Journal of Research in Forestry, Wildlife & Environment Vol. 10(2) June, 2018
http://www.ajol.info/index.php/jrfwe
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E-mail: jfewr@yahoo.com
ISBN: 2141 – 1778
Bernice et al., 2018

NURSERY PERFORMANCE AND EARLY GROWTH OF TWO *Moringa oleifera* ACCESSIONS GROWN UNDER VARIED MANURE LEVELS

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ABSTRACT

The study was conducted at the Department of Forestry and Wildlife Management Nursery Site, Federal University Dutsin-Ma, Katsina State, Nigeria to evaluate nursery performance and early growth of two Moringa oleifera accessions grown under varied manure levels. The treatments included two Moringa oleifera accessions (Katsina-Nigeria and Maradi-Niger), two manure types (Poultry and Small ruminant) and rate of application (0 t ha^{-1}, 4.27 t ha^{-1}, 8.53 t ha^{-1} and 17.10 t ha^{-1}). These were laid out as 2 x 2 x 4 factorial in a randomized complete block design, replicated four times. The results obtained showed that seeds of Maradi-Niger accession had the highest cumulative emergence percentage (94%), mean daily emergence and number of emerged seedlings. Plant height, collar diameter and number of leaves were higher in Maradi-Niger accession than in Katsina-Nigeria accession. The dry matter yield showed that Maradi-Niger accession had the highest (3634 t ha^{-1}) than Katsina-Nigeria accession (3172 t ha^{-1}). In general, the application of 4.27 t ha^{-1}, 8.53 t ha^{-1} and 17.10 t ha^{-1} of poultry manure to the soil medium ensured consistent increase in the plant height, number of leaves and collar diameter. The control treatment (0 t ha^{-1}) had the least values of all the morphological characteristics. The 17.10 t ha^{-1} poultry manure treatment gave significant increase ($p<0.05$) in the plant growth vigour. The application of 17.10 t ha^{-1} poultry manure also gave the highest values of dry matter yield followed by 8.53 t ha^{-1}, 4.27 t ha^{-1}and 0 t ha^{-1}, respectively.

Keywords: Soil pH, treatment, manure, plant height, collar diameter, number of leave

INTRODUCTION

In agroforestry system, where high amounts of nutrients are removed from the plantation area at harvest, fertilization in a general sense seems to be the only way to maintain sustainable production (Szott and Kass 1993). This was very evident in the results from a two-year study presented by Reyes-sanchez *et al.* (2006), where dry matter yield of unfertilized *Moringa* decreased by about 60% during the second year of production. In spite of this, few fertilization experiments have been performed with *Moringa* under field condition (Oliveira *et al*., 2009).

Fuglie, (2001) indicated that *Moringa oleifera* has gained a lot of popularity due to recent discoveries of its usefulness to mankind, resulting in rapid growth of interest for the plant. A multi-purpose plant widely known for its ethno-medicinal (Farooq *et al*., 2012) and culinary properties (Stevens *et al*., 2013). All parts of the *Moringa* tree are edible and have long been consumed by humans (Fahey, 2005). In developing countries, *Moringa* has the potential to improve nutrition, boost food security, foster rural development, and support sustainable land care (NRC, 2006).

The use of organic manure as fertilizer releases many important nutrients into the soil and also nourishes soil organisms, which in turn slowly and steadily make minerals available to plants (Erin, 2007). Amujoyegbe *et al.* (2007) stated that the use of organic manure resulted in improvement in crop yield, and this suggests that their use would aid the vegetative development of the plant.
With the increase in the utilization of *Moringa* and research interest in Nigeria (Stevens *et al.*, 2013), Nnam, (2009) and Eze *et al*. (2012) pointed out that most research efforts in Nigeria are on basic science, nutritional and medicinal properties and utilization of the plant. Most of these studies make the available

knowledge far from conclusive and often contradictory and the problem of inadequate essential nutrients in substrate for growing plants reduces crop growth and yield persists (Baiyeri and Mbah, 2006). Most organic wastes, compost and animal manures, as well as, inorganic fertilizers serve as amendments to improve on the soil/substrate fertility status (Stoffella *et al.*, 1997). Agyenim-Boateng *et al*. (2006) also indicated that not much work has been done on *Moringa oleifera* cultivation especially in the different ecological zones of Nigeria with respect to its growth and productivity using the different types of organic manure commonly used by local farmers. Animal manures, such as small ruminant and poultry serve as low cost fertilizer when applied to agricultural soils (Babalola and Adigun, 2013) and these are readily available in Dutsin-Ma environs owing to the prevalence of livestock farms.

MATERIALS AND METHODS

Study area

This experiment was conducted at the Department of Forestry and Wildlife Management Nursery Site, Federal University Dutsin-Ma, Katsina State, Nigeria from July to September, 2017. Dutsin-Ma lies between latitude 12º 27' and 22''N and longitude 7º 30' and 83''E (Figure 1).

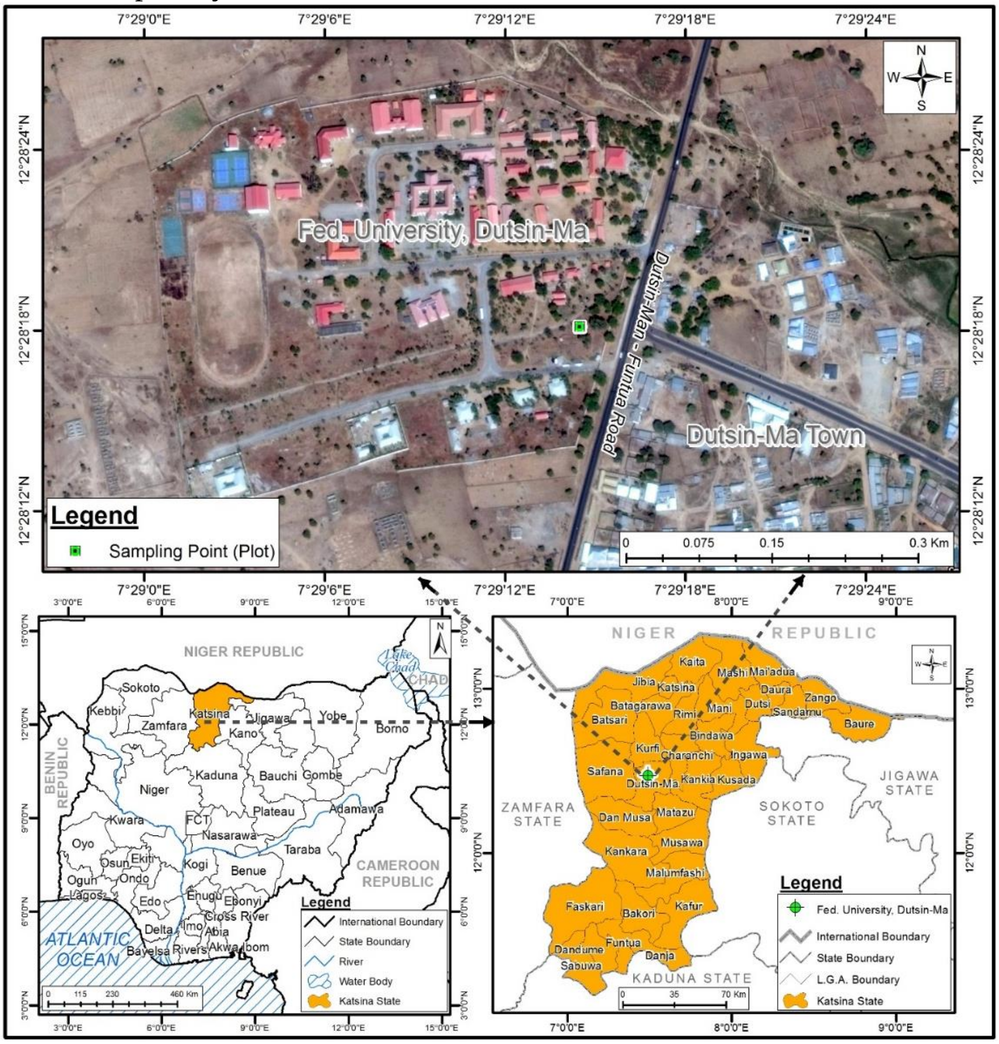

Figure 1: Federal University, Dutsin-Ma showing Study area (Plot)
Source: Map Gallery, Geography Department, ABU, Zaria

The daily minimum and maximum temperatures range from 32ºC to 43ºC. Dutsin-Ma, in Katsina State experiences unimodal rainfall pattern with an annual rainfall of about 1100 mm, with a single peak in August. Dry season lasts for a minimum of seven months (November-May) while the wet season spans June to October.

Experimental Design and Treatment

The experimental design was a 2×2×4 factorial in randomized complete block design (RCBD) replicated four times in a pot experiment of size 14x16 cm each. The treatment combinations comprised two accessions of Moringa (Katsina and Maradi-Niger, obtained from Katsina State, Nigeria and Maradi in Niger), two manure types (poultry and small ruminant manure) and four application rate (0 t ha^{-1}, 4.27 t ha^{-1}, 8.53 t ha^{-1} and 17.10 t ha^{-1}).

Composite surface soil samples 0-3cm were used in the potting mixtures. Each pot contained 15 kg soil. Cured poultry and small ruminant manure were incorporated into the soil in the pots at the rates of 0 t ha^{-1}, 4.27 t ha^{-1}, 8.53 t $ha^{-1}$and 17.10 t ha^{-1}, respectively before sowing the seeds. Two Moringa seeds were sown and latter thinned to one plant/pot and were grown for eleven weeks as an indicator. Two litres of water was added to each pot of soil before sowing and subsequently the plants were rain-fed to the end of experiment in September. Morphological growth (plant height, number of leaves and collar diameter) of the plants were monitored for eleven weeks.

DATA COLLECTION

After 6 weeks of planting, growing seedlings were randomly selected from each treatment plots and the stem height, stem collar diameter and number of leaves were determined on weekly basis for 6, 7, 8, 9, 10 and 11 weeks, thereafter, samples were harvested and oven dried. The fresh and dry weight was determined respectively. The germination % was also calculated

Germination percentage

The following data were measured: percentage seedling emergence was calculated as the ratio of emerged seedlings to the total number of seeds sown multiplied by 100; mean daily emergence was calculated as the total number of emerged Seedlings divided by the cumulative number of days to seedling emergence; emergence span was estimated as the number of days from first seedling emergence to the last seedling emergence.

Seedling height

This was measured in cm from the soil surface to the shoot apex with a measuring tape and a metre rule.

Collar diameter

This was measured at a height of 3.0 cm from the base of each stem with the aid of a ruler and an electronic digital calliper (0-150mm).

Plant fresh weight

The plant fresh weight (g) was determined after carefully removing the seedlings from the growing medium and all soil particles washed off. The plant fresh weight was determined using an electronic weighing scale.

SOIL AND ORGANIC MANURE ANALYSIS

Soil and organic manure preparation

Core soil samples 0-3cm were collected bulked and the composite soil samples sent to the Ahmadu Bello University for Laboratory analysis. The poultry and small ruminant manure were obtained from the Department of Animal Science, Federal University Dutsin-Ma, Research and Teaching farm. The manure samples were also bulked and sent for chemical analysis.

Soil and Manure Samples Analysis

The sample was analysed for its physical and chemical properties. The samples were sieved using a 2mm sieve and analysed for particle size. pH (1:2.5) soil to water ratio, Organic carbon, available P, total Nitrogen, Potassium, Magnesium, Calcium, and Sodium.

PHYSIOCHEMICAL ANALYSIS

Determination of Organic Carbon

The Wet oxidation method for the determination of soil organic carbon as described by Walkley and Black (1934) was maintained.

Determination of Calcium and Magnesium (Titrimetric Method)

The Titrimetric method for the determination of Calcium and Magnesium in the soil as described by Black, (1965) was used.

pH Determination

The electronic soil pH determination as described by Bates, (1954) was followed.

Particle Size Analysis (PSA)

The Hydrometer Method of Soil Mechanical Analysis as described by Bouyoucos, (1951) was used.

Determination of "Available" P (Bray No. 1 Method)

The determination of Available P in soil as described by Bray and Kurtz (1945) was used.

Determination of Total Nitrogen

The regular Macro-Kjeldahl Method as described by Black, (1965) was used for the determination of total Nitrogen.

Statistical analysis

All data collected were subjected to analysis of variance (ANOVA) using SAS (9.1) (2000). Significant differences were separated using Duncan Multiple Range test at 0.05% probability level.

RESULT

Physical and Chemical properties of the Experimental Soils and Manure

Important physical and chemical properties of the experimental soils and animal manure are presented in Table 1. The result of particle size distribution indicates that the soil belongs to medium soil textural class (Sandy loam). The soil pH values were observed to be slightly acidic (6.90), poultry manure strongly alkaline (8.90) and animal manure very strongly alkaline (9.80) respectively. The value of soil exchangeable Ca^{2+} was 13.52mg kg^{-1} and that of Mg^{2+} 3.67mg kg^{-1}, the value exchangeable Na^{+} was slightly higher than that of K^{+} in the soils. The organic carbon contents for the soil was found to be 5.90 (g/ kg^{-}1), poultry manure 294.1 (g/ kg^{-}1) and small ruminant 132.1(g/ kg^{-}1) respectively. The nitrogen content of the soil was 0.86 g/ kg^{-}1, poultry manure 11.4 g/ kg^{-}1 and small ruminant 5.90 g/ kg^{-}1. Available soil phosphorus was found to be 3.52 Mg/kg^{-1} while that of poultry and small ruminant manure were observed to be 1.26 Mg/kg^{-1} and 0.86 Mg/kg^{-1} respectively.

Table 1: Some Physical and Chemical properties of the Experimental Soils and Manure

Characteristics	PM	SRM	Soil
Textural class	-	-	Sandy loam
Sand (g/ kg-1)	-	-	510
Silt (g/ kg-1)	-	-	420
Clay (g/ kg-1)	-	-	70
pH	8.90	9.80	6.90
O.C(g/ kg-1)	294.1	132.1	5.90
N(g/ kg-1)	11.4	5.90	0.86
P (Mg/kg-1)	1.26	0.86	3.52
Na (C mol/kg^{-1})	-	-	0.34
K (C mol/kg^{-1})	-	-	0.23
Mg (C mol/kg^{-1})	-	-	3.67
Ca(C mol/kg^{-1})	-	-	13.52

Key: SRM=Small Ruminant Manure, PM= Poultry Manure

Seedling emergence parameters as influenced by *Moringa oleifera* accessions

The results of seedling emergence parameters as influenced by *Moringa oleifera* accessions are presented in Table 2. The result indicated that the number of emerged seedlings, non-emerged seedlings, cumulative emergence percentage and mean daily emergence significantly (P<0.05) differed between the *Moringa oleifera* accessions, whereas emergence span was not-significantly (P> 0.05) different. The cumulative emergence percentage (94%) and number of emerged seedlings (30) were highest in the Maradi-Niger accession. The number of non-emerged seedlings was low with Niger accession (2). Comparatively, the Katsina-Nigeria accession had low number of emerged seedlings (24), cumulative emergence percentage of 75% and consequently the highest number of non-emerged seedlings (8).

Table 2: The effect of *Moringaoleifera* accession on seedling emergence parameters

Accession	C E. %	SE	E S	SE	MDE	SE	No OF NES	SE	No of ES	SE±
Niger	93.75[a]	±1.31	1.75[a]	±0.02	2.73[a]	±0.03	2[b]	±0.04	30[a]	±0.96
Nigeria	75.00[b]	±1.42	1.75[a]	±0.02	2.18[b]	±0.05	8[a]	±0.08	24[b]	±0.72

Note: C.E% cumulative emergence, E.S emergence span, MDE mean daily emergence, No OF NES number of non-emerged seedlings, No of ES number of emerged seedlings.

Means with the same letter along the column are not significantly different (Duncan's Multiple Test at P< 0.05)

Effects of Accession, Manure type and Rate of application on plant height, number of leaves and collar diameter of *Moringa oleifera*

Table 3 shows the results of the effects of accession, manure type and rate of application on the plant height, number of leaves and collar diameter of *Moringa oleifera*. The result indicates that there were significant (P< 0.05) differences among the *Moringa* accessions with regards to plant height, number of leaves and collar diameter. The Maradi-Niger accession of Moringa had the highest plant height (39.0 cm), number of leaves (450.63) and collar diameter (7.21 mm) respectively. Whereas the Katsina-Nigeria accession of Moringa had the lowest plant height (35.9 cm), number of leaves (427) and collar diameter (7.06 mm) respectively. The manure effect indicated that plant height, number of leaves and collar diameter were significantly (P< 0.05) influenced by the type of manure applied. The results showed that the application of poultry manure significantly influenced the plant height (42.27 cm), number of leaves (502) and collar diameter (7.69 mm) than small ruminant manure application respectively for both accessions. The rate of manure application significantly (P<0.05) influenced the plant height, number of leaves and collar diameter respectively. The highest plant height, number of leaves and collar diameter was achieved by the application of 17.10 t ha^{-1}**,** followed by 8.53 t ha^{-1}, and 4.27 t $ha^{-1}$of poultry manure respectively. The effect of small ruminant manure application rate on collar diameter, number of leaves and plant height was observed not to be significantly different (P>0.05) for both accessions. The effect of manure application on Moringa accessions showed that there was a significance (P<0.05) difference among the accessions considered. Application of poultry manure was observed to influence the plant height, number of leaves and collar of Maradi-Niger accession more than the small ruminant manure.

Table 3: Effects of Accession, Manure type and Rate of application on plant height, number of leaves and collar diameter of *Moringa oleifera*

Treatment	Plant height (cm)		Number of leaves		Collar diameter (mm)	
Accession	Mean	SE	Mean	SE	Mean	SE
Niger	39.02^{a}	±0.42	450.63^{a}	±0.62	7.21a	±0.15
Nigeria	35.91^{b}	±0.91	427.09^{b}	±0.01	7.06b	±0.14
Manure Types						
Poultry	42.27^{a}	±0.11	502.09^{a}	±0.15	7.69a	±0.12
Small Ruminant	32.66^{b}	±0.21	375.63^{b}	±0.22	6.47b	±0.15
PM Rate (t ha^{-1})						
0	28.10^{d}	±0.14	298.69^{d}	±0.27	5.78c	±0.14
4.27	40.53^{b}	±0.16	482.94^{b}	±0.38	7.30b	±0.17
8.53	36.42^{c}	±0.20	410.50^{c}	±0.41	7.09b	±0.20
17.10	44.82^{a}	±0.22	563.30^{a}	±0.24	8.16a	±0.22
SRM Rate (t ha^{-1})						
0	28.13^{a}	±0.01	296.13^{a}	±0.21	5.71a	±0.07
4.27	31.48^{a}	±0.02	301.41^{a}	±0.31	6.22a	±0.08
8.53	31.72^{a}	±0.02	310.32^{a}	±0.30	6.31a	±0.10
17.10	32.11^{a}	±0.03	314.11^{a}	±0.34	6.44 a	±0.41

Note: PM poultry manure, SRM small ruminant manure, Means with the same letter are not significantly different (Duncan's Multiple Test at P< 0.05)

DISCUSSION

In this study Seedling emergence, plant height, number of leaves and collar diameter were observed to significantly influence by the accessions of *Moringa oleifera* studied. The Niger accession of *Moringa oleifera* had the highest emergence rate, main daily emergence and number of emerged seedlings, indicating that it germinated faster than Nigeria accession *Moringa oleifera*. The highest plant height, number of leaves and collar diameter and were observed in Niger accession while Nigeria accession showed the least. These could be probably due to variations in the genetic potentials of the accessions and/or the inherent variability across the collection environments. The accessions were collected from two locations belonging to different ecological zones. Ugwuoke *et al*. (2001) earlier reported that different agro-ecologies may differ in climatic and edaphic factors, and hence the variation in weather and soil conditions might result to varying nutrient concentrations in the different plant parts including the seeds. Therefore, the variability observed in the accessions may not be unrelated with the ecological zones from where they were collected. Variability observed in the performances of the accessions also indicates that source of seed or seed collection could influence the quality of the seedlings.

Higher values of plant height, number of leaves and collar diameter were obtained in the poultry manure media. This is an indication that Moringa plants could respond positively to poultry manure application. Ndubuaku *et al*. (2014) observed that poultry manure increased the nutrient status of the soil and boost crop productivity. Baiyeri and Tenkouano (2008), Ndukwe *et al*. (2011) and Aba *et al*. (2011) maintained that that animal manure is a valuable source of crop nutrients and organic matter, which can improve the soil biophysical conditions making the soil more productive and sustainable for plant growth. Chukwuka and Omotayo (2009) specifically noted that application of organic fertilizers significantly improves the soil chemical properties and nutrient uptake in plants, thereby enhancing plant growth. Some other authors further pointed out that the application of liquid agro-industrial by-products increased soil-plant nutrient supply by releasing structurally bound elements such as N, P and Ca in soil solution during decomposition thereby increasing crop growth and yield. Also in a related study by Ede *et al*. (2015) notice that in an integrated nutrient management encompassing poultry manure and other organic media in Moringa production resulted in a positive response of Moringa to the application of poultry manure. Hence topsoil and poultry manure mixtures can constitute a suitable medium for potting Moringa plants.

The application of 17.10 t ha^{-1} PM poultry manure, SMR small ruminant manure, followed by 8.53 t ha^{-1}, and 4.27 t ha^{-1} rate gave the highest values for plant height, number of leaves and collar diameter. The application of these rates was observed to increase vegetative growth of Moringa plant, and this corroborates with the findings of Ewulo *et al*. (2008). None application of animal manure resulted in lower plant growth. This confirms the work of Baiyeri and Mbah, (2006) that poor availability of essential nutrients in substrate for growing container plants reduces crop growth and yield.

However, the optimum level for fertilizer application should be further ascertained. Uchenna *et al*. (2015) reported that the application of 5 to 10 t ha^{-1}of poultry manure to the soil medium ensured consistent increase in the plant height, stem girth, internode length, number of leaves and branches. In a related study conducted by Heywood (2002), it was observed that variations in essential chemical compositions can occur as a result of differing soil conditions, seasonal fluctuations and other environmental factors.

CONCLUSION

The study is therefore concluded that both poultry manure and small ruminant animal manure are valuable sources of fertilizer for the growth of both accessions of *Moringa oleifera* because they had influence on the growth performance over the controls. However, the Maradi-Niger accession performed better than Katsina-Nigeria accession while poultry manure at 17.10 t ha^{-1} proved more superior to small ruminant animal manure because it produced better growth attributes such as plant height, number of leaves, collar diameter and plant dry matter (biomass) followed by the control. The results obtained in this study therefore suggest that the use of these animal manure should be encouraged so as to provide leaves and other useful plant parts for medicinal and other purposes and also to enhance quantity and possibility of shortened time for plant maturity. The study shows that poultry manure at 17.10 t ha^{-1} proved to be good source of manure and its use must be encouraged with more emphases on the use of poultry manure

Recommendations

1. Poultry manure at 17.10 t ha^{-1} proved to be a better source of manure and its use should be encouraged.
2. The Maradi-Niger Moringa oleifera accession is recommended for multiplication instead of the Katsina-Nigeria accession.

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