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Growth of F_3 Amazon cocoa seedlings as influenced by Pacesetter organo-mineral fertilizers in an alfisol in Nigeria

Ibiremo O. S.[1]; Ogunlade M. O[1], Ogunleti D. O.[2] and Fagbola, O[3].
[1]Cocoa Research Institute of Nigeria, P. M. B. 5244 Ibadan.
[2]Federal College of Agriculture, I. A. R. & T, Moor Plantation, Ibadan
[3] Department of Agronomy, University of Ibadan, Ibadan.

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ABSTRACT
A greenhouse investigation was carried out to determine the effect of pacesetter organo-mineral fertilizers grade A (fortified with urea) and grade B (unfortified) on the growth of cocoa seedlings in the Cocoa Research Institute of Nigeria during the seedling production season of 2003.
The pacesetter organo-mineral fertilizers were applied to cocoa seedlings at planting at two rates to supply rates equivalent to 10 and 20 kg Nha^{-1} and a control (0kg Nha^{-1}) in a completely randomized design with four replicates. Agronomic growth parameters were obtained on number of leaves per plant, stem diameter, plant height, root and shoot dry weight for a period of six months. Pacesetter-Organo-mineral fertilizer grade A applied to supply 20 kg Nha^{-1} improved the height and dry matter accumulation by 5.8 and 61.2% respectively compared to the control. In addition, it significantly ($P < 0.05$) improved the number of leaves per plant of cocoa seedlings at 4 and 6 months after planting (MAP) compared to the control and organo-mineral grade B. Therefore, fortification of organic fertilizers with urea performed better than unfortified organic fertilizer on the growth of cocoa seedlings. It is recommended that the use of pacesetter organo-mineral fertilizer grade A will improve the seedling performance of cocoa.

Keywords: Cocoa seedlings, organo-mineral fertilizer, urea, dry matter, growth

INTRODUCTION

Cocoa production declined considerably in the mid-seventies up till 1999 due largely to crude oil discovery and exploration, which led to neglect of agricultural sector by successive governments. However, as a result of policy shift of the civilian administration to accord cocoa production which had been hitherto the main stay of our economy the right priority, the federal government has evolved some interventions through the establishment of National Cocoa Development Committee (NCDC) (Akinwale, 2006).
The total land area presently under cocoa cultivation is estimated at 0.6-0.8 million hectares. Fertilizer application is therefore becoming increasingly important in cacao cultivation in Nigeria because of the limited availability of virgin forest soils. New cocoa farms have to be established in depleted secondary forest soils and under old unproductive cocoa plantation. The usage of organic materials as suitable alternatives to chemical fertilizers in enhancing soil nutrient levels as well as ameliorating soil physical properties for crop production has been variously advocated (Fu *et al*, 1987; Obatolu and Agboola, 1991). It is also an important regulator of numerous environmental constraints to crop productivity (Woomer *et al*, 1994). Due to removal of subsidies on inorganic fertilizers, which results in high cost of procurement, non-availability at the appropriate time required for application, coupled with its negative effects on the soil (soil acidification), research effort in the last few years focused on development of organic fertilizers and use of locally available cheap agro wastes as nutrient sources for crops (Ojeniyi, 2006). This informed the establishment of Pacesetter organo-mineral fertilizer plant owned by Oyo State Government of Nigeria, which produced Pacesetter organo-mineral fertilizer A
The objective of this experiment was therefore to evaluate the effect of organo-mineral fertilizer types and rates on the growth of F_3 Amazon cocoa seedlings raised in depleted soils collected from old cocoa plantations.

MATERIALS AND METHODS

The greenhouse investigation was conducted at the Cocoa Research Institute of Nigeria (CRIN), Ibadan to determine the effect of pacesetter organo-mineral fertilizers grade A (fortified with Urea) and grade B (unfortified) on the growth of cocoa seedlings during the seedling production season of 2003. Soil samples were collected at 0-30 cm depth on the cocoa plantation of CRIN, mixed, air-dried and sieved to pass through 2 mm sieve. Organo-mineral

fertilizer grades A and B were procured from the Pacesetter fertilizer plant, Bodija, Ibadan, Nigeria. Pods of F_3 Amazon cocoa were obtained from the CRIN plantation at Ibadan.

The soil was analysed for the texture, pH, N, P, K, Ca, Na, organic carbon and exchangeable acidity contents as described by IITA (1979). Five kilogrammes sieved soil was filled into each of the black plastic pots with perforated base for drainage purpose and watered to field capacity. Three fresh cocoa beans were planted to each pot at 5 cm depth and thinned to one seedling/pot two weeks after emergence. Emergence occurred at five to seven days after sowing. The two pacesetter organo-mineral fertilizers were applied to cocoa seedlings at two rates each to supply an equivalent of 10 and 20 kg Nha^{-1} and a control (0 kg Nha^{-1}) for a total of five treatments (0.6 and 1.2 g/pot for grade A; 2.8 and 5.6 g/pot for grade B respectively).

The pots were arranged in a completely randomized design with four replications. Watering was done twice a week. Plant height, stem girth and number of leaves were measured monthly for six months. The cocoa seedlings were then uprooted, oven-dried and the dry matter yield (DMY) determined. The data obtained were analysed using analysis of variance and mean differences were separated by Duncan multiple range

RESULTS AND DISCUSSION

The soil used for the trial was sandy loam that was moderately acidic with a pH of 6.10 (Table 1). The available P of 6.9 mg kg^{-1} was considered low for good cocoa production (Wessel, 1971). Similarly, the exchangeable K of 0.12 cmol kg^{-1} was not adequate for cocoa soils (Egbe *et al*., 1989). The exchangeable Ca (0.42 cmol kg^{-1} was grossly inadequate for cocoa compared with the initial level of 0.5 cmol kg^{-1} soil. On a general note, the soil was deficient in most of nutrient elements required by cocoa except that of total nitrogen, which was exactly the critical value adequate for cocoa. This will still require N supplementation so that the value will not fall below the critical level. The influence of organo-mineral fertilizers was not significant on stem girth of cocoa at 2, 4 and 6 months after planting (Table 2). Specifically, Pacesetter organo-mineral fertilizers grade A applied to supply 10 and 20 kg Nha^{-1} depressed marginally the stem girth of cocoa seedlings by 4.9% and 2.4% respectively compared to the control at 6 MAP. Similarly, Pacesetter organo-mineral fertilizer grade B applied to supply 10 kg Nha^{-1} depressed the stem girth by 19.4% compared to the control. The depression could be attributed to the slow release of nutrients by the organic fertilizer and nutrient immobilization due to activities of microbial population in the soil. This view is consistent with the findings of Fagbayide and Joseph-Adekunle (2002) and Aiyelaagbe *et al.,* (2005).

In addition, the number of leaves of cocoa seedlings was not significantly affected at 2 MAP due to application of organo-mineral fertilizers. However, at 4 and 6 MAP, the effect of Pacesetter organo-mineral fertilizer grade A applied to supply 20 kg Nha^{-1} significantly ($P < 0.05$) enhanced the number of leaves produced by cocoa seedlings (Table 2) compared with organic-mineral grade B applied at 10 kg Nha^{-1}. Similarly, the effect of grade B at 20 kg significantly improved the number of leaves per plant by 38.5% compared with organo-mineral grade B applied at 10 kg Nha^{-1}.

Organo-mineral fertilizer grade A applied at 10 and 20 kg Nha^{-1} and grade B applied at 20 kg N ha^{-1} significantly ($P < 0.05$) enhanced the height of cocoa seedlings at 1 MAP (Table 3). However, at 2, 4 and 5 MAP, the influence of the fertilizers was not significant on the height of cocoa seedlings. This might be as a result of rapid initial demand for nutrients met by application of these fertilizers, particularly, the fortified one and the nigh level of unfortified fertilizer. Organo-mineral fertilizer grade B significantly ($P < 0.05$) improved the height of cocoa seedlings at 3 MAP compared to the control (no fertilizer application). Organo-mineral fertilizer grade A applied at 20 kg Nha^{-1} significantly ($P < 0.05$) increased the height of cocoa seedlings compared with organo-mineral fertilizer grade B applied at 10 kg Nha^{-1} by 30.2%. This was consistent with findings of Moyin –Jesu and Atoyosoye (2002). Odedina (2002) found that cocoa pod husk enhanced the growth and nutrient uptake of cocoa tomato in southwestern Nigeria respectively.

The root dry matter yield of cocoa seedlings was not significantly affected by organo-mineral fertilizer application (Table 4). However, organo-mineral fertilizer grade A at 20 kg N ha^{-1} increased the root dry matter by 58.8% compared with its counterpart applied to supply 10 kg Nha^{-1}. Similarly, the shoot dry matter of cocoa seedlings was significantly ($P < 0.05$) enhanced by organo-mineral fertilizer grade A at 20 kg N ha^{-1} compared with all other treatments (Table 4). Moyin-Jesu and Atoyosoye (2002) found that organic fertilizer application significantly increased the growth of cocoa seedlings as well as leaf N, P, K Ca, Mg and soil organic matter.

The enhanced performance of organo-mineral fertilizer grade A applied at 20 kg N ha^{-1} could be attributed to the level of urea fortification in which the microbial population were able to utilize the available N to hasten the decomposition of the manure. This would enhance the release of nutrients from the fertilizer. This was consistent with the findings of Ojeniyi, (2006) in which organic fertilizer application enhanced the growth of okra and amaranthus and also improved soil organic matter, total N available P, exchangeable K, Ca than NPK fertilizer

Table 1: Initial Soil Physical and Chemical Properties before the commencement of the study

Properties	Unit	Value
Sand	g kg^{-1}	620.00
Silt	g kg^{-1}	224.00
Clay	g kg^{-1}	156.00
pH		6.10
Organic C	g kg^{-1}	1.62
Available P	mg kg^{-1}	6.90
Total N	g kg^{-1}	0.90
Exchangeable K	cmol kg^{-1}	0.12
Exchangeable Ca	cmol kg^{-1}	0.42
Exchangeable Na	cmol kg^{-1}	0.36
Exchangeable Mg	cmol kg^{-1}	0.46
Exchangeable Acidity	cmol kg^{-1}	0.18
ECEC	cmol kg^{-1}	1.94
Base Saturation	%	90.72%

Table 2: Effect of organo-mineral fertilizers on stem girth and number of leaves of cocoa seedlings in an alfisol in Nigeria

Treatment	Stem Girth (cm)			Number of leaves/plant		
	MAP			MAP		
	2	4	6	2	4	6
A0	0.46a	0.66a	0.86a	7.00a	12.67bc	24.67ab
A10	0.49a	0.66a	0.82a	7.33a	13.00abc	19.33ab
A20	0.42a	0.62a	0.84a	7.33a	17.33a	33.00a
B10	0.49a	0.66a	0.72a	8.00a	10.67c	13.00b
B20	0.42a	0.76a	0.86a	6.67a	16.67a	18.00ab

Means in columns followed by the same letters are not significantly different by Duncan's Multiple Range Test at ($P < 0.05$), MAP = Months After Planting

A0 – Control - no fertilizer application, A10 – pacesetter organo-mineral fertilizer grade A applied to supply 10 kg Nha^{-1}, A20 – pacesetter organo-mineral fertilizer grade A applied to supply 20 kg Nha^{-1}, B10 - pacesetter organo-mineral fertilizer grade B applied to supply 10 kg Nha^{-1}, B20 - pacesetter organo-mineral fertilizer grade B applied to supply 20 kg Nha^{-1}

Table 3: Height of cocoa seedlings as influenced by organo-mineral fertilizer application in an alfisol in Nigeria

Treatments	Plant Height in cm (MAP)					
	1	2	3	4	5	6
A0	14.57b	17.67a	20.33ab	18.33b	14.83a	30.00a
A10	18.50a	18.00a	23.00ab	21.17ab	23.3a	30.50a
A20	17.81ab	7.33b	24.73a	20.17ab	19.17a	31.75a
B10	18.57a	12.25a	21.67ab	21.83ab	23.17a	24.50b
B20	18.67a	18.17a	24.60a	24.66a	22.33a	27.50ab

Means in columns followed by the same letters are not significantly different by Duncan's Multiple Range Test at ($P < 0.05$)

Table 4: Dry matter accumulation as influenced by organo-mineral fertilizer application to cocoa seedlings in an alfisol in Nigeria at six months after planting

reatment	Root dry weight (g/plant)	Shoot dry weight (g/plant)
A0	3.93ab	6.32b
A10	4.40ab	8.55b
A20	5.24a	11.32a
B10	2.35b	6.90b
B20	5.18a	7.67b

Means in columns followed by the same letters are not significantly different by Duncan's Multiple Range Test at ($P < 0.05$)

CONCLUSION

Pacesetter organo-mineral fertilizer grade A improved the seedling performance of cocoa. This therefore suggests, that urea will be a good source of nitrogen to fortify organic fertilizer(s) thus raising nitrogen content in a bid to reduce the quantity of materials (bulk) to be applied in the nursery compared to unfortified organic materials that is very low in nitrogen.

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