CACAO POD HUSK AS SOURCE OF POTASH FERTILIZER[1] /

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Compendio

Se estableció un experimento de campo con maíz como cultivo testigo, con el propósito de comparar la ceniza de la cáscara de la mazorca del cacao como fuente de potasio contra el efecto del muriato comercial de potasio (41% K). Los resultados de tres años mostraron que no hubo diferencia significativa entre los dos materiales. Ambas fuentes de potasio resultaron significativamente mejores que las parcelas no tratadas. Utilizando el contenido promedio de 38% K en las cenizas, se hizo la estimación de que el grueso de las necesidades totales de Ghana en cuanto a fertilizantes potásicos así como el de otros cuatro países productores de cacao, incluyendo tal vez Brasil (Bahía), puede ser obtenido a partir de esta fuente.

Introduction

Besides the manufacture of chocolate and confectionery for which the premier ingredient is the cacao bean, many other useful products such as candles, cacao butter, cooking fat, lighting oil, ointment, hard and soft soap, fuel and "saline purge" can be prepared from the beans for peasant household consumption (6). Knapp and Churchman (11) and Greenwood-Barton (8) have reviewed the possible other uses to which the traditional waste products, mostly the roasted cacao bean shell and the defatted cacao cake, could be put. Interest in the utilization of the cacao pod husk for purposes such as soap manufacture, preparation of animal feed rations and fertilizers led to the determination by several investigators (Table 1) of the chemical composition of this cacao farm waste. Recently, a thorough review of research into the utilization of cacao farm wastes (or cocoa by-products) namely the cacao pod husk and the draining fresh juice (sweatings) was published by Adomako (1). The review paper, with particular reference to the prospects in Ghana, highlighted topics such as: the production from the cacao bean sweatings of power alcohol, wine and sugars; the manufacture from the pod husk of soft soap, pectin, other polysaccharides, paper, fiber board, microbial and single-cell protein, preparation of animal feed rations and manufacture of fertilizers. Detailed review on the utilization of the cacao pod husk and the shell (testa) as either organic manure or as fertilizer was reported by Ahenkorah *et al* (2).

The purpose of this paper is to provide data from field trials using the cacao pod ash as potash fertilizer and comment on the practical feasibility of substituting, or at least supplementing, imported potash fertilizers with processed cacao pod ash in Ghana and other cacao producing countries.

Materials and methods

Cacao husk ash as source of K-fertilizer

Dried cacao pod husks were thoroughly ashed in an open container, allowed to cool and passed through 18 mesh sieve to ensure reasonably uniform size. The few residues were discarded. Random samplings of the various batches of the ash, which had been mixed previously, were analysed on EEL flamephotometer for the potassium content 47 (42.8-53.4% K). The ash was stored temporarily in large air-tight polyethylene bags.

1 Received for publication April, 1981.

* The authors gratefully acknowledge the technical assistance of the Soil Science personnel and that of the field staff at the CRIG Sub-station at Afosu. This paper is published with the permission of the Director, CRIG., New Tafo – Akin, Ghana.

Table 1. Chemical composition of cacao pod husk (% oven dry husk).

		Ankrah (3)	Acquaye *et al* (Kenten, 10)	Bateman & (Fresnillo, 4)	Dittmar (7)	Otchere E.O. (Adomako, 1)	Mean
Protein	6.25(5.70-7.60)	6.25(5.63-7.50)	7.18(5.63-8.36)	6.8	7.12(5.69-9.69)	6.7	6.72(5.66-829)
Crude Fibre	–	27.30(24.30-29.6)	–	35.4	36.40(33.2-39.4)	34.5	33.40(28.75-34.50
Ash	8.0(7.73-8.33)	8.10(7.60-8.70)	–	9.7	9.44(8.48-10.20)	8.0	8.65(7.94-9.08)
Na	0.016(0.014-0.031)	0.01(0.01-0.031)	–	–	–	–	0.013(0.01-0.03)
K	3.77(3.43-4.27)	3.20(2.50-3.70)	2.69(2.29-3.76)	–	3.63(3.46-4.37)	–	3.32(2.92-4.02)
Ca	0.46(0.42-0.52)	0.44(0.33-0.70)	0.53(0.52-0.56)	0.63	0.26(0.16-0.42)	0.5	0.47(0.36-0.55)
P	0.12(0.10-0.15)	0.09(0.04-0.12)	0.11(0.08-0.14)	0.17	0.18(0.13-0.21)	0.1	0.13(0.09-0.15)
Fe	–	0.003(0.002-0.005)	–	–	–	–	0.003(0.002-0.005)
Mg	0.25(0.21-0.33)	–	0.34(0.31-0.41)	–	0.30(0.24-0.36)	–	0.30(0.25-0.37)
S	0.05(0.05-0.09)	–	–	–	–	–	0.05(0.05-0.09)
Moisture content	85.70(84.2-86.90)	78.7(70-82)	–	–	–	–	82.20(77.1-84-4)
pH	5.8(5.7-5.8)*	–	–	–	–	–	5.8(5.7-5.8)
Si	–	–	–	–	0.06(0.04-0.09)	–	0.06(0.04-0.09)
CO_3	0.0015	–	–	–	–	–	0.0015

* pH determination: 90 ml boiling water was slowly added with stirring to 10 g dry ground husk; suspension cooled to room temperature and pH determined on Beckman Zeromatic pH meter.

Field Trial

The trial was sited on a portion of Block F at the CRIG sub-station, Afosu. The soil is Boi (indurated) series, an Oxisol. It is sedentary, developed over lower Birrimian phyllites, pH 5.5, moderately deep (60-100 cm), about 2% slope, moderately well drained, silty clay loam texture with frequent quartz gravel and has compact indurated B-horizon. Details on the soil survey have been reported (12).

An area of 0.40 ha was cleared of the secondary bush in March 1977. A split plot design consisting of two main fertilizer treatments, cacao husk ash and commercial muriate of potash (50% K_2O or 41.5% K), was laid out on five main experimental blocks. Each block was divided into sub-plots to contain ten fertilizer treatments made up of five levels each of the ash and muriate. A sub-plot carried a core plot of 20 hills of maize plants *Zea mays* Var. Composit IV. The hills, each of which had two maize plants, were spaced 90 x 30 cm. Each core plot was fully guarded with two rows of maize hills. The maize was planted within the first fortnight in April and a month later fertilized at a distance of 15 cm around each hill, at the rates shown below:

K – source	Levels				
	0	1	2	3	4
Cacao husk ash (g/hill)	0	1.1	2.2	3.3	4.4
Muriate (g/hill)	0	1.25	2.50	3.75	5.0
Equivalent: kg K/ha	0	23.2	46.6	69.7	93.0
kg K_2O/ha	0	28.0	56.0	84.0	112.0

All plots were clean weeded. The maize was harvested four months later, dried to about 10% moisture and weighed.

The trial was repeated practically the same way on same subplots and within the same months for the three consecutive years 1977-79 inclusive. However, in May 1979 during the fertilizer application, a basal dressing of 84 kgN/ha as ammonium sulphate (20-21% N) was applied to the whole field to prevent any probable nitrogen deficiency.

Results and discussion

When the three year results were pooled and analysed no significant yield difference was observed between the ash and the muriate. Both or either of the two K sources was significantly better than the untreated plots. This suggests that the general effect of the ash on the maize yield over the three year period was the same as the conventional muriate of potash fertilizer. This observation confirms the results of our preliminary greenhouse experiment in which sweet pepper *Capsicum annuum*, corn *Zea mays* and tomato *Lycopersicum esculentum* were used as the test plants (9). Results of the individual year yield of dry grain (with about 10% moisture) from the respective treatments are summarised in Table 2. A general decline in the maize yield was observed after 1977 crop. This amounted to 66% and 51% of the first harvest for the 1978 and 1979 harvests respectively. The basal application of the 84 kg of nitrogen per hectare in the 1979 trial did not arrest the decline. The erratic rainfall pattern during the two cropping seasons obviously contributed to the general low yields. It is also probable that the doses of fertilizers applied were low for the area even though a generally recommended national rate was applied (12).

The overall effect of the ash caused significant yield difference of more than 16% (16-18) over the muriate in the 1977 season ($P < 0.01$) and 1979 ($P < 0.05$) season. However, in 1978, the effect of the muriate was 9.2% greater than the ash. A plot of yield response against the different levels of the K fertilizer sources did not indicate a clear curvilinear relationship except for that of the 1978 ash application, whose peak occurred between the 1 and 3 levels. The muriate application indicated a plateau yield beyond level 1 for 1977 and a rapid yield drop after level 3 in 1979. Even though no significant difference was recorded among the various levels, the individual year yields suggest that for the ash a dose exceeding level 3 (69.7 kg K/ha) does not appear to be beneficial while that of the muriate appeared to be about level 1 (23 kg K/ha).

From the information given by Adomako (1) it is estimated that approximately 45.4 kg fresh husk yield about 550 grams ash from the equivalent of 6.8 kg dry husks. This quantity of husk is obtained from about 154 fresh pods which produce 5.4 kg marketable dry beans. From the data in Table 1 coupled with the above information, it is estimated that the quantities of crude potash fertilizers (shown in Table 3 as ash) can be obtained from some of the main cacao producing countries.

Table 2. Mean yield of dry maize grains from plots fertilized with cacao husk ash and muriate of potash over the 1977, 1978 and 1979 crop years.

Fertilizer Levels / Source	0	1	2	3	4	Mean
1977 Dry grains kg/ha						
Ash	152	187	163	207	156	173
Muriate	113	115	125	124	129	121
1978 Dry grains kg/ha						
Ash	70	90	101	100	78	88
Muriate	101	109	113	97	107	105
1979 Dry grains kg/ha						
Ash	92	99	80	91	69	86
Muriate	59	59	71	70	55	63

It is known that all the cacao producing countries listed in Table 3, except perhaps Brazil (Bahia), consume comparatively very low quantities of fertilizers. Ghana, for example, imported approximately 2720 tons of potash fertilizers in the 1973/74 financial year (5). It is obvious from Table 3 that all or the bulk of the total needs of potash fertilizers of such countries can be obtained from this source. The general average content of 38% K (range 34-36% K) of the husk ash (Table 1), occuring mostly in the carbonate form, compares favourably not only with the commonly used muriate of potash with 41 to 52% K but also with both the sulfate of potash (40-43%) and nitrate of potash (36-39% K) fertilizers.

Abstract

A field experiment with maize as the test crop was set up to compare cacao husk ash as a source of potash with commercial muriate of potash (41% K). Three years results showed that there was no significant difference between the ash and the muriate as source of K. Both K sources were significantly better than the untreated plots. Using the average content of 38% K of the ash, it was estimated that the bulk of the total needs of potash fertilizers of Ghana and some four other cacao producing countries, including perhaps Brazil (Bahia), can be obtained from this source

Table 3. Average quantity of potash from cacao pod husk estimated from exported beans* in five major cacao producing countries.

Countries	Metric tons			
	Dry husk	Ash	Potash as K	
			a***	b****
Ghana	480 121	39 153	18 449	15 027
Nigeria	286 449	23 360	11 007	8 965
Ivory Coast	279 398	22 785	10 736	8 745
Brazil (Bahia)	237 487	19 367	9 126	7 433
Camerouns**	131 505	10 724	5 053	4 116

* Calculated from nine years (1969/70-1977/78) average sales (Gill and Duffus, Cocoa Market Report No. 286, 1979).

** Figures from Camerouns are based on 1977/78 produce only.

*** Calculated from data in Table 1 column 1.

**** Calculated from data in Table 1 column 7.

Conclusion

The application of the cacao husk ash as source of K fertilizer on maize, pepper and tomatoes is equally effective as the commercial muriate of potash. The K content in both sources are comparable. The ash with its renewable source is adequate to satisfy the annual K-fertilizer needs of each of the major cacao producing countries. There is urgent need to process, distribute and use the husk ash in more convenient and suitable form.

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INSTITUTO INTERAMERICANO DE COOPERACION PARA LA AGRICULTURA*

Febrero de 1981

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En 1960, la Conferencia General de Pesas y Medidas (CGPM) y la Oficina Internacional de Pesas y Medidas (BIPM) decidieron por unanimidad en París, sede del BIPM, crear un sistema internacional de unidades de pesas y medidas (SIU). En 1975 había ya 44 países miembros del BIPM cuya tarea principal es asegurar la unificación mundial en torno del SIU. Hoy día los Estados Unidos de América e Inglaterra han adoptado también el uso del SIU.

Por ejemplo, el kilogramo es unidad de masa, y ya no de peso; el recurso al concepto de peso queda abolido, pues corresponde en realidad a la fuerza de atracción debida a la gravedad, y, por lo tanto, los cuerpos en el espacio interplanetario no tienen peso, pero sí conservan su masa. La unidad de fuerza es el newton (N), que corresponde a la necesaria para producir una aceleración de un metro por segundo sobre una masa de un kilogramo. La unidad de presión o esfuerzo es el pascal (Pa) y equivale a la noción abolida de kilogramos (fuerza) por centímetro cuadrado: 9 806 650 kg (fuerza)/m^2 = 1 Pa.

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2. Los símbolos no se escriben con mayúsculas. Excepciones: los derivados de nombres de personas.
3. Los prefijos métricos no se escriben con mayúsculas. Excepciones: tera T, giga G, mega M.
4. Los símbolos se escriben siempre igual, sean singular o plural, ej.: 5 mm, no 5 mms.
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7. No se usa el punto después del símbolo (24 m, no 24 m.), excepto al final de un párrafo.
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