International Journal of
Agriculture
(IJA)

Effect of Fertilizer Types and Rates on the Production of Moringa (*Moringa Oleifera*) in Ogbomoso

CARI Journals

Journal of Agricultural Policy
ISSSN 2520-1223 (Online)
Vol.3, Issue No.2, pp 21 – 34, 2020

www.carijournals.org

Effect of Fertilizer Types and Rates on the Production of Moringa (*Moringa Oleifera*) in Ogbomoso

[1*]Olawepo Taiye Femi, [2]Akanbi Wasiu Babatunde, [3]Olayiwola Shakirat Ayobami, [4]Ojo Abisoye Oyepero, [5]Idiaro Salimat, [6]Atotileto Zainab Bolajoko

[1,3]Department of Agricultural Science Kwara State College of Education, llorin, Nigeria.

*Correspondence Author E mail: taiyeolawepo2012@gmail.com

[2]Department of Crop and Soil Science, Ladoke Akintola University of Technology, Ogbomoso, Nigeria

[4]National Center for Genetic Resources and Biotechnology, Ibadan Nigeria.

[5]Department of Biology, Kwara State College of Education, llorin, Nigeria.

[6]Department of Intergrated Science Kwara State College of Education, llorin, Nigeria.

Abstract

Purpose: An experiment was conducted to study the effect of fertilizer types and rates on the production of moringa in Ogbomoso on the Teaching and Research Farm of Ladoke Akintola University of Technology, Ogbomoso, in 2012 and 2013 planting seasons.

Methodology: The experimental design was randomized complete block design with 3 replicates. Nine treatments were used. The treatments were no fertilizer, 400 kg/ha NPK, 600 kg /ha NPK, 800 kg/ha NPK, 1000 kg/ha NPK, 2.5 t/ha tithonia compost, 5.0 t/ha tithonia compost, 7.5 t/ha tithonia compost and 10.0 t/ha tithonia compost. The land was prepared by ploughing and harrowing after the pre cropping soil sampling to determine the physical and chemical properties of the soil. Data collected were plant height, number of leave/plants, dry matter yield, fruit and seed yield components, biomass proximate and elemental compositions. The analyses of variance done were on the data collected and means were separated using Duncan's Multiple Range Test (P $\leq$0.05).

Results: Vegetative growth of moringa was better enhanced by the application of 1000 kg/ha NPK, as it produced the tallest plant height and the greatest number of leaves/plants which is followed by the 10.0 t/ha tithonia compost. The fertilizer application had significant effect on the seed and fruit yield of moringa. 1000kg/ha of NPK gave the highest seed and fruit yield components such as fruit set, number of fruits per plant and 100 seed weight. The application of 10.0 t/ha tithonia compost had highest proximate and nutrient composition in moringa leaves production.

Unique contribution to theory, policy and practice: In conclusion, the application of 10.0 t/ha tithonia compost produce a comparable result as 1000 kg/ha NPK (15:15:15) fertilizer and may be used as alternate to NPK (15:15:15) fertilizer in the production of moringa. Hence 1000kg of NPK/ha or 10.0 tons tithonia compost/ha were recommended for moringa biomass and seed production in Ogbomoso.

Keywords: *Moringa, Tithonia Compost, Seed Yield, Yield Component, Replacement Value*

1.0 INTRODUCTION

Moringa (*Moringa oleifera* Lam.) though a native of India but is now being grown worldwide in the tropics and sub-tropics (Palada and Chang, 2003). It is indigenous plant to Sub-Himalayan regions of Northwest India, Africa, Arabia, Southeast Asia, the Pacific and Caribbean Islands and South America and is now being distributed in the Philippines, Cambodia and Central and North America (Rajangem, 2001). It thrives best in a tropical climate and is commonly found near the sandy beds of rivers (Palada and Chang, 2003).

Moringa is a promising food source for animals and humans in the tropics because moringa trees are fully-leafed out at the end of the dry season when other foods are typically scarce (Aiyelaagbe, 2011). Moringa can be used as a feed supplement in cattle (Foidl *et al*., 2001; Fuglie, 2001), rabbits (Nuhu, 2010) and guinea pigs (Pamo *et al*., 2005). In addition, the plant contains almost no toxins and is very drought-resistant (Foidl *et al*., 2001).

Nutritional analysis has shown that moringa leaves are extremely nutritious (Aregbeore, 2002). Studies have shown that moringa can be a cheap, all year-round source of high quality food for both humans and animals. It is also rich in health promoting phytochemicals such as carotenoids, phenolics (chlorogenic acids), flavonoids (quercitin and kaempherol glycosides), various vitamins and minerals (Foidl, *et. al*., 2001; Becker and Siddhuraju, 2003;). It is a reservoir of vitamins (Olson 2001), minerals such as calcium, phosphorus, iron, magnesium, manganese and potassium. (Foidi *et al*, 2001)

The moringa seeds contain 40% (w/w) oil, consisting of 71% (v/v) oleic acid (Folkard and Sutherland, 1996). Moreover, the seeds are now valued for the production of an all-purpose oil. Moringa seed oil is comparable to the high market-value olive oil, and is considered to be a substitute for sperm whale oil, often used for lubricating purposes (Booth and Wickens, 1998). The moringa biodiesel from the seed meets all the three criteria for environmentally sustainable fuel production; namely social, technical and commercial low cost with the potential for high oil seed production and the added benefit of an ability to grow on marginal land. These properties support the suitability of this plant for large scale vegetable oil production needed for a sustainable biodiesel industry (Ibironke, 2011). Moringa seeds have the ability to purify water, honey and milk (Benkaddour, 2016).

Moringa grows well in soils with adequate quantities of essential nutrients. However, supply of adequate quantity and type of fertilizer had been a big problem. 32 and 48 kg NPK per ha per week was recommended by Olivier, (2007) while 50 kg/ha/month with NPK fertilizer at International Trypanotolerance Centre (Akinbamijo *et al.,* 2004). Finding the quantity and type of fertilizer needed, to maintain a good growth of the moringa plant is a difficult task since there is at present no literature is specific on the recommendation (Oliver, 2007). Palada and Chang (2003) suggested that fertilizers should be applied at planting time at the rate of 300 g of N or 1-2 kg compost per tree. In another report, application of 7.5 kg of farm yard manure and 0.37g of ammonium sulphate /tree was reported to increase pod yield by three fold compared to when fertilizer is not applied. (Ramachandran *et al* 1980). Ted (2005) suggested the addition of 300 g of complete fertilizer or 0.5-2 kg of manure per tree and this should be applied at planting. Amaglo *et al (2006)* suggested 1.5 tons of organic manure/hectare to arrest decline in the leaf production of moringa. Adebayo *et al* (2011) reported significant response of all growth parameters except stem girth when moringa was treated with organic amendment at 5 t/ha.

The intensification of production of this crop involves the use of chemical fertilizers (i.e., nitrates and urea) and organic fertilizers (poultry manure, rabbit manure, cattle manure) (Pamo et al., 2002; Adegun and Ayodele, 2015). However, the use of chemical fertilizers can also be a source of pollution to the environment and considerably increases the production costs of crop. Faced with this situation, moringa producers are increasingly shifting to alternative fertilizer sources that preserve the environment and improve the nutritional quality of the forage (Berkić et al., 2004), such as the use of manure and compost, which from this perspective, provide undeniable assets to different forage crops (Mboko et al., 2013). Previous studies have shown that organic fertilization (125 g plant-1 and 10 t ha-1, respectively) can improve the height and biomass of moringa (Pamo et al., 2002; Uchena et al., 2015). However, few studies have been conducted on the use of tithonia compost manure at different rates in moringa production. Hence hypothesized that tithonia compost manure at different rates would influence the growth of moringa. Therefore, this study was carried out with the aim of improving the production of moringa through adequate fertilization. The objective of this study was to determine the effect of fertilizer types and rates in the production of optimum moringa biomass and fruit in Ogbomoso.

2.0 MATERIALS AND METHODS

The study was carried out in the experimental field of Ladoke Akintola University of Technology, Ogbomoso in 2012 and 2013. Ogbomoso lies on latitude $8^0$10' N and longitude 4^0 10' E with elevation of 390 m above sea level. The area had a bimodal rainfall pattern with May-July and September –November as wettest months. The treatments were:

Fertilizer types and rates:

FI = No fertilizer F2 = 400 kg/ha NPK F3 = 600 kg /ha NPK

F4 = 800 kg/ha NPK F5 = 1000 kg/ha NPK F6 = 2.5 t/ha Tithonia Compost F7 = 5.0 t/ha Tithonia Compost F8 = 7.5 t/ha Tithonia Compost F9 = 10.0 t/ha Tithonia Compost

Experimental Design used was randomized complete block design (RCBD) with three replicates. The gross experimental area was 71m x 11 m (781m^2), a replicate was 71m x 3m (213m^2) and the plot size was 3m x 2m (6m^2). There were 1m gaps between replicates and plots.

This compost prepared consists of tithonia biomass and cured poultry manure mixed in ratio 3:1 dry weight (Akanbi, 2002; Adediran, *et al,* 2009*).* Prior to the use of the tithonia compost, samples were taken to the laboratory and analyzed for N, P, K, Ca, Mg, Fe, Cu and Zn contents according to IITA (1979). The nutrient contents were used to determine the equivalent quantity of the tithonia compost needed to meet the recommendation for the test crop. (Akanbi. 2002)

Soil samples were collected at the depth of 0-15cm using a bucket auger to determine the physical and chemical analyses. The samples were bulked, air dried, crushed and sieved through 2 mm mesh. Particle size, pH, total nitrogen (N); potassium (K), organic carbon, available phosphorus (P); iron (Fe), copper (Cu) and Zinc (Zn) and exchangeable acidity were determined using the methods of IITA (1979).

The experimental land was ploughed and harrowed. The land was pegged into main plot and sub plots. Planting of cuttings was carried out according to treatments at spacing of 50cm x 50cm. Other cultural practices to ensure proper growth of the plant were carried out as explained by Akanbi (2016) (personal contact).

Data collection

Data were collected on growth parameters, dry matter yield, fruit and seed yield components, and biomass proximate and elemental compositions of the leaves as followed:

Growth parameters:

Data were collected on growth parameters by selecting six plants, which were tagged per plot for determination of growth parameters at 2, 4, 6, 8, 10 and 12 weeks after planting.:

i. Plant height: This was done by measuring the distance between the soil surface and the tip of the shoot of six tagged plants using a ruler and recorded in cm
ii. Number of leaves/plants: This was done by taken by counting the number of fully expanded green leaves /plant on tagged plant. The average was taken and recorded per plant.

Fresh and Dry Biomass Yield: -

At harvest, (12WAP) the plants were cut 20cm above the ground to determine the yield parameters of the fresh and dry biomass yield of the stem and leaf.

Reproductive Parameters: -

These were determined using 5 plants per plot that were left to grow to maturity. The following parameters were measured:

i. Numbers of fruits / plant. This was done by counting the number of numbers of fruits/plant
ii. % fruit sets using the formula

$$\% \text{ fruit set} = \frac{\text{Number of fruits/plants}}{\text{Number of flowers per plant}} \times \frac{100}{1}$$

Fruit and Seed parameters:

The fruiting patterns of the selected plants were monitored. At ripening, fruits were selected per treatment. Seeds were extracted from the fruits and the following seeds characteristics were measured.

i. Number and weight of seeds/fruit. This was done by counting the number of seeds per pod and then weighing the seeds per pod using a digital weighing scale.
ii. 100 seed weight. This is done by randomly selecting 100 seeds and weighed using a digital weighing scale
iii. Number of filled and unfilled seeds/fruit. This done by counting filled and unfilled pod per plant.

Statistical analysis

The analyses of variance done were on the data collected following procedure of Gomez and Gomez (1991) and significant means were compared using New Duncan's Multiple Range Test ($P \leq 0.05$)

3.0 FINDINGS

Journal of Agricultural Policy
ISSSN 2520-1223 (Online)
Vol.3, Issue No.2, pp 21 – 34, 2020

Results of soil analyses of the experimental site, for the pre-planting and post-harvest soil were shown in Table 1. The experimental site was slightly acidic going by the observed pH values with a range of 0.02 (6.70 and 6.50) in both years and low in organic carbon (9.75 - 9.58 % organic C). The organic matter was high in both years but the three essential nutrients that are N P K were low with value less than one in both

Table 1: Pre-planting and post-harvest soil characteristics of experiment 5 in 2012 and 2013

Parameter Determined	Soil Sample			
	Pre-cropping	Post-cropping	Pre-cropping	Post-cropping
	2012		2013	
Ph	6.7	6,60	6.66	6.5
Na	0.46	0.44	0.4	0.38
K	0.6	0.57	0.54	0.5
Ca	0.34	0.32	0.3	0.28
Mg	0.12	0.12	0.1	0.09
H+	0.075	0.8	0.66	0.6
% Organic carbon	9.75	9.6	9.74	9.58
% Organic matter	16.81	16.55	16	15.25
% Total nitrogen	0.11	0.1	0.09	0.08
Fe	0.1	0.07	0.09	0.06
Zn	0.12	0.1	0.1	0.08
Available P.	9.45	9.38	9.4	9.32

Tables 2 show the effects of fertilizer types on moringa plant height at different growth stages. The result indicated that the application of 1000kg NPK/ha significantly produced taller plant throughout the period of growth while the shortest plant height was produced with the application of 2.5 tons tithonia compost/ha and no fertilizer treatment.

Table 2: Effects of fertilizer types and time of application on plant height (cm) of moringa plant in 2012

Treatments	2	4	6	8	10	12WAP
			2012			
No fertilizer	4.25c	7.04g	11.30d	28.70g	62.26g	80.80f

Journal of Agricultural Policy
ISSSN 2520-1223 (Online)
Vol.3, Issue No.2, pp 21 – 34, 2020 www.carijournals.org

400kg/ha NPK	5.15a	8.30d	14.17c	40.84f	88.39e	115.42d
600kg/ha NPK	4.80b	9.10c	16.74b	47.50d	100.25c	115.73d
800kg/ha NPK	5.38a	9.90b	19.28a	52.33b	112.32b	127.64b
1000kg/ha NPK	5.40a	10.92a	19.85a	57.05a	127.51a	150.33a
2.5ton/ha compost	5.42a	7.45fg	12.46d	41.41f	80.82f	103.03e
5.0ton/ha compost	5.17a	6.92s	12.44d	44.57e	89.34e	111.38d
7.5ton/ha compost	5.25a	7.51ef	13.32od	49.90c	91.006	120.52c
10.0ton/ha compost	5.32a	7.76e	13.67c	50.39c	96.20d	120.41c
			2013			
No fertilizer	5.31c	8.10g	12.37c	29.77g	63.30g	82.86f
400kg/ha NPK	6.20a	9.35d	15.23c	41.93f	89.45e	115.47d
600kg/ha NPK	5.86b	10.15c	17.80b	48.56d	102.27c	117.80d
800kg/ha NPK	6.42a	10.97b	20.33a	53.38b	114.36b	129.74b
1000kg/ha NPK	6.45a	12.028	20.908	58.12a	129.56a	153.43a
2.5ton/ha compost	6.45a	8.50cfg	13.51d	42.46f	81.92f	105.10°
5.0ton/ha compost	6.22a	8.02g	13.50d	45.63e	90.44e	114.42d
7.5ton/ha compost	6.30a	8.57ef	14.37cd	50.95c	93.07e	122.57c
10.0ton/ha compost/	6.37a	8.82e	14.73c	51.44c	98.26d	122.46c

Means in columns with different superscripts are significantly different at $P < 0.05$

Tables 3 show the effect of fertilizer type on number of leaves/plants in 2012 and 2013. The number of leaves/plants was not significantly affected with the fertilizer type at 2 and 4 WAP. However, at 6 WAP, 800 kg NPK/ha significantly produced higher number of leaves/plant and comparable to 100kgNPK/ha, 5.0, 7.5, and 10.0 tithonia tons compost/ha. Also, at 8, 10 and 12WAP, application of 1000kg NPK produced highest number of leaves per plant.

Table 3: Effect of fertilizer types and time of application on number of leaves/plants of moringa in 2012

Treatments	2	4	6	8	10	12WAP
			2012			
No fertilizer	2.11a	3.88a	7.66cd	13.11abcd	17. 22bcd	22.11b
400kg/ha NPK	2.44ab	3.77a	7.55d	13.33bcd	17.1lcd	22.00cd
600kg/ha NPK	2.44ab	3.66a	7.77cd	12.55cd	17.1lcd	21.88cd

Journal of Agricultural Policy
ISSSN 2520-1223 (Online)
Vol.3, Issue No.2, pp 21 – 34, 2020

800kg/ha NPK	2.55ab	4.00a	8.55ab	13.66ab	18.22ab	22.66b
1000kg/ha NPK	2.55ab	4.00a	8.22abc	13.77a	19.11a	24.00a
2.5ton/ha compost	2.66a	3.44a	8.11bcd	12.22d	16.22d	20.77cd
5.0ton/ha compost	2.55ab	3.66a	8.44ab	12.66bcd	16.22d	20.44d
7.5ton/ha compost	2.66a	3.88a	8.77a	12.77abcd	16.55d	20.55d
10.0ton/ha compost	2.66a	3.94a	8.77a	13.77abcd	17.88cd	22.22b
2013						
No fertilizer	2.30ab	3.40a	7.66cd	12.13bcd	15.62bcd	19.21b
400kg/ha NPK	2.34ab	3.42a	6.55d	12.35bcd	15.51cd	19.00cd
600kg/ha NPK	2.34ab	3.43a	6.37cd	11. 53ab	15.31cd	19.18cd
800kg/ha NPK	2.35ab	4.00a	7.35ab	12.55ab	16.32ab	19.26b
1000kg/ha NPK	2.46ab	4.00a	7.42bc	12.74a	17.31a	22.008
2.5ton/ha compost	2.60a	3.30a	7.11bcd	11.25d	14.22d	18.37cd
5.0ton/ha compost	2.35ab	3.42a	7.34ab	11.65bcd	14.42d	18.24d
7.5ton/ha compost	2.60a	3.45a	7.47a	11.37bcd	13.99d	18.30d
10.0ton/ha compost	2.60a	3.38a	7.97a	12.57bcd	15.48cd	20.22b

Means in columns with different superscripts are significantly different at $P < 0.05$

All the treatments with nutrient were not significant to each other when the effect of fertilizer was determined on fruit set in 2012 and 2013 (Table 4). They were comparable to each other when fertilizer types were evaluated in the study but no application of fertilizer recorded the lowest percentage fruit set in moringa.

Table 4: Effect of fertilizer types and time of application on fruiting parameters of moringa plant in 2012

Treatments	% fruit set	Number of fruit /plants	Number of seed /fruits
2012			
No fertilizer	57.81b	8.44e	10.22bc
400kg/ha NPK	66.33a	9.33dc	11.77a
600kg/ha NPK	63.60ab	12.22bc	11.77a

Journal of Agricultural Policy
ISSSN 2520-1223 (Online)
Vol.3, Issue No.2, pp 21 – 34, 2020

800kg/ha NPK	64.50a	12.88b	10.66bc
1000kg/ha NPK	66.58a	14.66a	10.66bc
2.5ton/ha compost	66.73a	10.55cd	10.88b
5.0ton/ha compost	65.53a	10.55cd	10.66bc
7.5ton/ha compost	63.85ab	10.1lde	10.77bc
10.0ton/ha compost	64.86a	11.88bc	10.00c
	2013		
No fertilizer	52.82b	7.64e	9.12bc
400kg/ha NPK	60.23a	9.00de	10.00ab
600kg/ha NPK	59.20ab	11.12bc	11.00a
800kg/ha NPK	60.50a	12.42b	9.65bc
1000kg/ha NPK	60.18a	13.46a	9.16bc
2.5ton/ha compost	62.13a	9.65cd	10.00b
5.0ton/ha compost	62.23a	9.45cd	9.26bc
7.5ton/ha compost	57.85ab	9.14de	9.27bc
10.0ton/ha compost	60.56a	10.88bc	9.40bc

Means in columns with different superscripts are significantly different at P< 0.05

The number of fruit/plants was significantly affected by the fertilizer type. The 1000kgNPK/ha treatment significantly produced higher number of fruit/plants over all other fertilizer types studied in the experiment in both years. However, the no fertilizer treatment had the lowest number of fruits/plant when compared with the fertilized treatment.

Number of seeds/fruits was also significantly affected by the fertilizer type in 2012 and 2013. 600kgNPK/ha significantly supported higher number of seeds/fruits and similar to 400kgNPK/ha. This as similar to all other fertilizer type except 10.0tons tithonia compost/ha which had the lowest number of seeds/fruit and comparable to 7.5tons tithonia compost/ha, 5.0 tons tithonia compost/ha in both years.

The fertilizer type significantly affected the number of unfilled pods of moringa (Tables 5). In both years no fertilizer significantly had highest number of unfilled pod and significantly different from other treatments studied. The treatments with nutrient, 5.0-ton tithonia compost/ha and 7.5ton tithonia compost/ha recorded the least number of unfilled pods and comparable with 10.0 tons tithonia compost/ha, 1000kgNPK/ha, 2.5ton tithonia compost/ha, 800kg NPK/ha and 600kgNPK/ha respectively.

Table 5: Effect of fertilizer types and time of application on moringa fruit quality in 2012

Treatments	Number of Unfilled pod/plants	Seed weight/ fruit (g)	100 seed weight (g)
	2012		
No fertilizer	2.11a	6.93a	29.37e
400kg/ha NPK	1.44b	4.30a	30.51de
600kg/ha NPK	l.11bc	4.56a	31.63bcd
800kg/ha NPK	1.1lbc	4.83a	32.38b

Journal of Agricultural Policy
ISSSN 2520-1223 (Online)
Vol.3, Issue No.2, pp 21 – 34, 2020

1000kg/ha NPK	0.88bc	5.08a	33.75a
2.5ton/ha compost	1.13bc	4.42a	30.67cd
5.0ton/ha compost	0.77°	4.44a	32.32b
7.5ton/ha compost	0.77c	4.45a	31.63bcd
10.0ton/ha compost	0.88bc	4.62a	31.81bc
No fertilizer	2.00a	4.43a	27.77e
2013			
400kg/ha NPK	1.20b	4.36a	28.41de
600kg/ha NPK	1.00bc	4.50a	29.43cd
800kg/ha NPK	1.00bc	4.73a	32.48b
1000kg/ha NPK	0.99bc	5.00a	33.75a
2.5ton/ha compost	0.98bc	4.48a	29.67cd
5.0ton/ha compost	0.72c	4.40a	32.32b
7.5ton/ha compost	0.70c	4.55a	29.23cd
10.0ton/ha compost	0.83bc	4.60a	30.21bc

Means in columns with different superscripts are significantly different at $P < 0.05$

The seed weight/fruit was not significantly affected by the fertilizer types. All fertilizer types were comparable with each other in both years. However, the weight of 100 seeds (g) was significantly affected by the fertilizer type in 2012 and 2013. 1000kgNPK/ha significantly recorded highest weight (33.75gm) in 2012 and not comparable with any other fertilizer type. Similar trend was also observed in 2013. The least weight was obtained from no application treatment in both years.

The application of fertilizer types had significant effect on the proximate composition of moringa leaves in 2012 and 2013 (Table 6). The treatment with 10 tons/ha of tithonia tithonia compost had the highest value of crude protein, ether extract, crude fibre, total ash and moisture content in both years. The results show treatment with tithonia compost had more of crude protein, ether extract, crude fibre, total ash and moisture content in both years. This was followed by treatment with mineral fertilizer. The no fertilizer had the least proximate composition.

Table 6: Effect of fertilizer types and time of application on proximate composition(mg/100g) of moringa in 2012

Treatment	CP	EE	CF	Total ash	MC
2012					
No fertilizer	22.56c	5.04d	5.95e	1.02a	8.57e
400kg/ha NPK	22.77cde	5.16bcd	6.12d	2.01a	8.59e
600kg/ha NPK	22.61c	5.20bcd	6.25d	2.02a	8.90cd

800kg/ha NPK	22.97cde	5.34ab	6.62c	1.99a	8.75de
1000kg/ha NPK	22.64dc	5.13cd	6.56c	2.98a	8.99bc
2.5ton/ha compost	22.92bc	5.21bc	6.93b	1.96a	9.13b
5.0ton/ha compost	23.04b	5.26bc	7.05b	2.02a	9.57a
7.5ton/ha compost	22.86bcd	5.49a	7.05b	2.05a	9.46a
10.0ton/ha compost	23.28a	5.34b	7.33a	2.47a	9.49a
2013					
No fertilizer	23.26e	5.14d	6.22e	1.04a	8.69e
400kg/ha NPK	23.67cde	5.24bcd	6.67d	2.05a	8.71e
600kg/ha NPK	23.61e	5.30bcd	6.88d	2.08a	8.99cd
800kg/ha NPK	23.67cde	5.44ab	7.02c	2.04a	8.67de
1000kg/ha NPK	23.93de	5.13cd	7.06c	2.30a	9.12bc
2.5ton/ha compost	23.93bc	5.33bc	7.45b	2.00a	9.44b
5.0ton/ha compost	24.34b	5.36bc	7.45b	2.07a	9.78a
7.5ton/ha compost	23.46bcd	5.53a	7.55b	2.01a	9.84a
10.0ton/ha compost	24.58a	5.55a	7.98a	2.60a	9.96a

Means in columns -with different superscripts are significantly different at P<0.05

The application of fertilizer type had significant effect on the elemental composition of moringa leaves in 2012 and 2013 (Table 7). The treatment with 10 tons/ha of tithonia tithonia compost had the highest value of P, Ca, K, Fe and Zn in both years. The result showed treatment with tithonia compost had more of P, Ca, K, Fe and Zn in both years similar to what was obtained for proximate composition. This was followed by treatment with mineral fertilizer. The no fertilizer had the least elemental composition.

4.0 DISCUSSION

Vegetative growth of moringa was better enhanced by the application of NPK fertilizer as it produced the highest plant height and number of leaves/plant which is followed by the treatments with tithonia compost manure and was comparable with to mineral fertilizer. The fertilized plants show increased in all the parameters measured than the non-fertilized plant Fugile, (1999) reported that application of phosphorus and nitrogen fertilizer to moringa trees will encourage root development as well as leaf canopy growth. The crop growth and vegetative yield parameters of vegetable amaranth have been found to respond significantly to N, P and K fertilizer application (Ainika and Amans, 2011). 1000kg N P K/ha gave the highest value of plant height and number of leaves/plants.

The application of organic manure produced a significantly higher vegetative growth than the control. This had proved that organic manure in this case tithonia compost manure may be an alternative to chemical fertilizer as it contain nutrient essential for plant growth Agboola *et al* (1991). Compost manure is also a store of primary and trace element (Janic 1986).

The result show that fertilized moringa plant had more pods/plant with the no fertilizer having the lowest number of unfilled pods/plants. The seeds weight/fruit were not significant to both fertilizer types. However, the weight of 100 seeds was significant for both fertilizer types.

Compost manure contain high amount of phosphorus and potassium which are important for maturation of the crop (Isitekhale *et al* 2013). The percentage fruit set is not significant to fertilizer types but was significant to the number of fruit/plant and number of seeds/plants.

1000kg of NPK /ha produced the highest fruit/plant and number of seeds/fruits. These show that fertilizer application enhances fruit production in moringa. The report collaborates Akanbi *et al* (2010) which reported N fertilizer and compost application had significant influence on the okra production. This also collaborate the report of Smith *et al* (2008) and Babatola and Olaniyi (1997). There was linked of positive effect of availability of adequate nutrient for plant use and improved vegetative, synthesis and translocation of photosynthesis and significantly increase in number and weight of fruit and yield component. (Akanbi, *et al* 2010).

The application of fertilizer significantly increased the nutrient content of moringa leaves. The application of NPK and compost manure had increase in the P, K, Na, and Mn content of moringa and this result corresponded to earlier work done by Law-Ogbomo *et al* (2013). It has been reported that the application of organic manure increased the nutrient concentration of arable and other crops (Atere *et al,* 2013). Similarly, NPK application also improved the nutrient content of moringa which has earlier been reported (Chuckwuka *et al* 2009). The improvement of calcium, potassium, and sodium content of moringa by the application of compost manure agreed with the earlier work of Olowokere *et al,* (2013).

5.0 CONCLUSION

Fertilizer types and rates affect the vegetative, seed and fruit yield of moringa. 1000kg/ha of NPK gave the highest vegetative, seed yield and fruit yield components such as fruit set, number of fruits per plant and 100 seed weight. Application of tithonia compost equally gave better biomass and seed yield over non fertilizer plants. It seemed that for optimum production of moringa biomass and seed, there is the need for application of fertilizers these could be either organic or inorganic. The 1000kg NPK fertilizer was as effective as using 10.0 tons tithonia compost/ha. Hence 1000kg of NPK/ha or 10.0 tons tithonia compost/ha were recommended for moringa biomass and seed production.

REFERENCES

Adegun, M.K., O.J. Ayodele. 2015. Growth and yield of Moringa oleifera 'as influenced by spacing and organic manures in South-Western Nigeria. *Int J Agron Agric Res.* 6:30–37.

Adeniran, J.A., Taiwo, L.B., and Sobolo, R.A., (2003). Effect of organic waste and method of composting on compost maturity, nutrient composition and yield of two vegetable Crop. *Journal of sustainable Agriculture, 22: 95-105.*

Ainika, J.N. and. Amans E. B., (2011) Growth and yield response of vegetable Amaranth to topic fertilizer and farmyard manure as Samarth Nigeria proceeding of 29th conference of horticulture society of Nigeria (HORT SON) 24- 29 July 2011

Aiyelaagbe, I. O. 2011. Nigerian Horticulture: Facing the challenges of human health and agricultural productivity. Keynote address presented at the 29th Annual National Conference of Horticultural Society of Nigeria 24-29. Makurdi.

Akanbi W. B. (2002) Growth, nutrient uptake and yield of maize and Okra as influenced by Compost and nitrogen fertilizer under different cropping system. Ph.D. Thesis.

Akinbamijo, O.O., Adediran, S. A., Nouala, S. and Saecker, J (2004). Moringa fodder in ruminant nutrition in the Gambia. Retrieved September 16, 2008, from *moringa news. org/docwnents/Fodder. Doc.*

Aregboore, B. (2002) Intake and digestibility of batik grass mixture by growing goat small ruminant 46, 32-28

Atere, C. (2013) Effect of cacao pod compost with or without N and P on the yield of soya beans. Discover the world research http://www.reseachgate.net

Babalola L.A and Olaniyi T.O., (1997) Effect of NPK 15:15:15 fertilizer level and plant spacing in performance shell life of okra in proceeding 15th HORTSON conference Ibadan. 8th -11th April 1997.

Becker, K. and Siddhuraju O. (2003) The potential of *Moringa oleifera* for agricultural and industrial uses in multiple attributes of moringa L.J. Fuglie (ed) CTA U.S.A. pp45

Benkaddour, N. 2016. Contribution à l'etude de l'efficacite de la graine de Moringa oleifera dans la depollution des eaux d'oued safsaf. Mémoire de fin d'étude pour l'obtention du diplome d'ingenieur d'etat en agroforesterie option: Technologie Des Industries Agro-Alimentaires.

Berkić, S., Z. Milakovic, A. Kristek, M. Antunovié. (2004). Pea yield and its quality depending on inoculation, nitrogen and molybdenum fertilization. *Plant, Soil Env.* 39(1):39–45.

Booth, F. E. M. and Wickens, G. E. (1998). Non-timber Uses of Selected Arid Zone Trees and Shrubs in Africa. FAO Conservation Guide, Rome, Italy. 92–101.

Chukwaka, K. S. and O. E. Omotayo (2009). Soil fertility restoration potential of tithonia green manure and water hyacinth compost on a nutrient depleted soil in south western Nigeria *Researched Journal of Soil Bios* 120-30

Foidl, N., Harinder, P. S. and T. K. Becker, (2001). Potentiel du *Moringa oleifera* pour les besoins agricoles et industriels *in* L'arbre de la vie, Les multiples usages du Moringa. CTA et CWS, Dakar, pp.45 à 78.

Folkard, G. K. and Sutherland, J. P. (1996). *Moringa* oleifera: A tree and a litany of potential. Agroforestry Today (July – September). Pp. 5–8.

Folkard, G. K. and Sutherland, J. P. (1996). *Moringa oleifera:* A tree and a litany of potential. Agroforestry Today (July – September).5–8.

Fuglie, L. J. and K.V., Sreeja. (1999). Cultivation of *Moringa oleifera* in Miracle tree - The multiple attributes of moringa L.J. Fuglie(ed) CTA U.S.A. PP153-158

Ibironke, D. *(2001) How to earn massive income cultivating and selling moringa medicinal plant* Success Digest Extra. Monday may 30, 2011 Vol. 6 No 28.

Isitekhale, W. A. Ford, S. P., and Raul, V. O. (2013) Effect of phosphorus and potassium on the growth, and yield components of tomato. *Horticultural journal of America.* 23:466 - 490.

Janick, T. M. and J.E. Simon (1986) physiology of crops. Timber press, Portland, Oregon, USA, Pp 511-517.

Law-Ogbomo S. T. and Bose, B. (2013). Effect of different rates and types of N.P.K. fertilizer on the biomass yield and quality of moringa. *Int. j agronomy* 4 ID 841238:3

Mboko, A.V., F. Tendonkeng, F.N.E. Matumuni, G.T. Zougou, E. Miégoué, B. Boukila, T.E. Pamo. (2013). Effet comparé de deux légumineuses fertilisées au molybdène sur la croissance et le rendement de Brachiaria ruziziensis à différentes périodes de fauche dans l'ouest Cameroun. Int. Form. Group 7:2513–2525.

Nuhu, F. (2010). Effect of moringa leaf meal (molm) on nutrient digestibility, growth, carcass and blood indices of weaner rabbits. A thesis submitted to the School Of Graduate Studies, Kwame Nkrumah University Of Science And Technology, Kumasi. P84.

Olivier Caroline (2011) Intensive *Moringa oleifera* cultivation in the North of Senegal http://www.syfia.com/fr/article.asp?article_num=2854 (error : replace CRS - Catholic Relief Service - by CWS - Church World Service).

Olowookere, T. M., Yusuf, A., and Adeyemi F., M. (2012). Influence of growth media composition on growth and vegetative yield of drum stick (*moringa oliefera*). Being a paper presented at the first Unilorin Moringa International conference, University of Ilorin, Nigeria 11th September 2012.

Olson, M. (2001). Introduction to Moringa farming, pp11-28 in L. C. Fuglie (ed), miracle tree (*Moringa oleifera*) natural nutrition for the tropic. World service, West Africa, regional office, Dakar, Senegal.

Palada. C. M. and L. C. Chang (2003). Suggested practices of *Moringa oleifera*. International cooperators' guide. AVRDC Pub 03 -545.

Pamo Tedonkeng E., Boukila B., Momo Solefack M. C., Kana J. R., Tendonkeng F. and Tonfack L. B. (2004). Potentiel de germination de *Moringa oleifera* Lam. sous diffe*rents traitements a Dschang dans les Hautes terres de 1'Ouest- *Cameroun Journal of Cameroon Academy of Science Vol. 4 N0. 3 pp 199 - 203. (In Press)*

Pamo, E. T., Niba, A. T., Fonteh, F. A., Tedonkeng, F., Kana, J. R., Boukila, B., & Tsachoung, J. (2005). Effet de la supplémentation au Moringa oleifera ou aux blocs multinutritionnels sur l'évolution du poids post-partum et la croissance pré-sevrage des cobayes (Cavia porcellus L.). *Livestock Research for Rural Development*, *17*(4), 9p.

Rajangam J. R., S. Azahkia, T. Manavalan A. thangarajVijayakamar and N. Muthuiri-shan (2001). Status of the productionand utilizations of Moringa products. Workshop proceeding October 29-November, 2001. Darus Salaam Tanzania.

Ramachandram C., Peter K.U and Gopalakrishman P.K., (1980). Drum stick (*Moringa oliefera*) A multipurpose Indian Vegetable economic 130.34:276-283.

Smith, S. A. and Read, D. (2008). Mycorrhizal Symbiosis. 3rd edition, Elsevier Academic Press, London

Ted, R. (2005). Farm and forest productions and marketing profile for Moringa. Specialty crop for pacific island agro-forestry. (http://agroforestrv.netscps)

Uchenna, M.N., E.E. Amos, P.B. Kayode, I.P. Ezeaku. (2015). Application of poultry manure and the effect on growth and performance of potted Moringa (Moringa oleifera Lam) plants raised for urban dwellers use. *Am J Plant Nutr Fer Tech.* 5:33–39.