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Improving Physic Nut (*Jatropha curcas*) – a Bio-fuel and Multipurpose Crop Production in Sub-Saharan Africa through Appropriate Nursery Media

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Physic nut *(Jatropha curcas)* is a bio-fuel and multipurpose crop that can be used to produce biodiesel, biogas and latex. The toxic substances – curcin and diterpenoids in raw *Jatropha* leaves and seeds can scare grazing animals away and this suggests the possibility of using the plant as live fence to curb cattle menace which is one of the major constraints facing crop production in Sub-Saharan Africa especially in Nigeria. Despite its nutritive, medicinal and economic values, *Jatropha* is one of the most neglected crops in Nigeria and in sub-Sahara Africa at large. There is often loss of vigour of *Jatropha* seedlings due to high seed oil content which results in rancidity and weak seedling growth. An experiment was conducted at Enugu State Polytechnic, Iwollo, Enugu state, Nigeria to determine the appropriate nursery media towards improving the production of *Jatropha curcas* in sub-Saharan Africa. Four nursery media viz: 3:2:1; 1:2:1; 0:0:1 and; 1:0:0 of top soil, organic manure and river sand respectively, were evaluated. The experiment was laid out in Completely Randomized Design (CRD) with three replications. Data on emergence percentage, seedling height, number of leaves per seedling and seedling girth were collected and analyzed using Analysis of variance (ANOVA) for CRD. The treatment means with significant differences were separated using least significant difference at 0.05 probability level. The results showed that there was no significant difference (p>0.05) among the treatments in emergence percentage of

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Jatropha curcas. However, there were significant differences ($p<0.05$) among the treatments in seedling height and stem girth with the highest values obtained in 1:2:1 of top soil, poultry droppings and river sand, respectively and the least in 0:0:1 of top soil, poultry droppings and river sand, respectively. It could be concluded that the use of 1:2:1 of top soil, organic manure and river sand, respectively significantly improved seedling growth of *Jatropha curcas* compared to the other treatments and could therefore be recommended for *Jatropha curcas* nursery for improved production of the crop in sub-Sahara Africa.

Keywords: Bio-fuel; emergence; growth; Jatropha; nursery; seedling.

1. INTRODUCTION

Physic nut *(Jatropha curcas)* is a drought resistant flowering plant belonging to the spurge family, Euphorbiaceae. It originated from Central America and is cultivated in South America, Asia and Africa [1,2]. The name (*Jatropha*) was derived from the Greek words "iatros" (physician or doctor) and "trophos" (nutrition or feed) because of its many potential medicinal applications [3], hence the common name physic nut. In Nigeria, it is referred to as "Lapalapa" by the Yorubas, "Chinidazugu" by the Hausas, "Okwueme" by the Igbos and it is also called "Boboochi" by the natives of Agbani and Obe village in Nkanu Local Government Area in Enugu State, Nigeria [4]. According to Adeoye et al. [5], *Jatropha curcas* is called "Bini da Zugu" in Hausa, "Odo- ala" in Igbo, "Lapalapa or Botuje" in Yoruba.

Jatropha curcas is a multipurpose crop with high economic importance. It is referred to as a bio-fuel crop [6,7]. Products of the crop are now gaining ground all over the world especially in making bio-diesel and bio-gas to power engines. It has good feedstock qualities for biodiesel production [8]. *Jatropha* biodiesel meets European Union (EN14214) and North American standards (ASTM D6751) [9,10]. The fruit hulls can be used as green manure or to produce biogas. *Jatropha* seed oil is used to make soap, lubricants, varnish, insecticides or medicine [11]. The oil kernel meal which is extracted from decorticated seeds can be used as fertilizer or as feedstock in biogas production [8]. *Jatropha* kernel meal is a protein-rich product, but only kernel meal obtained from detoxified kernel meal from toxic genotypes of *Jatropha curcas* can be safely used as feed resources [10,12]. *Jatropha* latex is used as dye or as a pesticide and molluscicide [13]. The leaves are used as feed in the rearing of silkworms, and in human nutrition as a vegetable when detoxified for their antimicrobial and anti-inflammatory properties [10]. *Jatropha curcas* leaves or seeds if not detoxified are deleterious to human and animal. They contain toxic substances – curcin and diterpenoids [14]. It is used as a live fence in many tropical and subtropical countries [15]. Presently, researches are being aimed at using *Jatropha* live fence to curb cattle menace which is one of the major constraints facing crop production in sub-Saharan African mostly in Nigeria.

Despite the numerous economic importance of *Jatropha curcas* and increasing interest in the crop as an energy crop all over the world, its production in sub-Saharan Africa is low. Jingura and Kamusoko [15,16] observed that although *Jatropha curcas* has emerged in recent times as a leading energy crop in sub-Saharan Africa with over 39 countries out of 49 in the region involved in its cultivation, the results of production data in terms of agronomic issues and seed yields analyzed showed that most of the attributes generically associated with *Jatropha* have not been achieved in the region and there has been inadequate research to support *Jatropha* cultivation. They observed that by 2008, only five countries in the region (Senegal, Nigeria, Mali, Ethiopia, and Zimbabwe) had policies promoting *Jatropha* cultivation and that those policies were not informed by empirical evidence arising from the performance of *Jatropha* in the region hence, did not promote viable cultivation of the crop in the region. Ojiako et al. [17] noted that the first *Jatropha* Cultivation and Biofuel Production Workshop/Training in Nigeria was just held in 2010 which is an indication that *Jatropha* management practice in Nigeria and in sub-Saharan Africa is just evolving. Santos and Silva [13] noted that the growing and management practices of *Jatropha curcas* are poorly documented. Efforts towards achieving improved *Jatropha* production in sub-Saharan Africa should include good crop establishment in the field and proper management. *Jatropha curcas* can be propagated by seeds or by cuttings. According to Heuzé et al. [18], *Jatropha* plants propagated from cuttings produce many branches but yield fewer seeds and are affected by wind erosion because of their poorly developed taproots. For establishment of a lasting *Jatropha* plantation, propagation by seed is recommended [19]. However, biological constraints such as poor germination rate and loss of vigour affect its propagation through the seeds. There is high oil content in *Jatropha* seed which causes rancidity and poor seedling growth during propagation [20,21]. Finch-Savage and Bassel [22] noted that seedling vigour is an important factor in crop establishment. The inherent low germination and loss of vigour in *Jatropha* can be improved by raising the seedlings in the nursery using appropriate nursery media. Nurseries provide the means to control moisture, light, physical and chemical soil constituents in such a way as to produce healthy and uniform seedlings necessary for planting. [23,24,25] noted that nursery grown *Jatropha curcas* seedlings have a higher chance of survival than the direct seeded in the field and they produce seeds earlier. A nursery media is a substance through which plant root grows and extract water and nutrients. Selecting a good nursery media is fundamental to good nursery management. A good nursery media ensures warmth which aids germination and produces vigorous seedlings which have the capability to establish themselves in field conditions and; increases the survival rate of seedlings in the field. According to Basweti et al. [26], a good nursery media should be well drained, which means an air-filled porosity of at least 15%; re-wets easily; does not shrink away from the side of the nursery container as it dries; be of suitable pH (between 5.0 and 6.5) which is satisfactory for most plants; free from weed seeds, fungal pathogens or can be sterilized without producing harmful byproducts; readily available and; not expensive. Different nursery media have been suggested for tree crops seedlings [27-34]. Soil nursery media is the most commonly employed media for raising seedlings in the nursery due to its availability and affordability. Soil nursery media is usually a mixture of top soil, well decomposed organic manure and river sand in different proportions. It basically gives physically support to growing seedlings, supplies nutrients, water and air to the root system. There is dearth of information on the appropriate nursery media for improved *Jatropha* production. Appropriate nursery media for improved *Jatropha* production should be available, affordable and easy to use by the famers [35,36]. The study was therefore, to evaluate the effect of different soil nursery media on emergence and seedling growth of physic nut (*Jatropha curcas*) aimed at improving the production of the bio-fuel and multipurpose crop in sub-Saharan Africa through appropriate nursery media. The findings will provide the knowledge needed in raising *Jatropha* seedlings in the nursery at an easy and affordable cost to boost *Jatropha curcas* production in sub-Saharan Africa.

2. MATERIALS AND METHODS

2.1 Description of the Study Site

The study was carried out in the nursery of the Teaching and Research Farm of the Department of Agricultural Technology, Enugu State Polytechnic, Iwollo, Nigeria. The study area is located within Latitude 06^o 16.834^{I}N and Longitude 07^o 16.834^{I}E. The rainfall pattern is bimodal: between April-June and September – November with short spell in August known as August break.

2.2 Source of Seeds

The *Jatropha curcas* seeds used for the experiment were collected from the Ministry of Agriculture, Enugu State, Nigeria.

2.3 Experimental Design

The experiment was laid outs in Completely Randomized Design (CRD) comprising four treatments with three replications. The treatments were 3:2:1; 1:2:1; 0:0:1 and 1:0:0 by volume of top soil, organic manure and river sand, respectively.

2.4 Nursery Operation

The experiment was carried out in the nursery. Different nursery media comprising a mixture of top soil, well cured poultry manure and river sand in the ratio of 3:2:1, 1:2:1, 0:0:1, 1:0:0, respectively were prepared and put inside poly-pots. Three poly-pots were used for each treatment. The poly-pots were perforated to allow for water drainage. 10 seeds of *Jatropha curcas* were sown in each poly-pot at a depth of 5 cm. The nursery was watered as at when due. Seedling emergence was observed daily starting from the sowing date to 14 days after sowing. The nursery was managed for 6 weeks.

2.5 Data Collection

Seedling emergence, seedling height, number of leaves per seedling, and seedling stem girth were observed during the study period. The total number of seedlings that emerged in each poly-pots 14 days after planting were counted and used to calculate the emergence percentage. Thus;

$$\text{Emergence percentage} = \frac{\text{Total number of seedlings emerged}}{\text{Total number of seeds sown}} \times \frac{100}{1}$$

Two stands from each poly-pot were tagged and used as sample plants upon which data were collected on seedling height, Stem girth seedling and number of leaves per seedling. Data collection on these growth parameters was on two weekly intervals up to 6 weeks after sowing. Seedling height was determined using measuring tape to measure from the base of the seedlings to the apical bud of the seedlings. Number of leaves per seedling was determined by direct counting of the leaves per seedling. Stem girth seedling was determined by measuring the stem circumference at the seedling base using measuring tape.

2.6 Statistical Analysis

The data collected from the study were subjected to analysis of variance (ANOVA) for Completely Randomized Design using Genstat Release 10.3DE software [37] and significant means were separated using Least Significant Different (LSD) at 5% probability levels.

3. RESULTS

The result of analysis of variance presented in Table 1 showed that there was non-significant difference among the treatments in emergence percentage and in number of leaves of *Jatropha curcas* seedlings. The result also showed that there was non-significant difference in the height of *Jatropha* seedlings at two weeks after sowing. However, there were significant differences ($p<0.05$) among the treatments in seedlings heights at 4 and 6 weeks after sowing (WAS). At 4 WAS, the tallest seedling (20.33cm) was obtained in 1:2:1 treatment followed by 3:2:1 (18.75cm) and; 1:0:0 (18.25cm), while the shortest (15.92cm) was observed in 0:0:1 by volume of top soil, poultry droppings and river sand, respectively. Similarly, at 6 WAS, the tallest seedling (24.13cm) was obtained in 1:2:1 treatment followed by 3:2:1 (20.83cm) and; 1:0:0 (18.92cm), while the shortest (16.42cm) was obtained in 0:0:1 by volume of top soil, poultry droppings and river sand, respectively. The stem girths of the *Jatropha curcas* seedlings did not differ significantly among the treatments at 2 WAS. However, there were significant differences ($p<0.05$) in the stem girths of the seedlings among the treatments at 4 and 6 WAS. At 4 WAS, the highest stem girth (3.45cm) was obtained in 1:2:1 by volume of top soil, poultry droppings and river sand followed by 3.167cm obtained in 3:2:1 and 2.867cm obtained in 1:0:0 while the least (2.633cm) was obtained in 0:0:1 by volume of top soil, poultry droppings and river sand. Similarly, at 6 WAS, the highest stem girth (3.867cm) was obtained in 1:2:1 by volume of top soil, poultry droppings and river sand followed by 3.467cm obtained in 3:2:1 and 3.067cm obtained in 1:0:0 while the least (2.817cm) was obtained in 0:0:1 by volume of top soil, poultry droppings and river sand.

4. DISCUSSION

Improved production of physic nut (*Jatropha curcas*) – a bio-fuel and multipurpose crop in Sub-saharan Africa can be achieved through appropriate nursery media as indicated by the results of this study. Nursery media has been found to influence seedling emergence and

Table 1. Effect of different nursery media on emergence percentage, height, number of leaves and stem girth of Physic nut (*Jatropha curcas*) seedlings

Nursery media		Seedling height (cm)			Number of leaves			Stem girth (cm)		
	EP (%)	**2WAS**	**4WAS**	**6WAS**	**2WAS**	**4WAS**	**6WAS**	**2WAS**	**4WAS**	**6WAS**
3:2:1	36.7	15.42	18.75	20.83	2.83	4.17	5.17	2.933	3.167	3.467
1:2:1	56.7	16.77	20.33	24.13	3.67	5.50	5.33	2.833	3.45	3.867
0:0:1	40.0	15.33	15.92	16.42	3.33	3.67	4.17	2.567	2.633	2.817
1:0:0	53.3	17.62	18.25	18.92	3.33	4.50	4.67	2.8	2.867	3.067
$LSD_{0.05}$	NS	NS	2.811	1.688	NS	NS	NS	NS	0.2535	0.196
CV (%)	28.3	11.1	8.2	4.5	20.6	16.5	22.7	10.9	4.4	3.2
S.E	13.23	1.815	1.493	0.897	0.677	0.736	1.099	0.3021	0.1346	0.1041

E.P.: Emergence percentage. NS: Not Significant; $LSD_{0.05}$ = Least significant difference at 5% probability level; CV = Coefficient of variation; S.E. = Standard error. WAS = Weeks after sowing growth [38,39]. The evidence in this study revealed important influences of different nursery media to the growth of *Jatropha curcas* seedlings. Emergence percentage was not significantly influenced by different nursery media. This was in agreement with the findings of Baiyeri [27] who reported non-significant media effect in African breadfruit. The different nursery media evaluated were all soil-based media and probably provided similar soil conditions for germination and emergence of *Jatropha* seedlings. The results obtained in seedling height and girth indicated that *Jatropha curcas* seedlings showed superior performance when nursery media containing a mixture of top soil, poultry droppings and river sand in the ratio of 1:2:1 by volume respectively, was used followed by 3:2:1. The results were in line with the findings of Ahmad et al. [40] and Turhan et al. [41] who reported that the best medium for the growth of saffron was mixture containing manure with its double application. The nursery media containing poultry manure (1:2:1 and 3:2:1) performed better than those with no poultry manure (1:0:0 and 0:0:1). This possibly was an indication that the soil was poor in nutrient and required nutrient amendment for proper *Jatropha* nursery management. The farming practices in Sub-saharan Africa such as bush burning, intensive cultivation, overgrazing and lack of crop rotation or shifting cultivation due to unfavourable land tenure system predispose the soil to physical and chemical degradation and loss of soil nutrient. Nigeria is one of the five African countries with policy promoting *Jatropha* cultivation [15]. Nwite and Alu, [42] noted that southeastern Nigeria commonly suffer from inadequate supply of major plant nutrients such as nitrogen, phosphorus and basic cations which are often the causes of poor and unprofitable yields of crops. The non significant differences observed in seedlings heights and girths among the different nursery media at 2 WAS were probably due to less time for the mineralization of the nutrients from the poultry manure used in some nursery media. Miyasaka et al. [43] reported slow release of nutrients in organic manure with time. Abou-Elmagd et al*.* [44] noted that poultry manure is rich in nitrogen and other plant nutrients and favours plant growth and development. This possibly explained the vigourous growth observed in seedlings that were raised with nursery media containing poultry droppings at the later stage of the nursery. 0:0:1 treatment contains only river sand which has a characteristic high porosity and low water holding capacity. This probably explained the poor growth responses shown by the seedlings planted in the media. Baiyeri and Mbah [45] noted that potting medium that possesses high water holding capacity alongside optimum nutrient and aeration for plant growth would be an advantage in nursery industry. Number of leaves per seedling was not significantly influenced by different nursery media as at the time the experiment lasted probably because no branching was observed. According to Kathiresan et al*.* (1997), number of leaves is an induction of number of lateral branches per plant.

5. CONCLUSION

The findings of the study showed that different nursery media significantly influenced the growth of physic nut (*Jatropha curcas*) seedlings. Vigourous seedling growth was obtained in nursery media containing a mixture of top soil, organic manure and river in the ratio 1:2:1 by volume followed by 3:2:1 by volume. Seedlings grown in only topsoil (1:0:0 by volume of top soil, organic manure and river sand) and in only river sand (0:0:1 by volume of top soil, organic manure and river sand) did not show vigourous growth.

6. RECOMMENDATIONS

For improved production of *Jatropha curcus* in sub-Saharan Africa, the use of soil nursery media comprising top soil, organic manure and river sand in the ratio of 1:2:1 by volume which is available, affordable and easy to use by farmers in sub-Saharan Africa is recommended for further studies.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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