Supported by tetfund TERTIARY EDUCATION TRUST FUND

EVALUATION OF GROWTH PERFORMANCE OF DESERT DATE (*Balanite aegypticaca. L*) SEEDLINGS ON DIFFERENT SOILS IN SAVANNA AGROLOGICAL ZONE OF NIGERIA

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Received: December 13, 2021 Accepted: February 20, 2022

ABSTRACT

Preliminary study was carried out to evaluate growth performance of *Balanites aegyptiaca* seedlings on different soils at the nursery of Federal College of Forestry Mechanization Afaka, Kaduna. Farm land soil, forest soil and granulated iron stone soil were sourced within the college premises and FRIN/JICA plantation and used for the experiment. *Balanites aegyptiaca* seedlings were sown on the different soils and each was replicated eight (8) times. The experiment was laid out in Complete Randomized Design (CRD). Growth parameters were collected forth-nightly and was subjected to analysis of variance (ANOVA) and Duncan multiple range test (DMRT). Results revealed there are significant ($P \leq 0.05$) differences in the plant height, stem diameter and number of leaf among the three different soils for the growth assessment. The growth rate recorded from the farm land soil are statistical higher ($P \leq 0.05$) in leaf width, plant height and stem diameter compared with forest and granulated iron stone soils. Mean seedlings biomass production is significantly higher ($P \leq 0.05$) in farmland soil in leave dry weight (LDW), stem dry weight (SDW), root dry weight (RDW), and total dry weight (TDW) compared with forest soil and granulated iron stone soil. Leaf area (LA) of seedlings were showing similarities under different soil types. Soil from farmland gives the best result, therefore it is recommended for raising and nurturing of *Balanites aegyptiaca* seedlings in the nursery for multiple plantation establishment without addition of any plant nutrient media.

Key Words: *Balanites aegyptiaca* seedlings, soils, heterogeneous environment, farmland, forest soil, ironstone and mineral elementsIntroduction

Introduction

Forest resources are the fruits of evolution that are developed through the combined influence of physical environment and people, and play an important economic, social and cultural role, particularly in the lives of many communities. In the other hand, soil is defined as the topmost layer of the earth surface which is essential for plant growth, it is a heterogeneous environment where abiotic factor such as pH, nutrient availability, soil porosity, moisture and biotic factors. These abiotic factors interaction with organism are keys to the creation of niches available for microorganisms to survive and proliferate. (Dumbrell *et. al.*, 2009). The degree of aeration, temperature and water content of soil strongly affects seed germination and seedling emergence via the seed-soil contact. According to Hartmann *et al.*, 2007), seedling production is influenced by the type of soil used, and environmental factors such as oxygen, water, temperature and for some species light. Complexity degree in both time and space has been describe as panacea for soil properties. The variability in soil properties is a function of prevailing soil forming factors and vegetation growing on it. (Obasi *et al.*, 2011)

Balanites aegyptiaca is a species classified as a member of Zygophyllaceae. This tree is native to mainly Africa and parts of Middle East. It is called Desert date, soap berry tree, Thorn tree, and in Egypt, it is called Egyptian Myrobalan and Egyptian balsam. While in Hausa it is called Aduwa, in Tuareg language it is called 'Taboraq", in Swahili Mchunju while it is called Bedena in Amharic (Delile, 2016). It is widely spread in the drier regions of Africa from Mauritania to Nigeria (Manji *et al.*, 2013). It has about 25 known species distributed from tropical Africa to Burma. It is a savannah tree that can attain the height of more than 6 metres with large spread of crown and simple spine of up to 5cm long (Manji *et al.*, 2013). The branches have long, straight green spines arranged in spirals. The dark green compound leaves grow out of the base of the spines and are made up of two leaflets which are variable in size and shape. The fluted trunk has grayish brown, ragged-bark with yellow-green patches where it is shed (Delile, 2016).

The plant is well known for its multipurpose medicinal uses, and rich in steroidal saponins that produced diosgenin, which is a source of steroidal drugs such as corticosteroids, contraceptives and sex hormones (Farid *et al*., 2002). The species is known to provide diverse goods and services such as food, fodder, fibre, timber, gum, lipid and medicines (Orwal *et al.*, 2009). It is also a good species for shade, shelter and used for boundary, barrier or support being a thorny tree species (Orwal *et al.*, 2009). However, due to excessive exploitation for a variety of purposes, this species falls in the category of endangered plant species (Elfeel, 2012). Desert date is reported to be highly resistant to pest and insects attack, and for this reason, it is widely used for the production of different household utensils (Rabi'u *et al.*, 2013). The species holds great potentials and as such recommended for use in Agroforestry.

The objective of the study is to determine the extent to which the species will respond to different types of soil to enhanced growth and development for successive and multiple plantation establishment, since the forest growth and survival in relation to soil types and parameters in forest estate are of the utmost importance to foresters and forest ecologists in predicting future growth and ecosystem stability

Materials and Methods

Experimental Site

The study was carried out in the nursery of the Federal College of Forestry Mechanization, Forestry Research Institute of Nigeria, Afaka, Kaduna State, Nigeria. It lies between latitude 10^0 35'and 10^0 34' North and longitude 7^0 21'and 7^0 20' East, and 613m above sea level (Adelani, 2015; Sodimu, 2016) in Northern Savannah ecological zone. The average annual temperature and rainfall is 25.2 °C and 1211mm respectively, with mean monthly relative humidity reaching up to about 29%. It is an open woodland with tall grasses of about (1m -3m) in height usually with broad leaves. (Sodimu *et al*., 2019).

Treatment and Experiment Design

The experiment consists of three soil types namely: forest soil, iron stone soil and farm land soil, laid out in Complete Randomized Design with eight replications per treatment.

Materials

Forest soil and granulated iron stone were collected from FRIN/JICA plantation at Afaka. The ironstone was from a deep level through the use of digger. Farmland soil was collected from Crop Production Technology (CPT) departmental practical site. Other materials used include Soil auger, watering can, black polythene pots, mortar and pestle.

Method

The two soil samples (farmland and forest soils) were collected using soil auger at 10cm depth while the iron stone soil was collected and grinded with a mortar and pestle to fine particles, then each soil samples were thoroughly mixed together to form a uniform sample, 10g of each soil were packed and labelled for laboratory analysis and the rest are then filled into polythene pots to commence the experiment. The seedlings of four weeks' old which are raised under normal environmental conditions were gotten from Trial Afforestation Project, (TAP) at the point of collection the seedlings were good looking, the leaves are greenish and glabrous with no sign of nutrients deficiency of any nature. These are transplanted into soil samples and readings were taken forth nightly for three (3) months.

Growth parameters for assessment

The growth variables measured were: seedling stem height, collar diameter and number of leaves. Metre rule was used to measure height, micrometer screw gauge for collar diameter and number of leaves was counted fortnightly for twelve weeks. Seedlings biomass was assessed at the end of the experimental period (3 Months) through destructive method (Mukhtar, 2016). Seedlings were sampled and separated into root, stem and leaves. The leaf area of seedlings was measured by tracing the area covered on graph sheet using the proportional method of Maku *et al.*, (2014). Fresh weight of root, stem and leaves were measured before they were oven dried for 24h at 80°C to constant weight.

Analysis Procedures

***Soil analysis*:**

The three (3) soil types were analyzed for its chemical properties at the soil science laboratory of Ahmadu Bello University Zaria, Nigeria.

Soil laboratory analysis procedures

Soil pH was determined in suspension of soil water at ratio of 1:2 soil to water and measured using glass electrode pH water as was described by Nelson and Sommer (1982). Available Phosphorus (P) was determined using Bray method of Grossman and Ranches (2002). Exchangeable Calcium (Ca) and Magnesium (Mg) were determined using EDTA (Ethylene Diamine Tetra-Acetic Acid) Versanate titration method, Potassium (K) using flame photometer (Handershot and Lelande, 1993) and Nitrogen was determined using micro Kieldahl digestion method (Nelson and Sommer, 1982).

Statistical analysis:

The data collected were analyzed using Anova at P= 0.05 probability level and subjected to Duncan Multiple Range Test (DMRT) (Steel and Torrie, 1960)

Results and Discussion

The data recorded for the evaluation of growth performance of *Balanite* aegyptiaca seedlings is presented in tables below:

Number of Leaves

Number of Leaves of *Balanite aegyptiaca* plant as influenced by different soil sources shows that leaves were high at farm land and forest soils throughout the trial period. At 2 weeks after transplanting, forest soil produced highest (7.00) leaves while farmland had the least (5.13). Least significant number of leaves were obtained from plants grown in iron stone soil 6 to 12WAT, while forest and farm land soils maintained consistent and significantly ($P \leq 0.05$) higher number of leaves than iron stone soil. This observation is in line with finding of (Emeghara *et al*., 2017) that farm land soil is good soil media source for nurturing *Balanite aegyptiaca*.

Table 1: Influence of soil type on number of leaves of *Balanite aegyptiaca*

	Number of leaves					
Treatment	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT
Farmland soil	5.13^{b}	6.13	6.50^{a}	6.50^{a}	6.50^{a}	6.50^{a}
Forest soil	6.38^{a}	6.25	6.25^{a}	6.25^{a}	6.25^{a}	6.25^{a}
Iron stone soil	6.38^{a}	5.38	5.00^{b}	5.00^{b}	5.00^{b}	5.00^{b}
SE$\pm$	0.25	0.69	0.24	0.24	0.24	0.24

Means followed by same letter(s) within same column are not statistically different at *P=0.05* level of probability using DMRT

WAT= Weeks after transplanting

Plant Height

The results of soil type on plant height is presented in table 2 shows that plant height of *Balanite aegyptiaca* as influenced by different soil were statistical similar in farmland and forest soils. The least significant ($P \leq 0.05$) growth of *Balanite aegyptiaca* occur in the iron stone soil. Miehe (1986) reported that *Acacia albida* planted on farmland soil grew better than all other soil type, while Emeghara *et al*. (2008) observed that Jatropha curcas planted on farmland soil grow luxuriantly.

Table 2: Influence of Soil type on Plant Height (cm) of *Balanite aegyptiaca*

	Plant height (cm)					
Treatment	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT
Farmland soil	16.69[a]	16.67[a]	17.00	17.98[a]	18.26[a]	18.45
Forest soil	16.05[a]	16.88[a]	16.86	17.45[ab]	17.95[ab]	18.45
Iron stone soil	14.49[b]	14.79[b]	15.31	15.83[b]	16.31[b]	16.74
SE±	0.73	0.70	0.68	0.69	0.69	0.68

Means followed by same letter(s) within same column are not statistically different at *P=0.05* level of probability using DMRT

WAT= Weeks after transplanting

Stem diameter

Stem diameter of *Balanite aegyptiaca* presented in table 3 shows no significant (P≥0.05) different between the sampling interval for all the treatments. At 2 to 8WAT forest soil and farm land soil maintained consistent significantly higher stem diameter than iron stone soil. However, at 2WAT, iron stone soil was highest followed by forest soil while farmland soil recorded lowest stem diameter. At 12WAT, forest soil was highest (6.95) followed by farmland soil (6.46) and the least was iron stone soil (6.41). The above result did not agree with the finding of Sodimu (1998) that ironstone soil gives better growth of stem diameter of young seedlings.

Table 3: Influence of Soil Type on Stem Diameter (mm) of *Balanite aegyptiaca*

	Stem diameter (cm)					
Treatment	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT
Farmland soil	4.70	4.98	5.43[b]	6.00[b]	6.31[b]	6.46[b]
Forest soil	4.89	5.30	5.99[a]	6.42[a]	6.81[a]	6.95[a]
Iron stone soil	4.94	5.09	5.39[b]	5.88[b]	6.28[b]	6.41[b]
SE±	0.14	0.12	0.14	0.14	0.14	0.14

Means followed by same letter(s) within same column are not statistically different at *P=0.05* level of probability using DMRT

WAT= Weeks after transplanting

Leaf Width

Table 4 below showed the leaf width of *Balanite aegyptiaca* as influenced by different soils were not significantly (P≥0.05) different. B*alanite aegyptiaca* planted on forest soil at 4WAT had highest width of 102.8cm as against 78.38cm and 25.53cm in iron stone and farm land soils. However, at 6-10WAT, farmland soil had higher width than forest and iron stone soils, with highest width of 146.49cm recorded at 10WAT. However, there were no data available 12WAT for the three soil type. The above results agree with the finding of Emeghara *et. al.* (2008) and Elfee (2012) that nutrients composition of farmland soil resulted in wider leaf when compared with other soils.

Table 4: Influence of Soil Type on Leaf Width (cm) *Balanite aegyptiaca*

	Leaf width (cm)					
Treatment	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT
Farmland soil	75.84	25.53[b]	148.92[a]	143.90[a]	146.49[a]	0.00
Forest soil	73.97	102.8[a]	110.02[b]	110.48[b]	115.51[b]	0.00
Iron stone soil	79.82	78.38[a]	81.44[c]	76.01[c]	79.02[c]	0.00
SE±	2.72	8.66	8.59	8.31	8.25	0.00

Means followed by same letter(s) within same column are not statistically different at *P=0.05* level of probability using DMRT

WAT= Weeks after transplanting

Seedlings biomass

Leaf dry weight (LDW), stem dry weight (SDW), root dry weight (RDW), total dry weight (TDW) and leaf area (LA) of seedlings were showing similarities under different soil types. Seedlings raised with farmland soil produce superior seedlings biomass while iron stone soil have the least (table 5). This is in agreement with the work of Mukhtar (2012) and Maku *et al.* (2014)

Table 5: Seedlings biomass of *Balanite aegyptiaca* under different soil type.

Treatment	LDW(g)	SDW(g)	RDW(g)	TDW(g)	LA(cm^2)
Farmland soil	1.50^a	1.24^a	2.50^a	5.24^a	8.40^a
Forest soil	1.42^a	0.94^b	2.24^{ab}	4.60^a	7.30^{ab}
Iron stone soil	0.84^b	0.92^b	1.68^b	3.44^b	6.00^b
SE$\pm$	0.14	0.093	0.216	0.354	0.627

Means followed by same letter(s) within same column are not statistically different at *P=0.05* level of probability using DMRT

WAT= Weeks after transplanting

Chemical properties of soil

Table 6 show chemical properties of the three soil type used for the experiment. Farmland and ironstone soils were slightly acidic while forest soil is closely neutral. The forest soil had the highest calcium (Ca) content followed by farmland soil, and iron stone soil was the least. Forest soil had the highest magnesium (Mg) content, next was the farmland soil and the least was the iron soil. The iron stone had the highest potassium (K) content followed by the forest soil and farmland was the least. The farmland soil had the highest phosphorus (P) content followed by forest soil while iron stone was the least. This result implies that farmland soil has the highest nutrient capacity and soil pH for the growth and development of the seedlings.

Table 6: Chemical properties of the Soils Use in the Experiment

Soil Type	Soil pH	Ca	Mg	N	K	P
Farmland soil	6.00	2.40	1.41	1.05	0.43	8.28
Forest soil	6.35	4.80	2.82	1.58	0.70	2.12
Iron stone soil	5.70	1.50	0.88	1.23	0.87	1.73

Conclusion and Recommendation

Conclusion

It is evident from this study that farmland soil gives best results while granulated iron stone soil gives least for the optimum growth performance of *Balanite aegyptiaca* in the Northern Guinea Savanna, Agrological zone of Nigeria.

Based on the above result, soil from farmland give best result, and therefore, recommended for raising and nurturing of *Balanites aegyptiaca* seedlings in the nursery for multiple plantation establishment without addition of any plant nutrient media.

References

Adelani DO 2015. Effect of Pregermination treatment and Sowing on Early Growth of Seban (*Sebania seban*). *Applied Tropical Agriculture*, 20 (1): 31 – 36.

Baker CJ 2006. Drilling into dry soil. (No-tillage seeding in conservation agriculture) In: C.J. Baker, K.E. Saxton, W.R. Ritchie, W.C.T. Chamen, D.C. Reicosky, M.F.S. Ribeiro, S.E. Justice and P.R. Hobbs FAO and CAB International, Rome, (Italy), (Eds.) Pp. 74-84

Delile A 2016. Balanites Genus: U. S National Plant Germination System. Handbook on seedling Evaluation, 3rd edition.

Dumbrell AJ, Nelson M, Helgason T, Dytham C & Fitter AH 2009. Relativeroles of niche and Natural Processes in Structuring a Soil Microbial Community, The ISME Journal 4: 337-345.

Elfeel AA 2012. Effect of seed pre-treatment and sowing orientation on germination of *Balanitis aegyptiaca* seeds. *Journal of Agriculture Environmental Science*, 12: 897-900.

Emeghara UU, Adelani DO, Sodimu AI & Sirajo A 2017. Influence of Seed Storage Duration on Chemical Composition, Germination and Early Seedling Growth of *Jatropha curcas* in the Northern Guinea Savanna Agrological zone. *Forest and Forest Products Journal*. 10: 97-105. ISSN: 2006-8026.

Emeghara UU, Olukotun O, Onwuegbuna DO, Sodimu AI & Isola A 2008. Growth Response of *Jathropha curcas* Cuttings as Influenced by Various Sources of Soil Nutrients. Books of Abstract of the Paper Presented at the 26th Annual Conference of the Horticultural Society of Nigeria (HORTSON), Held at Mubi, Adamawa State, Nigeria.Pp7

Farid HE, Hastinger O, Kunert CW & Hnburger M 2002. New Steroidal glycosides from *Balanities aegyptiaca Helvet. Chim.* 88: 1019-1026.

Grossman RB, & Ranches TG 2002. Bulk Density and Linear extensibility in Methods of Soil Analysis. *Soil Science*.5:201-228

Handershot, W.H and Lelande, M. D (1993). Soil Reaction and Exchangeable Acidity in Soil Sampling and Method of Analysis. *Soil Science* 5:141-145.

Hartmann HT, Kester DE, Davies FT & Genve RI 2007. Hartmann and Kester's plant propagation, principles and practices. 7th Edn., Prentice-Hall of India Pvt. Ltd., p. 880

Ladipo DO 1989. *Balanite aegyptiaca*: A Native Tree Potential for Agroforestry and Arid Zone Afforestation in Nigeria. Trees for Development in Sub Saharan Africa. Proceedings of a Regional Seminar Held by The International Foundation for Science (IFS), ICRAF House, Nairobi, Kenya. Pp. 207 – 212.

Manji AJ, Sarah EE, & Modibbo UU 2013. Studies on the potentials of Balanites aegyptiaca seed oils as raw materials for the production of liquid cleansing agents. International Journal of Physical Sciences, 8 (33): 1655-1660.

Maku JO, Gbadamosi AE, & Fadoju OA 2014. Germination and Seedlings Growth of *Mansonia altissima (A. Chev)* in Response to Hormonal Treatment. International Journal of Agriculture and Forestry. 4 (4): 269-274.

Mukhtar RB 2012. Effect of Some Silvicultural Treatments on Early Growth of *Diospyros mespiliformis.* MSc. Dissertation of the Department of Forest Resources Management, University of Ibadan, Nigeria

Miehe S 1986. *Acacia albida* and Other Multipurpose Tress on The Fur- Farmlands in the Jebel Marra Highlands, Western Darfur, Sudan. Agroforestry System.4 (2):89 – 119.

Nelson DW & Sommer LE 1982. Total Carbon Organic and Organic Matter in Method of Soil Analysis. *Soil Science*. 5:127-186.

Olujobi OJ & Dahunsi. OM 2009. Comparative effect of potting soils from different sources on early growth of *Afzelia africana* seedling. *Journal of Researches in Agricultural Sciences*, 2(1&2): 82-86

Orwa C, Mutua A, Kinddit R, Jamnadass R & Anthony S 2009. Agroforestry Database: a tree reference and selection guide version 4.0. Retrieved from: www.worldagrofrestry.org/sites/treedatabases.asp. 15/06/2017

Rabi'u T, Garba KA, Ibrahim A, & Murtala R 2013Indigenous trees inventory and their multipurpose uses in Dutsin-ma area Katsina State. European Scientific Journal, 9 (11): 288-300

Steel RGD & Torrie JH1980. Principles and procedures of statistics with special reference to the Biological Sciences. McGraw-Hill book company Inc. New York, USA. 481pp.

Sodimu AI 1998. Influence of Granulated Ironstones Overlay Depth on the Growth of Teak (*Tectona grandis* Linn F.) Seedlings in South Western Nigeria. B. For. & Wild life Mgt. Thesis Submitted to Department of Forestry and Wildlife Management. University of Agriculture Abeokuta, Nigeria. Pp 23

Sodimu AI, Onwumere GB, & Yilwa VM 2019. Soil Based Heavy Metals Originating from Anthropogenic Activities on Floristic Composition of Some Selected Sites in Kaduna Northern Guinea Savanna of Nigeria. *Asian Journal of Environment and Ecology.* Vol. 10 (4); 1-10. ISSN: 2456 – 690X. DOI: 10.9734/AJEE/2019/V10: 430122. www.journalajee.com/index.php/AJEE

Sodimu AI 2016. Soil Heavy Metal Content from Some Human Activities and the Effect on Biodiversity in Kaduna Northern Guinea savanna of Nigeria. Unpublished Ph. D Thesis Submitted to *Department of Biological Sciences, Nigeria Defence Acedemy, Kaduna* Pp305