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Effects of Composting on Three CPH Based Fertilizer Materials Used for Cocoa Nursery

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Abstract:
In its raw or processed form, CPH has the potential to be used as organic fertilizer but few studies have been conducted in Nigeria. This study was designed to examine the utilization of CPH as organic fertilizer to raise cocoa seedlings in nurseries. In this study, composite was made using CPH only and 1:1 v/v of CPH and Goat dung (GD) to mixture by weight. Raw CPH was allowed to decompose naturally. Exhausted soil devoid of any amendment was used as control. The three composite were monitored for 54 days and were used for cocoa seedling production using 25, 50, 100 and 200 kg ha^{-1} application rates with four replicates each for 10 weeks. The composted CPH only, showed that it contained 4.9%Nitrogen, 0.6%Phosphorous, 3.6%Potassium, 33.3%Carbon and 17.0% moisture while the uncomposted CPH contained 2.7%Nitrogen, 0.1%Phosphorous, 3.0%Potassium, 31.8%Carbon and 11.7% ash content indicating that composting enhanced Nitrogen, Phosphorous, Potassium and Carbon contents. However, composted CPH+GD (1:1 v/v) contained 5.9%Nitrogen, 0.5%Phosphorous, 4.1%Potassium and 22.0% moisture. Composting thus improved Carbon, Nitrogen, Potassium and moisture contents as compared to composted CPH only and uncomposted CPH (control). The effects of composted CPH+GD (1:1 v/v), composted CPH only and uncomposted CPH on the plant height (16.1cm, 7.5cm and 9.5cm), stem girth (2.6cm, 1.6cm and 1.4cm) and number of leaves (10.5, 5.9 and 5.6) of the planted cocoa seedlings at the tenth week after planting showed that composted CPH+GD (1:1 v/v) medium was highest and significantly different ($P<0.05$) from those grown on composted CPH only and uncomposted CPH. Application rate of 200 kg ha^{-1} supported the highest plant height (15.5cm), stem girth (3.1cm) and number of leaves (11.0) of cocoa seedlings than the lower rates, which were not significantly different from themselves. Nevertheless, the performance of the seedlings raised on composted CPH+GD (1:1 v/v) suggests its potential as a good organic fertilizer for cocoa nursery.

Keywords: *Cocoa pod husk, Goat dung, Composting and Cocoa seedlings.*

1. Introduction

Theobroma cacao is an important tropical rain forest species that is grown for its oil rich seed to produce cocoa and cocoa butter. The cocoa pod is composed of about 42% beans, 2% mucilage and 56% pod husk (Oladokun, 1995). By-products of cocoa include pod husks, shell and sweating. Better cocoa production will certainly be enhanced if economic use is made of the by-products. Opeke (1992) reported that cocoa farmers will earn a little more for their labour if these by-products are put into utmost use. Presently, pod husks constitute a waste product in the cocoa industry and a serious disposal problem. They become a significant source of disease inoculums when used as mulch inside the plantation.

Cocoa pod husks contain 3 to 4 percent potassium on a dry basis (Wood and Lass, 1985). Pod husk ash which is gotten from burning CPH, has been used to make soap in Ghana and Nigeria (Oduwole and Arueya, 1990; Arueya, 1991). UNCTAD (2004) reported that Nigeria contributes about 11% to the world cocoa production. This author further reiterated that even though the origin of cocoa has been confirmed to be from the Americas, Ivory Coast, Ghana, Cameroon and Nigeria have got about two thirds of the contributions to the world cocoa production with the exporting of cocoa beans standing at three quarters. Cocoa pod husk, which is the major agricultural waste of the cocoa industry, has been found to be unusually rich in potassium and can constitute a viable source of potash production (Douglas, 2006; Adeoye*et al.,* 2001).Potash has a wide range of industrial uses, some of which are for the production of other potassium salts, dehydrating agents, fertilizer (KCL) and so on.

Cocoa pod husks have been reportedly put into use by several studies but there is an urgent need to put it into an easily practiced use because of its vast availability locally. Smith (1989) reported that there is about 1 million tonnes of dried CPH that are produced annually in Nigeria. Even though an appreciable percentage of these pod husks have been found to be used for feeding ruminants, the remaining percentage must be equally put into use to avert the imminent black pod disease it causes when left on the plantation unattended to. The claim of Wood and Lass (1985), about CPH containing 3 to 4 % potassium is supported by the fact that crops grown near to where CPH had been dumped performed unusually well. It is on this basis that this study hopes to assess the management of CPH and develop a recycling method for its use in Agriculture.

2. Materials and Methods

Three composting systems were set up out of which two of the composting systems comprised of 30kg of fresh cocoa pod husks with average weight of 93g each. About 10kg of goat dung used in one of the composting systems was collected from different locations where goats are reared around Ajilosun area in Ado – Ekiti metropolis. About 90kg of exhausted soil was collected from the gully erosion site in Ajilosun street Ado- Ekiti in Ekiti State, Nigeria.

2.0 Composting Systems

Two types of composts were employed in this study. The first being the composting of 10kg of fresh cocoa pod husks plus 10kg of goat dung. The fresh cocoa pod husks were chopped into small bits and later mixed thoroughly with the goat dung by pounding until a homogenous mixture was perceived. The mixture was heaped and labelled "composted CPH + GD 1:1 v/v".

Second, 20kg of fresh cocoa pod husks was equally chopped into small bits, pounded and heaped as done above. This was labelled "composted CPH only". The two composts were continuously mixed every day for 54 days with the monitoring of change in temperature and moisture content of the heaps. Monitoring of the Nitrogen, Phosphorus, Potassium and Organic Carbon together with other nutrient elements was done on the 1st, 8th, 15th, 36th and 54th day of composting. The mixture of the two heaps was done to accomplish the release of nutrients gradually through mineralization as reported by Moyosore (2006). About 2kg of already dumped CPHs that were allowed to decompose naturally for 54 days with average weight of 83g each was selected for use. The selected CPHs were chopped into small bits, sun dried for five days and ground into powder with a grinder. This was labelled as "uncomposted CPH".

2.1. Preparation of Potting Media

The exhausted soil was sieved to remove stones, pebbles and other foreign materials and to enhance thorough mixing of the fertilizer materials. The exhausted soil was bagged and washed with distilled water with a view to making it nutrient free. The washing of the exhausted soil was done for 3 days consecutively after which it was air dried properly.

The three fertilizer materials were prepared as follows;

Assuming $2x10^6$kg soil is in 1 hectare (Adeoye personal Communication)

Therefore 2×10^6kg soil requires 2.5 tonnes of fertilizer

1kg soil will require $\frac{2{,}500kg}{2x10^6kg}$

10kg soil will require $\frac{2.5x10^3}{2x10^6} \times 10$

$= \frac{2.5x10^4}{2x10^6}$

$= \frac{2.5}{2} x\ 10^{-4-6} X10^3$

$= \frac{2.5}{2} X10^{-4-6+3}$

$= 1.25 \times 10$

$=$ 12.5g

This means that 12.5g of fertilizer materials would be mixed with 10kg of exhausted soil. In order to make up for four rates of application of fertilizer materials, 25, 50, 100 and $200kg^{-1}$ ha were employed in the green house experiment.

2.2. Green House Experiment

Sixty polythene bags were filled with 10kg of the composite samples of exhausted soil. Four rates of fertilizer materials were thoroughly mixed with 48 of the polythene bags containing the soil. The remaining twelve bags were made to be devoid of any fertilizer materials with a view to checking if the exhausted soil contained any minute nutrients after the thorough washing with distilled water. These twelve bags devoid of any amendment were used as the control for this experiment.

The polythene bags were arranged using Randomized Complete Block Design (RCBD) in the green house. This arrangement implies that 16 polythene bags were maintained for each of the fertilizer materials amended with the soil.

2.3. Operations Involved in Planting and Post Planting of Cocoa Seedlings

To assess the efficiency of the fertilizer materials, cocoa seedlings were used as a test crop. Fresh cocoa seeds were collected from the pod and soaked in water up to six hours. Water was drained and the seeds were allowed to stay overnight. This was done in accordance with the method of ensuring adequate growth of seeds by Anand*et al* (1995).

The cocoa seeds were planted in the 60 polythene bags with four replicates maintained for each rate of fertilizer materials amended with the soil in the green house. The filled polythene bags were watered before the planting of cocoa seeds and watering continued twice a day at 0.7 litre per bag until the experiment was terminated at the tenth week.

2.4. Data Collection and Statistical Analyses

Data was collected on the two composting systems employed in this study. Physicochemical properties of the materials used and temperature change during the composting in this study were involved in data collection. Data was equally collected on the agronomic variables of cocoa seedlings planted as experimental plant in the green house.

The following agronomic parameters were considered:

(a) The height of cocoa seedlings in centimetres
(b) The stem girth in centimetres
(c) The number of leaves

All these parameters were measured for 10 weeks after planting (WAP) and data were subjected to analysis of variance (ANOVA) and mean separated using Duncan multiple range tests as reported by SAS (1995). Again, Pearson correlation coefficient between rate of application of fertilizer materials and agronomic variables of cocoa seedlings at different stages of growth was equally determined in this study.

3. Results

The physiochemical properties of goat dung used in one of the composting systems are shown in Table 1. The dung contained 54.2% carbon, 0.61% phosphorus, 2.5% Nitrogen, 0.9% potassium, 3.61% ash and 24.0% moisture. The pH of the material is near neutral (7.76 in H_2O). However the physiochemical properties of the exhausted soil used showed that it contained 2.1% organic carbon, 19.0ppm available phosphorus, 0.51% Nitrogen, 1.03 Meq /100g soil potassium and pH (KCl) of 6.20 (Table 1). The physiochemical properties of uncomposted CPH shown in Table 1 indicate that it contained 31.8% Organic Carbon, 2.7% Nitrogen, 0.1% Phosphorous, 3.1% Potassium, 11.7% Ash and 29.0% moisture. The pH in H_2O is 7.2. However, the composting systems set up in this study which comprised of composted CPH + GD (1: 1v/v) and composted CPH only as shown in Table 2 revealed that composted CPH + GD (1: 1 v/v) contained organic carbon which ranged between 35.9% and 48.2% for first and last day of composting respectively.

The increase observed in organic carbon was 34.2%. The Nitrogen content ranged between 5.25 and 5.89% for the first and last day of composting respectively. The increase observed in the Nitrogen and Potassium contents was 12.19 and 12.88% respectively. The Phosphorous, ash and moisture contents showed an inconsistent trend during the composting. Phosphorous and Potassium contents of the composted CPH only increased with time during composting by 141.7 and 38.2% respectively. Nitrogen, Carbon, ash and moisture contents also showed an inconsistent increase during the composting (Table 2).

3.1. Growth Variables of Cocoa Seedlings

3.1.1. Stem Girth

The effect of the three sources of fertilizer materials on the stem girth of cocoa seedlings is shown in Table 3.There was a significant difference between the fertilizer materials throughout the period of observation. The trend in stem girth of seedlings was in the following order; CPH+GD > CPH only >uncomposted CPH. The addition of GD during composting contributed between 47.56 to 78.73% to stem girth at 4 and 2 weeks after planting respectively.

Furthermore, composting contributed between 12.90 to 250.00% to stem girth at 7 and 2 weeks after planting respectively. The effect of the rates of fertilizer application on the stem girth is shown in Table 4.9; the addition of 200kg^{-1} ha of fertilizer application was different significantly from other lower rates throughout the period of observation, however there was no significant difference among 100, 50 and 25kg^{-1} ha rates in the first 5 weeks of observation. Again, 100 and 50kg^{-1} ha rates of fertilizer application were not significantly different from themselves between 7 and 10 weeks after planting. (Table 4).

Physiochemical properties	Exhausted Soil, Goat Dung, Uncomposed CPH
Moisture content (%) Ash content (%) Available phosphorus (ppm)	- 24.00 29.03 - 3.61 11.66 18.99 0.61 0.09
Organic carbon (%)	2.12 54.17 31.82
Total Nitrogen (%)	0.51 2.45 2.66
Calcium (meq/100g)	1.52 - -
Sodium (meq/100g)	24.00 - -
Potassium (meq/100g)	1.03 0.85 3.04
Magnesium (meq/100g)	0.01 - -
Acidity (meq/100g)	0.40 - -
CEC (meq/100g)	3.21 - -
Clay (%)	5.20 - -
Silt (%)	3.40 - -
Sand %	91.40- -
pH in water	7.01 7.76 7.20
pH in Kcl	6.20 - -

Table 1: Physical and chemical properties of exhausted soil and organic materials used

	CPH + GD (1:1v/v)					CPH ONLY				
Properties	1	8	15	36	54	1	8	15	36	54
Moisture content (%)	11.35	11.03	11.27	11.32	22.00	10.02	10.14	10.06	9.94	17.00
Dry matter (%)	88.65	88.77	88.73	88.68	-	89.97	89.86	89.97	90.06	-
Organic carbon (%)	35.92	36.93	38.69	42.57	48.20	33.14	33.35	34.66	33.13	33.30
Phosphorus (%)	0.43	0.46	0.49	0.47	0.49	0.24	0.35	0.40	0.51	0.58
Nitrogen (%)	5.25	5.67	5.88	5.88	5.89	4.18	4.45	4.67	4.66	4.88
Potassium (%)	3.65	3.74	3.91	3.97	4.12	2.59	3.03	3.05	3.09	3.58
Ash content (%)	7.08	6.95	7.11	6.98	-	9.75	9.83	9.78	9.88	-
pH in water	-	-	-	-	9.45	-	-	-	-	9.71

Table 2: Physiochemical Properties of the Composting Systems during maturation at different days of composting

Organic fertilizer materials				
WAP	Exhausted Soil (control)	CPH + GD	CPH only	Uncomposted CPH
2	0.00d	0.91a	0.51b	0.19c
3	0.00d	1.08a	0.70b	0.20c
4	0.00d	1.21a	0.82b	0.37c
5	0.00d	1.33a	0.88b	0.50c
6	0.00d	1.68a	1.04b	0.68c
7	0.00d	2.33a	1.40b	1.24c
8	0.00d	2.41a	1.46b	1.28c
9	0.00d	2.52a	1.51b	1.31c
10	0.00d	2.64a	1.60b	1.35c

Table 3: Effect of three sources of organic fertilizer materials on the stem girth of cocoa seedlings

Means with the same letters in each row are not statistically significant by Duncan multiple range rate at 5% level of significance.

Organic fertilizer rates (kg^{-1} ha)					
WAP	0	25	50	100	200
2	0.00c	0.31b	0.46b	0.52b	0.86a
3	0.00c	0.44b	0.54b	0.63b	1.10a
4	0.00c	0.51b	0.63b	0.74b	1.30a
5	0.00c	0.56b	0.76b	0.84b	1.47a
6	0.00d	0.64c	0.92bc	1.08b	1.89a
7	0.00d	0.72c	1.53b	1.59b	2.79a
8	0.00d	0.76c	1.62b	1.62b	2.87a
9	0.00d	0.86c	1.66b	1.68b	2.96a
10	0.00d	0.84c	1.74b	1.81b	3.06a

Table 4: Effect of four rates of organic fertilizer application on the stem girth of cocoa seedlings.

Means with the same letters in each row are not statistically significant by Duncan multiple range rate at 5% level of significance.

3.1.2. Number of Leaves

The effect of the three sources of fertilizer materials on the number of leaves is shown in Table 5. CPH + GD 1:1 v/v was significantly different from CPH only and uncomposted CPH throughout the period of observation. The addition of GD during composting contributed between 9.76 and 77.36% to number of leaves at 4 and 10 weeks after planting respectively. However, composting contributed between 26.73 and 38.89% to number of leaves at 5 and 3 weeks after planting. Composting process did not significantly enhance the number of leaves of cocoa seedlings between 6 and 10 weeks after planting.

Cocoa seedlings receiving 200 kg^{-1} ha rate consistently had the highest number of leaves which was significantly different ($P<0.05$) from other rates throughout the period of observation (Table 6). Also, 100, 50 and 25 kg^{-1} ha rates of fertilizer application were significantly different from themselves except at 6 and 7 weeks after planting.

3.1.3. Stem Length

The effect of the three sources of fertilizer application on the stem length is shown in Table 7. There was significant difference between CPH + GD 1:1 v/v other sources throughout the period of observation. Beyond 4 weeks after planting, there was no significant difference between CPH only and uncomposted CPH treated cocoa seedlings. The addition of GD during composting contributed between 113.32 and 124.18% to stem length at 9 and 6 weeks after planting respectively. Composting process heightened stem length by between 22.59 and 62.50% at 4 and 3 weeks after planting respectively.

Optimum performance in terms of stem height was observed for seedlings raised on 200 kg^{-1} ha rate of fertilizer which was significantly different ($p<0.05$) from the lower rates (Table 8). From 4 weeks upward, the stem length of seedlings raised on 200 and 100 kg^{-1} ha fertilizer material did not differ significantly, but were significantly different from those seedlings that received 25 kg^{-1} ha.

3.2. Correlation between Variables

The correlation between rate of fertilizer application and the three agronomic variables were positive and significant during the 3, 6 and 10 weeks of observation (Table 9). Out of the three variables, stem girth had the highest correlation coefficient of 0.63 and 0.65 at 6 and 10 weeks after planting respectively, which were significantly different ($P<0.001$). The least coefficient (0.43) was between rate of fertilizer application and stem length at 6 weeks after planting ($P<0.01$).

Organic fertilizer rates				
WAP	**Exhausted Soil (control)**	**CPH + GD**	**CPH ONLY**	**Uncomposted CPH**
3	0.00c	1.67a	1.50ab	1.08b
4	0.00d	2.25a	2.05b	1.50c
5	0.00c	3.42a	2.75ab	2.17b
6	0.00c	4.58a	3.08b	2.75b
7	0.00c	7.33a	4.42b	3.92b
8	0.00c	8.67a	5.17b	4.75b
9	0.00c	9.58a	5.50b	5.00b
10	0.00c	10.50a	5.92b	5.58b

Table 5: Effect of three sources of fertilizer materials on number of leaves of cocoa seedlings.

Means with the same letters in each row are not statistically significant by Duncan multiple range rate at 5% level of significance.

Organic fertilizer rates (kg^{-1} ha)					
WAP	**0**	**25**	**50**	**100**	**200**
3	0.00c	0.78b	1.44b	1.22b	2.22a
4	0.00c	1.11b	2.00ab	2.00ab	2.89a
5	0.00c	1.89b	2.89ab	2.56b	3.78a
6	0.00c	2.33b	3.33b	3.11b	5.11a
7	0.00c	3.33b	4.78b	5.00b	7.78a
8	0.00d	3.89c	6.11b	5.67bc	9.11a
9	0.00d	4.00c	6.78b	6.11c	9.89a
10	0.00d	4.33c	7.33b	6.67bc	11.00a

Table 6: Effect of four rates of Organic Fertilizer Application on Number of Leaves of Cocoa Seedlings

Means with the same letters in each row are not statistically significant by Duncan multiple range rate at 5% level of significance.

		Organic fertilizer materials		
WAP	Exhausted soil	CPH + GD	CPH ONLY	Uncomposted CPH
2	0.00b	3.67 a	2.53 a	3.36 a
3	0.00c	9.79 a	4.48 b	7.28 a
4	0.00c	14.56 a	6.54 b	8.03 b
6	0.00c	15.02 a	6.70 b	8.35 b
5	0.00c	13.84a	6.42b	7.87b
7	0.00c	15.53 a	7.18 b	8.56 b
8	0.00c	15.73 a	7.29 b	9.10 b
9	0.00c	15.89 a	7.43 b	9.33 b
10	0.00c	16.02 a	7.51 b	9.45 b

Table 7: Effect of three sources of organic fertilizer materials on stem length of cocoa seedlings

Means with the same letters in each row are not statistically significant by Duncan multiple range rate at 5% level of significance.

			Organic fertilizer rates (kg^{-1} ha)		
WAP	0	25	50	100	200
2	0.00d	1.61c	3.34b	2.91bc	4.87a
3	0.00c	4.08b	6.50b	6.87b	11.29a
4	0.00d	5.16c	9.19b	9.28b	13.88a
5	0.00d	5.63c	9.62b	9.50b	14.08a
6	0.00d	5.97c	10.24b	9.67b	14.21a
7	0.00d	6.22c	10.71b	10.06b	14.69a
8	0.00d	6.34c	11.11b	10.41b	14.97a
9	0.00d	6.39c	11.21b	10.61b	15.32a
10	0.00d	6.42c	11.34b	10.70b	15.50a

Table 8: Effect of four rates of organic fertilizer application on the stem length of cocoa seedlings

Means with the same letters in each row are not statistically significant by Duncan multiple range rate at 5% level of significance.

	Weeks after planting		
	3	6	10
Stem girth	0.50**	0.63***	0.65***
Stem length	0.54**	0.43**	0.44**
Number of leaves	0.55**	0.49**	0.52**

Table 9: Pearson correlation coefficient between fertilizer application rates and agronomic variables of cocoa seedlings at different stages of growth
*Note: **, *** = Significant at 1% and 0.1% respectively and positive correlation*

4. Discussion

In this study, the composition of Nitrogen and Phosphorous reported for goat dung is in line with the report of Salem (1975) that gave a range of 2-3% N and 0.4-0.7% $P_2 0_5$ for these nutrients in goat dung. The submission of Wood and Lass (1985) that CPH contain 3 to 4% potassium on dry basis proved to be correct in the sense that the chemical composition of the processed CPH used in this study, gave 3.04%.

It can be seen from the results of the physicochemical properties of the composting systems that organic carbon, phosphorus, Nitrogen and potassium contents of the two composting systems increased with days of composting. These increments over time mean that nutrients were gradually released through mineralization of the composts; similar observation was made by Moyosore (2006). The compost of CPH+GD 1:1 v/v was observed to produce the higher contents of these nutrients when compared to the compost of CPH only.

It is observed from the result that composted CPH+GD 1:1 v/v produced the best performance in terms of stem girth, stem length and number of leaves throughout the period of observation. Although composted CPH only and uncomposted CPH produced appreciable performance on the agronomic variables but they could not be matched up with the result produced by composted CPH+GD 1:1 v/v. The optimum performance of composted CPH+GD 1:1 v/v could be linked with the addition of GD in the compost which presumable is an additional source of nutrients that promotes better performance.

The effect of high rate of fertilizer application on the stem girth of cocoa seedlings was tremendous. Even though 200 kg^{-1} ha rate of fertilizer application had the best performance throughout the experiment in term of stem girth, 100, 50 and 25 kg^{-1} ha rates of fertilizer application produced a non-significant effect on the stem girth at 2, 3, 4 and 5WAP. This can be attributed to the fact that nutrients were slowly released from the added fertilizer materials. Again, the effect of 100 and 50 kg^{-1} ha rates of fertilizer application were not significant at 7WAP up to 10WAP. This result implies that cocoa seedlings during nursery need a substantial rate of fertilizer application with a view to producing a very good performance in terms of stem girth.

Composted CPH + GD 1:1 v/v again had the best performance out of the three fertilizer materials used in this study on the number of leaves produced throughout the period of the experiment in the green house. Composted CPH only and uncomposted CPH had a non-significantly different effect on number of leaves from 6 to 10WAP. It was observed that 200 kg^{-1} ha rate of fertilizer application had the best performance in terms of number of leaves produced throughout the experiment whereas 100, 25 and 50 kg^{-1} ha rates of fertilizer application produced a non-significantly different result at 6WAP and 7WAP. This trend was recorded at 4WAP between the two rates of fertilizer application on number of leaves produced.

It can be seen that composted CPH + GD 1:1 v/v had the best performance in terms of stem length when compared with composted CPH only and uncomposted CPH throughout the 10 weeks of monitoring in the green house. Although, uncomposted CPH was better than composted CPH only up to 4WAP with respect to stem length. This trend changed from the 5 WAP up to 10 WAP with composted CPH only being better, mineralization process can be implicated for this change. It can again be seen that 200 kg^{-1} ha rate of fertilizer application gave the best performance in terms of stem length of cocoa seedlings throughout the experiment. Lower rates of 100 and 50 kg^{-1} ha of fertilizer application had no significantly different effect on the stem length of cocoa seedlings from 3WAP to 10WAP. This result again suggests that a substantial rate of fertilizer application is needed during the nursery of cocoa seedlings so as to attain the best performance in terms of stem length.

Positive and significant correlation between rate of fertilizer application and the agronomic variable suggest higher rate of fertilizer application enhances the performance of the measured variable which further reiterates earlier submission in this work.

5. Conclusion and Recommendation

Due to the results obtained from the effects of the three sources of organic fertilizer materials and their rate of application of the organic fertilizer materials on all the agronomic variables monitored in this study, it can be concluded that they all varied with rate of application of the organic fertilizer materials. Composted CPH + GD 1:1 v/v that had the best performance in all the agronomic variables monitored is believed to achieve this feat due to the addition of goat dung during the composting. Composted CPH only and uncomposted CPH were not significantly different from each other going by the results obtained from the agronomic variables monitored. It is advisable to add an organic waste to the composting of CPH as this will ultimately yield a very positive and productive result in improving soil fertility. Composted CPH only and uncomposted CPH are not totally advisable since their outcome on the growth of cocoa seedlings used in this study did not give the best performance.

Again, it is recommended that a substantial rate of fertilizer application that is more than 200 kg^{-1} ha that had the best performance on the monitored agronomic variables, be used in the nursery of cocoa seedlings with a view to bringing the best out of the growth of the seedlings. It is recommended that further experiment needs to be conducted to really ascertain the best organic waste that can be composted with CPH so as to attain the best outcome in terms of improving soil fertility.

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7. References

i. Adeoye, G. O., Sridhar, M. K. C. and Ipinmoroti, R. R. (2001). Potassium recovery from farm wastes for crop growth, Communications in Soil Science and Plant Analysis, 32: Nos. 15 & 16, 2347-2358
ii. Anand, J. A., Wilson, M.O.P. Kal, R.D. (1995), Effect of Vermiwasl, on seed germination and seedling growth J. soil boil. Ecol. 15:90-95.
iii. Arueya, G. L. (1991). Utilization of cocoa pod husk in the production of washing powders. In: Abst. International cocoa conference: Challenges in the 90s, Kuala Lumpur, Malaysia, 25-28 Sept; 1991.
iv. Douglas, A. (2006). Feasibility and Viability report on the production of potash from cocoa pod husk in Ghana: Exclusive summary. Submitted on June 7, 2006 – 16:37.
v. Moyosore, O.S. (2006). Effects of growth media and light intensity on the performance of macropropagule of plantain (Musa sp).BSc project report submitted to Department of Crop, Soil and Environmental Sciences, Faculty of Agricultural Science, University of Ado – Ekiti (Unpublished). Pp 15-45.
vi. Oduwole, O. O. &G. L. Arueya. (1990). An economic analysis of Soap production from cocoa pod husk, Café, cacao. The 34:231-234.
vii. Oladokun, M. A. O. (1995). Encouraging domestic consumption of cocoa and cocoa products in Nigeria. Issues in production, processing and Trade. Proceedings of exhibition and workshop on cocoa held at the Ondo State Trade Fair Complex, Akure, Nigeria. April 19-24, pp. 30-32.

viii. Opeke, L. K. (1992). Tropical Crops in Spectrum. Ibadan, 1992, pp. 116-122.
ix. SAS Institute. (1995). SAS/STAT User's guide. Version 6, 4th edition, volume 1 and 2.SAS Institute Inc. Cary, N.C. Available at www.kellogg.northwestern.edu/rc/sas.htm.Assessed on 12th February, 2009.
x. Smith, O. B. (1989). Solutions to the practical problems of feeding cocoa pods to ruminants. Department of Animal Science, OAU, Ile – Ife, Nigeria pp. 1-8.
xi. UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT (2004).G-24 Discussion Paper Series. Commodities under Neoliberalism: The Case of Cocoa. G-24 Discussion Paper No. 25. Pp 2.
xii. Wood G.A.R. &Lass R.A. (1985).Cocoa 4th edition. Longman Group UK Limited, Harlow, Essex, England, pp. 11-37.