Soil-based Media for Germination and Growth of African Oil Bean (*Pentaclethra macrophylla* Benth) Seedlings

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Abstract

An experiment was carried out, involving three different soil-based media constituted at four media ratios, on seedling emergence and growth of African oil bean (*Pentaclethra macrophylla* Benth) seed at the plant house of School of Agriculture and Agricultural Technology, Federal University of Technology Owerri, to determine the best media for mass production of oil bean seedlings. The top soil alone served as the control while the other three soil-based media; top soil mixed with cow dung, top soil mixed with rice hull and top soil mixed with saw dust were prepared in the ratios: 1:1, 1:2, 1:3 and 1:4. The treatments were laid out in a Completely Randomised Design (CRD) and replicated six times. Data were collected on days to emergence, plant height, numbers of root hairs, and root length, taken 50 days after planting (DAP). The combination of top soil mixed with saw dust (at 1:3 ratio) performed better than the other media in all the parameters studied showing earliest time of approximately 18 days to emergence, highest mean value of 23.50 cm for plant height, highest mean value of 119 for number of root hairs and 26.60 cm root length.

Keywords:soil-based media, African oil bean, seedling emergence and growth

Introduction

Large-scale cultivation of some crop plants has been constrained by the availability of planting materials. Studies have shown that inherent low multiplication rate in cassava (Okpara and Baiyeri, 2006) and short durability for seeds of Vigna subterranea in storage (Oboh, 2007) are some factors responsible for low availability of planting materials. The problem of planting materials is more obvious in crops whose edible parts are also used for planting. Seedling production from edible plant parts namely; stem, root, seed etc, are often neglected to the detriment of the yielding potentials of the crops which in turn worsen the prevailing food availability problems.

African oil bean (*Pentaclethra macrophylla* Benth) is a multipurpose plant as almost all its parts are useful. Food wise, the seeds of oil bean can be eaten boiled or roasted. Fermentation of seeds can also be carried out to produce a snack or condiment with a meaty taste. The cooked, processed, and fermented seeds are used in the preparation of many delicious cuisine including African salad, soups and sausages (Aju and Okwulehie, 2005; Enujiugha and Akanbi, 2005). Furthermore, the high degree of saturated oil in the seed of this crop makes it suitable for cooking purposes.

In the farm, African oil bean is used in intercropping as an agroforest plant because it does not severely affect growth of associated crops. Some species of this tree crop shed their leaves during the farming season thereby allowing adequate sunlight

to reach other associated crops. Also, as the leaves fall and decay, they help in improving soil fertility.

Traditionally, extracts from the ripe fruits are applied externally for the treatment of wounds in both man and animals. Extracts from the leaf, stem bark, seed and fruit pulp have anti-inflammatory and anti helmintic activities. They are also used to treat gonorrhoea, obesity, heart problems, high blood pressure, convulsion, and also as analgesic. The bark from the root is used as a laxative, an antidote against dysentery and as a liniment against itch. An infusion of the bark is used as an abortiaficient in Cameroon (Oboh, 2007). *Penthraclethra macrophylla* also plays a major role in various traditional ceremonies and festivals.

Industrially, pestles, mortars, wooden hoe handles and other wooden tools can be made from this tree crop. Wood from African oil bean is hard and suitable for making electric poles, railway sleepers, and general carpentry. Ash from wood or pods is used as mordant in dying industries while the empty dry pods and branches serve as fuel-wood for cooking. Oil extracted from the seeds can also be used as drying oil for cosmetics, paints and varnishes.

Bees often forage the flowers of this tree crop for their nectar which help them in the production of honey (Latham, 2008), thus making this tree most suitable candidate in agroforest agricultural system. Aesthetically, African oil bean is occasionally used in road beautification by planting them along streets and avenues. In spite of the usefulness of this crop there is dearth of information on efforts made for commercial production of its seedlings. Currently, this crop though not endangered by genetic erosion has greatly declined in number in some areas (Oboh, 2007) whereas in most cases they are found growing in the wild. Consequent upon the aforementioned, this study was set up to determine the most favourable germination medium for *P. macrophylla* with the view to ensuring its domestication in order to forestall any danger of genetic erosion.

Materials and Methods

This research was carried out at the Plant house of School of Agriculture and Agricultural Technology, Federal University of Technology, Owerri located at latitude 50 25'N and longitude 70 0' E, within the rainforest zone of south-eastern Nigeria with altitude 57.55 m above sea level, a mean annual rainfall of 2500 mm and relative humidity of 88.6 %.

Materials used for this study comprised: seeds of *P. macrophylla* (Figure 1), obtained from germplasm collection of Department of Crop Science and Technoogy, Owerri, top soil, cow dung, from FUTO cattle ranch, rice hull, from Abakaliki rice mill, and saw dust, from Naze saw mill. Black perforated nursery polyethylene bags of 25 × 23 cm were used for potting.

The treatments comprised: top soil alone, top soil mixed with cow dung, top soil mixed with rice hull, and top soil mixed with saw dust. The mixtures were made at the ratio of 1:1, 1:2, 1:3 and 1:4 for each media giving a total of 12 treatments while the top soil alone was used as the control. The treatments were constituted and filled up to the three-fourths of the nursery bag watered and labelled appropriately. The treatments were replicated six times and assigned to the experimental units at random using Completely Randomised Design (CRD). Physical method of scarification of seeds was carried out using knife. Care was taken not to damage the embryos/seeds to avoid introduction of fungal and bacterial pathogens into the seeds. The soaking and drying method as described by Basu and Pal (1980) was modified, as the scarified seeds were soaked in water for 24 hours, drained and spread on wood ash, and then allowed to dry for 24 hrs at normal laboratory temperature. The seeds were then planted in the polyethylene bags at 2 seeds per bag and later thinned down to one. The bags were watered once a week with about 3 mL per bag while cultural phyto-sanitory practice was adopted by hand-picking weeds as they appeared.

Data were collected on: days to emergence, plant height (cm), number of root hairs formed and root length, taken 50 days after planting (DAP). All data collected were analysed using analysis of variance (ANOVA). Test of means of significance was done using Fisher's least significant difference at 5% level of probability.

Figure 1 Sample of seeds of *Pentaclethra macrophylla* used for the study

Results

Table 1 contains the result of the effects of nursery media and media ratio on days to emergence of African oil bean seeds. There was no significant difference (P=0.05) on days to emergence among the different media and their ratio. However, the Medium TS+SD at the ratio of 1:3 recorded the least mean value of days to emergence (DTE) of 18.85 days. On the other hand, the medium TS+CD at the ratio of 1:2 had the highest mean value for days to emergence of 22.58 days.

Result on the effects of nursery media and media ratio on plant height at 50 days after planting is presented in Table 2. Contrary to the result on emergence, there was significant differences (P=0.05) for nursery media and media ratio (P=0.05) while there was no significant difference in medis x ratio interaction with regards to plant height at 50 days after planting. TS+SD medium at the ratio of 1:3 recorded the highest mean plant height of 23.50 cm while the medium TS+CD at the ratio 1:1 had the least mean plant height of 13.60 cm.

Table 3 shows the effects of nursery media and media ratio on the number of root hairs at 50 days after planting. Result showed that there were no significant differences on the effect of the nursery media and media ratio on the number of root hairs 50 days after planting. However, TS+SD medium at the ratio of 1:3 had the highest mean value of 119.30 for number of root hairs counted at 50 DAPS. On the other hand, the medium TS+CD at the ratio 1:2 had least mean value of 40.50 for number of root hairs at 50 DAP.

Table 1 Effects of nursery media and media ratio on days to emergence of *P. macrophylla*

Nursery media	Media ratio				
	1:1	1:2	1:3	1:4	Mean
TS+CD	21.20	25.30	22.00	21.80	22.58
TS+RH	21.70	24.50	20.00	18.50	21.18
TS+SD	21.20	18.00	17.50	18.70	18.85
Mean	21.37	22.60	19.83	19.67	
$LSD_{(0.05)}$	Media = NS				
$LSD_{(0.05)}$	Ratio = NS				
$LSD_{(0.05)}$	Media x ratio = NS				

Where; TS= Top soil, CD= cow dung, RH= Rice hull, SD= Saw dust

Table 2 Effects of nursery media and media ratio on plant height at 50 days after planting (DAP)

Nursery media	Media ratio				
	1:1	1:2	1:3	1:4	Mean
TS+CD	13.60	16.70	15.88	14.80	15.25
TS+RH	15.20	14.20	16.70	21.36	16.87
TS+SD	17.40	22.30	23.50	19.90	20.78
Mean	15.4	17.73	18.69	18.69	
$LSD_{0.05}$	Media = 6.82				
$LSD_{0.05}$	Ratio = 7.89				
$LSD_{0.05}$	Media x ratio = NS				

Table 3 Effects of nursery media and media ratio on number of root hairs of *P. macrophylla* at 50 DAP

Nursery media	Media ratio				
	1:1	1:2	1:3	1:4	Mean
TS+CD	43.0	40.5	62.6	55.6	50.4
TS+RH	66.3	54.3	65.6	107.6	73.5
TS+SD	63.5	81.3	119.0	74.5	84.7
Mean	57.6	58.7	82.5	79.2	
$LSD_{0.05}$	Media = NS				
$LSD0_{.05}$	Ratio= NS				
$LSD_{0.05}$	Media x Ratio = NS				

With respect to root length (Table 4), result shows that there was no significant difference in the nursery media and media x ratio interaction. However, there was a significant difference (P=0.05) in the media ratio used. The ratio of 1:3 gave the longest root length of 21.1 cm followed by

Table 4 Effects of treatment media and media ratio on root length of *P. macrophylla* 50 days after plinting.

Media	Ratio				
	1:1	1:2	1:3	1:4	Mean
TS+CD	18.50	13.90	19.40	13.40	16.30
TS+RH	19.50	16.50	17.30	21.50	18.70
TS+SD	17.30	21.20	26.60	16.60	20.43
Mean	18.43	17.20	21.10	17.17	
LSD0.05 Media = NS					
LSD0.05Ratios = 8.26					
LSD0.05 Media x ratio = NS					

18.4 cm for 1:1 ratio. Generally, the medium TS+SD recorded the highest mean value of 26.6 cm at 1:3 top soil:saw dust mixture followed by TS+RH with 21.5 cm at 1:4 ratio, whereas the least mean root length of 13.40 cm was observed for the medium TS+CD at 1:4 media ratio.

Discussion

Major consideration in choice of base materials used in formulating potting media for seed germination and seedling growth are; nutrient, moisture, aeration and anchorage. To a large extent, the physicochemical properties of potting media are determined by its base materials (Sahin et al, 2005; Baiyeri and Mbah, 2006). Furthermore, potting media should be formulated so as to create clear variability and marked differences in their composition. In this study, the base materials were top soil mixed with; rice hull, cow dung and saw dust, and the three soil-based media were formulated in four ratios of 1:1, 1:2, 1:3 and 1:4. Clear differences were observed in plant height. In addition, emphasis on the recycling of certain biodegradable waste products for crop production informed the choice of the major components of the base materials as in Ogbede et al. (2009) that used municipal waste in cassava production.

Although there was no significant difference on the effect of the three different soil-based media used in this study on seedling emergence, there was variability on days to emergence. The least mean days to emergence of 17.50 days at the ratio of 1:3 was observed for the media TS+SD. Saw dust which has the capacity to open heavy soils have some implications on the low bulk density of this medium as it had more (three times) saw dust and less of top soil. Thus, it enhanced seedling emergence due to low soil compaction. In many seed based experiments, seeds of many plant species will not germinate well at an Oxygen level considerably lower than that present in the atmosphere. This agreed with Mayer and Poljakoff-Mayber (1989). Also, the low bulk density of this medium enabled proper drainage which helps in the maintenance of appropriate temperature suitable for germination at against water log condition that reduces the temperature of a medium. This is in line with Robert (1988). On the contrary, TS+CD medium at the ratio of 1:2 had the highest mean value of days to emergence of approximately, 26 days. This could be attributed to the nature of this medium, because it is bulky and poorly aerated. Cow dung also has low porosity making it prone to water logging which could have led to delayed emergence. The water logged condition may lead to seed decay. This agrees with Ball (1975) who reported that poor physical condition of a medium is a very common inhibitor of seedling development.

From this study, TS+SD at the ratio of 1:3 had the highest mean plant height value of 23.50 cm. This may be due to the neutral pH of saw dust (7.05) (Nwachukwu et al., 2011) which aided fast nutrient mineralization and made nutrients in the medium readily available to the embryo that resulted in vigorous increase in plant height. On the other hand, lowest plant height of 13.60 cm for TS+CD at the ratio of 1:1 indicated a slow release of nutrients in cow dung medium was probably due to nutrient immobilization in cow dung, which invariably affected the nutrients availability to the seeds (Gana, 2009). However, this result is in disagreement with the report of Osaigbovo et al. (2010) who reported highest value for plant height in top soil and cow dung mixture, though the conditions of the two experiments may not be same. The root development of *P. macrophylla* at 50 days after planting indicates no significant differences on the number of root hairs and root length. Similar to the results on emergence and plant height, the medium TS+SD at the ratio of 1:3 consistently recorded the highest mean for number of root hairs and root length at 50 DAP of

119.30 and 26.60 cm, respectively. Again, the lowest mean value of 50.43 for number of root hairs and 13.40 cm for root length was recorded for the medium TS+CD at the ratio of 1:2 and 1:4 respectively. Studies have shown that critical to plant growth is the relative balance of air and water within a soil's pore space (Bruckner, 1997; Caron and Nkongolo, 1999). Low porosity and poor aeration are interwoven and these conditions will retard root development as observed in this experiment in TS+CD medium. The synthesis and metabolic activities (cell division and differentiation) that facilitate root development require sufficiently aerated medium such as provided by TS+SD.

Conclusions

Potting media can enhance mass production of African oil bean seedlings for agroforestry establishment. In this experiment the medium, top soil mixed with saw dust at the ratio of 1:3 consistently performed better than the other media used in the study. Hence, this medium can support mass propagation of *P. macrophylla*.

References

Aju, P.C. and I.C. Okwulehie. 2005. *Pentaclethra macrophylla* (Benth): an important but neglected fruit tree species in south eastern Nigeria. In L. Popoola, P. Mfon and P.I. Oni, eds. Proceedings of the 30th Annual Conference of the Forestry Association of Nigeria held in Kaduna.

Baiyeri, K.P. and B.N. Mbah. 2006. The effect of soilless media and soil-based nursery media on seedling emergence, growth and response to water stress of African breadfruit (*Treculia Africana* Decne). African J. Biotechnol. 5: 1405-1410.

Ball, V. 1975. The Ball Red Book, 13th Ed. Geo. J. Ball Inc., USA.

Basu, R.N. and P. Pal. 1980. Control of rice seed deterioration by hydration-dehydration pre-treatments. Seed Sci. Technol. 8: 151-160.

Bruckner, U. 1997. Physical properties of different potting media and substrate mixture- especially air and water capacity. Acta Horticulturae 450: 263-270.

Caron, J and V.K.N. Nkongolo. 1999. Aeration in growing media: recent developments. Acta Horticulturae 481: 545-551.

Enujiugha, V.N. and C.T. Akanbi. 2005. Compositional changes in African oil bean (*Pentaclethra macrophylla* Benth) seeds during thermal processing. Pakistan J. Nutrition 4: 27-31.

Gana, A.K. 2009. Evaluation of the residual effect of cattle manure combinations with inorganic fertilizer and chemical weed control on the sustainability of chewing sugarcane production at Badeggi southern Guinea Savanna of Nigeria Middle. East J. Sci. Res. 4: 282-287.

Latham, P. 2008. The oil bean tree (Pentaclethra macrophylla, Benth). Bees for Development Journal 38 online.

Mayer, A.M. and A.M. Poljakoff. 1989. The Germination of Seeds, 4th Ed. Pergamon Press, London.

Nwachukwu, I.O.I., N.E. Ngwu and C. Achumba. 2011. Characterization and evaluation of selected Nigerian Agricultural by-products for copper and Zinc sorption. J. Environ. Sci. Res. Manage 3: 103-109.

Oboh, G. 2007. *Pentaclethra macrophylla* Benth. In H.A.M. Vander Vossen and G.S. Mkamilo, eds., PROTA 14: Vegetable Oils/ Oleagineux. (CD-ROM). PROTA Wageningen Netherland.

Ogbede, K.O., T.T. Epidi, F.N. Ikpe, G.A. Osakwe and E.M. Nwokeji. 2009. Effect of tillage and municipal waste on the incidence and severity of termites on cassava in Owerri. Proc. of the5th National Conference of organic agric, 15-19 Nov. 2009.

Okpara, D.A. and S.O. Baiyeri. 2006. Effect of growth media on propagation of four varieties of cassava. In G.N. Asumugha, A.O.O lojede, J.G. Ikeorgu, U. Herbert, eds. Repositioning Agriculture for Sustainable Millennium Development Goals in Nigeria. Proceeding of the Annual Conference of Agriculture Society of Nigeria (ASN) held at National Root Crop Research Institute, Umudike, Oct 16th - 20th, 2006.

Osaigbovo, A.U., C.N.C. Nwaogualaand J.E. Falodun. 2010. Evaluation of potting media for the production of pepper fruit (*Dennetiatripetala*) seedlings. Afr. J. Gen. Agric. 6: 47-51.

Roberts, E.H. 1988. Temperature and seed germination. Symp. Soc. Exp. Biol. 42: 109-32.

Sahin, U., S. Ors, S. Ercisli, O. Anapali and A. Eristken. 2005. Effect of pumice amendment on physical soil properties and strawberry plant growth. J. Central Europ. Agric. 6: 361-366.

Manuscript received 28 April 2013, accepted 31 March 2016