Influence of Soil Locations and Watering Regimes on Early Growth of Moringa oleifera Lams

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Abstract

A study was carried out at the Green House of Kogi State University, Anyigba to investigate the influence of soil from three different locations and watering regimes on early growth characters of Moringa oliefera in the Southern Guinea Savannah region of Nigeria. This study is aimed at identifying the best soil location as well as watering regime to be used in the propagation of M. oleifera. The experiment was a 2 x 3 factorial experiment in Completely Randomized Design (CRD). Soil were obtained from Kogi State University Animal Production and Research Farm (SL_1), Kogi State University Demonstration Farm (SL_2) and Kogi State University Faculty of Agriculture (SL_3) while the watering regimes were once and twice daily including the control (WR_1,WR_2 and WR_0). Thirty six pots were filled as a replicates for each of the treatment and seedlings transplanted for the ten weeks the experiment lasted. The parameters measured were plant height, stem diameter and numbers of leaves. Results obtained from this experiment shows that there were no significant differences found among the three soil locations however, SL_1 gave the highest yield for growth characters. Watering regimes was found to be less significant for the vegetative growth of Moringa in general however WR_2 gave the best yield for vegetative growth. The analysis of variance shows that soil locations and watering regimes were significant only for stem diameter at 4WAT and number of leaves at 6WAT where SL_1 and WR_1 gave the best yield for vegetative growth for the two characters (stem diameter and number of leaves).

Keywords: *Moringa oleifera*, Soil locations Watering regimes, Early growth

Introduction

In recent times, *Moringa oleifera* has gained a lot of popularity due to recent discoveries of its usefulness to mankind, resulting in rapid growth of the plant. Therefore, considerable research has been conducted into the extraction of its seed oil; use in agroforestry systems, water purification property, medicinal and nutritional benefits (Fuglie, 2001). This makes *M. oleifera* one of the most useful tropical plants. The relative ease, with which it propagates through both sexual and asexual means and its low demand for soil nutrients and water, makes its production and management easy. Hence introduction of this plant into agricultural land use system can be beneficial to both the owner of the farm and the surrounding ecosystem (Foidl *et al*., 2001). It is a fast growing plant reaching 6-7 m in a year in areas receiving less than 400 mm annual rainfall (Odee, 1998). Interest in *Moringa* in recent times is skewed towards its medicinal properties and, hence, much research has gone into this aspect. Consequently, the demand for the plant products has been on ascendancy.

Moringa oleifera Lam. is a multipurpose and exceptionally nutritious vegetable tree with a variety of potential uses. It is a sub-tropical species that is known by different regional names as benzolive, drumstick tree, kelor, marango, mulangay, nébéday, saijhan, mooringai and sajna. It has very high nutritional properties that would be useful as food supplement, especially in those relegated communities. Besides its nutritional and medicinal applications, *M. oleifera* is very useful as an alley crop in the agroforestry industry. It is useful not only for human beings but also for animals as well as various industrial applications. Besides *Moringa oleifera* being processed into a medicine, it contains acetone which can be prepared into herbal formulation which is an effective anti-malaria bio agent (Patel *et al.*, 2010). Such trees have the potential to be a source of new drugs (Singh *et al*., 2010). It is also an effective water clarifier using the seed, thus providing millions of people with clean drinking water (Francis and Amos, 2009). The leaves, fruit, flowers and immature pods of this tree are used as a highly nutritive vegetable in many countries, particularly in India, Pakistan, Philippines, Hawaii and many parts of Africa. It is originated initially in the Northern part of India some 5000 years back and soon moved into the Southern parts as well, where it was known as 'Murungaikeerai' (*Moringa* leaves) and 'Murungaikaai' (*Moringa* vegetable). The *Moringa* tree had spread to most part of Asia, nearly the whole of Africa, South America, southern part of North America and some parts in Europe (Somali *et al*., 1984). *Moringa* has been used as a traditional medicine around the world, for anemia, skin infections, blackheads, anxiety, bronchitis, catarrh, chest congestion, asthma, blood impurities, cholera, glandular, swelling, headaches, conjunctivitis, cough, diarrhea, eye and ear infections, fever, abnormal blood pressure, hysteria, pain in joints, pimples, psoriasis, respiratory disorders, scurvy, semen deficiency, sore throat, sprain, tuberculosis, for intestinal worms, lactation and diabetes. The healing properties of *Moringa* oil have been documented by ancient cultures.

Moringa oil has tremendous cosmetic value and is used in body and hair care as a moisturizer and skin conditioner. *Moringa* oil has been used in skin preparations and ointments since Egyptian times (Mughal *et al*., 1999).

The leaves possess remarkable nutritional and medicinal qualities. They contain high amount of vitamin C, which fights a host of illnesses including colds and flu; vitamin A, which acts as a shield against eye diseases, skin diseases, heart ailments, diarrhoea, and many other diseases; Calcium, which builds strong bones and teeth and helps prevent osteoporosis; Potassium, which is essential for the functioning of the brain and nerves, and Proteins, the basic building blocks of all our body cells. Another important point is that *Moringa* leaves contain all of the essential amino acids in a good proportion, which are the building blocks of proteins. These leaves could be a great boon to people who do not get protein from meat. *Moringa* even contains argenine and histidine, two amino acids especially important for infants, who are unable to make enough protein for their growth requirements (Babu, 2000).The micro-nutrient content is even more in dried leaves; (ten times the vitamin A of carrots), (17 times the calcium of milk), (15 times the potassium of bananas), (25 times the iron of spinach) and (nine times the protein of yogurt).

Therefore it is necessary to increase the utilization of *Moringa* leaves consumption by the different communities. It should be consumed either fresh or dry. Dried leaves can be stored for a long time and can be used regularly. Many companies across the world manufacturing various products of *Moringa* leaves such as *Moringa* Tea, *Moringa* Tablets, *Moringa* Capsules, *Moringa* leaves Powder, *Moringa* Soaps and *Moringa* Face wash etc.
Moringa oleifera is a multipurpose, fast growing tree species of the monogenic family *Moringacea* of the order *Brassicales*. It is now naturalized across the topics and is cultivated widely in Africa Thailand, Burma, Singapore, West Indies, Sri Lanka, Mexico, Malaysia and the Philippines (Fahey, 2005). In Nigeria, it is commonly referred to as Zogallagandi in Hausa, Ewe-Igbale in Yoruba and Okwe Oyibo in Igbo language. The tree has been shown by many researchers to be very nutritious and highly medicinal. Anwar *et al*. (2007) reported that different parts of this plant contain important minerals and are good source of Vitamins, Protein, amino acids and various phenols. It has also been shown that *Moringa* seeds apart from been a good source of oil, can also be an effective ingredient for water treatment. The increased focus on biodiesel makes *Moringa* very important prospect to the economy of the rural dwellers as the biodiesel potential of the tree has been shown to be high (Onyekwelu and Olabiwonnu, 2010). The importance of this specie in nutrition, health and other economic uses therefore, makes its study imperative.

Materials and Methods

The experiment was conducted under the Green house of the Department of Crop Production, Kogi State University Anyigba. Anyigba is located in the Southern Guinea Savanna of the agro ecological zones. The experimental site is between latitude $7^0 6^I$N and longitude $7^0 43^I$E.

Seeds from matured *Moringa oleifera* were harvested from the parent tree at Kogi State Agricultural Development Programme (ADP) Plantation zone B Anyigba after which seed viability test was conducted using floatation method.

Soil samples were collected at three different locations. The First Soil type was collected from Animal Production Research Farm, the Second Soil type was collected from Kogi State University Research and Demonstration Farm, and the third sample was collected from Faculty of Agriculture, Kogi State University Anyigba, all within Anyigba environment.

Sample Preparation: The samples of the soil collected were taken to the laboratory for particle size analysis in order to determine their textural classes. (Table 34)

The soils were air dried and later sieved with 2 mm sieve to remove clods and debris.

The seeds were sundried to reduce excessive moisture and crushed with hands to remove the husk from the seeds.

The seeds were soaked in water overnight and those that go under the water surface were considered viable and selected for planting.

Planting and Labeling: The planting was initially done on three germination boxes for 2 weeks each of which contained soil from the three different locations. Thirty six poly pots of uniform sizes were filled to the brim with soil from the three different locations. Soils from the first location were contained in Twelve poly pots, Soils from the second location were also contained in Twelve poly pots and Soil from the third location were as well contained in Twelve Poly pots. The poly pots were labeled as; SL_1, SL_2, SL_3 for soil locations respectively andWR_0, WR_1 and WR_2 for watering regimes respectively.

Experimental design: The experiment was a 2X3 factorial experiment carried out in a Completely Randomized Design (CRD) with four replications for each soil locations and the various watering regime.

Table 1: Factor Combination

	SL_1	SL_2	SL_3
WR_I	SL_1WR_I	SL_2 WR_I	SL_3 WR_I
WR_2	SL_1WR_2	SL_2 WR_2	SL_3 WR_2
WR_0	SL_1WR_0	SL_2 WR_0	SL_3 WR_0

Note:

- WR_1= Watered once Daily
- WR_2=Watered Twice Daily
- WR_0=Control
- SL_1=Soil location one
- SL_2=Soil location two
- SL_3=Soil Location three

Parameters measured are: plant height (cm), stem diameter and number of leaves,

Statistical Analysis

Data collected were subjected to one-way analysis of variance (ANOVA) procedure for Completely Randomized Design (CRD). Fishers Least Significant Difference were used to separate the significant mean difference.

Results

The experiment lasted for ten weeks during which data were collected every two weeks (that is, data were collected at 2,4,6,8 and 10 weeks after transplanting).

Seeds planted on soil location one (SL_1) was found to germinate earlier followed by seeds planted on soil location three (SL_3). However, seeds planted on soil location two gave the least germination percentage.

Effect of Soil Locations on Plant height, Stem Diameter and Number of Leaves

The result obtained from plant height shows that soil locations had significant influence on height of plant only at 2 and 8 WAT (Table 2). The highest plant was obtained from SL_1. This was significantly different from SL_2 and SL_3. However SL_3 gave the least height of plant. At 4, 6 and 10 weeks,

Soil location had no significant influence on height of plant (Table 2). The result obtained for stem diameter shows that soil location had no significant influence on stem diameter at 2, 8 and 10 WAT (Table 3).

Result obtained from number of leave shows that soil locations had no significant influence on leave numbers at 2, 4, 8 and 10 WAT. Plants obtained from pot treated with SL_1 gave the highest number of leaves followed by pot treated with SL_3 however SL_2 gave the least number of leaves (Table 4).

Effect of Watering Regimes on Plant height, Stem diameter and Number of leaves

Watering regime also had significant influence on plant height only at 6 and 8 WAT with WR_2 (watered twice daily) which gave the highest plant height and was significantly different from WR_1 although the control pots (WR_0) gave the least height of plant. Watering regime had no significant influence on height of plant at 2, 4 and 10 WAT (Table 2).

Watering regimes had significant influence on stem diameter only at 4 and 10 WAT. The highest stem diameter were obtained from WR_2 however these were not significantly different from the stem diameter obtained from WR_1, the control Pots (WR_0) gave the least stem diameter. Watering regimes was found to show no significant influence on stem diameter at 2, 6 and 8 WAT (Table 3).

Watering regimes had significant influence on number of leaves only at 4, 6 and 10 WAT. Pot treated with WR_2 gave plants with the highest number of leaves at 6 and 10 WAT which were significantly different from number of leaves obtained from plants treated with WR_1 at 6 WAT although this was not significantly different from number of leaves obtained from Pots treated with WR_1 at 10 WAT. Number of leaves obtained from Pot treated with WR_1 gave the highest number of leaves followed by Pot treated with WR_2 at 4 WAT although control pot (WR_0) gave plant with the least number of leaves at 4, 6 and 10 WAT respectively (Table 4)

Interaction Effect of Soil Locations and Watering Regimes on Plant Height, Stem Diameter and Number of Leaves on Early growth of *Moringa Oliefera*

Interaction effect of soil location and watering regimes was found to have no significance influence on height of plant at 2, 4, 6, 8 and 10 WAT (Table 2).

Interaction effect of soil location and watering regime had significant influence on stem diameter only at 4 WAT (Table 3).

Soil location one Watered once daily (SL_1WR_1) gave the highest yield for Stem diameter (Table 5) however, WR_1 had significant influence on stem diameter obtained from SL_2 i.e. Stem diameter obtained from pots treated with SL_1WR_1 was significantly different from pots treated with SL_2WR_1 but SL_1WR_1 was not significantly different from pot treated with SL_3WR_1. The control pot (WR_0) gave a higher stem diameter for SL_1 which was significantly different from SL_2 and SL_3 although stem diameter obtained from SL_2 and SL_3 are not significantly different. Also WR_2 gave a higher stem diameter for SL_1, SL_2, and SL_3 which were not significantly different. Stem diameter obtained from Pots treated with SL_2WR_1 was not significantly different from SL_1WR_0 those obtained from SL_3WR_1 was not significantly different from SL_1WR_2.

Interaction effect of soil location and watering regime was found to be significant only at 6 WAT (table 5).
SL_1 watered once daily (WR_1) gave plant with the highest number of leaves (Table 6). These was significantly different from pot treated with SL_2 and SL_3 respectively however the control pots (WR_0) gave plant with a higher number of leaves which were significantly difference from pot treated with SL_2 and SL_3 respectively.

WR_2 also gave a higher yield in terms of number of leaves for SL_1 which was also significantly different from Pots treated with SL_2 and SL_3 however the number of leaves obtained from pot treated with SL_2WR_1 was not significantly different from the control pots treated with SL_1 (Table 6).

Table 2: Influence of Soil Locations and Watering Regimes on Plant Height

TREATMENTS	*WEEKS AFTER TRANSPLANTING(WAT)*				
SOIL LOCATION	2	4	6	8	10
SL_1	82.20[a]	187.00	169.00	305.00[a]	386.00
SL_2	66.20[b]	121.00	195.00	237.00[b]	309.00
SL_3	58.60[c]	126.80	179.00	219.00[c]	284.00
Significance	*	NS	NS	*	NS
LSD(0.05)	2.63	--	--	8.75	--
WATERING REGIME					
WR_0	68.60	127.00	123.00[c]	177.00[c]	271.00
WR_1	69.80	154.50	195.00[b]	280.00[b]	345.00
WR_2	68.60	153.80	225.00[a]	299.00[a]	363.00
Significance	NS	NS	**	**	NS
LSD(0.05)	2.63	21.61	4.63	8.75	46.77
INTERACTION					
(SL and WR)Significance	NS	NS	NS	NS	NS
LSD	--	--	--	--	--

Means followed by the same letter(s) in the same column are not significantly different ($P \leq 0.05$).

Table 3: Influence of Soil Location and Watering Regimes on Stem diameter

TREATMENTS	WEEKS AFTER TRANSPLANTING				
SOIL LOCATIONS	2	4	6	8	10
SL_1	2.45	6.31	15.00	18.25	17.05
SL_2	2.60	4.30	12.65	15.30	15.70
SL_3	2.85	5.39	10.70	15.16	14.55
Significance	NS	NS	NS	NS	NS
LSD	--	--	--	--	--
WATER REGIME					
WRo	2.60	3.05[b]	10.95	13.95	5.30[b]
WR_1	2.60	6.60[a]	14.85	18.15	20.85[a]
WR_2	2.70	6.35[a]	12.55	16.61	21.15[a]
Significance	NS	*	NS	NS	*
LSD(0.05)	--	0.32	--	--	0.66
INTERACTION					
(SL & WR)					
Significance	NS	**	NS	NS	NS
LSD(0.05)	--	0.32	--	--	--

Means followed by the same letter(s) in the same column are not significantly different ($P \leq 0.05$).

Table 4: Influence of Soil Locations and Watering Regimes on Numbers of Leaves at 2, 4, 6, 8 and 10 Weeks after Transplanting(WAT)

TREATMENTS	WEEKS AFTER TRANSPLANTING				
SOIL LOCATION	2	4	6	8	10
SL_1	360.00	567.00	497.00[a]	691.00	238.00
SL_2	277.00	406.00	259.00[c]	403.00	179.00
SL_3	377.00	520.00	305.00[b]	443.00	161.00
Significance	NS	NS	**	NS	NS
LSD(0.05)	49.30	31.50	15.08	45.40	23.11
WATERING REGIME					
WR_O	292.00	343.00[c]	195.00[c]	311.00	35.00[b]
WR_1	396.00	609.0[a]	417.00[b]	652.00	283.0[a]
WR_2	326.00	541.00[b]	449.00[a]	574.00	260.00[a]
Significance	NS	*	**	NS	*
LSD(0.05)	--	31.50	15.08	--	23.11
INTERACTION(SLAND WR)					
Significance					
	NS	NS	**	NS	NS
LSD(0.05)	49.30	31.50	15.08	45.40	23.11

Means followed by the same letter(s) in the same column are not significantly different (P ≤ 0.05).

Table 5: Interaction Effect of Watering Regime and Soil Location on Stem Diameter at week 4

	WRo	*WR₁*	*WR₂*
SL_1	1.46[d]	2.60[a]	2.25[bc]
SL_2	0.85[e]	1.50[d]	1.95[c]
SL_3	0.74[e]	2.50[ab]	2.15[c]
LSD(0.05)	0.32		

Means followed by the same letter(s) in the same column are not significantly different (P ≤ 0.05).

Table 6: Interaction Effect of Watering Regime and Soil Location on Number of Leaves at Week 6

	WRO	*WR_1*	*WR_2*
SL_1	124.00[d]	207.00[a]	166.00[c]
SL_2	23.00[h]	136.00[d]	100.00[e]
SL_3	48.00[g]	74.00[f]	183.00[b]
LSD(0.05)	15.08		

Means followed by the same letter(s) in the same column are not significantly different (P ≤ 0.05).

Table 7: Particle Size Analysis (%)

Sample ID	%Silt	%Clay	%Sand	Textural Class
ST1	2.28	10.76	86.96	Loamy Sand
ST2	1.28	10.76	87.96	Loamy Sand
ST3	1.28	13.76	84.6	Loamy Sand

Discussions

Effect of Soil Location on Growth Characters of *Moringa*

Generally soil location was found to have no significant influence on the growth character of moringa. (Ramachandran *et al.*, 1980) observed that *Moringa* plant can thrive well in loamy sand soil due to their well drainage ability but cannot flourish in waterlogged conditions.

Number of leaves, stem diameter and plant height were found to be less significance to soil location. These may be attributed to the fact that soil from the three locations used belong the same textural class (loamy sand), therefore are expected to perform in the same manner.

However (Benzerra *et al.*, 2004) observed that sandy clay soil is optimum for rapid *Moringa* seed emergence and improve plant establishment including stem diameter branches and height among others.

Establishing the best soil location for early growth of moringa, SL_1 was found to give the highest yield for number of leaves at 6 WAT (497.00) (Table 4) and plant height at 2 and 8 WAT (82.2 cm and 305 cm).(Table 2). This result is similar to (Fuglie, 1999) findings, where he observed that *Moringa* tree can grow up to the height of 10 or 12m. Also Odee, (1998) observes that *Moringa* can grow up to 6 to 7 m in a year. This was followed by SL_2 which gave plants with heights of 66.20 cm and 207 cm at 6 WAT. However SL_3 gave the least height of plant at 2 and 8WAT (Table 2).
SL_1 gave plants with higher number of leaves (497) which is followed by SL3, Although SL_2 gave the least number of leaves at 6 WAT (Table 4) Watering regimes was found to be significance for number of leaves at 4, 6 and 10 WAT, plant height at 6 and 8 WAT and Stem diameter at 4 and 10 WAT. WR_2 gave the highest yield for growth characters.

In general, watering regimes was found to be less significant. This can attributed to the fact that the soil texture from the three location used for the experiment behaves alike and therefore, they have low water holding capacity associated with higher drainage hence leaving a smaller volume of available water for plant use although Odee (1998), estimated that *Moringa* plants receiving 400 mm annual rain fall may grow to the height of 6-7 m in a year under field condition.

WR_2 produced the tallest plant with height of 225.00 cm and 299 cm at 6 and 8 WAT (Table 2). These were followed by WR_1 however the control pots (WR_0) gave plants with the least height.

Also WR_2 gave the highest stem diameter at 4 and 10 WAT however this was not significantly different from WR_1 although the control pots (WR_0) gave the least stem diameter (Table 3).

For number of leaves, plant with the highest number of leaves were obtained from WR_1 also follow by WR_2 at 6 and 10 WAT. However at 4 WAT, WR_1 gave the highest number of leaves (609.00) followed by WR_2 (541.00) with the control (WR_0) giving the least number of leaves (Table 4).

Effect of Interaction on Early Growth Characters

Generally, interaction was found to be less significant for the growth characters although interaction effect of soil location and watering regimes was significant for stem diameter at 4 WAT where SL_1WR_1 was found to perform best. Also the interaction effect of soil location and watering regimes was found to be significant for number of leaves at 6 WAT where SL_1WR_1 also gave the highest number of leaves.

Conclusions

This experiment was carried out to check the influence of different soil locations and watering regimes in the performance of seedlings of *Moringa* Oleifera. Base on the results obtained from the experiment, soil locations was found to be less significant for early growth characters as there were no significant differences among the soils obtained from the three different locations (Kogi State University Animal Production Farm, Kogi State University Demonstration Farm and Kogi State University, Faculty of Agriculture Respectively). However watering regimes was found to be significant at ($P \leq 0.05$) level of probability for some growth parameters e.g numbers of leaves however WR_2 (pots watered twice daily) gave the best yield for the vegetative growth where significance was observed while the WR_0 gave the least yield.

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