



Evaluation of Growth Performance of Physic Nut (*Jatropha curcas*) Seedlings on Different Soils in the Northern Guinea Savanna Agrological Zone of Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Authors AIS and RS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors GLL and OO managed the analyses of the study. Authors NOO and TAA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The preliminary study was carried out to evaluate the growth performance of *Jatropha curcas* seedlings on different soils at the nursery of the 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. *Jatropha curcas* 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 that there are significant ($P>0.05$) difference in the height, stem diameter and number of leaf among the three different soil for the growth assessment. The growth rate recorded from the farm land soil are statistical higher

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($P > 0.05$) in leaf width, plant height and stem diameter than the other two soil while the growth parameters assessed were significantly lower ($P > 0.05$) in iron stone soil and forest soil. It is recommended based on the parameters assessed that soil from the farmland gives the best result for raising and nurturing of *J. curcas* in the nursery without addition of any plant nutrient media.

Keywords: *Jatropha curcas* seedlings; forest soils; guinea savanna; nursery; nutrient media.

1. INTRODUCTION

Jatropha Curcas is a species of flowering plants in the spurge family *Euphobiaceae*; it is cultivated in the tropical and sub-tropical region around the world [1]. The common names include purging nut, physic nut, Barbados nut, in Nigeria the plant is called binidazugu (Hausa) lapapapa / botuje (Yoruba); odoala (Igbo) [2]. *Jatropha curcas* is a native to Mexico and Central American and was likely transported to India and Africa in 1500s by Portuguese sailor. *Jatropha* is a drought resistant perennial crop which grows well in marginal soil. It is easy to establish, grow very fast and can produce seeds for 50 years. The seeds have oil content of 37% [3] and the oil can be combusted as fuel without being refined. It burns with clear smoke-free flame and has been tested successfully as fuel for simple diesel engines. It is a plant that has gained a considerable interest among other hardy plants that can be used to reclaim eroded land [1]. The by-product is the press cake, a good organic fertilizer; the oil also contains an insecticide. *Jatropha curcas* is rugged, easy to propagate and grows in many parts of the country. Medically, it is used to cure diseases such as cancer, piles, paralysis and Dropsy [4,5]. All parts of the plant including seeds, leaves and barks are either used as fresh or as a decoction in traditional medicine and for veterinary purposes. The leaves are used to cure common cold, catarrh and stalk is also being used to cure toothache [2,5]. The oil from the kernels can be transformed into biodiesel fuel through esterification [6]. *J. curcas* is not grazed by animals including goat and serves as a live bio-fence around. The pepsin digestible nitrogen in *Jatropha curcas* meal has also been found to be about 93 – 96% and suggesting high availability of protein when fed to animals [7,8], it is also cheaper and good source of livestock feed [4] *J. curcas* has become an important crop internationally, it has so many useful purposes, this includes medicinal uses to cure some diseases and ailments as well as skin rashes, it is used as insecticides, it is also a significant source of vitamin and nicotinamide; it is used to reclaim eroded land and also the oil from the seeds is a bio-fuel which is an attractive alternative to crude oil [4].

Cultivation is un-complicated. *Jatropha* grows in tropical and sub-tropical region complete germination is achieved within nine (9) days. *Jatropha* a large soft weeded deciduous shrub is a widely growing hardy plant, in arid and semi-arid region of the country on degraded soil having low fertility and moisture [9]. It thrives well on stony, gravelly or shallow and even on calcareous soil having soil depth of about two feet. Despite its importance, there is limited supply of *Jatropha curcas* to meet the demand of the people. Therefore, there is need for large scale production of *Jatropha curcas* on a most suitable soil source. Although, it can be grown under wide range of arid and semi-arid climate condition but cannot withstand heavy frost [1]. Depending on soil quality and rainfall, oil can be extracted from the nuts after two (2) to five (5) years. The annual nut yield ranges from 0.5 to 12 tons. It can be cultivated successfully in the region having scanty to heavy rainfall with rainfall ranges from 500 – 1200 mm [10]. Adding manure during the germination has negative effect during that phase, but is favourable if applied after multiplication by seed [11]. Hence, the objective of the study is to evaluate the growth performance of *Jatropha curcas* on different soils for large scale production to meet demand and supply of the plant.

2. MATERIALS AND METHODS

2.1 Experimental Site

The experimental was carried out at Federal College of Forestry Mechanization Afaka Kaduna. It lies between $10^{\circ}37'$ North and longitude $7^{\circ}47'$ East [12]. The college is situated in the Northern Guinea Savanna ecological zone. Rainfall is approximately 100 cm annually with the lowest 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 [13].

2.2 Treatment and Experiment Design

The experiment consists of three soil types namely: Forest soil, Iron stone soil and farm land soil, laid in a Completely Randomized Design and each treatment was replicated eight times.

2.2.1 Materials

The materials used for the experiment are as follows:

- i. Forest soil collected from FRIN/JICA plantation.
- ii. Farmland soil collected from Crop Production Technology (CPT) Departmental practical site.
- iii. Granulated iron stone collected from FRIN/JICA plantation from a deep level through the use of digger.
- iv. Black polythene pots.
- v. Soil auger
- vi. Watering can.

2.2.2 Methods

The two soil samples (farmland and forest soils) were collected using soil auger at 10 cm 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, 10 g 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.

2.2.3 Growth parameters for assessment

The plant height was assessed, measuring from the base of the plant to the apex. The average was computed; number of leaves were also counted and the stem of the plant assessed using a veneer caliper. The number of the nodes were recorded and at the end of the terminal experiment, the plant was removed and the length of the longest root and the total number of the root were computed.

2.3 Analysis

2.3.1 Soil analysis

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

2.3.2 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 [14]. Available Phosphorus (P) was determined using the Bray method of Grossman and Ranches [15]. Exchangeable Calcium (Ca) and Magnesium (Mg) were determined by using EDTA (Ethylene Diamine Tetra-Acetic Acid) Versanate titration method; Potassium (k) using flame photometer [16] and lastly, Nitrogen was determined using the micro Kieldahl digestion method apparatus [14].

2.4 Statistical Analysis

The data collected were analyzed using ANOVA at $P > 0.05$ probability level and subjected to Duncan Multiple Range Test (DMRT).

3. RESULTS AND DISCUSSION

The data recorded for the evaluation of growth performance on *Jatropha curcas* seedlings for three (3) months on the three different soil sources are presented in the tables below.

Number of Leaves of *Jatropha* plant as influenced by different soil sources were significant ($P > 0.05$) at all the sampling intervals except at 4 weeks after transplanting. At 2 weeks after transplanting, farm land soil produced significantly higher number of leaves than all other soil types but statistically comparable to plants grown in forest soil. Least significant number of leaves resulted from plants grown in iron stone soil. At 6 to 12 weeks after transplanting, forest soil and farm land soil maintained consistent significantly ($P > 0.05$) higher number of leaves than iron stone soil. This observation is in consonance with the work of [17] that Farm land soil are good soil media source for nurturing *J. curcas*.

Plant height of *Jatropha curcas* plant as influenced by different soil were significant ($P > 0.05$) higher in farmland soil than other two (2) Soil. The least significant ($P > 0.05$) growth of *J. curcas* occur in the iron stone soil [18] reported that *J. curcas* planted on farmland soil grew better than all other soil types.

Stem diameter of *Jatropha curcas* plant in Table 3 show no significant ($P > 0.05$) different between the sampling interval for all the treatments. At 2

to 8 WAT forest soil and farm land soil maintained consistent significantly higher stem diameter than the iron stone soil. However, at 2 WAP, the iron stone soil was the highest followed by the forest soil while the farmland soil was the lowest. At 12 WAT, the forest soil was the highest at (5.95) followed by the farmland soil at (5.46) and the least was the iron stone soil at (5.41). The above result did not agree with the work of [19] that ironstone soil gives better growth of stem diameter of young seedlings.

Leaf width of *Jatropha Curcas* plant influenced by different soils were significant ($P < 0.05$) at all the sampling period from the 2 to the 12 WAT. *Jatropha Curcas* plant on the farm land soil maintained the highest leaf width of the three (3) treatments, next was the plant in the forest soil while the least was the iron stone. This is in agreement with the work of Emeghara et al., (2008) that nutrients composition of farmland soil

gives good leave width when compared with other soils.

Table 5 show the chemical properties of the three (3) types of soil used in the experiment, two (2) of the three (3) soils (Farmland soil and Ironstone soil) were slightly acidic while the forest soil closely neutral. The forest soil had the highest calcium (Ca) content followed by the farmland soil and the iron stone soil was the least, the 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 the farmland was the least. The farmland soil had the highest phosphorus (P) content followed by the forest soil while the 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 1. Influence of soil type on number of leaves of *Jatropha curcas*

Treatment	Number of leaves					
	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT
Forest Soil	6.00(ab)	5.38	5.25(a)	5.25(a)	5.25(a)	5.25(a)
Iron stone	5.38(b)	4.38	4.00(b)	4.00(b)	4.00(b)	4.00(b)
Farmland soil	6.13(a)	5.13	5.50(a)	5.50(a)	5.50(a)	5.50(a)
SE ±	0.25	0.69	0.24	0.24	0.24	0.24

i. Means in the same column followed by unlike letters are significantly different at $P > 0.05$ level of probability using Duncan's Multiple Range Test (DMRT)

ii. WAT = Weeks after transplanting

Table 2. Influence of soil type on plant height of *Jatropha curcas*

Treatment	Plant height					
	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT
Forest Soil	15.03a	15.48a	15.86a	16.43a	16.95a	17.45c
Iron stone	13.45b	13.79b	14.31c	14.81c	15.31b	15.74b
Farmland soil	15.29a	15.65a	16.00a	16.78b	17.26ab	17.45a
SE ±	0.72	0.69	0.67	0.68	0.68	0.67

i. Means in the same column followed by unlike letters are significantly different at $P > 0.05$ level of probability using Duncan's Multiple Range Test (DMRT)

ii. WAT= Weeks after planting

Table 3. Influence of soil type on stem diameter of *Jatropha curcas*

Treatment	Stem diameter					
	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT
Forest Soil	3.89(a)	4.30b	4.99b	5.42(a)	5.81(a)	5.95(a)
Iron stone	3.94(a)	4.09b	4.39b	4.88(b)	5.28(b)	5.41(b)
Farmland soil	3.70(b)	3.98a	4.43b	5.00(b)	5.31(b)	5.46(b)
SE ±	0.14	0.12	0.14	0.14	0.14	0.14

Means in the same column followed by unlike letters are significantly different at $P > 0.05$ level of probability using Duncan's Multiple Range Test (DMRT).

WAT= Weeks after transplanting

Table 4. Influence of soil type on leaves width of *Jatropha curcas*

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

i. Means in the same column followed by unlike letters are significantly different at $P > 0.05$ level of probability using Duncan's Multiple Range Test (DMRT)

ii WAT= Weeks after transplanting

Table 5. Chemical properties of the soils use in the experiment

Soil	Soil PH	Ca	Mg	N	K	P
Iron stone	5.7	1.50	0.88	1.23	0.87	1.73
Farmland soil	6.0	2.40	1.41	1.05	0.43	8.28
Forest soil	6.35	4.80	2.82	1.58	0.70	2.12

4. CONCLUSION AND RECOMMENDATION

4.1 Conclusion

It is an evident from the results of this study that significant difference occurs among the three (3) soils evaluate in raising of *J. curcas*. However, based on all the parameters assessed farmland soil gives the best results while granulated iron stone soil gives the least for the optimum growth performance of *Jatropha curcas* in the Northern Guinea Savanna, Agrological zone of Nigeria.

4.2 Recommendation

Based on the above result *Jatropha curcas* can be best raised using farmland soil without additional of any other potting media. Although, the other two (2) soils (granulated iron stone and forest soil) can be used in the absence of farm land soil but additional plant nutrient media like organic or inorganic fertilizers will be needed for optimum growth and development of the plant.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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