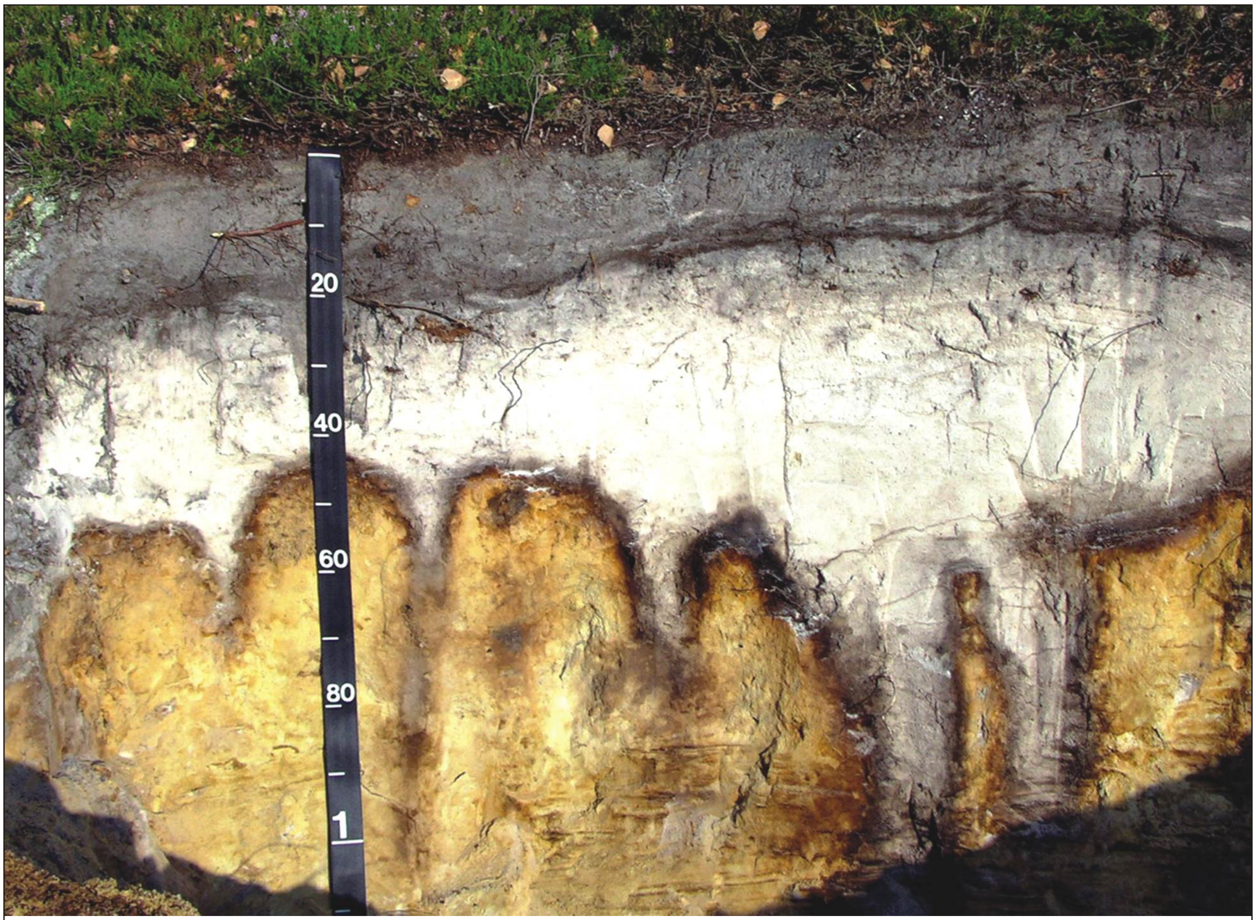

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Research Article
Effects of Dolomite on Some Growth Parameters of Poly Bag Coconut (*Cocos nucifera* L.) Seedlings in an Ultisol

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Abstract

Background and Objective: Dolomite is a naturally occurring rock mineral that contains calcium and magnesium as its chief mineral/nutrients. Dolomite as a source of plant nutrients for raising poly bag coconut seedlings was evaluated at the Nigerian Institute for Oil Palm Research (NIFOR). **Materials and Methods:** The study, conducted in 2 tasks was laid out in a Completely Randomized Design (CRD) and consisted of four levels of dolomite namely; 0, 100, 200 and 300 g in 5 replications. Task 1 had a 45 g basal application of NPK 15:15:15, while task 2 had a 65 g basal application of urea (N = 45%). Data were collected on plant height, stem girth, leaf area and number of leaves at 4 MAP, 8 MAP and 12 MAP (Months after planting). **Results:** Results showed that application of 100 g dolomite with a basal NPK 15:15:15 increased plant height over control throughout the sampling period, while application of 200 g dolomite with a basal NPK 15:15:15 only increased plant height over control at 12 MAP. Increased application rate of dolomite at 300 g with a basal NPK 15:15:15 depressed plant height throughout the sampling period. Application of 200 g dolomite with a basal urea only slightly increased plant height over control at 8 MAP. **Conclusion:** This study has shown that dolomite can be used to complement inorganic fertilizers, specifically NPK 15:15:15 for raising coconut seedlings in a naturally leached sandy soil.

Key words: Coconut, dolomite, ultisol, sandy soil, coconut seedlings, inorganic fertilizers

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Dolomite consist of calcium and magnesium as its main nutrient. Though, calcium is rarely applied directly to soil as a plant nutrient, it is however, a constituent of cell wall as Ca-pectate in the middle lamella of cell walls and for this reason tends to accumulate in leaves[1]. Calcium is essential for the growth of meristems, of specific importance in root development being essential for the proper growth and functioning of the root tip. Calcium is also concerned with cell division, cell elongation and detoxification of hydrogen ions and provides a base for neutralization of organic acids[1]. Magnesium is a constituent of the chlorophyll molecule and is concerned with numerous enzyme reactions in which it is regarded as a most effective activator. It acts as a carrier for phosphorus and is important in the formation of seeds of high oil content containing phospholipids[1].

Coconut (*Cocos nucifera* L.) is a very important cash crop in Nigeria which provides food for the teeming population and raw materials for industries. One way to sustain its cultivation is through nursery establishment. For coconut seedlings in the nursery, it has been reported that some or all of the major elements are required[2-5], depending on the environment. Trials conducted at the Nigerian Institute for Oil Palm Research (NIFOR) on coconut seedlings in the nursery seem to suggest that it might be uneconomical to apply fertilizers to nursery coconut seedlings. This has led to a paucity of information in comparison with the oil palm on the management of coconut seedlings using fertilizer inputs in the nursery. According to Ugbah[6], only two experiments on fertilizer use in coconut nursery seedlings have been reported in Nigeria. Ikuenobe *et al.*[7] found that application of up to a maximum of 28 g/seedlings NPKMg 12:12:17:2 did not enhance growth of tall coconut variety raised for 1 year in the nursery, whether the seedlings were subjected to weed interference for 36 weeks or kept weed-free throughout.

However, Remison and Jose[5] found complete mixture of NPKMg fertilizer significantly increased growth of dwarf coconut seedlings raised in the nursery for one year, although optimum rates could not be ascertained from this trial as only rate of the complete mixture was used. Coconuts can be cultivated on a wide range of soils[8], though the bulk of the cultivation is in the coastal regions many of which are sandy. Clayey alluvial soils which are not too acid (pH above 4.5) and rich in nutrients are the best coconut soils[9]. Coconut seedlings have been successfully cultivated in soils with pH above 6.0. Ugbah[6] reported a soil pH of 6.6 of sandy loam used for the cultivation of poly bag coconut seedlings at NIFOR main station.

In this present study, dolomite as a source of calcium and magnesium with a basal dressing with urea and NPK 15:15:15 was applied to coconut seedlings in an ultisol.

The objective was to determine the efficiency of dolomite as a source of nutrients for raising coconut seedlings in the nursery with minimal use of urea and NPK 15:15:15.

MATERIALS AND METHODS

Description of study area: This experiment was conducted at the Soils and Land Management Division of the Nigerian Institute for Oil Palm Research (NIFOR) between June, 2013 and July, 2014. The Nigerian Institute for Oil Palm Research (NIFOR) is located on Latitude 6°33^1 N and Longitude 5°37^{1}E and 149.4 m above sea level. It is located in the rain forest zone of Nigeria characterized by rainy season (February/March-November) and dry season (November-February/March. There is a short break in the rains in August, known as 'August break.' Rainfall ranges from 1500-2135 mm, while minimum and maximum temperature ranges are between 21-31°C with a mean annual temperature of 25°C.

Experimental design: Sprouted seed nuts of the hybrid variety of coconut were sown in a naturally leached sandy soil in late June of 2013. The seedlings of identical heights were sorted out three months after sowing and treatments were randomly assigned using the Completely Randomized Design (CRD) in five replications. The study was set up as two tasks; task 1 had a 45 g basal application of NPK 15:15:15, while task 2 had a 65 g basal application of urea (N = 46%). The control palms also received a basal application of NPK 15:15:15 or urea, but no dolomite. Total experimental units were 40.

Data collection: Data collection started exactly 3 months after sowing of the sprouted seed nuts (1 month after treatment application) in late September of 2013 and terminated in late June of 2014 (12 months after sowing and 10 months after treatment application). These data are plant height which was measured with the aid of a meter rule from the palm base to the top of the drawn up leaves. Stem girth was measured by means of a twine as the circumference of the palm base and spread on a ruler, while number of leaves were simply counted. Leaf area was measured by using the regression model $y = 2.2138+0.7192x$[10] where, x is the product of leaf length and breadth which were measured by using a measuring tape.

Laboratory analyses: The soil used for the experiment was sub-sampled, passed through a 2 mm sieve and analyzed for its chemical properties using standard laboratory procedures as follows: Soil pH was determined using a pH meter[11], using a 1:1 soil water ratio. Soil organic carbon was determined by the Walkley and Black method[12], Total Nitrogen (TN) was determined by micro Kjeldahl[13] method. Available phosphorus was extracted by the Bray-1 extractant[14]. Soil exchangeable bases were extracted by the ammonium acetate method buffered at pH 7[15]. Calcium and magnesium were read with the aid of an Atomic Adsorption Spectrophotometer (AAS), while potassium and sodium were read with a flame photometer. The composition of dolomite used for the study was determined using five sub-samples. Total P, Cu, Zn, Fe and Zn contents were determined by dissolving 2 g of dolomite in a mixture of perchloric, nitric and hydrochloric acids[16] and total P and micro-nutrients were determined on the Atomic Absorption Spectrophotometer (AAS). Exchangeable bases were determined in a mineral acid as suggested by Hesse[17] using 5N HCl. The Mg and Ca contents in the extract were read using Atomic Absorption Spectrophotometer (AAS), while K and Na levels were determined on a flame photometer.

Statistical analysis: Data collected were subjected to one way Analysis of Variance (ANOVA) using Gens tat statistical software, while significant means were separated using Duncan's New Multiple Range Test (DNMRT) at 5% level of probability.

RESULTS

The results of the soil's chemical properties (Table 1) showed that the soils contained little or no plant nutrients. The soils were acidic, while the major nutrients such as; total nitrogen, available phosphorus and exchangeable potassium were low. Calcium, magnesium and sodium were also low. These soils were preferred due to their little or no nutrient such that; the performance of coconut seedlings could be ascribed to the effects of the applied treatments only. The chemical composition of the dolomite used for the study is shown in Table 2. Analytical data of the dolomite showed that it contains 28.56, 47.36, 2.09 , 0.11 ,0.01 and 1.05% of Ca, CaO, Mg, K, P_2O_5 and Fe, respectively with very low levels of Cu, Zn and Mn.

Effects of dolomite on plant height of poly bag nursery coconut seedlings: Application of 100 g dolomite with a basal application of NPK 15:15:15 increased plant height of nursery coconut seedlings over control at 4 MAP, while at 8 MAP application of 100 g dolomite with a basal dressing with NPK 15:15:15 only slightly increased plant height of nursery coconut seedlings over control (basal application of NPK 15:15:15, but no dolomite). At 12 MAP, application of 100 g and 200 g dolomite with a basal application of NPK 15:15:15 increased plant height of poly bag coconut nursery seedlings over control. Plant height was depressed with increased application rates of dolomites of up to 200 and 300 g (Table 3). Application of 200 g dolomite with a basal application of urea slightly increased plant height over control (basal dressing with urea but no dolomite) at 8 MAP. At 12 MAP, application of dolomite did not improve plant height of poly bag coconut nursery seedlings (Table 3).

Table 1: Chemical properties of the soil used for the experiment

Parameters	Values
pH (H_2O)	4.50
Organic carbon (%)	0.05
Total nitrogen (%)	0.08
Available phosphorus (mg kg^{-1})	5.50
Exchangeable K (cmol kg^{-1})	0.10
Ca (cmol kg^{-1})	0.03
Mg (cmol kg^{-1})	0.20
Na (cmol kg^{-1})	0.10

Table 2: Chemical properties of the dolomite used for the study

Chemical property of dolomite	Composition (%)
Ca	28.56
CaO	47.36
Mg	2.09
MgO	6.07
K	0.11
P_2O_5	0.01
Cu	0.001
Zn	0.03
Fe	1.05
Mn	0.02

Effects of dolomite on stem girth of poly bag nursery coconut seedlings: Application of 100 g dolomite with a basal application of NPK 15:15:15 increased stem girth of poly bag coconut seedlings throughout the sampling period at 4 MAP, 8 MAP and 12 MAP which corresponds to two, four and eight months after treatment application, respectively (Table 4). Application of dolomite with urea as a basal dressing did not improve the stem girth of poly bag coconut seedlings. Basal application of urea without dolomite produced higher mean stem girth than a combination of urea and dolomite throughout the sampling period (Table 4).

Effects of dolomite on leaf area of poly bag nursery coconut seedlings: Application of 200 g dolomite with a basal application of urea produced higher mean leaf area when compared with the control (only basal application of urea) at 8 MAP and 12 MAP (4 and 8 months after treatment

Table 3: Effects of dolomite on plant height (cm) of poly bag nursery coconut seedlings

	Basal application of NPK 15:15:15			Basal application of urea		
Treatment (g/pot)	4 MAP	8 MAP	12 MAP	4 MAP	8 MAP	12 MAP
0	85.80[ab]	123.0	149.9	55.67	94.00	139.8
100	92.70[b]	124.5	159.1	48.60	84.75	122.7
200	81.20[a]	110.6	152.0	49.00	96.60	138.6
300	82.68[a]	114.3	140.4	42.00	81.00	113.3

Means without alphabetical letters in a column are not statistically different using Duncan's new multiple range test g, MAP: Months after application

Table 4: Effects of dolomite on stem girth (cm) of poly bag nursery coconut seedlings

	Basal application of NPK 15:15:15			Basal application of urea		
Treatment (g/pot)	4 MAP	8 MAP	12 MAP	4 MAP	8 MAP	12 MAP
0	8.54	10.00[ab]	11.64	6.46	8.42[ab]	10.66[ab]
100	9.26	11.60[b]	12.00	6.06	7.04[ab]	9.20[ab]
200	8.88	10.73[ab]	11.28	5.66	6.83[ab]	10.00[ab]
300	7.98	9.54[a]	9.88	5.50	5.65[a]	8.80[a]

Means without alphabetical letters in a column are not statistically different using Duncan's new multiple range test, MAP: Months after application

Table 5: Effects of dolomite on leaf area (cm^2) of poly bag nursery coconut seedlings

	Basal application of NPK 15:15:15			Basal application of urea		
Treatment (g/pot)	4 MAP	8 MAP	12 MAP	4 MAP	8 MAP	12 MAP
0	578.1	1458.0	1345.0	359.2	174.4	1272.0
100	736.1	1406.0	1522.0	221.5	688.1	935.0
200	574.5	1144.0	1384.0	267.7	884.7	1312.0
300	510.1	1220.0	1187.0	133.6	594.7	1016.0

Means without alphabetical letters in a column are not statistically different using Duncan's new multiple range test, MAP: Months after application

Table 6: Effects of dolomite on number of leaves of poly bag nursery coconut seedlings

	Basal application of NPK 15:15:15			Basal application of urea		
Treatment (g/pot)	4 MAP	8 MAP	12 MAP	4 MAP	8 MAP	12 MAP
0	4.40	5.00	6.00	3.00	5.00[ab]	6.67[b]
100	4.80	5.40	6.00	3.40	5.75[b]	6.80[b]
200	4.40	6.00	6.00	2.60	5.00[ab]	6.00[ab]
300	4.00	5.40	5.60	2.60	4.00[a]	5.00[a]

Means without alphabetical letters in a column are not statistically different using Duncan's new multiple range test, MAP: Months after application

application, respectively), while application of 100 g dolomite with a basal application of NPK 15:15:15 produced a higher leaf area at 4 MAP and 12 MAP (Two and eight months after treatment application) when compared with control (only basal application of NPK 15:15:15) (Table 5).

Effects of dolomite on number of leaves of poly bag nursery coconut seedlings: Application of 100 g dolomite with a basal application of urea increased mean number of leaves of poly bag coconut seedlings over control throughout the sampling period. Higher rates of 200 and 300 g depressed mean number of leaves. Similarly, application of 100 g dolomite with a basal NPK 15:15:15 slightly increased mean number of leaves over control (only basal application of NPK 15:15:15) at 4 MAP (2 months after treatment application). Increased application of dolomite up to 200 g also improved mean number of leaves at 8 MAP (4 months after treatment application). Application of dolomite with a basal application of NPK 15:15:15 did not improve mean number of leaves at 12 MAP (8 months after treatment application) (Table 6).

DISCUSSION

Data collected after 4, 8 and 12 months of treatment application are presented for discussion. In this study, application of 100 g dolomite improved plant height of nursery coconut seedlings over control irrespective of whether NPK15:15:15 or urea was used as the basal dressing. Similarly, application of dolomite with NPK15:15:15 improved stem girth of poly bag coconut seedlings, while leaf area and number were improved throughout the sampling period by dolomite with urea as a basal dressing. This is contrary to the findings of earlier researches who opined that poly bag coconut seedlings do not need fertilization. They opined that the growing seedlings have sufficient nutrients to draw from the endosperm and later the decaying husk[6,7]. The assumption by the earlier workers has been debunked by Ohler[18] in the Ivory Coast and Mendoza[4] in the Philippines. The two workers from the two different countries have reported that fertilizer application is recommended for nursery seedlings right from the first 1 or 2 months after planting in the bed as this practice has been found indispensable in order to obtain seedlings transplantable at the age of 6 months. Recent studies carried out at the Nigerian Institute for Oil Palm Research have however shown that coconut seedlings in the nursery respond to both organic and inorganic fertilization. Aondona *et al*.[19] observed responses of coconut seedlings in the nursery to both organic and inorganic fertilizers. Osayande *et al*.[20] also observed responses of coconut seedlings to a combination of NPK 15:15:15 and coconut fibre biochar. With respect to rock mineral of which dolomite is a part, their use in coconut cultivation has long been recognized. Coconut Research Institute of Sri Lanka (CRIS) recommended up to 1000 g of dolomite and 500 g of rock phosphate. In this present study, dolomite was used to raise coconut seedlings in poly bags. In combination with NPK 15:15:15:15, dolomite increased plant height and stem girth of nursery coconut seedlings, while leaf area and number of leaves were enhanced when applied in combination with urea. This could be attributed to the multiple nutrients provided by a combination of dolomite and NPK 15:15:15 when compared with urea which contains only N. This observation agreed with that coconut requires the complete nutrient combination for development[1]. Dolomite in combination with urea however performed poorer when compared with dolomite in combination with NPK 15:15:15 especially in terms of plant height and stem girth. Its performance was, however, comparable when compared with NPK 15:15:15 in terms of leaf area and number of leaves. The values obtained for plant height of coconut seedlings when combined with urea showed that dolomite in combination with urea could not produce transplantable seedlings as the values were lower than the control palms. This could be attributed to the fact that urea is a single element fertilizer and could not properly complement dolomite which chief constituents are only Ca and Mg. The values of plant height, stem girth, leaf area and number of leaves obtained in this study were however lower than those obtained previously[20].

CONCLUSION

Dolomite as a source of plant nutrients for raising coconut seedlings in poly bag was studied at the Nigerian Institute for Oil Palm Research. Results showed that application of 100 g dolomite with a basal NPK 15:15:15 increased plant height over control throughout the sampling period. Though, a basal application of dolomite with urea performed well with respect to leaf area and number of leaves, the values obtained for plant height suggested that dolomite in combination with urea could not be used to raise transplantable coconut seedlings. The study concludes that dolomite can be used to raise transplantable coconut seedlings in an ultisol when combined with NPK 15:15:15.

SIGNIFICANCE STATEMENT

This study has discovered that coconut nursery seedlings cultivated in a sandy acidic soil can be improved by application of dolomite combined with NPK 15:15:15. The study will help researchers and coconut farmers uncover the critical areas of dolomite as a plant nutrient.

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