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Research Article

Effect of different manures on establishment and growth of *Moringa oleifera* seedlings in Owerri, South East Nigeria

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Abstract

The recent increase in awareness of the various nutritional and medicinal benefits of *Moringa oleifera* plant has given rise to a high demand for the plant and its products. Moringa trees have been reported to perform well in backyard gardens and around homesteads due to soils rich in organic matter, but poorly in forest plantations. The use of inorganic fertilizers are expensive and unsustainable among smallholder farmers in this region hence the use of farm yard manure offers a viable alternative. In this experiment, two hundred and forty *Moringa oleifera* seedlings were planted in plots measuring 9m x 9m separated by 2m paths in a randomized complete block design with three replications. Four different farm yard manure types collected from pigs, poultry, cattle, sheep and goats, were applied as treatments to the seedlings two weeks after transplanting with a control where no manure was applied. The plant height and girth were measured over a seven week period. The results indicate significant differences in height and girths of the plant ($P<0.05$) with pig manure recording the highest mean height of 89cm followed by sheep and goat and poultry manure which recorded 71 and 72cm respectively. The pig manure also recorded the highest increase in plant girth with a value of 1.11cm followed by poultry manure with 0.89 cm. It can be concluded that *Moringa* farmers desirous of establishing forest plantations of the crop would require significant amounts of pig and poultry manures to guarantee quick establishment and ultimately high yield and productivity.

1. Introduction

In recent times, *Moringa oleifera* plant has gained wide popularity in many parts of Nigeria due to renewed acclaim for its efficacy in nutrition and medicine for both humans and animals. Consequently, considerable research has been conducted on the extraction of the seed oils, use in agroforestry, water purification, medicinal and nutritional benefits [1]. It is fast growing, reaching heights of 6-7 m per year in areas with less than 400 mm annual rainfall. Interest in *Moringa* in recent times is skewed towards its medicinal properties, consequently, the demand for the plant products has been on the ascendancy. Its ease of propagation through sexual and asexual means and tolerance to poor soils and water, makes production and management easy and also one of the most useful tropical plants [2]. Besides its use in nutritional and medicinal applications, *M. oleifera* is also very useful as an alley crop in agro-forestry. It is

useful for both man and livestock and also for many industrial applications [3].

In some homes in many urban areas in Nigeria, *Moringa oleifera* trees can be seen towering above the roof level within and outside fenced compounds. Street vendors and hawkers could be seen carrying *Moringa* based preparations indicated for the reduction in various ailments such as blood sugar, high blood pressure, arthritis, malaria, and as a supplement for pregnant and nursing mothers. There have been claims that Moringa trees perform better in terms of growth and establishment when planted within backyard gardens and the homestead but perform poorly in forest plantations. This could be a disincentive and might discourage commercial producers of the crop, given the high industrial demand for the leaves, seeds and roots for medicinal purposes. Although the plant can survive under most environmental conditions, more studies on its agronomy and establishment in response to different organic manure types in the southeast ecological zone of Nigeria are imperative to adequately domesticate the plant in the region.

Farmyard manure from different categories of livestock and poultry are rich in organic matter although the response of different plants to its application may vary and may depend on the animal and feed consumed. Manure types can be differentiated by moisture content as follows: Solid: <80 per cent moisture, semi-solid: 80 to 90 per cent moisture, liquid: >90 per cent moisture [4]. Solid and semi-solid manures have higher organic matter contents than liquid manure due to the higher content of solids and bedding added. Thus, the nutrient content of manure is highly variable and depends on the type of livestock operation, moisture content, use of bedding, type of bedding, age of the animal, feed type and or supplements used [5]. Therefore, the nature of the manure needs to be considered when calculating application rates to achieve the desired results. The manure used in this study was used as-is, and was not subjected to any type of processing.

Generally, farm yard manure is an ideal source of nitrogen (N). The total N in it is, ammonium N and organic N with very little nitrate-N. Nitrates in manure soils result from nitrification which results from the action of microorganisms in the soil that convert ammonium to nitrate. This and other types of transformation determine the availability of nitrogen to plants [6].

Although inorganic or chemical fertilizers are quick acting, their rising cost coupled with environmental concerns about their inability to provide sustained balanced conditioning of the soil and the demand for organically produced crops has shifted attention to organic manures [7]. The use of organic manure as fertilizer releases many nutrients into the soil in addition to nourishing soil organisms, thereby slowly and steadily making minerals available to plants [8]. Organic materials also serve as soil conditioners, improving soil physical properties such as water infiltration, water holding capacity, aeration and permeability [9].

In this era of sustainable development, ecologically sound agricultural technologies such as the use of organic manure are necessary to avert long term decline in productivity for both food and tree crop production [10, 11]. Therefore, the objective of the study was to evaluate the effects manure from five sources namely; sheep and goat; cattle; pig; poultry, could have on the establishment and growth of *Moringa oleifera* in Owerri, southeastern Nigeria.

2. Materials and methods

2.1 Experimental site

The research was carried out at the Teaching and Research Farm, Federal University of Technology, Owerri, Imo State from July to November 2013. Owerri is situated in southeastern Nigeria and lies between latitude 5° 29' N and longitude 7° 2' E, at an elevation of about 100mm above sea level. The climatic data are as summarized in the Imo State Ministry of Lands and Survey Atlas with a mean annual rainfall, 2500mm, temperature range, 26.5-27.5°Cand humidity, 70-80%. The duration of dry season (i.e. months with less than 64mm rainfall) is between December to February. The annual evaporation is 1450mm and the soil type is, essentially, sandy loam with an average pH of 5.5.

2.2 Experimental materials

Two hundred and forty *Moringa oleifera* seedlings about four weeks old were procured from Moringa Resources Limited, Owerri, Imo State; a commercial nursery and taken to the farm site where they were transplanted from the nursery bags. Fresh and semi-

solid (80-90 % moisture content) farm yard manure from sheep and goat, cattle, pigs and poultry were collected from the FUTO Teaching and Research Farm, and were applied on 'as is' basis.

2.3 Experimental treatments and design

The treatments consisting of different types of manure such as cattle, sheep and goat, poultry, pigs and a control, which did not contain any manure were applied to the experimental plots accordingly. The manure collected from FUTO Teaching and Research Farm was transferred to the site using black polythene sac bags. The manure was applied at the rate of 10 tonnes per hectare, measured with a weighing balance of 81kg of manure per plot measuring 81 m^2. The site for planting was cleared manually and the plot demarcated according to the layout and the experimental design. The organic manures were then applied to the plots in a randomized complete block design with five treatments (manure type) and three replications (blocks). The manures were then, evenly, spread around the seedlings, within a radius of 50 cm around each seedling stand to avoid direct contact of the manure with the seedlings. The seedlings were planted at 3 m intra-row distance and at 3 m inter-row planting space. Observations were taken weekly to determine the height and girths of the plants for seven weeks.

2.4 Data collection and analysis

Data collected were subjected to analysis of variance (ANOVA) as randomized complete block design with five treatments (manure types) and three replications (blocks) according to the procedures of [12]. Where significant differences were detected, means separation was done using least significant difference (LSD) at 5% level of probability.

3. Results and discussion

3.1 Chemical composition of manure from different sources

The chemical compositions of farm yard manure from different animal sources are shown in Table 1. Poultry manure contains the highest contents of N, P, K, Ca and Cu but contained the lowest content of Mn. Pig manure had the highest contents of Mg, Zn, and Fe while cattle manure had the least contents of N, K Mg, Ca, Na and Zn, however, it contained the highest content of Mn.

Table 1. Nutrient Composition of animal manures

Parameters (g/kg)	Cattle	Swine	Poultry	Sheep and Goat
N	15.6	16.9	30.2	15.9
P	6.9	6.3	10.6	8.7
K	7.3	7.6	10.3	8.9
Ca	21.2	31.6	37.2	24.2
Mg	11.2	19.2	17.3	12.5
Na	1.1	1.6	2.1	1.3
Fe (mg/Kg)	614.6	650.7	630.9	576.3
Zn(mg/Kg)	54.8	81.2	75.4	38.6
Cu(mg/Kg)	29.1	29.1	27.3	23.8
Mn(mg/Kg)	321.9	260.3	217.9	256.8

Data adapted from [14]

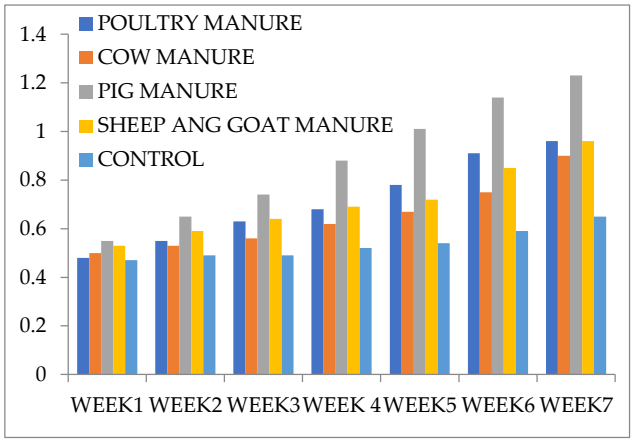

Figure 1. Showing the rate of growth (m) of *Moringa oleifera* in each treatment

3.2 Moringa Plant height and girth

The effect of manure on the height of *Moringa* seedlings is shown in Table 2 and Fig 1. There were significant differences among the treatments under study. The highest increase in the height of *Moringa* oleifera occurred on the pig manured plots followed by the poultry manured plot and then sheep and goat manured plot, cattle manured plot and then the control. There was no significant difference in height between the cattle and sheep and goat manured plots.

The data and figure on the effect of manure on the performance of *Moringa* seedlings girth are shown in Table 3 and Fig 2 respectively. The effect of the manure treatment on the plant girth followed the same trend. There were significant differences among the treatments. *Moringa* girth on pig manure showed the highest increase followed by poultry, sheep and goat manure, cow manure and then the control.

Table 2. Height of *Moringa oleifera* seedlings as influenced by weeks after application of manure measured in centimeters (cm)

Type of manure	Weeks							Mean	LSD
	1	2	3	4	5	6	7		
Poultry	50	55	63	68	78	91	96	71	0.033
Cattle	50	53	56	62	67	75	90	65	0.033
Pig	55	65	74	88	101	114	123	89	0.033
Sheep and Goat	53	59	64	69	72	84	96	72	0.033
Control	47	48	49	52	54	57	65	54	0.033

The outcome of this experiment is in agreement with the result from [13] on the effect of organic manure on shoot height and stem girth of *Moringa* seedlings which showed that the shoot height of seedlings treated with poultry manure produced the highest length compared to those treated with cattle manure and controls respectively.

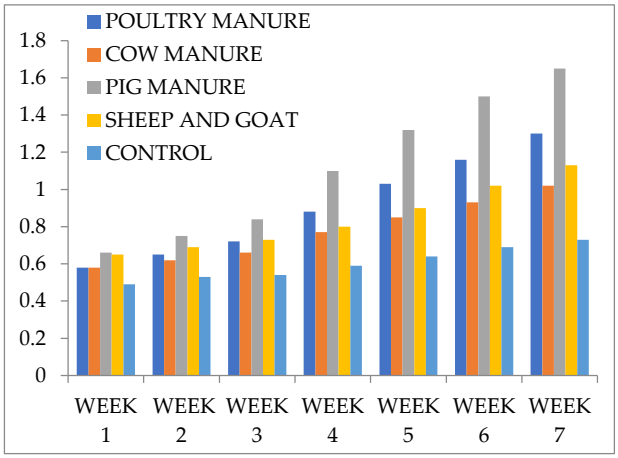

Figure 2. Showing the increase in girths (cm) of *Moringa oleifera* in each treatment

According to that study, the seedlings treated with poultry manure recorded the highest values followed by those treated with cow dung and the controls recorded the least values. Also, there was a general increase in biomass as the weeks progressed in all the treatments. Poultry manure- treated seedlings yielded significantly higher weights than the controls. Similarly, the cattle manure- treated seedlings also showed significant differences between them and the controls in the dry weight of the above-ground components of the seedlings. The positive impact of the manured plots could be attributed to the addition of organic matter to the soil which increased the supply of Nitrogen in the form of Ammonium-N (NH_4) as well as Nitrate –N (NO_3). This is because Nitrogen is the mineral element most often deficient for crop production in the highly leached soils of southeastern Nigeria. It also leads to the availability of the various macro and micro nutrients such as phosphorous, potassium, magnesium, calcium etc. Organic matter improves soil structure; water infiltration and water retention; soil aeration, reduces the risk of erosion [9]. In addition, it has a buffer effect that influences the variation of soil pH, increases the reserve of nutrients and activates growth hormones; it also supplies some vital nutrients for plants and the carbon containing compounds are food for small animals and micro-organisms. Manures often improve the structure of soils; they may do this directly through their action as bulky diluents in compacted soils or indirectly when the waste products of animals or microorganisms cement soil particles together. These structural improvements increase the amounts of water useful to crops that soil can hold, they also improve aeration and drainage and encourage good root growth by providing enough pores of the right sizes in the soil [4].

The study indicates that pig, sheep and goat manures, poultry manure and cow manure are valuable sources of fertilizer for the growth of *Moringa oleifera* because they have greatly improved growth of treated plants over the controls. However, pig manure proved more superior to other manure because it produced better growth in height and girth than its counterparts. Swine manure contained 1.5 to 5.0 kg of nitrogen in 1000 litres with about 65 per cent available as ammonium, a form that plants can use directly [4]. The rest of the N is organic, some of which were mineralized into plant-available N within the first year of its application. This gave liquid swine manure an edge as readily available nitrogen source. It must be emphasized that all the nitrogen in the manure was not readily available.

Table 3. Girth of *Moringa oleifera* seedlings as influenced by weeks after application of manure in centimeters (cm)

Type of manure	Weeks							Mean	LSD
	1	2	3	4	5	6	7		
Poultry	0.58	0.65	0.72	0.88	1.03	1.16	1.30	0.89	0.04
Cattle	0.58	0.62	0.65	0.77	0.85	0.93	1.03	0.77	0.04
Pig	0.66	0.75	0.84	1.1	1.32	1.49	1.65	1.12	0.04
Sheep and Goat	0.65	0.69	0.73	0.80	0.90	1.02	1.13	0.85	0.04
Control	0.47	0.53	0.54	0.88	0.64	0.69	0.73	0.60	0.04

Means with different superscripts are significantly different (P<0.05).

The total available N is the sum of the ammonium N and that portion of the organic N that was decomposed (mineralized) into a form that was plant available.

The low performance of cow manure when compared to other sources in this experiment could be attributable to the fact that solid cattle manure, contains much higher organic N content due to the large amounts of solid fecal matter and bedding, which raises the carbon to nitrogen (C:N) ratio. Carbon in the manure bedding-mix serve as a food source to soil organisms. As the microorganisms ingest the carbon (C), they also consume some N, making it temporarily unavailable to plants in a process called immobilization. When the organisms die, nitrogen and other nutrients are released back into the soil. Hence, cattle manure acts as a slow release fertilizer that continues to supply nutrients many years after application. It is believed that only 10 to 20 per cent of the N in solid cattle manure is in the form of ammonium, resulting in low availability in the year of application. Regardless of what type of manure is being used, producers should use annual manure and soil analysis to calculate their application rates. However, due to the nature of solid manure, meeting the crop N requirement may result in over application of phosphorus (P). In order to manage soil P levels, one alternative is to supplement the manure N with commercial fertilizer N to meet the crop requirement.

4. Conclusions

The results obtained in this study suggest that application of animal manure especially pig manure and poultry manure to *Moringa* seedlings greatly enhanced the establishment and growth rate of the *Moringa* more than the control treatment where no manure was applied. This could mean that crop and livestock farmers could take advantage of this information to increase their output of *Moringa* and other crops, since there is a high demand by industrial processors as well as increase the animal production for a sustainable supply of animal manure for overall environmental sustainability. It is evident from this study that high amounts of organic matter in the form of animal manure are required in order to achieve high rate of establishment and productivity of Moringa in forest plantations. Although there is some relative level of awareness in Moringa use and cultivation in the southeastern states of Nigeria, a level of optimal utilization has not been attained. In some homes where *Moringa oleifera* are used as live fences, although many respondents agree with the claims of high nutritional and health benefits of the plant, they however, are yet to put it to optimal use. As a result, the overgrown trees are common place in most households and even when they are pruned, they are applied more as mulch than for nutritional and medicinal uses. More emphasis should be directed at promoting the domestic and industrial utilization of the plant and its parts for both human and animal consumption.

Authors' contributions

Study design, N.J.A.; Read and reviewed the first draft, I.E.; Made contributions from relevant literature, I.I.E. and P.A.D.; Data collection, M.P.O.

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Availability of data and materials

All data will be made available on request according to the journal policy.

Conflicts of interest

The authors hereby declare that there were no conflicts of interest in the course of this research study.

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