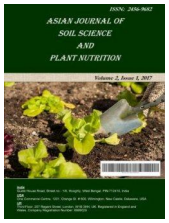

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Influence of Organic Fertilizer (Nomau®) on Soil, Leaf Nutrient Content, Growth and Yield of Physic Nut (*Jatropha curcas*) in Makurdi, North Central, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author ACO designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors NDO and ATG managed the analyses of the study. Author AA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aim: The aim of investigation was to evaluate the influence of organic fertilizer on soil, leaf nutrient content, growth and yield of Physic nut in Makurdi, North Central, Nigeria.
Study Design: The experiment was laid out in a randomized complete block design and replicated trice.
Place and Duration of the Study: Field experiment was carried out at Teaching and Research Farm of the University of Agriculture, Makurdi, Nigeria during 2009 and 2010 cropping seasons.
Methodology: The trial consisted of four treatments: organic fertilizer (Nomau®) at rate of 0, 0.50, 0.75 and 1.00 t ha^{-1}. Soil samples were collected from the plough layer (0 – 20 cm) at the

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beginning of the experiment as composite. After harvest of the first and second cropping seasons, soil composite samples were collected on the basis of treatments for routine chemical analysis. The Nomau® manure was incorporated into the soil two weeks before planting physic nut. Parameters measured at three weeks intervals number of primary branches, plant height and leaf area and yield at the end of cropping season.

Results: Organic fertilizer is an important contribution of organic matter that improves the physical and chemical characteristics of the soil. The soil at the experimental site had soil pH which was adequate for producing most crops in the tropics, low in organic matter, available phosphorus, cation exchange capacity, exchangeable calcium, potassium and Magnesium. It increased SOM, N, P, Mg, K, Na and CEC. Its application significantly increased number of primary branches, plant height, leaf area, leaf N, P and K concentrations of physic nut and yield relative to control.

Conclusion: The findings from the experiment shows that maximum production of physic nut and soil sustainability can be achieved from treatment 1.00 t ha^{-1} if properly managed in Markudi, Nigeria.

Keywords: Organic fertilizer; physic nut; nutrient content; soil chemical properties; yield.

1. INTRODUCTION

Agriculture is known to be the oldest industry in the world. Its purpose in the growing of Crops and rearing of animals, all geared towards production of food and feed for man and his live stocks. Over the years, grain yields have depreciated drastically due to the degrading nature of soils, poor fertility management and low import technology to improve the fertility of the soil. The use of organic manure could be adopted [1]. Following geometric increase in population, especially in Nigeria, adequate attention should be directed towards massive and cheapest way of food production. In order to achieve this, emphasis should be laid on the easiest means of enriching our soil which organic manure is one. The organic production system aims at supporting and sustaining healthy ecosystems, soil, farmers, food production, the community, and the economy.

Reduction and elimination of the adverse effects of synthetic fertilizers and pesticides on human health and the environment is a strong indicator that organic agriculture is gaining worldwide attention [2,3]. Organic fertilizers are environmentally friendly, since they are from organic sources [4]. The current global scenario firmly emphasizes the need to adopt eco-friendly agricultural practices for sustainable food production. The cost of inorganic fertilizers is increasing enormously, to the extent that they are out of reach for small and marginal farmers. The organic fertilizers provide nutritional requirements, suppress plant pest populations, and increase the yield and quality of agricultural crops in ways similar to inorganic fertilizers [1,5,6,7]. Organic fertilizers promote microorganisms growth and help to reduce the application of inorganic fertilizers and contribute to improving soil fertility and reducing a negative environmental impact [8]. Organic fertilizers contain macro-nutrients, essential micro-nutrients, vitamins, growth-promoting indole acetic acid (IAA), gibberellic acid (GA) and beneficial microorganisms [9]. The sustainability of conventional agriculture in world is under threat from the continuous degradation of land and water resources and from declining yields due to the indiscriminate use of agro-chemicals. Inorganic fertilizer application has obvious not provided the much needed sustainability of crop production under continuous system [10]. Vanlawe [11] stated that organic matter management remains a corner stone for successful farming in many areas of the tropics.

Physic nut (*Jatropha curcas*) is a bio-diesel crop belonging to the family of Euphorbiaceace which comes from the genus Jatropha. It is a large shrub native of Central America and Mexico co-traditionally grown as a hedge in countries of Sub-Saharan Africa, tropical and other sub tropical regions of the world. The name (*Jatropha curcas*) is derived from the Greek words (jatros) meaning “physician” and (trophe) meaning “nutrition” hence the common name physic Nut. It is a small tree or shrub with smooth gray bark, which exudes a whitish coloured watery, later when cut. Normally, it grows between three and five metres in height, but can attain a height of up to eight or ten meters under favourable conditions [12].

Physic Nut is a drought resistant perennial that can grow in wastelands even on gravelly, sandy and saline soils, flowering usually once a year

but under certain conditions can flower almost throughout the year like in permanently humid regions or under irrigation and fertilization. The ideal climate for Jatropha can be summarized as an annual rainfall not exceeding 600 mm in moderate climate conditions, 1200 mm in hot climatic zones and soil pH less than 9 [13]. The atmospheric temperature is 20°c as the plants are sensitive to ground frost that may occur in winter. Jatropha grows in soils that are quite infertile, usually found at lower elevations sometimes below 500 mm [14] and it can also be grown in deserts due to its resistance to high degree of aridity.

Physic nut leaves are smooth, large and green to pale green in color measuring 4-6lobes and 10-15cm in length and width. The ratio of male to female flowers averages 29:1 but this is highly variable and may range from 25 to 93 male flowers to 1 to 5 female flowers produced on each inflorescence [15]. It also has been reported that the male-to-female flower ratio declines as the plant ages [16], suggesting that fruiting capacity may increase with age. The unisexual flowers of Jatropha depend on pollination by insects, including bees, flies, ants and thrips. One inflorescence will normally produce 10 or more fruits. Fruit set generally results from cross pollination with other individual plants, because the male flowers shed pollen before the female flowers on the same plant are receptive. In the absence of pollen arriving from other trees, Jatropha has the ability to self pollinate, a mechanism that facilitates colonization of new habitats [15]. This study was conducted to evaluate the effects of organic fertilizer on soil properties, growth performance, leaf nutrient content and yield of Physic nut in Makurdi, North Central, Nigeria.

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiments were conducted at the Teaching and Research farm of the University of Agriculture, Makurdi (Latitude 7^0 41^1N and Longitude 8^0 35^1E), Benue State during the 2009 and 2010 cropping seasons. The site was not used for any cropping activities for the past three years. The site is located at an elevation of about 98 meters above sea level. This Location falls within the Southern Guinea Savanna Agroecological zone of Nigeria. The soil of the experimental site was classified as Typic Ustropepts and Typic Haplustults (USDA) or Eutric Cambisols and Haplic Lixisols (FAO), [17].

2.2 Experimental Treatments and Design

There were four levels of the industrial organic fertilizer **(**Nomau®). The treatments were replicated three times in a Randomized Complete Block Design (RCBD) giving a total of 12 plots with each plot measuring 4 x 3 m with an alley of 0.5 m between plots and 1m between replications. The Nomau® manure was incorporated into the soil two weeks before planting physic nut seeds. Treatments were: 0.00, 0.50, 0.75 and 1.00 t ha^{-1}.

2.3 Land Preparation and Planting

The land was manually cleared and ridged. The organic fertilizer was incorporated. Physic nut plant was used as a test crop. Planting was done in July, 2009. Physic nut plants were monitored for two cropping seasons. The seeds were manually drilled on rows to 3 cm depth after two weeks of incorporation of organic manure into the soil. The seedlings were later thinned to one per hole at 1 m plant –to –plant spacing three weeks after planting to give a plant population of 10,000 plants per hectare. Weeding was done manually at four weeks interval.

2.4 Date Collection

The following growth parameters were measured at three weeks intervals (from three to twelve weeks after planting in the first season and continues from forty nine to fifty eight weeks after planting in the second season) number of primary branches, plant height and leaf area and yield.

2.5 Soil Analysis

Soil samples were collected from the plough layer (0 – 20 cm) at the beginning of the experiment as composite. After harvest of the first and second cropping seasons, soil composite samples were collected on the basis of treatments. The soil samples were bulked, air-dried and sieved using a 2-mm sieve for routine chemical analysis, as described by Carter [18]. Particle-size analysis was carried out for textural class using the hydrometer method [19]. Soil pH was determined in a soil/water (1: 2) suspension using a digital electronic pH meter. Soil organic carbon was determined by the Walkley and Black procedure by wet oxidation using chromic acid digestion [20]. Total N was determined using micro-Kjeldahl digestion and distillation techniques [21], available P was determined by

Bray-1 extraction followed by molybdenum blue colorimetry [22]. Exchangeable K, Ca and Mg were extracted with a 1 M NH_4OAc, pH 7 solution. Thereafter, K was analysed with a flame photometer and Ca and Mg were determined with an atomic absorption spectro-photometer [23]. Cation exchange capacity (CEC) was determined using the procedures described by IITA [24] and modified by Anderson and Ingram [25].

2.6 Manure Analysis

The organic fertilizer (Nomau®) was analyzed for organic matter, nitrogen, phosphorus, Potassium, Magnesium, Calcium and Sodium. Total N was determined using macro-Kjeldahl method. Available phosphorus was determined by Bray-1 method. The exchangeable K and Na were determined on a flame photometer while Mg and Ca were determined on Atomic Absorption Spectrophotometer (AAS).

2.7 Statistical Analysis

Data collected were subjected to analysis of variance (ANOVA) and significant means were compared using Duncan New Multiple Range Test (DNMRT) at 5% probability level.

3. RESULTS AND DISCUSSION

The mean rainfall distribution for the two cropping seasons was presented in Table 1. In 2009 rainfall was highest in the month of August followed by October and June. In 2010, September recorded highest rainfall of 335.5 mm and was followed by July (196.9 mm), August (178.1 mm) and May (133.1 mm).

Table 1. Mean rainfall distribution (mm)

Month	2009	2010
Jan	2.3	0
Feb	0	0
March	3	12.6
April	73.8	31.4
May	196.3	133.1
June	235.6	113
July	84.6	196.9
August	334	178.1
September	141	335.5
October	284.1	121.3
November	1.2	24
December	0	0
Total	1355.9	1145.9

Sources: Federal Ministry of Aviation, Meteorological Department, Makurdi, Benue State

3.1 Soil Properties

The nutrient concentration of organic manure used is presented in Table 2. The organic manure was quite high in organic matter and Ca had more than Mg, N, K, and Na. Table 3 presents initial and after harvest soil analysis data for 2009 and 2010 cropping seasons. The data indicated that the soils were loamy sand with high sand particle. The soils pH were adequate for producing most crops in the tropics, low in organic matter (OM), available phosphorus (P), cation exchange capacity (CEC), exchangeable calcium (Ca), potassium (K) and Magnesium (Mg).

Table 2. Chemical analysis of packaged organic manures used (Nomau)

Nutrient element	Nomau
Organic matter (%)	42.01
Nitrogen (%)	2.91
Phosphorus (%)	12.19
Potassium (%)	1.62
Magnesium (%)	3.13
Calcium (%)	15.91
Sodium (%)	0.69

Soil chemical analysis results at the end of 2009 and 2010 cropping seasons showed increase among all treatments, for soil pH except the control. The highest pH values 6.31 and 6.32 were obtained at the plot that received 1.00 t ha^{-1} of nomau while the control has the lowest pH values 6.02 and 6.00. This could be due to the fact that the organic manure had a relatively high buffering capacity based on its high organic matter content (42.01%) and can fix any change in its pH during organic matter decomposition. In support of this, Ano and Agwu [26] had found that organic manure increased soil pH and macronutrients of soil in southern Nigeria.

The increase in soil organic matter in both cropping seasons by all organic fertilizer treated plots particularly at the higher rates is an indication of the quality of the organic manures and that soil organic matter increases with the amount incorporated. Treatment 1.00.t.ha^{-1} was the highest rate and recorded the highest organic matter 2.62 and 2.39% in 2009 and 2010 cropping seasons respectively and the control recorded the lowest values 1.42 and 1.38%. This increase in soil organic matter with increased rates of organic manure has been reported by Okpara and Mbagwu [27] that increase in organic matter with poultry manure

Table 3. Physicochemical properties of soil before planting and after harvests

Sample	pH	Org. M	Total N	Avail. P	Exch. Cations (cmol/kg)				CEC	Exch. A	Sand	Silt	Clay
	H_2O	%		mg kg^{-1}	Na^+	K^+	Ca^{2+}	Mg^{2+}	cmol/kg		%		
2009													
Pre planting	6.14	1.53	0.04	7.00	0.15	0.03	2.38	0.56	2.24	1.02	78.00	12.80	9.20
0.5 t ha^{-1}	6.21	2.17	0.08	8.08	0.24	0.05	3.36	0.98	2.81	0.99	72.96	18.40	8.64
0.75t ha^{-1}	6.25	2.29	0.08	9.24	0.29	0.06	3.84	1.14	3.12	0.98	70.96	19.12	9.92
1.00 t ha^{-1}	6.31	2.62	0.09	10.21	0.33	0.07	4.03	1.21	3.09	0.96	70.24	21.84	7.92
0.00 t ha-1	6.02	1.42	0.03	6.83	0.16	0.04	2.36	0.49	2.23	1.02	74.24	16.84	8.92
2010													
0.50 t ha-1	6.20	2.11	0.05	8.02	0.21	0.04	3.34	0.95	2.74	0.96	72.55	19.01	8.44
0.75t ha-1	6.25	2.22	0.06	9.13	0.24	0.04	3.67	1.09	3.05	0.95	71.08	19.12	9.80
1.00 t ha-1	6.32	2.39	0.06	10.07	0.29	0.05	3.98	1.15	3.01	0.95	71.03	20.87	8.10
0.00 t ha-1	6.00	1.38	0.02	6.11	0.11	0.03	2.31	0.46	2.16	0.99	74.09	16.54	9.37

application on vegetable crops; Osundare [28] who reported increase in soil organic matter from the application of organic manure such as sorted city refuse.

Addition of organic fertilizer brought about improvement in most of the soil chemical properties. Total nitrogen, available phosphorus and exchangeable cations were improved in both cropping seasons. The organic fertilizer decomposed to release organic matter, N, P, K, Ca and Mg. Hence soil OM, N, P, K, Ca and Mg tended to increase with level of organic fertilizer. The plots that received 1.00 t ha^{-1} of organic fertilizer (nomau) had the highest of these nutrients and the control obtained the lowest in the both cropping seasons. Improvement in nutrient status of organic fertilizer amended plots implies that organic fertilizer could be used for soil management and sustainable production of physic nut. In support of this, Ano and Agwu [26] had found that animal manure increased soil pH and macronutrients of soil in southern Nigeria. Also, Bahl and Torr [29]; Salako [30] reported that poultry manure improved surface P and other major nutrients and yield of maize. These findings confirmed earlier report by Lombin et al [31] that animal manure improved soil productivity in two ways; through improvement of the physical conditions of the soil and through the nutrient it supplies to the soil. The nutrient contents of 2010 cropping season was higher in all plots that received nomau than the control. This could be as a result of residual effect of organic manure. This result is in conformity with the studies of IITA [32] who reported that organic manure incorporated into the soil increase plant nutrients such as nitrogen, phosphorus, potassium, magnesium, calcium and sodium. Nutrients contained in organic manures are released more slowly and are stored for a longer period in the soil ensuring longer residual effects, improved root development and higher crop yields [33].

The results of organic fertilizer on cation exchange capacity for both cropping seasons are presented in Tables 3. The organic fertilizer treated plots produced highest cation exchange capacity. Among plots treated with organic fertilizer, treatment 1.00 t ha^{-1} had the highest cation exchange capacity (CEC) .The control had the least value of cation exchange capacity. The increase in cation exchange capacity for all plots that received organic fertilizer in both cropping seasons was the product of high organic matter content that resulted from the applied manures. This increase in cation exchange capacity is responsible for the increase and retention of exchangeable cations as observed in this experiment. This result agreed with Lombin et al., [31] who reported that organic manure is a major contributor to the cation exchange capacity of the soil. Lal and Kang [34] have also reported that the higher the organic matter contents of the soil, the higher the cation exchange capacity. This contribution of organic manure to increase nutrient holding capacity of the soil is consistent with the findings of Davis et al. [35] and Duriugbo et al. [36].

The decrease in exchangeable acidity observed in this study was as a result of these organic fertilizer treatments. The initial exchangeable acidity (1.02 cmol kg^{-1}) was higher than the plots amended with organic fertilizer. The plot with the

least exchangeable acidity was 1.00 t ha^{-1} of nomau which recorded 0.06 and 0.05 cmol kg^{-1} in 2009 and 2010 cropping season respectively. This could be the effect of calcium released in the soil that resulted in increased soil pH. These results is in conformity with Naramabuye and Haynes [37] who reported that at lower pH values, where aluminium is highly soluble, addition of organic manure from poultry, pig and cattle caused aluminium concentration to be reduced compared with the control. This is attributable to the binding of aluminium to solid phase organic matter resulting in its reduction. Ano and Agwu [38] also reported the reduction in soil exchangeable acidity due to application of organic fertilizer.

3.2 Growth Parameters

The result of the effect of nomau organic fertilizer on number of primary branches of physic nut is presented in Table 4. Plot treated with 1.00 t ha^{-1} of organic fertilizer produced the highest number of primary branches (3.33) at 3 weeks after planting but were the same statistically with other treatments. At 6, 12, 49, weeks after planting 1.00 t ha^{-1} of organic fertilizer recorded the highest number of primary branches followed by 0.75 t ha^{-1} which was statistically similar to other rates except the control that had least performance on number of primary branches. Physic nut height has no significantly affected by organic fertilizer from 3 to 12 weeks after planting (Table 5). At 49 to 58 weeks after planting 1.00 t ha^{-1} of organic fertilizer had the highest mean plant height that was the same statistically with plant height obtained from plots treated with 0.75 t ha^{-1} and significantly different from the control. The shortest plant height was recorded from plots treated with no manure (control). Leaf area recorded under the various rates of nomau showed significant differences (P = .05) at 6, 9 and 12 weeks after planting as shown in Table 6. Treatment 1.00 t ha^{-1} amended plot recorded the highest mean value of leaf area, whilst the least was observed under the control this finding are also confirmed by Shah et al. [39] who found greater leaf area with the application of organic manure. Michael et al. [40] reported that poultry manure has been found to enhance the number of leaves in lettuce by providing sufficient amount of nutrients that accelerate the growth of leaves.

Effect of organic fertilizer treatments on some growth parameters in Tables (4. 5 and 6) revealed significant positive impacts of the different treatments on the studied growth parameters, i.e., primary branches, plant height (cm), and leaf area (cm^2) with superiority for the treatment 1.00 t ha^{-1} which produced the highest values for all the previous characters. These findings are in harmony with those obtained by Kumar et al. [41]. The superiority of plots treated with organic fertilizer could be because manure contains all the essential micro and macro elements required for plant growth. The significant difference in growth parameter obtained in this study can therefore be attributed to the increased nutrient availability and release of mineral nutrients by organic fertilizer treated plots as observed by Ano and Agwu [38]. The obtained results agreed with the finding of Ajari et al. [42] in okra production in which they reported that organic manure could increase plant height and branches of crops. The results also agreed with the Balyeri et al. [43] they studied that organic manure influenced growth, yield and nutritional quality of containerized aromatic pepper (*Capsicum annuum* L., var 'Nsukka Yellow'). They concluded that the poultry manure increased the leaf area due to sufficient nitrogen availability which in turn improve the vegetative growth of the crop.

3.3 Nutrient Uptake

The nitrogen uptake by physic nut as affected by organic fertilizer treatments is presented in Table 7. At 3, 6 and 49 weeks after planting nitrogen uptake was highest in plots treated with 1.00 t ha^{-1} of organic fertilizer (2.01, 2.32 and 2.49 % respectively) which was statistically higher than all other treatments except 0.75 t ha^{-1}. At 9 weeks after planting, all the plots that received organic fertilizer were statistically similar and higher than the control. At week 55 and 58 after planting the plots that received 1.00 t ha^{-1} of organic fertilizer had the highest value of nitrogen uptake and were statistically higher than all other treatments. Control had the least value of nitrogen uptake by physic nut and was significantly lower compared to other plots that received organic fertilizer application.

Phosphorus uptake at 3 weeks after planting showed no significant difference among the treatments although plot that received 1.00 t ha^{-1} of organic fertilizer has the highest P value of 0.28 % (Table 8). All the plots treated with organic fertilizer were significantly higher than the control in P uptake. A significant difference was observed on potassium uptake in physic nut due to application of different rates of organic

fertilizer (Table 9). The highest content of K was recorded in treatment 1.00 t ha^{-1} followed by 0.75 t ha^{-1}. All plots treated with manure were higher significantly than the control. The control recorded the least values of K content in physic nut.

Table 4. Effect of Nomau on primary branches of Jatropha

Treatments	Weeks after planting							
	3	6	9	12	49	52	55	58
0.50 t ha^{-1}	2.00a	6.00ab	6.67b	7.00ab	8.33ab	9.33ab	10.00a	10.33b
0.75t ha^{-1}	3.00a	7.00ab	7.67b	8.00a	9.33a	10.00a	10.67a	12.00a
1.00 t ha^{-1}	3.33a	8.00a	8.33a	8.67a	10.67a	10.67a	11.33a	12.33a
0.00 t ha^{-1}	2.00a	5.67b	6.33b	6.67b	8.33b	8.67b	9.67a	10.33b

Values with different letters in columns are significantly (P =.05) different

Table 5. Effect of Nomau on plant height (cm) of Jatropha

Treatments	Weeks after planting							
	3	6	9	12	49	52	55	58
0.50 t ha^{-1}	29.93a	36.73a	52.10a	56.43a	119.80ab	146.10b	151.73bc	160.50bc
0.75t ha^{-1}	34.87a	43.43a	55.13a	58.73a	130.63a	156.47a	162.37ab	167.97ab
1.00 t ha^{-1}	33.40a	41.47a	55.13a	60.73a	130.57a	160.23a	164.33a	171.47a
0.00 t ha^{-1}	28.20a	36.10a	49.23a	55.27a	114.07b	143.30b	149.40c	157.c

Values with different letters in columns are significantly (P =.05) different

Table 6. Effect of Nomau on leaf area (cm^2) of Jatropha

Treatments	Weeks after planting							
	3	6	9	12	49	52	55	58
0.50 t ha^{-1}	120.60a	129.37b	131.20b	133.97c	141.43a	140.80a	137.40a	134.40a
0.75t ha^{-1}	137.47a	148.10ba	150.43a	151.50a	141.03a	140.80a	141.53a	140.07a
1.00 t ha^{-1}	138.00a	146.03a	147.30a	148.67ab	143.10a	141.70a	142.00a	143.53a
0.00 t ha^{-1}	127.70a	137.63ab	140.70ab	141.17b	141.53a	141.40a	140.10b	139.30a

Values with different letters in columns are significantly (P =.05) different

Table 7. Effect of Nomau on nitrogen uptake (%)

Treatments	Weeks after planting							
	3	6	9	12	49	52	55	58
0.50 t ha^{-1}	1.84b	2.27b	2.31a	2.34b	2.45b	2.46b	2.46b	2.46b
0.75t ha^{-1}	1.98a	2.31a	2.35a	2.36ab	2.48a	2.49ab	2.48b	2.47b
1.00 t ha^{-1}	2.01a	2.32a	2.35a	2.38a	2.49a	2.51a	2.52a	2.52a
0.00 t ha^{-1}	1.72b	2.10c	2.11b	2.12c	2.28c	2.31c	2.32c	2.33c

Values with different letters in columns are significantly (P =.05) different

Table 8. Effect of Nomau on phosphorus uptake (%)

Treatments	Weeks after planting							
	3	6	9	12	49	52	55	58
0.50 t ha^{-1}	0.27a	0.28a	0.31b	0.34a	0.42a	0.43a	0.44a	0.44a
0.75t ha^{-1}	0.26a	0.28a	0.32ab	0.36a	0.41a	0.43a	0.45a	0.45a
1.00 t ha^{-1}	0.28a	0.31a	0.35a	0.37a	0.43a	0.44a	0.45a	0.46a
0.00 t ha^{-1}	0.21a	0.22b	0.23c	0.24b	0.28b	0.31b	0.32b	0.33b

Values with different letters in columns are significantly (P =.05) different

Table 9. Effect of Nomau on potassium uptake (%)

Treatments	Weeks after planting							
	3	6	9	12	49	52	55	58
0.50 t ha^{-1}	2.60b	2.89c	2.95c	3.04b	3.35b	3.38b	3.39b	3.41a
0.75t ha^{-1}	2.90ab	3.21b	3.24b	3.26a	3.41a	3.42ab	3.42ab	3.42a
1.00 t ha^{-1}	3.00a	3.25a	3.29a	3.18a	3.41a	3.43a	3.44a	3.44a
0.00 t ha^{-1}	2.11c	2.18d	2.22d	2.23c	2.32c	2.35c	2.36c	2.37b

Values with different letters in columns are significantly (P =.05) different

The increased availability of nutrient in soil observed for nomau treatments led to increased uptake of N, P and K as indicated by leaf analysis. Ojo et al. [44] reported increases in the levels of P and N in maize plant tissues due to incorporation of organic manure into the soil. This was linked to high content of N and P in nomau organic manure which are released upon its decomposition. Nahar et al. [45] and Mandal et al. [46] reported that organic manures incorporated into soil decompose and increase soil nutrient status thereby enhancing nutrient uptake by plants. Earlier, Ojeniyi and Adegboyega [47] found that organic manure increased leaf N, P, K, Ca and Mg contents of Celosia. Also Smith and Ayenigbara [48] found that GD increased leaf N, K and Ca status of Indian Spinach.This observation is in agreement with Isitekhale and Osemwota [49]. Isitekhale and Osemwota [49] advocated the use of manure since it enhances the release, availability and absorption of nutrients when compared to NPK fertilizer even after the first year of application.

3.4 Physic Nut Yield

The seed weight has a direct bearing on the final economic yield of a crop. The differences in the seed weight are generally related to the period between anthesis and maturation of seeds. During this period supply of assimilates to the fruits and formative seeds is crucial and plants with better supply of balanced nutrients are at greater advantage than those under the low nutrient supply [50]. The plot that received 1.00 t ha^{-1} of organic fertilizer (Table 10) produced the highest total yield per hectare (0.74 t ha^{-1}) which was statistically similar to plots that received organic fertilizer and significantly differed from the control treatment. The control treatment performance was the least among the treatments with the physic nut yield of 0.29 t ha^{-1} in 2009 cropping season. The yield of physic nut in 2010 showed significant difference among the treatments. The highest yield (1.54) was recorded in treatment 1.00 t ha^{-1} which was significantly higher than all other rates of organic fertilizer. In general, physic nut crop undergoing various doses of organic fertilizer treatments exhibited increased yield of seeds in comparison to the control; the maximum increase being recorded in plants undergoing organic fertilizer treatment where the seed yield was significantly higher than untreated plants Onwu et al. [51] reported that application of higher doses of nitrogen resulted in higher seed yield of Jatropha plant. Patolia et al. [52] recorded significantly higher yields in physic nut plants that received N and P (through urea, single super phosphate, farm yard manure and jatropha cake) over the controls.

Table 10. Effect of Nomau on plant yield

Treatment	2009 (t ha^{-1})	2010 (t ha^{-1})
0.50 t ha^{-1}	0.70a	1.26c
0.75t ha^{-1}	0.70a	1.38b
1.00 t ha^{-1}	0.74a	1.54a
0.00 t ha^{-1}	0.29b	1.15d

Values with different letters in columns are significantly (P =.05) different

4. CONCLUSION

The beneficial effect applications of organic fertilizer on the soil physico-chemical properties favorably influenced pH, CEC, organic carbon, total nitrogen, available phosphorus and potassium. The increases in soil pH, total nitrogen, available phosphorus, exchangeable cations and the reduction in exchangeable acidity are indicative of the facilitative effect of organic fertilizer on soil nutrient release for good crop performance.

Physic nut growth as demonstrated by number of primary branches, plant height (cm) and leaf area (cm^2) were significantly influenced by the application of organic fertilizer. Treatment 1.00 t ha^{-1} has been observed to significantly increase physic nut growth when compared to the others. Although physic nut has the ability to flourish under any condition even without fertilizer

application but greater yield is obtained when fertilizer is applied as observed from the research work.

The increased availability of nutrient in soil observed for organic fertilizer treatments led to increased uptake of N, P and K as indicated by leaf analysis.

The observations and findings obtained from the experiment on the Influence of packaged organic fertilizer (Nomau®) on soil, leaf nutrient content, growth and yield of Physic nut (*Jatropha curcas*) shows that maximum production of physic nut and soil sustainability can be achieved from treatment 1.00 t ha^{-1} if properly managed in Markudi, Nigeria.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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