T6. EFB contains high organic matter and nutrients therefore plants showed dominant growth over BRIS soil. This is because BRIS soil retains very low physical and chemical properties (Chelah. et al, 2011) and therefore plants received a very low quantity of nutrients and showed depressed plant growth. The additional biomass may increase or retain nutrient status at the level from where plants could able to receive sufficient nutrients (Edward. J. P., 2009). In addition, the biomass amendment might increase BRIS soil health, therefore, plant height increased (Chelah. et al., 2011).

C. Effect of activated biomass on fronds number of palm

The parameter of fronds number that showed in figure 2 indicated that both treatment T3 and T4 contributed to the highest significant reading while T1 was significant lowest. T3 and T4 show the highest value with 22.50 compared to other treatments, while T1 shows the lowest value with 19.25 compared to other treatments. The difference was at least 12.5%. Nevertheless, T2 shares statistical parity with both T3 and T4. T6, T7 were at par with T1 and T2. From the parameter collected, it shows that the increase of activated biomass application integrated with NPK rate will assist in the increasing of growth performance of coconut plants.

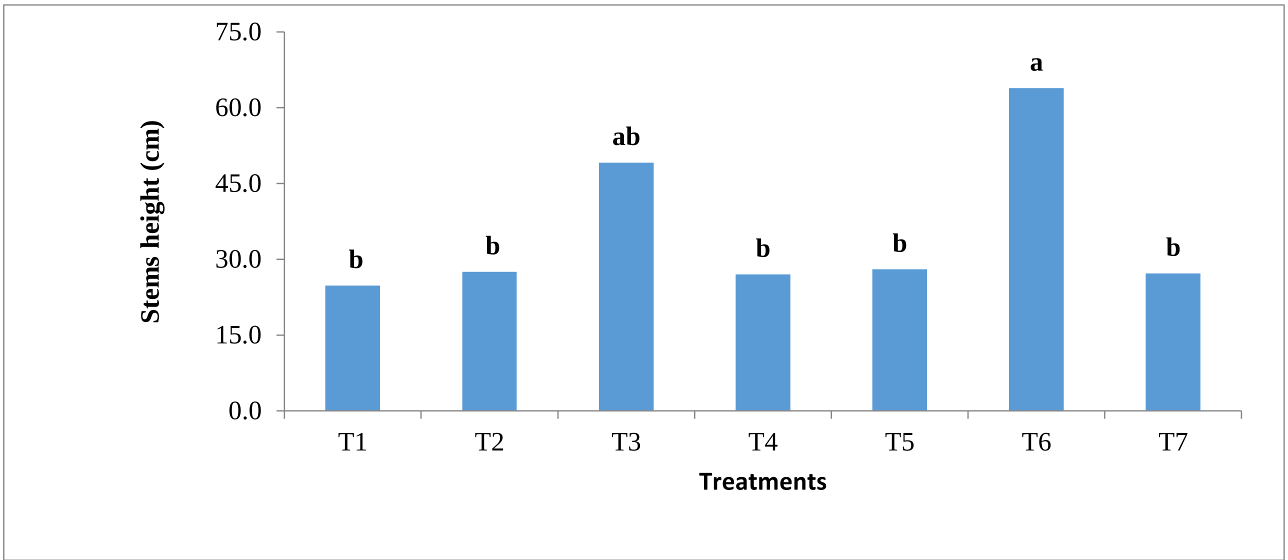

Figure 1: *Effect of activated biomass rate to the relationship between treatment and stems height. Bar with the same letter for each treatment are significantly different at P < 0.05.*

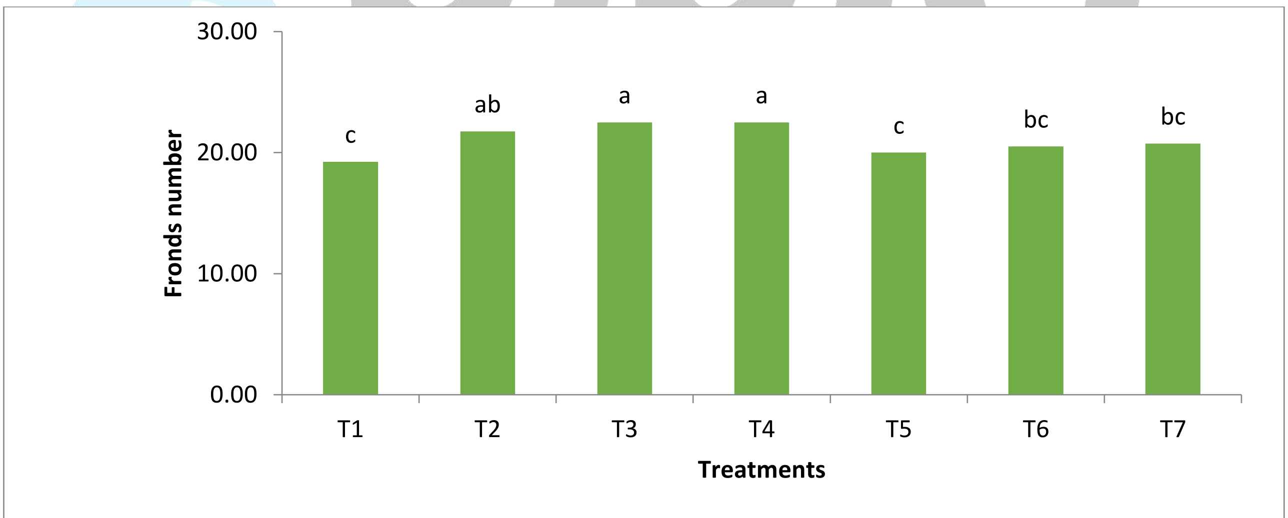

Figure 2: *Effect of activated biomass rate to the relationship between treatment and fronds number. Bar with the same letter for each treatment are significantly different at P < 0.05*

D. Effect of activated biomass on stems diameter and perimeter

Stem diameter was significantly affected by treatments. Nevertheless, T3 recorded the highest significant reading while T1 was the lowest significant (Table 2). Stem perimeter also shows a similar pattern to that of stem diameter whereby T3 recorded the highest reading while T1 was the lowest (Table 2). Regardless, there is a significant effect. According to Jithya (2010), the application of fertilizer application is mainly based on chemicals that are costly and exert negative impacts on soil health. Due to the nutrient demand during the production stage is a requirement for stem development and fruit production only. In common practices, higher fertilizer rates were utilized for the formation and initial yielding stage, which is also root growth and leaf recycling is not taken into account, than for the production stage (adult plant).

Table 1: *Mean square ANOVA Effect of activated biomass rate to the coconut growth parameters performance*

Source of variance	**Parameter**					
	Stem height (cm)	**Stem diameter (cm)**	**Stem perimeter (cm)**	**Fronds number**	**Fronds length (m)**	**Chlorophyll content (SPAD reading)**
Treatment	455.26	0.28	0.14	3.14**	0.10	8.29
Rep	96.73*	0.12	0.01	2.16	0.05	15.86
Grand mean	35.36	1.11	0.95	21.04	4.39	52.35
C.V. (%)	26.99	35.26	22.27	3.20	5.13	18.83

Note: mean with * is significant at 0.05, mean with ** is significant at 0.01

Table 2: *Mean comparison for parameter of stems diameter and stem perimeter affected by activated biomass rates*

Treatments	**Parameter**	
	Stem diameter (cm)	**Stem perimeter (cm)**
T1	0.70 c	0.70 b
T2	1.00 ab	0.90 ab
T3	1.25 a	1.10 a
T4	1.10 ab	1.00 a
T5	0.85 b	0.95 a
T6	1.15 a	1.10 a
T7	1.00 ab	0.90 ab
Grand mean	1.11	0.95
C.V. (%)	35.26	22.27

Mean value with the same letter for each treatment are significantly different at P < 0.05

E. Effect of activated biomass on Chlorophyll content

Chlorophyll content in the coconut leaves was varied according to the treatments (Table 3). Chlorophyll content in leaves at T4 recorded the highest while T1 was the lowest SPAD reading compared among treatments. Despite the difference in this observation, there is no significant effect was established, due to the red pigment in the leaf which reduced chlorophyll accumulation in leaves. Chlorophyll content in coconuts plant under BRIS soil condition was not significantly varied from each treatment. Alternatively, biomass amendment might increase soil health which enhances Chlorophyll content in the leaves of coconuts. In addition, Chlorophyll content gradually increased with increasing soil amendments in BRIS soil, and the highest chlorophyll content in leaves was observed under T4 and T6 treatment. These results indicate that mixing with activated biomass with BRIS may potentially yield better results compared to control.

Table 3: *Mean comparison for parameter of fronds length and Chlorophyll content effected by activated biomass rates*

Treatments	**Parameter**			
	Frond length (m)		**Chlorophyll content (SPAD reading)**	
T1	4.10	a	49.1	a
T2	4.30	a	52.0	a
T3	4.70	a	51.6	a
T4	4.60	a	55.7	a
T5	4.25	a	51.8	a
T6	4.55	a	53.5	a
T7	4.20	a	52.9	a
Grand mean	4.39		52.4	
C.V. (%)	5.13		18.83	

Mean value with the same letter for each treatment are not significantly different at P < 0.05

F. Effect of activated biomass on Fronds length

The frond length also shows a similar pattern in which no significant effect was established (Table 3). The highest length of fronds was observed in T3, followed by T4 while the shortest fronds length was recorded in T1. It was observed that organic fertilizers improved the growth parameters of coconut fronds length that significantly related to the plant's vigor of adult palm characters. The results indicated that the activated biomass rate may assist in the increasing length number of fronds. However, if the nutrient recycling rate from the soil by the extractor is known, the relation between the recycled nutrient quantity by the extractor and the inorganic nutrient quantity applied to the soil can be estimated. The estimated quantity could benefit to be applied for plants, according to the soil volume and the roots explore which the palm shading is significantly associated with the number of nutrients to increase the growth performance of plants.

G. Correlation analysis between parameters collected

The findings show in table 4 the strength of the positive relationship between stem perimeter and fronds numbers ($r = 0.66$, $p < 0.01$). In return stem diameter has significant positive association with stem perimeter ($r = 0.68$, $p < 0.01$). Achieving higher reading for these two particular parameters may benefit fond number reading positively. There is a moderate relationship between stem parameters and plant height ($r = 0.72$, $p < 0.05$). In conclusion, there is a significant relationship between fronds number, stem diameter, plants height, and stem perimeter. But all four of these aspects do not have a strong relationship. This indicated that the increase of fronds number will not impact the stem height and stem perimeter.

IV. CONCLUSIONS

The results obtained from all the parameters indicated the significant relation between activated biomass and the growth of coconut. The results also showed the excellent effect of plants grown with different activated biomass types and rates per palm (0, 3.0, 6.0, and 9.0kg/palm). The stem height of the plant was measured to justify the effects of activated biomass on plant height. T6 indicates the highest significant reading. T3 showed the best stem height in terms of alternatively activated biomass from CF sources. T3 and T4 contributed to the highest significant reading of fronds number. Stem diameter was not significantly affected by treatments. However, T3 recorded the highest reading. Despite this difference, no significant relationship was established. Chlorophyll content gradually increased with increasing soil amendments in BRIS, and the highest chlorophyll level in leaves was observed under T4 and T6 treatment. Despite the difference in this observation, there is no significant effect of red pigment in the leaf which reduced chlorophyll accumulation in leaves. Activated Organic biomass improved the growth parameters of coconut fronds length which the highest length of fronds was observed in T3. The practice if adopted can cope-up the nutritional requirement of seedlings at the field stage considerably reduce the cost of production of field maintenance and can produce well healthy plants for plantation. The study also has limitations due to the information of the activated carbon biomass study for in-field stages of coconuts especially in Malaysia is limited. There is less comparison study for the uses of organic fertilizer for coconut seedlings performance at different varieties i.e. inbred and hybrids.

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Table 4: *Correlation analysis between parameters of stems height, stems diameter, stems perimeter, Chlorophyll content and fronds number*

Parameters	Stem height (cm)	Stem diameter (cm)	Stem perimeter (cm)	Chlorophyll content (SPAD reading)	Frond number
Stem height (cm)	1	0.48	0.72	-0.16	0.07
		ns	*	ns	Ns
Stem diameter (cm)		1	0.68	-0.16	0.66
			**	ns	**
Stem perimeter (cm)			1	0.21	0.51
				ns	Ns

Chlorophyll content (SPAD reading)				1	0.17
					Ns
Frond number					1

Note: mean with * is significant at 0.05,
mean with ** is significant at 0.01

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