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Effect of Cocoa Husk Ash on Growth and Stem Nutrient Uptake of Kola Seedlings

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Abstract: Screen house experiments were conducted at Ibadan and Akure Southwest Nigeria to study effect of applications of Cocoa Pod Husk Ash (CPHA) on nutrient uptake by kola (*Cola nitida*) seedlings. Six levels of CPHA namely 0, 2, 4, 6, 8 and 10 t ha^{-1} and NPKF fertilizer (NPKF) applied to soil at 200 kg ha^{-1} were compared as to their effect on growth parameters and nutrient uptake by kola seedlings. CPHA at 2, 4, 6, 8 and 10 t ha^{-1} and NPKF increased stem girth, number of branches and leaf area. The NPKF gave highest leaf area. The 6 t ha^{-1} CPHA gave highest values of stem girth and number of branches among CPHA treatments. Application of CPHA increased stem N concentration and uptake of P, K, Mg and Ca. At Ibadan NPKF gave highest stem N and P content, but at Akure applications of CPHA gave higher stem N, P, Mg and Ca status than NPKF.

Key words: Kola, nutrient, seedling, growth, cocoa pod ash

INTRODUCTION

Kola nuts are source of essential oils and alkaloids used in the preparation of beverages and pharmaceutical products. Kola nut is also used as masticatory for its stimulating effect.

The bark of kola has medicinal value; its roots are used as chewing sticks and the wood in carving. Because of its economic importance, there is need to plant high yielding early maturing kola plants. The young plants should be raised in nurseries using fertile top soil rich in nutrients and organic matter. However, it is often difficult to obtain adequate suitable top soil due to deforestation. Also, the use of chemical fertilizers in Kola production is hindered by its scarcity, high cost and incomplete nutrient supply (Ogbalu, 1999; Ojeniyi and Adejobi, 2002).

It is therefore necessary to study cheap, locally sources agrowastes that could enhance balance nutrition and improve nutrient availability. Cocoa Pod Husk Ash (CPHA) is such a material (Odedina *et al*., 2003). Kola farmers often grow cocoa and Cocoa Pod Husk (CPH) is often burnt to eradicate spread of black pod disease caused by *Phytophtora palmivora*. Nigeria produces annually about 8,000,000 tonnes of CPH. A study by Egunjobi (1975) indicated that CPH could be used as fertilizer and nematicide. It increase maize yield by 124%. Greenwood and Burton (1965) cited by Egunjobi (1975) suggested the use of CPH as fertilizer in order to solve its disposal problem. Adu-Dapaah *et al*. (1994) in Ghana successfully tried CPHA as source of K in increasing maize yield. Odedina *et al.* (2003) found that CPHA 4 t ha^{-1} increased soil organic matter N, P, K, Ca and Mg and fruit yield of tomato. The study being reported was carried out to study effect of CPHA on growth and stem nutrient uptake of kola seedlings.

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MATERIALS AND METHODS

Screen House Experiment

Pot experiments were conducted at screen house of Cocoa Research Institute of Nigeria Ibadan and Federal University of Technology Akure (FUTA). The two experiments were conducted between 21st October 2003 ND 21ST April 2004. Top soil collected from cocoa plots established in two locations were put in 4 litre black pots with holes at the base. Pots were filled with 3 kg soil. CPHA was applied at 0, 2, 4, 6, 8 and 10 t ha^{-1} and NPK 15-15-15 fertilizer (NPKF) was applied at 200 kg ha^{-1}. The treatments were replicated three times using a randomized block design. There were four pots per treatment given 84 in each experiment. Ash was mixed manually with top soil during filling of pots. Improved variety of *Cola nitida* (2 leafed) seedlings collected from CRIN were potted in October 2003. Watering of seedlings was done every other day.

Leaf area, stem girth and number of branches were determined 6 months after treatment application. The leaf area was measured with a leaf are meter (Lamba Instrument Corporation Model 1, 31, 000).

Stem and Ash Analysis

After taken the growth parameters, stem samples were collected, oven dried at 80°C for 72 h and ground. Ground samples were dry ashed at 500°C for 4 h in a muffle furnace. Nutrients in CPHA and ash derived from Kola plants were extracted using perchloric-nitric-sulphuric acid mixture and filteres. Total N was determined using Kjeldahl approach, P in extract was determined using Molybdenum blue colorimetry, K was determined on flame photometer and Ca and Mg by EDTA titration (Juo, 1979). Uptake of P, K, Ca and Mg by stem was determined by multiplying nutrient concentration by weight of samples dry matter. Total N was recorded.

Data were subjected to analysis of variance and Duncan multiple range text ($p>0.05$) was used to compare the means on treatment basis.

RESULTS

CPHA applied at 2, 4, 6, 8 and 10 t ha^{-1} and NPKF (200 kg ha^{-1}) increased growth parameters of kola seedlings relative to the control at Ibadan and Akure (Table 1 and 2). The parameters increased were stem girth, number of branches and leaf area. Among the CPHA treatments, the 6 t ha^{-1} treatment tended to give highest leaf area at Akure. At both locations; NPKF gave highest value of leaf area compared with CPHA treatments. However, the leaf area value given by NPKF at Akure was similar to that given by 2 t ha^{-1} CPHA. At Ibadan, stem girths, given by 2, 4, 6, 8 and 10 t ha^{-1} CPHA and NPKF were similar. The treatments also gave similar values of number of branches at Akure.

Table 3 and 4 show data on stem nutrient uptake of cocoa seedlings at Ibadan and Akure, respectively. CPHA applied to soil at 2, 4, 6, 8 and 10 t ha^{-1} increased N concentration and uptake of P, K, Mg and Ca compared with control. Stem K and N concentration tended to increase with level of CPHA and stem Ca uptake also increased with level of CPHA up to 6 t ha^{-1}. Stem Mg uptake also increased with level of CPHA up to 6 t ha^{-1} ate and 4 t ha^{-1} CPHA at Ibadan. At Ibadan, NPKF gave

Table 1: Effect of Cocoa Pod Husk Ash (CPHA) and NPK fertilizer (NPKF) on growth parameters of kola seedlings at Ibadan

Treatments	Stem girth (cm)	No. of branches	Leaf area (cm^2)
0 t ha^{-1} CPHA	2.75c	0.70d	17.2d
2	3.45b	2.20c	70.4c
4	3.45b	2.15c	76.2b
6	3.45b	2.80a	76.4b
8	3.45b	2.80a	74.6b
10	3.45b	2.45b	76.4b
NPKF	3.60b	2.80a	94.6a

Values followed by same superscripts in a column are not significantly different

Table 2: Effect of Cocoa Pod Husk Ash (CPHA) and NPK fertilizer (NPKF) on growth parameters of kola seedling at Akure

Treatments	Stem girth (cm)	No. of branches	Leaf area (cm^2)
0 t ha^{-1} CPHA	3.3^{d}	0.70^{a}	40.4^{d}
2	4.4^{b}	1.15^{c}	120.2^{a}
4	4.9^{a}	1.40^{a}	74.4^{c}
6	4.4^{b}	1.70^{a}	102.6^{b}
8	4.1^{c}	1.40^{a}	94.2^{b}
10	4.2^{c}	1.70^{a}	114.4^{a}
NPKF	4.3^{b}	1.40^{a}	120.4^{a}

Values followed by same superscripts in a column are not significantly different

Table 3: Effect of Cocoa Pod Husk Ash (CPHA) and NPK fertilizer (NPKF) on stem nutrient status of kola seedling at Ibadan

Treatments	N (%)	P (g/plant)	K (g/plant)	Mg (g/plant)	Ca (g/plant)
0 t ha^{-1} CPHA	1.6^{e}	0.49^{e}	0.08^{d}	0.04^{a}	0.15^{b}
2	3.6^{b}	1.50^{b}	0.20^{c}	0.11^{b}	0.23^{a}
4	3.6^{b}	1.71^{b}	0.20^{c}	0.25^{c}	0.33^{a}
6	4.4^{c}	1.69^{b}	0.20^{c}	0.06^{a}	0.43^{c}
8	4.5^{c}	1.10^{c}	0.26^{a}	0.05^{a}	0.25^{a}
10	5.1^{a}	1.20^{c}	0.26^{a}	0.07^{a}	0.26^{a}
NPKF	6.1^{f}	3.60^{a}	0.24^{a}	0.05^{e}	0.14^{b}

Values followed by same superscripts in a column are not significantly different

Table 4: Effect of Cocoa Pod Husk Ash (CPHA) and NPK fertilizer (NPKF) on stem nutrient status of kola seedling at Akure

Treatment	N%	P (g/plant)	K (g/plant)	Mg (g/plant)	Ca (g/plant)
0 t ha^{-1} CPHA	5.5^{a}	1.3^{c}	0.22^{d}	0.17^{e}	2.8^{e}
2	9.2^{b}	1.8^{d}	0.44^{c}	0.19^{e}	3.9^{d}
4	7.3^{c}	2.4^{e}	0.47^{c}	0.32^{c}	8.8^{c}
6	9.2^{b}	2.8^{e}	0.55^{b}	0.37^{d}	11.1^{b}
8	9.5^{b}	2.8^{e}	0.60^{c}	0.23^{a}	7.6^{a}
10	12.3^{d}	2.8^{e}	0.68^{e}	0.21^{a}	7.6^{a}
NPKF	6.6^{a}	2.9^{e}	0.39^{f}	0.15^{e}	2.9^{e}

Values followed by same superscripts in a column are not significantly different

highest stem N and P content and relatively high stem K uptake. However, at Akure, the 2, 4, 6, 8 and 10 stem P uptake given by 4, 6, 8, 10 t ha^{-1} CPHA and NPKF were also similar Therefore at Akure, CPHA application gave higher plant nutrient status tan NPKF, whereas at Ibadan, NPKF gave higher plant N and P status. At both locations, CPHA applications gave higher values of plant Mg and Ca compared to NPKF.

DISCUSSION

The finding that CPHA increased growth of kola seedling is consistent with finding that it also increased uptake of N, P, K, Ca and Mg by the seedlings. Egbe *et al.* (1989) had found that fruit yield of kola trees was increased by P, K, NK and PK fertilizers. It is suggested by the present work that CPHA added N, P, K, Ca and Mg to soil which led to increased uptake of the nutrients by kola seedlings. The latter is corroborated by findings of Ojeniyi *et al.* (2001), Ojeniyi and Adejobi (2002), Odedina *et al.* (2003), Owolabi *et al.* (2003) Nottidge *et al.* (2005a, b) and Nottidge *et al.* (2006) that ashes derived from wood, forest and cocoa husk increased soil N, P, K, Ca and Mg, yield and nutrient status of crops such as maize, pepper, tomato, okra, celosia, amaranthus, yam and rice. An analysis of CPHA carried out by Odedina *et al.* (2003) indicated that it had 0.59% N, 0.49% P, 11.6% K, 2.7% Ca and 0.62% Mg. According to Ogbalu (1999), ash is traditionally used for improving soil fertility and nutrient availability in vegetable production in Southeast Nigeria. The findings that CPHA increased uptake of Ca and Mg unlike in case of NPKF is consistent with the use of ash as liming material and source of cations (Obi and Ekperigin, 2001).

The 6 t ha^{-1} CPHA gave the highest stem girth and number of leaves and relatively high leaf area among CPHA treatments. This observation can be related to the finding that the treatment gave the highest or relatively high values of stem P, K, Mg and Ca content (Table 4) at Akure and relatively high values of stem P, K and highest stem Ca uptake at Ibadan. Egbe *et al.* (1989) reported that PK fertilizer produced more kola pods than P, K, N, NP and NK treatments. Availability of Ca is known to stimulate apical growth in young plants. The highest leaf area recorded for NPKF is attributable to supply of N in more readily available form since N is mainly responsible for chlorophyll formation and leaf growth.

Reduction in P, MG and Ca uptake after 6 t ha^{-1} CPHA level could be due to competition for exchange sites dominated by Ca which adversely affected availability of K and enhanced fixation of P Ca (Adeleye and Omueti, 2006). There could also be leaching of excess Ca from exchange sites by repetitive watering of soil.

CONCLUSIONS

Cocoa pod husk is an effective source of N, P, K, Ca and Mg for kola seedlings. Its application to soil increase growth of kola seedlings and uptake of the nutrients. It is recommended for use at 6 t ha^{-1}. It ensures more balanced nutrition than NPK fertilizer.

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