EVALUATION OF ORGANIC FERTILIZER (NOMAU®) ON SOIL PROPERTIES, LEAF NUTRIENT CONTENT, GROWTH AND YIELD OF *JATROPHA CURCAS* IN OTUKPO, BENUE STATE, NIGERIA.

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ABSTRACT
Soil properties, leaf nutrient content, growth and yield of Jatropha Curcas were examined under different rates of organic manure in a field experiment conducted at Agricultural Vocational Training Centre, Otobi, Otukpo, Benue State. The experimental design was randomized complete block design with four rates of organic manure 0.00, 0.50, 0.75 and 1.00 t ha$^{-1;}$ and these rates were replicated thrice..The soil at the experimental site was slightly acidic and low in other soil nutrients. Results indicated that manure improved soil nutrients N (0.28 and 0.22 %), P (11.01 and 10.87 ppm) and K (0.33 and 0.29 cmol kg^{-1}) and lowered exchange acidity (0.94 and 0.93 cmol kg^{-1}) at treatment 1.00 t ha^{-1} in 2009 and 2010 respectively compared to initial soil analysis and control that had N (0.06 and 0.12 %), P (9.10 and 9.78 ppm), K (0.18 and 0.25 cmol kg^{-1}) and exchange acidity (1.01 and 0.97 cmol kg^{-1}) respectively. The organic manure significantly (P<0.05) increased leaf nutrients content higher than the control. The statistical analysis of the growth data showed that organic manure significantly affected all studied attributes with the highest recorded in plots that received 1.00 t ha^{-1}. The 1.00 t ha^{-1} treatment produced the highest total yield per hectare (0.97 and 1.71 in 2009 and 2010 cropping seasons respectively) which significantly differed from all other treatments, while the lowest yield of 0.42 and 1.21 t ha^{-1} respectively was obtained from the control. Based on the findings, it could be deduced that organic manure improves soil nutrient, increases leaf nutrient contents, promotes higher growth and yield of jatropha.
Keywords: Jatropha; organic manures; nutrient contents; performance.

INTRODUCTION
Jatropha curcas is a perennial poisonous shrub which normally grows up to 5m high. It belongs to the family Euphorbiaceae. The origin of the plant has been a bit of controversy as its origin is still not well established in literature. Most literatures suggest that it originated from Central America. According to the Centre for jatropha Promotion and Biodiesel (CPJ) (2010), it is still uncertain where its centre of origin is but it is believed to be from Central America and had such common names such as Barbados nut, bubble-bush, physic nut, purge nut or purging nut (USDA, 2008) . It has been introduced to Africa and Asia and is now cultivated worldwide. *Jatropha curcas* is a perennial shrub whose stem and branches contain latex. It has large green to pale-green leaves. According to Begg and Gaskin (1994) and Heller (1996), the jatropha has five to seven simple, ovate, shallow lobed leaves arranged alternately with 3-5 indentations and a length and width of 6-15cm. Its petioles are about 10cm long. Male and female flowers are produced on the same inflorescence and average 10 or 20 male flowers to each female flower. The flowers are yellow to green in colour, borne in the axils of the leaves, are small and mostly hidden by foliage. The fruits are small capsule-like, round and about 2.5cm - 4cm in diameter. They are green when immature, change to yellow when mature, becoming dark brown and split to release 2 or 3 black seeds, each about 2cm long (Begg and Gaskin, 1994; Heller, 1996).

Jatropha curcas is a multipurpose shrub and has many beneficial attributes that cut across both service and productive functions. As any agroforestry tree, it provides services like carbon sequestration, nutrient cycling, mulch and increases soil microbial activity. It is widely planted as a living fence and hedgerow to protect food crops from damage by livestock and as a wind break to prevent soil erosion and moisture depletion and for reclamation of degraded lands (Duke and Wain, 1981). The productive function of jatropha is very extensive as almost every part of the plant is useful for varying purposes. The seed contains oil that can be refined into biodiesel usable in standard diesel engine. The young leaves may be safely eaten, steamed or stewed with goat meat, said to counteract the peculiar smell of the goat meat (Ochse, 1980). The oil has been used for illumination, soap and candle making. Ashes of the burned root are used as a salt substitute (Morton, 1981). Duke and Wain (1981) list it as a pesticide and a rodenticide as well. The medicinal value of jatropha cannot be over emphasized as it has been used traditionally in many areas of the world as a folk medicine. Jatropha is a folk remedy for burns, convulsions, cough, dermatitis, diarrhoea, dysentery, fever, gonorrhea, hernia, inflammation, parturition, pneumonia, rheumatism, scabies, sores, stomach ache, syphilis, tetanus, tumors, ulcers, yaws, and yellow fever (Duke and Wain, 1981; List and Horhammer, 1979).

According to Openshaw (2000), growth of the plants is dependent on soil fertility and rainfall. Provided the nutrient level is sufficient, plant growth is a function of water availability, especially in the tropics. Flowers and seed production respond to rainfall and nutrients. Poor nutrient level will lead to increased failure of seed development. Thus, it is important to maintain soil fertility (Openshaw, 2000). It is also very important to improve on the production of such valuable plant through fertilizer application because of the major essential renewable source of energy derived from it. Furthermore, its cultivation can create regular employment opportunities to the rural societies as it provides a never ending marketing potential. However, organic fertilizer helps to promote plant growth and crop yield making the leaves greenish and fresh thereby causing the soil to release some of its store of plant food in a form that it can be absorbed by plants easily (Burkitt, 2007). Agriculture is a soil-based industry that extracts nutrients from the soil. Therefore, effective and efficient approaches to slowing nutrients removal and returning of nutrients to the soil will be required in order to maintain and increase crop productivity and sustain agriculture for the long term (Gruhn *et al.*, 2000). The maintenance of soil fertility involves the return to the soil of the nutrients removed from it by harvests, runoff, erosion, leaching, and other loss pathways (Aune, 1993).

Due to the increasing cost of chemical fertilizers, depletion of soil micronutrients, environmental and health hazards and expected premium prices for organically produced crops, the use of organic manure in farming has caught much attention of late (Ramesh *et al*., 2005). Organic manures are important ways of recycling nutrients into the soil. Organic manure is preferred to mineral fertilizer due to the high cost of the latter. In mixed farming, farmers can obtain free the organic manures but inorganic manures can never be obtained free (Kolavalli and Adam, 2011). Crew and Peoples (2004) stated that although chemical fertilizers release their nutrients faster into the soil for productivity, their effects have brought a lot of concerns to sustainability of production. According to Savci (2012), the detrimental effects of chemical fertilizers on the soil are not immediately seen because soils have strong buffering power due to their components but the toxic substances accumulate within the crops and cause harm to humans and animals who feed on them. Soil-fertility depletion in smallholder farms is the fundamental biophysical root cause for declining per capita food production in sub-Saharan Africa. If the nutrient removal rates of crops are not timely balanced by soil amendments aimed at maintaining the fertility of the soil, the soil will get poorer and productivity reduced (Logah, 2009). The use of chemical fertilizers has been good for some time now but the long term effects were not known until recently, causing a shift to sustainable organic farming (Blake *et al.*, 1999). Organic farming practices deliberately integrate traditional farming practices and make use of locally available resources. As such they are highly relevant to smallholder farmers who produce for themselves and local markets (Kolavalli and Adam, 2011). Organic farming contributes to achieve public goals at the national and local levels in Africa (IFOAM, 2009).

In Nigeria, despite the long history of land use and the continuous loss of the soil quality, there are no serious efforts to restore the soil quality and attempts in this direction are certainly missing. The present study was, therefore, intended to evaluate organic fertilizer (Nomau®) on soil properties, leaf nutrient content, growth and yield of *Jatropha Curcas.*

MATERIALS AND METHOD

EXPERIMENTAL SITE.

The experiment was conducted at the Agricultural Vocational Training Centre, Otobi, Otukpo (Latitude 07 11^1N and Longitude 08 10^1E), 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 101 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].

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 jatropha seeds. Treatments were: 0.00 (control), 0.50, 0.75 and 1.00 t ha^{-1}.

LAND PREPARATION AND PLANTING

The land was manually cleared and ridged. The organic fertilizer was incorporated. Jatropha plant was used as a test crop. Planting was done in July, 2009. Jatropha 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.

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 (1993). Particle-size analysis was carried out for textural class using the hydrometer method (Sheldrick, 1993). 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 (Nelson and Sommers, 1996). Total N was determined using micro-Kjeldahl digestion and distillation techniques (Bremner, 1996), available P was determined by Bray-1 extraction followed by molybdenum blue colorimetry (Frank *at al.,* 1998). 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 (Okalebo *at al.,* 2002). Cation exchange capacity (CEC) was determined using the procedures described by IITA (1979) and modified by Anderson and Ingram (1996).

MANURE ANALYSIS

The organic manure (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)

LEAF ANALYSIS

The leaf nutrient content analysis was done at week 6, 12 after planting in first season and 52 and 58 weeks after planting in second season. Leaf samples were collected, oven-dried at 700°C for 24 h and milled. Nitrogen was determined using micro-kjeldahl method. Samples were dry ashed using nitric-perchloric-sulphuric acid mixture for determination of P, K Ca and Mg. Phosphorus was determined using vanadolmolbdate colormetry, K and Na by flame photometer and Ca and Mg by EDTA titration (Tel and Hagarty, 1984).

GROWTH AND YIELD PARAMETERS

The 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 and plant height and yield.

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.

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 (352.20 mm) followed by October (298.10 mm) and June (274.40 mm). In 2010, September recorded highest rainfall of 341.50 mm and was followed by July (205.10 mm), August (198.40 mm) and May (147.50 mm). The total rainfall in 2009 (1487.70 mm) was higher than 2010 (1249.70 mm).

Table 1: mean rainfall distribution (mm)

Month	2009	2010
Jan	3.70	0.00
Feb	0.70	2.00
March	9.50	20.10
April	86.50	36.20
May	205.30	147.50
June	274.40	131.60
July	86.20	205.10
August	352.40	198.40
September	163.60	341.50
October	298.10	136.30
November	3.30	31.20
December	0.00	0.00
Total	**1487.70**	**1249.70**

Sources: National Root Crops Research Institute, Otobi Sub-station, Otukpo, Benue State

SOIL PROPERTIES

Table 2 shows the nutrient analysis of organic manure used. The organic manure was quite high in organic matter and Ca had more than Mg, N, K, and Na. The low organic carbon and available P and acidic nature of soils is expected to benefit from application of organic manure. Initial soil analysis was carried out to assess the soil fertility status at the study area before the conduct of the experiment and after harvests soil samples were also analyzed for 2009 and 2010 cropping seasons, these results of the soil analysis are presented in Table 3. The results indicated that the soil was loamy sand with high sand particle. Soil organic carbon and total nitrogen contents were 0.98 % and 0.06 %, respectively. The soil is acid with the pH of 5.83 and N, P and K are deficient. The soil is low in organic carbon, cation exchange capacity (CEC), exchangeable calcium (Ca) and Magnesium (Mg). There was an increase in soil pH and decrease in exchangeable acidity after harvests in plots treated with organic manure. This is in line with Ouédraogo *et al.* (2000), who reported an increase in soil pH on plots treated with manure (compost). The increase in soil pH could be attributed to the reduction of exchangeable Al in the acidic soils, which is reflected in this study by the decrease in total exchangeable acidity. On the other hand, the levels of exchangeable bases like K, Ca and Mg increased in all organic manure treatments and could also have contributed to the pH increment. This also in line with Zhang *et al*., (2006) who reported that organic manure in a subarctic soil increased phosphorus accumulation, high soil exchangeable and plant were able to recover nitrogen stress. Natschner and Schetmann (1991) and Agbede (2010) also reported that application of organic manure which contains high exchangeable calcium; potassium, magnesium and sodium, and the presence of these exchangeable bases in soil tend to increase soil acidity value.

Table 2: Chemical analysis of packaged organic manures (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

There was a general increase in soil organic carbon and other nutrients with application of organic manure than control plot. Soil organic carbon content was highest in the plot that received 1.00 t ha^{-1} of organic manure. These results are in good agreement with those of Meeuwissen (1992) and Kaschl *et al.* (2002) who found a positive correlation between the addition of organic manure and soil organic carbon contents. The increase in nitrogen, phosphorus, potassium, calcium, magnesium and sodium in the soil could be attributed to the increase in organic carbon contents observed. This finding agreed with the report of Grichs (1990) that organic manure is a store house for plant nutrients and major contributor to the cation exchange capacity of the soil. It serves as a buffering agent against pH fluctuation that plays key role in sustaining desirable soil physical conditions for satisfactory growth and development of crops. Martin *et al*, (2006) reported organic manures increase soil available phosphorus. Soil organic matter undergoes mineralization and releases substantial quantities of nitrogen, phosphorus, sulphur and smaller amount of micronutrients (Rahman, *at al*., 2013). Obatolu and Agboola (1993) identified soil organic carbon as one of the most importance indicators of soil fertility in the tropics while Adejuyigbe and Adeoye (2005) stated that the level of organic matter especially in tropical soils, is an essential determinant of its fertility. The nutrients released within the growing season consistently for the two years is supported by Camberato *et al.*, (1996) who reported that availability of nutrients especially potassium in manures in the year of application is similar to that of inorganic fertilizer.

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

Sample	pH	Org. C	Total N	Avail. P	Exch. Cations (cmol/kg)				CEC	Exch. A	Sand	Silt	Clay
	H_2O	%		Ppm	Na^+	K^+	Ca^{2+}	Mg^{2+}	cmol/kg			%	
2009													
Pre planting	5.83	0.98	0.06	9.10	0.65	0.18	2.34	1.15	3.61	1.01	71.25	20.45	8.30
0.5 t ha-1	6.22	1.45	0.16	10.01	0.62	0.29	8.17	2.21	3.70	0.97	70.18	19.84	9.98
0.75t ha-1	6.24	1.45	0.24	10.37	0.67	0.32	8.54	2.33	4.50	0.95	70.01	20.86	9.13
1.00 t ha-1	6.31	1.82	0.28	11.01	0.66	0.33	9.27	2.38	4.80	0.94	70.59	19.27	10.14
0.00 t ha-1	5.64	1.19	0.05	9.01	0.52	0.18	3.25	1.52	3.40	1.00	71.28	20.09	8.63
2010													
0.5 t ha-1	6.21	1.42	0.12	9.78	0.59	0.25	7.92	2.17	3.61	0.95	69.85	19.84	10.31
0.75t ha-1	6.22	1.44	0.22	10.07	0.61	0.29	8.37	2.26	4.38	0.93	71.87	18.67	9.46
1.00 t ha-1	6.32	1.73	0.22	10.87	0.62	0.29	9.08	2.32	4.73	0.93	70.59	18.67	10.74
0.00 t ha-1	5.62	1.14	0.04	8.23	0.47	0.15	3.04	1.41	3.31	0.99	71.54	19.22	9.24

LEAF NUTRIENT CONTENTS

Leaf nutrient content tended to increase with level of organic manure (Table 4 and 5). The plots treated with 1.00 t ha^{-1} organic manure have the highest values of leaf nutrient contents of N, P, K, Na, Ca and Mg followed by 0.75 t ha^{-1}. The control recorded the least values of leaf nutrient contents of N, P, K, Na, Ca and Mg. The organic manure on leaf nutrient content in most cases were statistically the same among treatments that received organic manure and significant ($p>0.05$) higher than the control plots. The increased availability of nutrient in soil observed for organic manure treatments led to increased uptake of N, P, K, Na, Ca and Mg as indicated by leaf analysis. This implies that organic manure could increase nutrient content in crop (Tarfa *et al.*, 2001). The increase in soil nutrient in the plots that received manure confirmed the report of Agboola (1974) that nitrate – nitrogen is liberated when plant residues are ploughed into the soil and crop could utilize this for their growth.

Table 4: Effect of nomau on nitrogen, phosphorus and potassium nutrient contents (%)

	N				P				K			
	Weeks after planting											
Treatments	6	12	52	58	6	12	52	58	6	12	52	58
0.50 t ha^{-1}	2.42b	2.51b	2.78a	2.81a	0.35a	0.38a	0.46a	0.47a	3.08a	3.16b	3.32b	3.35a
0.75t ha^{-1}	2.46a	2.55ab	2.79a	2.81a	0.35a	0.38a	0.46a	0.48a	3.11a	3.24a	3.51a	3.52a
1.00 t ha^{-1}	2.51a	2.59a	2.78a	2.82a	0.36a	0.41a	0.47a	0.47a	3.11a	3.27a	3.52a	3.52a
0.00 t ha^{-1}	2.11c	2.18c	2.34b	2.37b	0.27b	0.31b	0.35b	0.36b	2.23b	2.26c	2.33c	2.36b

Values with different letters in columns are significantly ($P < 0.05$) different

This significant higher nutrient contents than the control plots as observed in this study could be attributed to easy solubilization effect of released plant nutrients leading to improved nutrient uptake by the plant. This finding is in conformity with the findings of Aliyu (2000) who reported increase in growth with increase poultry manure rates. Also Smith and Ayenigbara (2001) found that organic manure increased leaf N, K and Ca status of Indian Spinach. This observation is in agreement with Isitekhale and Osemwota (2010) who advocated the use of manure since it enhances the release, availability and absorption of nutrients by plants. An increase in N, P and K, content of faba beans due to application of organic manure as reported by Faiyard *et al.* (1991) also lend support to the results obtained in the present investigation.

Table 5: Effect of nomau on sodium, magnesium and calcium nutrient contents (%)

	Na				Mg				Ca			
	Weeks after planting											
Treatments	6	12	52	58	6	12	52	58	6	12	52	58
0.50 t ha^{-1}	0.37a	0.42a	0.47b	0.48a	0.62a	0.65b	0.71b	0.72a	0.54b	0.61b	0.72a	0.71a
0.75t ha^{-1}	0.39a	0.43a	0.47b	0.49a	0.65a	0.66b	0.72ab	0.73a	0.59a	0.66a	0.72a	0.73a
1.00 t ha^{-1}	0.39a	0.43a	0.51a	0.51a	0.66a	0.71a	0.75a	0.76a	0.59a	0.66a	0.72a	0.73a
0.00 t ha^{-1}	0.28b	0.33b	0.35c	0.36b	0.53b	0.56c	0.59c	0.63b	0.52c	0.58c	0.63b	0.63b

Values with different letters in columns are significantly ($P < 0.05$) different

GROWTH PARAMETERS

The effect of organic manure on number of primary branches indicated that 3 to 9 weeks after planting there were no statistical different among treatments (Table 6). Although, treatment 1.00 t ha^{-1} has the highest number of primary branches 4.33, 5.00 and 6.00 respectively. All plots that received organic manure were significantly higher than the control from weeks 49 to58. The highest number of primary branches were observed at treatment 1,00 t ha^{-1} while the least branches were recorded at the control plots. This could be due to higher nitrogen uptake from plots treated with organic manure. Nitrogen is a major nutritional requirement for tissue differentiation and its role in increasing plant growth are well documented by various researchers (Aziz, 2007; Shedeed *et al*., 1986). Like nitrogen and phosphorous which were high in organic manure are essential constituents of the genetic material which augment cell division (Aziz, 2007). The increased primary branches as observed in this study in respect to organic manure treatments might be due to increased rate of new cell formation.

Table 6: Effect of nomau on number of primary branches of Jatropha

	Weeks after planting							
Treatments	**3**	**6**	**9**	**12**	**49**	**52**	**55**	**58**
0.50 t ha^{-1}	4.00a	4.33a	5.33a	5.67ab	8.33a	9.00a	10.00a	10.33a
0.75t ha^{-1}	4.00a	4.67a	5.67a	6.00ab	9.00a	10.00a	10.33a	10.67a
1.00 t ha^{-1}	4.33a	5.00a	6.00a	6.67a	10.00a	10.33a	11.33a	12.00a
0.00 t ha^{-1}	3.33a	4.00a	4.67a	5.00b	6.33b	7.00b	8.00b	8.67b

Values with different letters in columns are significantly ($P < 0.05$) different.

It was revealed from the result that, organically treated plots significantly influenced the plant height of Jatropha (Table 7). The tallest plants were obtained from plots treated with 1.00 t ha^{-1} of organic manure followed by 0.75 t ha^{-1} whereas the shortest was found from the control which had no manurial treatment. Plots treated with 1.00 t ha^{-1} of organic manure contained high nitrogen content which might have enhanced cell division and formation of more tissues resulting in luxuriant vegetative growth thereby increasing the plant height. Meyer and Anderson (2003) also reported similar results. This also indicated that the plots that received organic manure treatments were better than the control plot. It can be adduced that increasing level of PM could have resulted in an increase in the amount of nitrogen made available to the plants through mineralization and nitrogen is known to stimulate growth in plants (Anyaegbu, 2010).

Table 7: Effect of nomau on plant height (cm) of Jatropha

	Weeks after planting							
Treatments	**3**	**6**	**9**	**12**	**49**	**52**	**55**	**58**
0.50 t ha^{-1}	33.00ab	42.60ab	58.80a	62.43bc	131.70c	152.70c	162.97c	167.47b
0.75t ha^{-1}	36.00a	46.37a	59.73a	66.20ab	134.83a	160.73b	167.43b	176.37a
1.00 t ha^{-1}	37.17a	44.20a	63.20a	67.07a	137.77a	165.47a	172.17a	180.43a
0.00 t ha^{-1}	29.33b	38.27b	52.27b	59.60c	123.83c	143.57d	155.77d	162.60c

Values with different letters in columns are significantly ($P < 0.05$) different.

SEED YIELD

The result of the study showed that in the treatments improved crop yield and Jatropha plant responded significantly to the manure application. The result could therefore be attributed to the manure rate. The highest seed yield of 0.97 t ha^{-1} was obtained from 1.00 t ha^{-1} of organic manure which was significantly higher than yield obtained from all other treatments in 2009 cropping season (Table 9). Treatments 0.50 and 0.75 t ha^{-1} obtained yield of 0.81 and 0.87 t ha^{-1} respectively which were statistically similar and higher than the control. The yield of 1.72 t ha^{-1} was recorded at 1.00 t ha^{-1} of organic manure which was significantly different from all treatments in 2010 cropping season. The control obtained the lowest Jatropha seed yield in both cropping seasons. The observed improvement in the yield of Jatropha could be attributed to the ability of the manure to increase soil nutrient thereby increasing Jatropha yield. This result agreed with Sharma (2004), who reported that organic manure improves plant height, cob size, grain yield and weight of maize. The yield increase with an increase inorganic manure rates suggests that the manure supplies nutrients that enhanced vigorous growth, which are important indices that culminate in increase in yield. This result agrees with that Aliyu (2002, 2003) who reported significant response in yield to different types and rates of manure applications. 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 manure on soil nutrient release for good crop performance. These results further showed that the higher the organic matter, nitrogen, phosphorus and exchangeable cations under a favourable soil pH, the higher the yield of Jatropha plants (Onwu, at al., 2017).

Table 9: Effect of nomau on plant yield

Treatment	2009	2010
0.50 t ha-1	0.81b	1.50c
0.75t ha-1	0.87b	1.61b
1.00 t ha-1	0.97a	1.72a
0.00 t ha-1	0.42c	1.21d

Values with different letters in columns are significantly ($P < 0.05$) different.

CONCLUSION

It is concluded from this work that aside from improving plant nutrient availability, organic manure reduced soil exchangeable acidity and enhanced nutrients absorption by Jatropha as observed in the leaf nutrient contents. These improvements led to significant increases in growth and yield of Jatropha. The 1.00 t ha^{-1} nomau organic manure is recommended for soil productivity and yield of jatropha.

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