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UTILIZATION OF ASHED COCOA POD HUSK AND UREA FERTILIZER ON GROWTH AND DRY MATTER YIELD OF COFFEE ON ALFISOL IN IBADAN

[1]Akanbi, O. S.O., [2]Ojeniyi, S.O., [1]Famaye, A.O., [1]Ipinmoroti, R.R., [1]Ibiremo, O.S., [1]Oloyede, A.A., [1]Taiwo, N., [1]Aderolu, I.A. and [1]Orisasona, T.M.

[1]Cocoa Research Institute of Nigeria (CRIN), P.M.B 5244, Ibadan, Nigeria

[2]Federal University of Technology, P.M.B 704, Akure

E-mail: akanbioso2008@yahoo.com

ABSTRACT

A trial which was conducted on sandy clay, slightly acidic, low organic carbon (C) and available phosphorus (P) soil to evaluate the effect of ashed cocoa pod husk (ACPH) and urea fertilizer on growth and dry matter yield of coffee under green house condition at Cocoa Research Institute of Nigeria (CRIN), Ibadan in 2011. The treatments consist of ACPH applied at 5, 10, 15 and 20 Kg N ha^{-1}, urea (10 Kg N ha^{-1}) and control. The ACPH significantly ($p< 0.05$) enhanced coffee seedling growth parameters relative to control, while urea reduced the growth of coffee seedlings. Application of ACPH at all levels increased the soil pH, N, P, K, Ca, Mg and C significantly ($p< 0.05$) compared to control. It is concluded that growth and dry matter yield of coffee seedlings could be enhanced by the use of ashed cocoa pod husk at 15 kg N ha^{-1}.

Key words: Ashed cocoa pod husk, Organic carbon, Soil fertility, Urea, Coffee

INTRODUCTION

Coffee is an important crop with great potentials as an export and foreign exchange earner and a good source of industrial raw materials. However, coffee farmers in Nigeria have been recording low berry yield due to the fact that most of the coffee farms in Nigeria are established on medium to low fertility status soil (Obatolu, 1991). Although, inadequate soil fertility affects coffee production in Nigeria (Maisonneuve, 2002), the farmers rarely apply chemical fertilizer due to scarcity and cost. Other problems associated with continuous use of chemical fertilizer include imbalance nutrient supply, soil acidity, losses through leaching, volatilization and erosion, non availability of soil testing facilities and degradation of soil physical quality (Ojeniyi, 2010). Hence, there is need to intensify studies into locally sourced, cheap, adoptable organic source of nutrients. Coffee seedlings have been reported to respond favourably well to organic amendment such as green manures, farmyard manures, waste from processed coffee in forms of compost and mulch amongst others (Obatolu, 1991; Maisonneuve, 1992). The ashed cocoa pod husk can easily be obtained in cocoa farms since the husk is often incinerated to control the black pod disease of cocoa (Ajayi *et al.*, 2007a, 2007b). However, there is a dearth of research information on the effect of ashed cocoa pod husk on coffee performance. The objective of this study therefore, was to evaluate the potentials of ashed cocoa pod husk and Urea fertilizer for increasing coffee performance.

MATERIALS AND METHODS

Greenhouse experiment involving ashed cocoa pod husk and urea fertilizer was conducted in 2011 at the Cocoa Research Institute of Nigeria (CRIN) situated at Ibadan (7^0 22^1 N and 32^0 52^1E). Top soil (0-15 cm) used for the study was collected from the coffee plot and processed for routine analysis. The experimental design used was Completely Randomized Design (CRD) with six treatments replicated four times thereby, giving a total of twenty-four treatment combinations. The treatments were: Ached cocoa pod husk (ACPH) at 5, 10, 15 and 20 kg N ha^{-1}, urea at 10 kg N ha^{-1} and control. Two coffee seeds were planted per pot and later thinned to one stand per pot a month after germination. Equivalent quantities of the fertilizer materials were introduced into each of the twenty-four 10 kg soil a month after sprouting. Treatments were applied in a ring form while watering was carried out thrice a week throughout the period of the experiment. Weeding was done regularly as the case may be. Growth parameters such as plant height (cm), stem diameter (cm), number of leaves per plant, number of branches and leaf area (cm^2) were collected monthly for a period of six months. Coffee plants were segmented into parts (leaf, stem and root) in a brown envelope 6 months after treatment application. Dry matter yield was determined by weighing after oven drying of the parts to constant weight.

Soil analysis

Prior to the commencement of the experiment, surface (0-15cm) soil samples were collected with the aid of soil auger, bulked, air-dried and allowed to pass through a 2mm sieve mesh. Samples of the organic materials were also prepared for analysis. Chemical analysis was done as described by Carter, (1993). Organic matter (OM) was determined using wet dichromate method, total N by Kjeldahl method, available P by molybdenum blue colorimeter, exchangeable K, Ca and Mg were extracted using ammonium acetate, K was read on flame photometer, Ca and Mg on atomic absorption spectrophotometer. Ashed cocoa pod husk was analyzed accordingly for its chemical constituents**.**

Data analysis:

Data were subjected to analysis of variance (ANOVA) and treatment means separated by Duncan Multiple Range Test at 5% level of significant.

RESULTS AND DISCUSSION

The physicochemical properties of the experimental soil and ashed cocoa pod husk are as follows: The soil contained 651 gkg^{-1} sand, 164 gkg^{-1} clay and 153 gkg^{-1} silt, and was sandy clay. The clay + silt content of 317 gkg^{-1} soil was sufficient to hold enough water for sustainable coffee plant growth and to guard against short duration of drought (Egbe *et al*., 1989). The organic carbon of 9.82 gkg^{-1} soil was below the 19.0 – 32.0 gkg^{-1} soil ideal for tree crop production and suggests the need to increase the soil organic matter (SOM) content. The soil N of 0.79 gkg^{-1} and available P of 3.53 gkg^{-1} are far below the critical values of 0.90 gkg^{-1} and 60.0 $mgkg^{-1}$ soil respectively. The K, Ca and Mg contents of 0.17, 4.1 and 0.69 $Cmolkg^{-1}$ respectively were all below soil critical levels of nutrient elements of 0.4, 0.89 and 0.80 $Cmolkg^{-1}$ calculated for soils suitable for coffee production in Nigeria (Egbe *et. al*,. 1989). This therefore, suggests the need for soil fertility management for better coffee performance.

The ashed cocoa pod husk contained 6.91% Ca, 26.3% K in addition to N which is the only nutrient element supplied by the urea (reference fertilizer) used for the trial. The low N might be as a result of volatilization during the burning process. The C/N ratio (13) is conducive enough for early mineralization of nutrient especially N for coffee uptake. This is in agreement with the earlier work of Odedina *et al*., (2003) and Ayeni *et al*., (2008b) that ashed cocoa pod husk contained N, P, K, Ca, and Mg. Thus, application of ACPH helped to supply Ca and Mg to the coffee plants, for healthy growth performance compared to urea treated coffee plants, while its mineralization would have helped to improve the soil organic matter contents, which was inherently low and could not support sustainable cropping for long without organic material addition (Ipinmoroti, 2006). Generally, urea fertilizer addition reduced the growth parameters of coffee seedlings. The alkaline nature of the material is also expected to control the slightly acidic nature of the soil used. Hence, its continued usage over time will help to increase the pH of soil.

Table 1: Coffee seedlings height (cm) as affected by ashed cocoa pod husk and urea

	Plant height (cm) for six months					
Treatments	**1**	**2**	**3**	**4**	**5**	**6**
Control	12.87^{f}	18.40^{e}	32.17^{e}	34.63^{e}	41.37^{e}	46.80^{e}
ACPH@5kgNha^{-1}	14.00^{e}	19.33^{d}	33.23^{d}	37.50^{d}	45.03^{d}	50.21^{d}
ACPH@10kgNha^{-1}	14.67^{d}	20.13^{c}	38.23^{c}	47.60^{c}	51.13^{c}	63.00^{c}
ACPH@15kgNha^{-1}	19.23^{a}	25.03^{a}	47.40^{a}	56.47^{a}	64.00^{a}	69.13^{a}
ACPH@20kgNha^{-1}	17.80^{b}	22.83^{b}	43.76^{b}	51.67^{b}	52.08^{b}	64.10^{b}
Urea(10kgNha^{-1})	15.50^{c}	18.10^{f}	21.67^{f}	28.83^{f}	31.83^{f}	39.17^{f}

ACPH = ashed cocoa pod husk. *Means that carries the same letter are not significantly ($p \leq 0.05$) different*

Table 2: Coffee stem diameter (cm) as influenced by ashed cocoa pod husk and urea

	Stem diameter (cm) for six months					
Treatments	**1**	**2**	**3**	**4**	**5**	**6**
Control	0.24^{d}	0.27^{c}	0.50^{b}	0.60^{b}	0.70^{c}	1.54^{e}
ACPH@5kgNha^{-1}	0.24^{d}	0.30^{b}	0.50^{b}	0.60^{b}	0.70^{c}	1.57^{d}
ACPH@10kgNha^{-1}	0.25^{c}	0.30^{b}	0.50^{b}	0.60^{b}	0.70^{c}	1.73^{c}
ACPH@15kgNha^{-1}	0.31^{a}	0.40^{a}	0.60^{a}	0.70^{a}	0.80^{a}	2.40^{a}
ACPH@20kgNha^{-1}	0.27^{b}	0.30^{b}	0.50^{b}	0.60^{b}	0.73^{b}	2.10^{b}
Urea (10kgNha^{-1})	0.23^{e}	0.30^{b}	0.40^{c}	0.50^{c}	0.60^{e}	1.50^{f}

Means that carries the same letter along the same column are not significantly ($p \leq 0.05$) different.

Table 3: Effect of ACPH and Urea on coffee seedlings number of leaves per plant

	Number of coffee leaves per plant					
Treatments	**1MAA**	**2MAA**	**3MAA**	**4MAA**	**5MAA**	**6MAA**
Control	12..33^{d}	16.67^{d}	17.33^{e}	23.33^{e}	25.33^{e}	26.33^{e}
ACPH@5kgNha^{-1}	13.33^{b}	17.67^{c}	18.00^{d}	24.00^{d}	26.00^{d}	27.67^{d}
ACPH@10kgNha^{-1}	13.00^{c}	16.33^{e}	19.33^{c}	25.33^{c}	27.67^{c}	28.67^{c}
ACPH@15kgNha^{-1}	16.33^{a}	21.00^{a}	25.00^{a}	31.33^{a}	36.33^{a}	40.33^{a}
ACPH@20kgNha^{-1}	13.33^{b}	18.67^{b}	21.00^{b}	28.00^{b}	32.00^{b}	36.33^{b}
Urea(10kgNha^{-1})	12.00^{d}	13.67^{f}	15.33^{f}	21.00^{f}	22.33^{f}	26.00^{f}

ACPH - Ashed cocoa pod husk; MAA - months after application
Means that carries the same letter are not significantly ($p \leq 0.05$) different.

Table 4: Leaf area (cm^2) as influenced by ashed cocoa pod husk and urea.

	Leaf area (cm^2) for 6 months					
Treatments	**1**	**2**	**3**	**4**	**5**	**6**
Control	53.97^e	122.38^c	212.71^e	225.30^f	204.83^d	116.10^e
ACPH@5kgNha^{-1}	57.97^d	122.72^c	215.70^d	226.96^c	223.30^c	119.23^d
ACPH@10kgNha^{-1}	60.77^c	98.54^d	238.60^b	236.46^b	223.33^c	122.33^c
ACPH@15kgNha^{-1}	120.65^a	212.44^a	323.89^a	251.51^a	267.75^a	221.17^a
ACPH@20kgNha^{-1}	76.26^b	145.18^b	277.27^c	207.06^d	233.00^b	127.39^b
Urea (10kgNha^{-1})	55.89^d	54.49^e	93.88^f	112.60^e	163.87^e	103.32^f

ACPH- Ashed Cocoa pod husk, MAA- Months after application. *Means that carry the same letter are not significantly ($p \leq 0.05$) different..*

Table 5: Root length (cm) and dry matter yield(g/plant) as affected by ACPH and urea 6 months after application.

Treatments	**RL (cm)**	**RW(g)**	**LW(g)**	**SW(g)**	**TDMY(g/plant)**
Control	31.67^e	5.37^d	17.37^e	4.70^f	31.64^e
ACPH @ 5kgNha^{-1}	33.47^d	5.37^d	19.37^d	9.90^d	35.07^d
ACPH @ 10kgNha^{-1}	35.73^c	6.16^c	20.12^c	11.32^b	37.84^c
ACPH @ 15kgNha^{-1}	40.33^a	8.10_a	24.25^a	14.73^a	46.80^a
ACPH @20kgNha^{-1}	37.70^b	6.87^b	22.29^b	10.43^c	39.40^b
Urea(10kgNha^{-1})	23.93^f	2.52^e	14.14^f	8.21^e	27.08^f

RL- root length, RW-root weight, LW- leaf weight, SW-stem weight, TDMY- total dry matter yield *Means that carry the same letter are not significantly ($p \leq 0.05$) different.*

Tables 1 and 2 present data on coffee plant height (cm) and stem diameter (cm) as influenced by ashed cocoa pod husk. Ashed cocoa pod husk at all levels increased coffee seedlings height (cm) significantly ($p < 0.05$) over 6 months of planting relative to control. Plant height increased with increased rate of ACPH. The ACPH applied at 15 kg N ha^{-1} significantly increased coffee seedlings height relative to control throughout the growing period of the crop. At 6 months of growth, the highest seedling height of 69.13 cm was recorded when ACPH was applied at 15 kg N ha^{-1}. This was followed by ACPH @ 20 kg N ha^{-1} (64.10 cm); ACPH @ 10 kg N ha^{-1} (63.00 cm); ACPH@ 5 kg N/ha (50.21cm), control (46.80 cm) and urea (39.17 cm). Similar trend was observed for stem diameter (Table 2). Here, ACPH at 15 kg N ha^{-1} resulted to the highest stem diameter and was followed in descending order by ACPH at 20 kg N ha^{-1}; ACPH at 10 kg N ha^{-1}; ACPH at 5 kg N ha^{-1}; control and urea throughout the growing period. This result confirmed the earlier study of Adejobi *et al.* (2011), that addition of sole CPHA and in combination with other fertilizer sources increased growth parameters of coffee seedlings relative to control. The addition of urea to coffee seedlings however, resulted in reduction in all growth parameters considered.

Significant ($p<0.05$) impact of fertilizer treatments on the mean number of leaves per plant was observed from 2 months after application when ACPH at 15 kg N ha^{-1} resulted to a significantly higher number of leaves value than either the control and urea respectively (Table 3).

Leaf area (cm^2) of coffee seedlings followed the same trend as obtained for the plant height (Table 4). The ACPH addition at 15 kg N ha^{-1} recorded to the highest leaf area (cm^2) value per plant relative to control and the rest throughout the period of the trial. The leaf area value resulted from urea treatment was however, lower and smaller respectively compared with those due to organic fertilizers (Table 4).

Coffee seedling root length and weight as influenced by the application of ashed cocoa pod husk is presented in Table 5. The root length (cm) and weight (g) ranged from 23.93 – 40.33cm and 4.73 - 7.87g respectively. The values were significantly ($p < 0.05$) higher with ACPH application irrespective of rates relative to control and urea

The application of ACPH at a rate of 15 kg N ha^{1} gave the highest values for root length (40.33cm) and weight (8.10g/plant) respectively. The root length (RL), root weight (RW), leaf weight (LW) and stem weight (SW) however, reduced with urea application. Data on leaf and stem, dry weight (DW) (g/plant) followed the same trend as other growth parameters with ACPH at 15 kg ha^{-1} recording the highest weight values. Significantly ($P < 0.05$) higher growth and dry matter yield of the coffee seedlings resulted from the application of fertilizer materials over the control. This is an indication that the soil is low in fertility. Also, optimal and economic coffee production on the soil could be obtained only if fertilizer application is a management practice (Ipinmoroti *et al.*, 2011). Ashed cocoa pod husk (ACPH) based fertilizers resulted to significantly ($p < 0.05$) higher coffee seedling growth performance and dry matter yield than urea probably due to slow and steady rate of nutrient release from the ashed cocoa pod husk. This observation is in agreement with the earlier results of Ajayi *et al*. (2007a; 2007b and Akanbi *et al.,* 2013a) where significant increases were observed in Kola and cashew seedlings growth with ashed cocoa pod husk (ACPH) as a fertilizer source. The slow nutrient release pattern of the ashed cocoa pod husk compared to the fast rate by urea might helped in continuous steady nutrient supply to the coffee plant which must have been used to its advantage thereby resulting to faster growth and dry matter accumulation. The low growth rate recorded by coffee seedlings under urea application may have resulted from nutrient imbalance caused by the material (urea) which makes the rhizosphere to be more acidic thereby making the nutrients unavailable for the coffee plant. This might also be due to leaching of the urea fertilizer due to watering.

Slow but steady nutrient release due to application of ACPH is of great advantage on soils that are inherently low in organic matter and clay contents, especially the kaolitic (1:1) clay type, which are known to be low in cation exchange capacity (Ojeniyi, 2000; Agboola and Fagbenro, 1995), and cannot hold and supply sufficient nutrients for long. This is the characteristic of most soils in sub-Saharan Africa and Nigeria (Ogunwale *et al.,* 2002). The presence of Ca and Mg in ACPH in addition to N, P and K which are absent in the urea fertilizer and inherently low in the soil is another advantage. Coffee plants require good supply of both Ca and Mg for proper growth performance and production. The inability of the soil to supply adequate amount of Ca and Mg and the complete lack of these essential nutrients in urea must have resulted in the relatively poor growth of the coffee plants recorded and subsequently; the low dry matter accumulation obtained in urea treated soil and control.

CONCLUSION

The study shows that application of ACPH increased the agronomic parameters and the total dry matter yield (TDMY) of coffee. Being an effective fertilizing and liming material, it is recommended that, ACPH applied at a rate of 15 kg N ha^{-1} could serve as substitute for urea fertilizer which is costly and not readily accessible for the low income Nigerian coffee farmers.

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