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Evaluation of Different Nutritional and Soil Sources Fertilizers on the Early Growth of *Moringa oleifera* (Lam)

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

In any plantation establishment programme there should be adequate number of healthy seedlings and this depends on the nutrition and care given to them at the nursery stage. Pot experiment was conducted to assess the response of *Moringa oleifera* (Lam) seedlings to different soil and nutritional sources at nursery stage. One hundred seeds were obtained from Centre for Environmental Renewable Resources Research and Development (CENRAD) Ibadan, Nigeria and sown in germination trays. Seed germination was completed between 10-15 days, 36 uniformly growing seedlings were transplanted into polythene pots of size 29×25 cm and were filled with different soil sources at 500 gm (arable) soil, forest reserve soil and natural forest mixed with nutritional sources of the same ratio (10 gm) i.e. poultry manure, cow dung and N.P.K 15.15.15. The experiment was factorial arranged in a completely randomized design. Result showed that pots with natural forest soil mixed with 10 gm N.P.K (s3f3) produced seedlings with highest value In plant height (76.30 cm), stem diameter (3.47 mm) and number of branches (10.00) which was significantly different ($p< 0.01$) from the other treatments. The least value in plant height (30.70 cm) stem diameter (1.50 mm) and number of branches (3.3) were recorded in pots with forest reserve soil mixed with cow dung (s2f2). Interaction effect of soil and

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nutritional sources were significant for all the growth parameters assessed ($p<0.01$). Results showed that Natural forest soils treated with N.P.K 15.15.15 could be employed in raising Moringa oleifera seedlings at nursery stage for optimum performance.

Keywords: Moringa oleifera; growth; nutritional sources; different soil type.

1. INTRODUCTION

The forest plays an important role in protecting the soil, ameliorating the environment and protecting water resources. Non-timber forest products are very essential in urban and rural life, under which *Moringa oleifera* (Lam) belong [1]. *Moringa oleifera* is the most widely cultivated species of the genus Moringa, is the only genus in the family Moringaceae. English common names include: Moringa, [2] drumstick tree (from the appearance of the long, slender, triangular seed pods), horseradish tree (from the taste of the roots, which resembles horseradish, ben oil tree, or benzoil tree (from the oil which is derived from the seeds). It is a fast-growing, drought-resistant tree, native to the southern foothills of the Himalayas in the northwestern Indian, and widely cultivated in tropical and subtropical areas where its young seed pods and leaves are used as vegetables. It can also be used for water purification and washing, and is sometimes used in herbal medicine [3].

It has become a clear issue that man cannot sufficiently sustain its existence without adequately improving the level of food and fiber production as raw material for industrial uses. Most tropical soils are deficient in nitrogen and other macronutrients and uptake of these limited quantities of nutrients by plant roots from litter alone is insufficient [4]. Nitrogen allows plants to produce proteins needed to build living tissues for green stems, leaves and strong roots, phosphorus helps move energy throughout the plant while potassium aids plants in assimilating sugars needed for growth. The application of fertilizers is the only way to supply nutrients within a short period of time. Adegbidi et al. [5] reported that the effects of the mixed use of chemical fertilizer and organic matter on the growth of trees and soil fertility vary substantially according to the fertilizer amounts and the organic manure characteristics. The need to investigate the response of *Moringa oleifera* seedlings to different ratios of inorganic and organic fertilizer application on soil sources is essential as this will determine its optimum growth performance at the nursery stage. The objective of this study was thus; to investigate the effect of different nutritional and soil sources of fertilizers on early growth of *M. oleifera* so as to find the optimum dose of fertilizer for raising quality seedlings.

2. MATERIALS AND METHODS

This experiment was carried out at the West African Hardwood Improvement Project (WAHIP) of the Forestry Research Institute of Nigeria (FRIN), Ibadan (Latitude 7º3913' and longitude 3º8628' E.the Institute is situated at Jericho Hills in Ibadan North West Local Government Area of Oyo State. The climate of the area is tropically dominated by rainfall pattern ranging between 1400 – 1500 mm, average temperature is 30ºC. It has 2 distinct seasons rainy season (April – October) and dry season (November – March) [6]. The black polythene pots were purchased from CENRAD, Ibadan. Cow dung and poultry manure were collected from Federal College of Forestry Teaching and Research Farm Ibadan. N. P. K 15.15.15 fertilizer was obtained from Centre for Environmental Renewable Resources and Management Development (CENRAD), Jericho, Ibadan. The natural forest soil was collected from FRIN arboretum, forest reserve soil was collected from *Pinus caribea* Morelet plantation FRIN while the cultivated soil used was collected from Federal College of Forestry Ibadan farm. One hundred *Moringa oleifera* seeds were obtained from CENRAD and sown in germination trays filled with sterilized river sand.

Cow dung and poultry manure were dried, crushed and sieved with 2 mm diameter mesh sieve while the soil samples were also sieved. The same ratio of cow dung, poultry manure and fertilizer (N.P.K. 15.15.15) were measured in grams (10 gm each) and mixed with the soil samples, each treatment contained the same level of organic and inorganic fertilizers. 10gm of organic fertilizer, (cow dung and poultry manure of same ratio) and 10 gm of N.P.K. 15.15.15 were weighed in the soil laboratory of Forestry Research Institute of Nigeria. Cow dung and also 10 mg of poultry manure were applied on 36 seedlings i.e. cow dung and another 18 seedlings and 18 seedlings contained 10 gm of poultry manure, while other 18 seedlings

contained 10 gm of N.P.K. 15.15.15. Eighteen seedlings were used as control (without fertilizer). A total of 72 seedlings were transplanted after four weeks into polythene pots of 29 cm × 25 cm size filled with the different potting mixtures. Watering of the seedlings was done once daily. Seedling height (cm), stem diameter (mm) and number of branches were assessed after 4 weeks after transplanting for 12 weeks.

Table 1. Laboratory analysis of organic and inorganic fertilizer

Sample code	%N	%P	%K
Poultry manure	3.47	1.18	1.38
Cow dung	4.06	0.33	0.77
N.P.K. 15.15.15	15.00	15.00	15.00

Treatment Combinations:
Where;
(1) (i) S_1f_0 - Arable soil without fertilizer (control)
(ii) S_1f_1 - Arable soil with poultry manure
(iii) S_1f_2 - Arable soil with cowdung
(iv) S_1f_3 - Arable soil with N.P.K (15.15.15)
(2) (i) S_2f_0 - Forest reserve soil without fertilizer (control)
(ii) S_2f1 - Forest reserve soil with poultry manure
(iii) S_2f_2 - Forest reserve soil with cowdung
(iv) S_2f_3 - Forest reserve soil with N.P.K. (15.15.15)
(3) (i) S_3f_0 - Natural Forest soil without fertilizer (control)
(ii) S_3f_1 - Natural Forest soil with poultry manure
(iii) S_3f_2 - Natural Forest soil with cowdung
(iv) S_3f_3 - Natural forest soil with N.P.K (15.15.15)

2.1 Data Analysis

Analysis of variance was used to analyze the data obtained where significant, using SAS statistical package; Least Significant Differences (LSD) was used to separate the means.

3. RESULTS AND DISCUSSION

Table 2 shows that there was no significant difference in stem diameter of the seedlings subjected to various treatments at P<0.001 while N.P.K. 15.15.15 in natural forest soil (S_3F_3) had the highest stem diameter of 4.53mm. There was a continuous increase in stem diameter across the weeks. This was followed by N.P.K. 15.15.15 in arable soil (S_1F_3) that had value of 4.28 mm against cow dung in forest reserve soil (S_2F_2) which had the lowest stem diameter of 1.5mm across the weeks. This confirms the findings of [7] for *Camelia sinensis* that nitrogen containing fertilizers such as N. P.K had a significant effect on seedling growth parameters. Almeida et al. [8] had earlier reported that N.P.K fertilizer gave a positive response in seedling growth of cashew. This also supports the findings of Larcheveque et al. [9] that chemical fertilizers promote higher growth and root development compared to livestock organic manure in a Poplar plantation.

Table 3 revealed that there was no significant difference in the height of Moringa seedlings among the treatments at P<0.001. N.P.K. 15.15.15 in natural forest soil (S_3F_3) had highest height of 89.67 cm (P<0.001), this was achieved

Table 2. Effect of treatment on stem diameter (mm) of *Moringa oleifera* seedlings

Treatment	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT
S_1F_0	1.90	2.06	2.00	2.03	2.17	3.19
S_1F_1	1.93	2.07	1.97	1.97	2.17	3.20
S_1F_2	2.03	2.10	2.00	2.03	2.20	2.84
S_1F_3	2.07	2.20	2.40	2.63	3.17	4.28
S_2F_0	1.97	2.03	0.63	0.63	0.63	1.45
S_2F_1	2.10	2.13	1.97	1.93	2.00	3.17
S_2F_2	2.07	1.40	1.40	1.43	1.50	2.42
S_2F_3	2.03	2.03	0.00	0.00	0.00	0.00
S_3F_0	1.90	2.03	1.40	3.80	1.77	2.85
S_3F_1	2.03	2.07	2.13	2.17	2.60	3.00
S_3F_2	1.90	2.03	2.17	2.22	2.60	3.00
S_3F_3	1.93	2.00	2.07	2.47	3.47	4.53
Mean	1.99	2.01	1.68	1.94	2.02	2.83
Significance	<0.001***	<0.001***	<0.001***	<0.001***	<0.001***	<0.001***
Se±	0.1023	0.1023	0.1023	0.1023	0.1023	0.1023
LSD	0.9105	0.9105	0.9105	0.9105	0.9105	0.9105
C.V%	5.3	5.3	5.3	5.3	5.3	5.3

*Where: - WAT= Week after transplanting*** significantly difference (p<0.001)*

Table 3. Effect of soil mixture on the height (cm) of *Moringa oleifera* seedlings

Treatment	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT
S_1F_0	32.40	34.50	36.40	37.40	40.00	43.04
S_1F_1	28.40	37.33	41.33	42.33	46.00	54.25
S_1F_2	32.00	36.67	39.50	34.17	46.67	55.80
S_1F_3	40.17	41.33	46.00	54.33	66.67	74.55
S_2F_0	32.33	31.67	11.00	11.67	12.33	15.61
S_2F_1	34.73	33.73	35.17	37.83	42.50	48.72
S_2F_2	24.83	20.67	28.77	30.00	30.67	35.74
S_2F_3	26.33	34.33	0.00	0.00	0.00	0.00
S_3F_0	28.50	31.50	32.17	35.00	36.00	39.50
S_3F_1	34.83	35.57	46.50	50.33	52.33	60.28
S_3F_2	34.50	34.17	42.33	49.33	54.67	64.45
S_3F_3	30.90	32.33	43.33	58.00	73.33	89.67
Mean	31.66	33.81	3.38	37.45	41.74	48.47
significance	<0.001***	<0.001***	<0.001***	<0.001***	<0.001***	<0.001***
Se±	3.638	3.638	3.638	3.638	3.638	3.638
LSD	0.9105	0.9105	0.9105	0.9105	0.9105	0.9105
C.V%	5.3	5.3	5.3	5.3	5.3	5.3

*Where:- WAT = Week after transplanting*** significantly difference (<0.001)*

Table 4. Effect of soil mixture on number of branches of *Moringa oleifera* seedlings

Treatment	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT
S_1F_0	6.00	6.00	5.67	6.33	6.67	6.67
S_1F_1	7.00	6.00	6.33	6.00	6.00	6.00
S_1F_2	5.67	4.67	6.00	7.33	6.67	7.52
S_1F_3	4.00	6.00	8.67	9.67	9.67	10.23
S_2F_0	5.00	2.00	1.33	1.33	1.33	1.33
S_2F_1	6.33	3.67	4.00	5.00	5.33	6.50
S_2F_2	5.67	3.00	3.00	3.67	3.33	3.33
S_2F_3	5.67	4.33	0.00	0.00	0.00	4.33
S_3F_0	5.00	3.67	4.67	4.67	4.00	4.00
S_3F_1	6.67	6.33	7.33	6.67	6.67	6.67
S_3F_2	6.33	7.00	7.00	8.67	8.00	8.00
S_3F_3	6.33	6.33	8.67	10.33	10.00	11.00
Mean	5.81	4.91	5.58	6.17	6.00	6.33
significance	<0.001***	<0.001***	<0.001***	<0.001***	<0.001***	<0.001***
Se±	0.570	0.570	0.570	0.570	0.570	0.570
LSD	2.830	2.830	2.830	2.830	2.830	2.830
C.V%	10.3	10.3	10.3	10.3	10.3	10.3

*Where: WAT= week after transplanting*** significantly different (P < 0.001)*

due to the increase in the growth rate (height) of Moringa across the weeks. This was followed by N.P.K. 15.15.15 in arable soil (S_1F_3) that had a value of 74.55 cm, the trend was also maintained across the weeks while cow dung in forest reserve soil (S_1F_3) had the lowest height of 35.74 cm. Similar positive results has been reported by Hoque et al. [10] seedling growth was enhanced significantly with the application of N.P.K fertilizer. Tree seedlings need nutrients to grow, nitrogen for lots of green leaves, phosphorus for new tissues particularly the roots and potassium for seedling vigour.

Table 4 shows that there were significant differences in number of branches of Moringa seedlings among the treatments at P<0.001. N.P.K. 15.15.15 in natural forest soil (S_3F_3) had the highest value of 11.00. This was achieved due to continuous production in number of branches across the weeks. This was followed by N.P.K. 15.15.15 in arable soil (S_1F_3) that had the value of 10.23 which was also maintained across the weeks while cow dung in forest reserve soil (S_2F_2) had the lowest value of 3.33 across the weeks. This supports the findings of Jaenicke [11] who stated that cow dung contains

0.3% Nitrogen, 0.2% phosphoric acid and 0.1-0.5% while [12] also reported that cow dung is not as rich in nitrogen as many other types of fertilizers. He reported that cow dung has about 8% nitrogen, 2% phosphorus and 1% potassium. These nutrients are also slowly infused into the soil.

4. CONCLUSION

Based on the findings of these studies, seedlings raised with N.P.K. 15.15.15 mixed with natural forest soil had the highest plant height (76.30 cm), stem diameter (3.47 mm) and number of branches (11.00).

5. RECOMMENDATION

Natural forest soil mixed with N.P.K. 15:15:15 could be recommended for use in raising seedlings of *Moringa oleifera* for optimum growth performance since the seedlings presented most noticeable growth at the nursery stage.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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