IJART- Vol-4, Issue-5, October, 2019 Available online at http://www.ijart.info/
DOI: https://doi.org./10.24163/ijart/2017/4(5):150-158

INTERNATIONAL JOURNAL OF APPLIED RESEARCH AND TECHNOLOGY
ISSN 2519-5115
RESEARCH ARTICLE

Growth Perfomance of *Morus alba* L. (Mulberry Plant) on Soils from Selected Ecological Zones in Nigeria

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Received: July 19, 2019
Revised: Oct 30, 2019
Published: Oct 31, 2019

ABSTRACT

The study covered the growth of four varieties of *Morus alba* L. (K2, S30, S14 and S54) on the soils from three selected ecological zones (Rain Forest, Swamp Forest, Guinea Savannah) of Nigeria carried out within Federal College of Forestry, Ibadan. There were twelve (12) treatments; each treatment was replicated three times. The experiment was laid in 3 x 4 factorial experiments in completely randomized design (CRD). Growth variable such as plant height (cm), stem diameter (mm), leaf production and leaf area (cm_2) were assessed. Data collected were subjected to Analysis of Variance at 5% level of probability. The result revealed that T_7 (SOP+S14) had the highest mean height (27.97cm), stem diameter (3.74m), leaf production (17.33) and leaf area (20.57cm_2) while T_5 (SOP+K2) had least performance of 6.43cm, 2.11mm, 5.33 and 7.47cm2 respectively. Furthermore, analysis of variance showed that there was no significant difference (P<0.05) among treatments with respect to plant height, stem diameter, number of leaf and leaf area. The result indicated that selected varieties of white mulberry plant thrived well under the soils from selected ecological zones that were examined in this study. It was therefore recommended that, for best plant height and leaf production, S14, S30 and S54 varieties should be raised on Onne (SOP) soil, Ore soil (SOO) should be used to raise all the varieties of *Morus alba* studied and New Bussa (SNB) soil should be used in raising S30 and S54.

Keywords- : *Morus alba*, ecological zones, soils, mulberry plant

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INTRODUCTION

The importance of soil to forest production cannot be overemphasized because soil serves as a source of nutrient and water supplies to plants and entrapped air within the root region for respiration. Moreover, the soil supplies water to enhance chemical reaction within the plant, and supply plant nutrient that are essential for plant growth. In addition, one of the important factors of production in agriculture and forestry is productive soil. The requirement of productive soil are a good water-holding capacity, sufficient aeration and supply of decomposing mineral and humus that are dissolving at a rate rapid enough to meet the requirement of desire plant growth. The type of soil dictates how best it can be managed to obtain the high yield as well as the type of tree/plant to grow and silvicultural management to adopt. The physical properties of a soil largely determine the way in which it can be used. Soil structure, texture, moisture, aeration and depth are important in tree/plant growth (Ayeni, 2014). In other words, soils are the single most important factor responsible for tree growth.Furthermore, there are variability in soils and soil types; not all soils are equally suited for all species of trees and shrubs. Soils have chemical, physical and biological properties. Chemical properties that vary from site to site include; available nutrients, soil pH and organic matter content. Lack of nutrients or the unavailability of nutrients will limit plant growth. Soil pH, a measure of acidity or alkalinity affects the availability of some nutrients. The ideal pH range for tree growth is 5.5 to 6.5. Some trees begin to exhibit nutrient deficiency symptoms (especially iron) at higher soil pH. Organic matters in soil contribute to tree growth by improving soil structure, nutrient availability and water holding capacity. The physical aspects of the soil are as important as the chemical properties. Soil texture (proportion of sand, silt and clay) is an important factor in water holding capacity. Soils with large pore spaces (sand) retain less moisture than fine soils; soils containing mostly clay will be wet or poorly drained. Under optimum conditions, the pore space in soil should be 50% air and 50% water. However, compaction of soils decreases pore space and increases plant stress by reducing availability of oxygen to the roots. Soils also are alive with a wide range of bacteria, fungi and other organisms which contribute favourably to the soil environment (Ames, 2001) and influence plants growth in different ways. Among these plants is *Morus alba.Morus alba* L. (white mulberry) is an introduced, small to medium sized shrub. The leaves are alternate, simple, serrate and dentate, ovate to broad ovate and two to seven inches long (Dirr, 1990). The flowers are small, greenish, crowded in clusters and hanging in catkins. The fruit is blackberry brown to gray and smooth, becoming divided into narrow scaly ridges. Mulberries have brittle roots and need to be handled with care when being planted. Pruning should be done in the winter when the plant is fully dormant. Only badly placed branches or dead wood should be removed during pruning. Mulberries are bleeders and should not be cut when the sap is flowing. Different mulberries trees vary in fruit production. Sericulture is the most important commercial use for white mulberry. Young, fully developed leaves are best for feeding silkworm larvae. White mulberry can become weed trees as fruits are distributed by birds and other wildlife (Dirr, 1997).

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White Mulberry is a native to china, cultivated throughout the world wherever silkworms are raised (Barnes and Wagner, 1981). It is a large long-living tree with light grey bark, which gets darker with age. The leaves are light green soft and shiny in various shapes. The tree does not have special soil requirements and grows in almost all Europe. However, the area of growing does not overlap with the area of mulberry cultivation for silkworm breeding. Despite the fact that mulberry is tolerant to frost, the length of vegetation period plays an important role, thus North European countries do not have suitable climate for mulberry. In other to obtain as much good quality leaves as possible, mulberry requires special treatments (Butt *et al*., 2008). Fresh and well isolated leaves contain about 70% water, 7.5% protein, 1.1% lipids, 10.6% carbohydrates, 2.6% minerals substances, 5.2% and small amounts of vitamins (B, C and D) and enzymes. More and more information is available on the mulberry leaves as a good source of bioactive substances i.e. the substances that stimulate desired course of metabolic processes in humans. Mulberry foliage is the sole food for silkworm (*Bombyx mori*) and is grown under varied climate condition ranging from temperate to tropical. The leaf is a major economic component in sericulture since the quality and quantity of leaf provided per unit area have a direct bearing on cocoon quality and quantity (CSB, 2003). Apart from being known to be a source of food for silkworm, for the production of cocoon this is foundation of the international silk industry. It also provides general cover, as well as foraging and nesting habitat for many bird species. It is also recommended as a shelter belt tree to improve general wildlife in Great Plain (Hays, 1990) and to provide vegetative cover for bobwhite quail in northwest Oklahoma (Hann, *et al*., 2008).

Czarapata, (2005) reported that as at 2009, there was little published information regarding the conditions conducive to the establishment of white mulberry. Since it is a hard deep rooted plant, soil should be capable of supplying sufficient air, water and nutrients even at the deeper layers where the root system penetrates. Soil should be fertile, deep. Friable and clayey loam to loam in texture and porous with good water holding capacity (Nataraju *et al*., 2003), though it does well on a wide variety of soils. It prefers a warm, moist, well-drained loamy soil in a sunny position.

Mulberry sericulture has never been seriously practiced in Nigeria but record shows that imported larvae of *Bomboyx mori* L. were reared experimentally and was imported from Mr. L. C. Conjoin in 1963 and the first successful rear of mulberry silkworm in Nigeria was when the employment of modern technological methods have just been competed at the Forestry Research Institute of Nigeria (FRIN) (Onyolu, 2012). Therefore this study aimed to find the best zone for the establishing white mulberry varieties plantation under study for maximum production.

MATERIALS AND METHODS

The experiment was carried out at the department of Forestry Technology Nursery (Nursery A) of Federal College of Forestry, Jericho, Ibadan. The college is situated at Jericho Hill under Ibadan North-West Local Government areas of Oyo State. The area lies between latitude 7_{0}23’ N and longitude 3_{0}51’ E. The climate condition of the area is tropically dominated by rainfall pattern from 1400mm – 1500mm. the average temperature is about 26_{0}C, average relative humidity of about 65% with two distinct season of wet (April to October) and dry

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(November to March) (FRIN, Metrological Station 2013).

Soils were collected from three selected ecological zones of Nigeria. Ore in Ondo state, Onne Port Harcourt in Rivers State and New Bussa in Niger state. Stem cutting of varieties of *Morus alba* was obtained from Forestry Research Institute of Nigeria (FRIN), Sericulture unit, Ibadan.

Soils were analyzed at SMO Laboratory Service, Ibadan. Clogs of soil, stone and weeds were removed from the soils collected from three ecological zones before potting. The soils were thoroughly watered before planting. Each variety was replicated 3 times. Treatments were kept under weaning shed to reduce evapotranspiration. Watering was done once daily throughout the period of experiment and collection of data commenced two weeks after planting.

Variables assessed were plant height (cm) using calibrated ruler, stem diameter (mm) using digital vernier caliper, number of leaf, number of branches and leaf area (cm2) determined by Clifton Brown (1997) which is Leaf area = 0.74 (LxW)

The experiment was a 3 x 4 factorial experiment laid out in completely randomized design (CRD). There are 12 treatments in all and each treatment was replicated 3 times making a total of 36 stem cuttings of the varieties of mulberry plant.

Varieties/soil	SOO	SOP	SNB
K2	K2 + SOO	K2 + SOP	K2 + SNB
S30	S30 + SOO	S30 + SOP	S30 + SNB
S14	S14 + SOO	S14 + SOP	S14 + SNB
S54	S54 + SOO	S54 + SOP	S54 + SNB

SOO – Soil from Ore, Ondo State (Rainforest)

SOP – Soil from Onne, Port Harcourt, Rivers State (Swamp Forest)

SNB – Soil from New Bussa, Niger State (Guinea Savannah)

K2, S30, S14 and S54 are Mulberry Plant Varieties.

T1 - K2 + SOO

T2 - S30 + SOO

T3 - S14 + SOO

T4 - S54 + SOO

T5 - K2 + SOP

T6 - S30 + SOP

T7 - S14 + SOP

T8 - S54 + SOP

T9 - K2 + SNB

T10 - S30 + SNB

T11 - S14 + SNB

T12 - S54 + SNB

DMRT was used to separate means at 5% level of significance

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Table 1: Laboratory Analysis of Soils Used

Soil elements	SOO	SOP	SNP
pH	6.4	5.15	6.3
Ca (cmol)	12.16	12.66	13.33
Mg (cmol)	1.18	0.94	4.01
Na (cmol)	0.42	0.29	0.71
K (cmol)	0.22	0.13	0.35
Al	0.07	0.10	0.08
+H (cmol)			
ECEC (cmol)	14.05	14.12	18.48
Base salt (%)	99.51	99.30	99.57
%N	0.15	0.13	0.11
% Organic content	1.90	1.67	1.31
P (mg/kg)	14.94	30.68	11.06
Mn (mg/kg)	90.60	32.8	13.4
Fe (mg/kg)	16.15	53.05	8.65
Cu (mg/kg)	0.85	1.40	0.55
Zn (mg/kg)	7.20	7.75	2.85
%sand	89.60	88.60	85.60
%silt	6.20	6.80	8.80
% clay	4.20	4.60	5.60

Source: Analysis from SMO Laboratory service, Ibadan,

From above table, the top soil from swamp forest (SOP) had the highest pH (5.15) this is acidic. The pH under swamp forest can be attributed to the presence of micro organisms on the surface that acts on leaf litter, while the reduction in pH of soils from rainforest (SOO) and guinea savannah (SNB) with values 6.4, 6.3 may be attributed to the increase in bases such as Ca, K and Mg. the effective cation exchange capacity ECEC) in guinea savannah (SNB) was higher (18.48cmol/kg) than the other soils. This may be attributed to the degree of weathering and leaching processes as described by Kang et al., 1991. Further, Ore, rain forest soil (SOO) had the highest value of %N followed by Onne, Swamp forest (SOP), New Bussa and Guinea savannah (SNB) had the lowest value thus 0.15, 0.13 and 0.11 respectively. Also, Onne, Swamp forest (SOP) had the highest value of %P, followed by Ore, rainforest soil (SOO), while New Bussa, Guinea Savannah (SNB) had the lowest value thus 30.68, 14.94 and 11.06 respectively. The reason may be due to the fact that there had been a depletion of the essential nutrient in the soil due to continuous cropping system. Therefore, this work supported Shashidhar, *et al* (2009) that highly intensive mulberry cropping system causes depletion of nutrients in the soil and excess usage of inorganic fertilizers and pesticides caused deleterious effect on soil health.

RESULTS AND DISCUSSION

Table 2: Effect of soils from three selected ecological zones of Nigeria on growth variables of *Morus alba* seedlings.

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Treatment/Variables	Height (cm)	Stem Diameter (mm)	Leaf Production	Leaf Area (cm_2)	No of Branches
T_1	22.33	3.25	16.33	20.06	2.00
T_2	20.07	3.02	9.67	18.75	1.67
T_3	18.57	3.23	14.67	12.36	2.00
T_4	18.53	2.73	11.00	16.03	2.00
T_5	6.43	2.11	5.33	7.47	1.67
T_6	15.73	2.93	9.33	16.25	2.00
T_7	27.97	3.74	17.33	20.57	2.00
T_8	12.67	2.53	11.67	15.43	1.67
T_9	12.57	2.61	10.00	11.64	2.00
T_{10}	15.07	2.72	12.00	16.58	2.00
T_{11}	21.83	3.19	13.67	19.94	2.00
T_{12}	14.97	2.27	10.00	14.59	2.33

Table 3: Analysis of variance for height of *Morus alba* seedlings

SV	Df	SS	MS	F-cal	P-value
Factor-F1	3	363.46	121.16	2.31ns	0.10
Factor-F2	2	142.17	71.08	1.36ns	0.28
Int. F1xF2	6	430.61	71.77	1.37ns	0.27
Treatments	11	936.24	85.11	1.62ns	0.16
Error	24	1258.81	52.45		
Total	35	2195.05			

NOTE: * significant at a level of 5% probability (.01=<p<0.05); ns – Non significant (p>=.05); F1 - variety

PLANT HEIGHT

From the table above, T_7 (SOP + S14) had the highest height with value of 27.97cm, followed by T_1 (SOO + K2) with mean value of 22.33cm. While T_5 (SOP + K2) had the lowest mean height value of 6.34cm. The reason for the least performance may be due to the fact that variety K2 does not strive well on soil with high pH. This work supported Ames (2001) who stated that not all soils are equally suited for all species of trees and shrubs and some tree species begin to exhibit nutrient deficiency at higher soil pH, and the findings of Su (1998) that mulberry tree/plants have wide distribution and vigorous growth because, under soil pH value of 4.5 – 8.5 and salt content of 0.2%, mulberry plant still grow normally. Furthermore, there was no significant difference among the treatments used in this study at 5% level of probability.

STEM DIAMETER

From the table above, it was observed that T_7 (SOP + S14) performed best in stem diameter with mean value of 3.74mm, followed by T_1 (SOO + K2) with mean value of 3.25mm. While T_5 (SOP + K2) had the least performance in stem diameter with mean value of 2.11mm. The reason for the least performance may be due to the fact that variety K2 does not strive well on soil with

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high pH. This work supported Ames (2001) who stated that not all soils are equally suited for all species of trees and shrubs and plant depends on the soil type, plant variety and availability of plant nutrient. Analysis of variance (ANOVA) indicated significant differences between the interaction of the soils and varieties.

LEAF PRODUCTION

It was observed that T_7 (SOP + S14) performed best in Leaf Production with mean value of 17.33, followed by T_1 (SOO + K2) with mean Leaf Production of 16.33. While T_5 (SOP + K2) had the lowest performance in Leaf Production with mean value of 5.33. This may be due to the fact that the soils contained the major nutrient element (nitrogen. Phosphorus and potassium) required for mulberry leaf production. This work therefore supported the findings of Jaiswal, *et al.*, (2005), that mulberry leaf productivity is highly dependent on plant nutrients like NPK which are mainly essential for luxuriant growth of mulberry crop. Furthermore, there was no significant difference among the treatments used at 5% level of significance.

LEAF AREA

The table above, it was observed that T_7 (SOP + S14) had the highest leaf area of 20.57cm2, followed by T_1 (SOO + K2) with mean leaf area of 20.06cm2. While T_5 (SOP + K2) had the lowest mean leaf area value of 7.47cm2. This may be as a result of soil type and plant variety. This result was in accordance with Anikumar and John (1999) who stated that mulberry leaf yield and quality depends on the soil type, plant variety and availability of plant nutrients and agro-ecological conditions.

Number of Branch

As shown in the table above, T_{12} (SNB + S54) had the highest number of branches with mean value of 2.33, followed by T_1 (SOO + K2), T_3 (SOO + S14), T_4 (SOO + S54), T_6 (SOP + S30), T_7 (SOP + S14), T_9 (SNB + K2), T_{10} (SNB + S30) and T_{11} (SNB + S14) with mean value of 2.0, while T_2 (SOO + S30), T_5 (SOP + K2) and T_8 (SOP + S54) had the lowest number of branches with mean value of 1.67. This may be seen in the nutrient element of the soils which were in the same range and this supported the findings of Nataraju *et al.*, (2003) that *Morus alba* can grow on a wide variety of soils. Also there was no significant difference among the treatments used at 5% level of significance.

CONCLUSION AND RECOMMENDATION

Improved mulberry varieties with higher leaf productivity are very essential for enhancing and sustaining profitability in sericulture thus cultivation and tending of mulberry plants for the production of succulent and nutritious leaves for the feeding of silkworms (*Bombyx mori*) should be given great consideration for the sustenance of the production of silk. The result of this study showed that the selected varieties of white mulberry thrived well on soils from swamp forest (SOP), Rainforest (SOO) except K2 which had poor performance on soil from swamp forest (SOP + K2). Furthermore, the result also showed that varieties S30 and S54 performed well in soil collected from guinea savanna (SNB).

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