INFLUENCE OF GROWTH MEDIA ON THE RATE OF EMERGENCE, GROWTH PARAMETERS AND DEVELOPMENT OF *Garcinia cola* SEEDLINGS IN SOUTHEASTERN NIGERIA

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ABSRACT

The study investigated the influence of ground charcoal, sawdust, cured farm yard manure, rivers and, standard nursery soil (3:2:1, topsoil, poultry manure and river sand) and dry crop residues in the early growth and development of *Garcinia cola* in the nursery. *Garcinia cola* fruits were explored and gathered from a matured producing tree and the seeds processed. All the growth media were bagged in the standard perforated nursery polybags (27 cm x25 cm: 1 mm thick), were laid flat in Teaching Farm of Federal University of Technology, Owerri. Data on some growth parameters: Percentage emergence, plant height, number of leaves and wet and dry biomass weight were collected. The data collected were subjected to analysis of variance (ANOVA) and lest significant difference (LSD) was used for separation of significantly different means. The results showed that all the growth media enhanced seedling emergence above 75% and further revealed that at 12 weeks after planting, seedlings in sawdust could still be sustained. At the later stage of growth, seedlings in ground charcoal performed well more than standard nursery soil (3:2:1, topsoil, poultry droppings and river sand) in almost all the plant growth parameters and developments evaluated in *Garcinia cola* in the nursery.

Keywords: *Garcinia cola*, growth media, growth and development, nursery, Southeastern Nigeria

Introduction

Nursery operations involve raising seedlings of different media. Growth media are the materials similar to soil that physically support plants growth (Ekpo and Sita, 2010). Sakin *et al*, (2005): Agbo and Omaliko,(2006) reported that nursery potting media influenced quality of seedlings produced there off. The quality of nursery potting medium is important to the successful growing of plants in containers (Wilson *et al.*, 2001). The physical composition of a nursery mix has a profound effect on the supply of water and air to the growing plants (Beardsell and Nicholas, 1982) and affects anchorage, as well as nutrient and water-logging capacity of the medium. The development of standardized plant growing medium is an area of research that is fast gaining attention among workers in an attempt to providing alternative growing media other than soil that will be suitable for container culture. As nursery media development continues world-wide, a wide range of crop residues, organic wastes and industrial by-products used in nursery media for mutation, the preference largely depends on the relative availability, economics, physical and chemical attributes of the existing materials (Akanbi *et al* 2002). Soil imposes numerous limitations for plant growth due to the presence of disease causing organisms in it, poor drainage and aeration resulting in unfavorable soil compaction, degradation due to soil erosion and leaching

Garcinia cola is a medicinal fruit tree crop, which belongs to the family of Guttiferae. It is a tree that grows in the rain forest of West Africa. All parts of tree are useful in local traditional medicine in treating various ailment. Medicinal plants are of great importance to the health of individuals and communities. The medicinal value of these plants lies in some chemical substances that produce a definite physiological action on the human body (Edeoga *et al*., 2005). The most important of these bioactive constituents of plants are alkaloids, tannins, flavonoids, and phenolic compounds (Hill, 1952).

Plants have played a remarkable role in the traditional medicine of various countries. In recent years, the prevention of cancer and cardiovascular diseases has been associated with the ingestion of spices, fresh fruits, vegetables, or teas rich in natural antioxidants (Virgili *et al.*, 2001). Germination is one of the problems farmers usually encounter which reduces the availability of seedlings in the nurseries for possible plantation establishment. The aim of this study is evaluate the influence of some growth media on the rate of emergence, growth parameters and development of *Garcinia cola* seedlings in Southeastern Nigeria.

Materials and Methods

Study Area

This experiment was conducted at the screen house of the Teaching and Research farm of School of Agriculture and Agricultural Technology, Federal University of Technology Owerri, Imo state. Federal University of Technology Owerri is located on latitude 5^0 25' N and longitude 7^0 O' E and an elevation of 55 m above sea level. Owerri has a rain forest agro-ecological characteristics of about 2000 mm annual rainfall and 22-32^0 C mean annual temperature, 89-93% mean relative humidity. The soil of Owerri belongs to the soil mapping unit

number 431 that is Amakama-Orji-Oguta soil associated (FDAR, 1985).

Exploration, collection and seed processing

Matured tree of *Garcinia cola* was explored and identified in a semi wild (farm land) in Umuguma village in Owerri West Local Government Area of Imo state. Matured fruits were collected on-drop and taken to the Crop Science nursery unit and kept under shade after hitting the fruits with heavy stick to facilitate decay for easy extraction of the seeds. After 10 days the seeds were washed with running tap water and spread on the floor of the Crop physiology laboratory for 24 hours dry up the water.

Procurement and preparation of growth media

Charcoal was collect from the students' kitchen canteen in the University and ground with grinding machine. Cured sawdust was procured from the Naze timber market Owerri about 20 km from the University. Cured farm yard manure and poultry droppings were collected from the Animal farm unit of the University. River sand was collected from Otamiri river with the University. Topsoil was dug out from a fallow land of about 3 years.

Experimental design

An experiment of six (6) treatments were completely randomized and replicated 4 times. The treatments consists of charcoal, cured sawdust, cured farm yard manure, river sand, dry crop residue and standard nursery soil (3:2:1=topsoil, poultry droppings and river sand). These various growth media were measured and bagged appropriately into a 27x25 cm sized polyethene bags of 1 mm in thickness. Four seeds of *Garcinia cola* were introduced into the bags with different growth media and watered regularly.

Data collection

$$\text{Percentage seed emergence:} \quad \frac{\text{number of seeds emerged}}{\text{total number planted}} \times \frac{100}{1}$$

$$\text{Coefficient velocity of emergence:} \quad \frac{fi}{fixi} \times \frac{100}{1}$$

Where: *fi* is number of seeds newly germinating on day I; *xi* is number of days from the beginning of germination experiment, and k is the last day of germination.

$$\text{Mean emergence time:} \quad \frac{\sum ni\ di}{\sum ni}$$

Where: *ni* and *di* are, number of germinated seeds and the number of days from the beginning of germination of the experiment, respectively.

The morphological growth parameters measured were plant height (measured from the shoot junction to the shoot tip using a meter rule), number of leaves (determined by counting), leaf area (multiplication of the length and width of the leaves). All the morphological parameters were measured at 12, 24, 36 and 48 weeks, respectively. The fresh and dry weight biomass of the radicle and shoot biomass were determined by the use of a weighing balance at 12 months.

Data analysis

Data collected were subject to Genstat 2007 model and lest significant difference (LSD) was used for separation of significantly different means.

Results and Discussion

Effect of growth media on percentage seed emergence, coefficient velocity of emergence and mean emergence time of *Garcinia cola* in the nursery.

Growth media media (charcoal, farm yard manure, river sand, sawdust, dry crop residue and standard nursery soil had significant ($P<0.005$) effect on percentage emergence of *Garcinia cola* seedlings in the nursery. Charcoal and standard nursery soil growth media significantly ($P<0.05$) produced higher number of seedlings than those in river sand, farm yard manure, dry crop residue and sawdust respectively. Seedlings in river sand were significantly ($P<0.05$) higher than those in farm yard manure and dry crop residue. Growth media recorded significant ($P<0.05$) effect on coefficient velocity of emergence of *Garcinia cola.* Seedlings in standard nursery soil showed the highest coefficient velocity of emergence significantly ($P<0.05$) than those in charcoal, farm yard manure, river sand dry crop residue and sawdust. Growth media had significant ($P<0.05$) effect on mean emergence time of *Garcinia cola* seedlings in the nursery. Mean emergence time of *Garcinia cola* seedlings in standard nursery soil significantly ($P<0.05$) reduced seedling emergence time to 89.40 days than those in river sand (104.50 days), dry crop residue (111.50 days), farm yard manure (115.50 days) and sawdust (123 days) respectively. Charcoal medium significantly ($P<0.05$) reduced mean emergence time to 92.80 days compared to river sand, dry crop residue, farm yard manure and sawdust respectively (Table 1).

Table 1: Effect of growth media on percentage seed emergence, coefficient of velocity and mean emergence time of *Garcinia cola* in the nursery.

Treatments	Percentage seed emergence (%)	Coefficient velocity of emergence	Mean emergence time (days)
Charcoal	100.00	0.92	92. 50
Farm yard manure	80.60	0. 81	115.50
River sand	91.60	0.89	104.50
Saw dust	88.90	0.74	123.70
Standard nursery soil	100.00	1.22	89.40
Dry crop residues	85.50	0.85	111.50
$LSD_{(0.05)}$	7.18	0.20	8.91

LSD= Least significant difference.

Effect of growth media on plant height of *Garcinia cola* in the nursery at 12, 24, 36 and 48 weeks after emergence

At 12 weeks after emergence, plant height of seedlings in sawdust and standard nursery soil (3:2:1=topsoil, poultry dropping, river sand), respectively were significantly (P<0.05) taller than those seedlings in river sand, farm yard manure and charcoal, respectively (Table 2). Seedlings in river sand and farm yard manure and dry crop residue were significantly (P<0.05) taller than those in charcoal growth medium.

At 24 weeks after emergence, plant height of seedlings in charcoal and river sand were significantly taller than those in standard nursery soil, farm yard manure and sawdust and dry crop residue, respectively. Seedlings in standard nursery soil were significantly (P<0.05) taller than those in farm yard manure, sawdust and crop residue, respectively.

At 36 weeks after emergence, charcoal and standard nursery soil produced seedlings significantly (P<0.05) taller than those in farm yard manure, river sand and sawdust and dry crop residue respectively. Dry crop residue produced significantly (P<0.05) taller plants than those in river sand.

At 48 weeks after emergence, seedlings in charcoal growth medium were significantly taller than those in farm yard manure, river sand, sawdust and standard nursery soil and dry crop residue respectively. River sand and standard nursery soil growth media produced seedlings significantly taller seedlings than those in farm yard manure and sawdust growth media, respectively.

Table 2: Effect of growth media on plant height of *Garcinia cola* in the nursery at 12, 24, 36 and 48 weeks after emergence

Treatments	**Weeks after emergence**			
	12	24	36	48
Charcoal	8.93	20.20	22.25	20.32
Farm yard manure	11.46	9.75	12.45	12.53
River sand	11.45	19.25	10.75	17.10
Sawdust	13.07	9.08	12.35	11.83
Standard nursery soil	13.70	16.60	20.75	16.00
Dry crop residues	12.10	10.85	15.45	15.85
$LSD_{(0.05)}$	1.43	2.26	3.64	2.30

LSD= Least significant difference.

Effect of growth media on number of leaves of *Garcinia cola* in the nursery at 12, 24, 36 and 48 weeks after emergence

At 12 and 24 weeks after emergence, growth media had no significant (P<0.05) effect in the number of leaves produced in the nursery (Table 3). At 36 weeks after emergence, growth media showed significant (P<0.05) differences in leaf production. Charcoal, river sand standard nursery soil and dry crop residue produced significantly (P<0.05) higher number of leaves than those in farm yard manure and sawdust growth media respectively. At 48 weeks after emergence, numbers of leaves produced by the seedlings in charcoal were significantly (P<0.05) higher than those in farm yard manure, sawdust, river sand and standard nursery soil and dry crop residue respectively. Numbers of leaves recorded in river sand and standard nursery soil were significantly (P<0.05) higher than those recorded in farm yard manure and sawdust growth media, respectively. Dry crop residue medium significantly (P<0.05) recorded higher number of leaves than those in farm yard manure and sawdust growth media, respectively.

Table 3 Effect of growth media on number of leaves of *Garcinia cola* in the nursery at 12, 24, 36 and 48 weeks after emergence

Treatments	Weeks after emergence			
	12	24	36	48
Charcoal	8.00	12.00	10.25	20.32
Farm yard manure	8.00	10.00	8.00	12.53
River sand	8.00	12.00	9.50	17.10
Sawdust	8.00	10.00	8.00	11.83
Standard nursery soil	8.00	12.00	9.50	16.00
Dry crop residues	8.00	12.00	9.50	16.60
$LSD_{(0.05)}$	NS	NS	1.01	2.30

NS=Not significant; LSD= Least significant difference.

Effect of growth media on leaf area of *Garcinia cola* in the nursery at 12, 24, 36 and 48 weeks after emergence

At 12 weeks after emergence, leaf area recorded in farm yard manure growth medium was significantly (P<0.05) broader than in sawdust growth medium alone, compared to those in charcoal, river sand, sawdust, dry crop residue and standard nursery soil where no significant (P<0.05) differences were recorded (Table 4). At 24 weeks after emergence, seedlings in charcoal and river sand, respectively had significantly (P<0.05) broader leaves than those in farm yard manure, sawdust and standard nursery soil growth media, respectively. Standard nursery soil recorded significantly (P<0.05) broader leaves than those in farm yard manure and sawdust growth media respectively.

At 36 weeks after emergence, seedlings in sawdust growth medium significantly (P<0.05) produced leaves narrower than those in charcoal, farm yard manure, residue, river sand and standard nursery soil respectively. At 48 weeks after emergence, seedlings in charcoal produced significantly (P<0.05) broader leaves than those in farm yard manure, river sand, sawdust and standard nursery soil, respectively. River sand standard nursery soil produced broader leaves significantly (P<0.05) than those in sawdust growth media.

Table 4: Effect of growth media on leaf area of *Garcinia cola* in the nursery at 12, 24, 36 and 48 weeks after emergence

Treatments	Weeks after emergence			
	12	24	36	48
Charcoal	35.10	43.27	46.20	50.12
Farm yard manure	40.10	38.30	39.80	39.73
River sand	37.30	50.17	41.50	43.27
Sawdust	29.00	27.90	20.00	19.77
Standard nursery soil	36.30	55.20	33.20	40.34
Dry crop residues	36.50	53.20	39.70	41.20
LSD(0.05)	9.79	7.16	7.12	5.99

LSD= Least significant difference.

Effect of growth media on wet and dry biomass yield of radical and shoot of *Garcinia cola* seedlings in the nursery at 12 months

Fresh biomass yield of radicle and shoot of *Garcinia cola* seedlings were significantly heavier in charcoal than those in farm yard manure, river sand, sawdust and standard nursery soil. Also fresh biomass yield of radicle and shoot were significantly heavier in river sand than those in standard, farm yard manure and sawdust growth media respectively. Dry radicle and shoot biomass yield were significantly lighter in sawdust growth medium than in charcoal, farm yard manure, river sand and standard nursery soil respectively (Table 5).

Table 5 Effect of growth media on fresh dry biomass of *Garcinia cola* in the nursery at 12, 24, 36 and 48 weeks after emergence

Treatments	Fresh weight (g)		Dry weight (g)	
	Radicle	Shoot	Radicle	Shoot
Charcoal	9.33	16.98	3.95	3.51
Farm yard manure	4.62	10.37	2.10	2.13
River sand	8.55	14.12	3.01	2.88
Sawdust	2.81	6.33	1.74	1.46
Standard nursery soil	7.01	10.43	2.52	2.48
Dry crop residues	7.00	9.92	2.85	2.46
$LSD_{(0.05)}$	0.36	1.35	0.54	0.46

LSD= **LSD= Least significant difference.**

Discussion

Percentage germination and seedling emergence in different sowing media are determined by the composition of the media and the particle sizes of the different components of the media. Charcoal and standard growth media produced highest percentage of seedling emergence. This is in conformity with Ndubuaku and Oyekanmi (2000) who reported that use of materials as part of the sowing media will ensure greater aeration and drainage of the medium which will enhance germination and seedling emergence. Coefficient velocity of emergence of 1.22 (Standard nursery soil) and 0.92 (charcoal) resulted in high percentage seed emergence reduced emergence time of *Garcinia cola* seedlings in the nursery. Coefficient velocity of emergence increases; as more seeds germinate with shorter emergence time (Buss *et al*., 2005) and decreases as less seeds germinate and with shorter emergence time (Isfahan and Shariat, 2007). Charcoal is a highly porous and brittle material which properties are determined by the condition of the carbonization process and used raw materials. The most important physical characteristics of charcoal are highly porosity, low density, bad heat and electricity conductivity etc. The lower the coefficient velocity of emergence value the lower the germination capacity and the longer it takes for seeds to germinate. Growth parameters (plant height, number of leaves and leaf area) evaluated performed relatively well in all growth media used, including sawdust at 12 weeks after planting. As nursery media development continues world-wide, range of crop residues , organic wastes and industrial by-products are used in nursery media formulation; the preference largely depends on the relative availability, economics, physical and chemical attributes of the existing materials (Akanbi *et al.*, 2002).The physical composition of a nursery mix has a profound effect on the supply of water and air to the growing plants (Beardsell and Nichols, 1982) and affects anchorage, as well as, nutrient and water-holding capacity of the medium. This finding is not in conformity with Peter-Onoh *et al*, (2014); Henry *et al*., (2012). These researches reported that sawdust could only sustain seedlings for not more than 4 weeks in the nursery. This result could be attributed to the nature and size of the cotelydon of *Garcinia cola.* Cotelydon of a particular seed is a function of the amount of food reserve that sustains the plant at the early stage of growth and development the seedling. Some variations observed subsequently at various stages of growth could be as a result of the physical and chemical properties of the different media. Choosing the most suitable growing media for the achievement of a successful plant production is very important in potted growth. At the later stage of the nursery, seedlings of *Garcinia cola* in charcoal medium performed very well in almost all the growth parameters evaluated (plant height, number of leaves, leaf area and biomass yield) are index of seedling vigour. Seedling vigour is important for stable establishment and early vegetative growth as well as competitive ability in the field. Charcoal is mostly pure carbon, made by cooking wood with low oxygen. It should be noted that charcoal in a free supply of oxygen forms carbon dioxide (CO_2). Atmospheric carbon dioxide is the primary source of carbon in life on Earth and it plays an important role in photosynthesis. The increase in number of leaves per plant and branches per plant as N increased was an indication that N application increased the vegetative growth of Amaranth (Onwuchekwa-Henry and Muoneke, 2013). The most important physical characteristics of charcoal are highly porosity, low density, bad heat and electricity conductivity etc. Fresh and dry biomass weight of shoot height and root length of the seedlings in the nursery are factors that which is the determining factor of the amount and type of nutrient uptake, showed that the weight of the biomass weight (fresh and dry) in charcoal weighed more than those biomass in other growth media. Leaf dry weight and total dry matter weight are index of biomass production (Rodriguez et al., 1999). Charcoal addition enhanced seedling shoot to root ratio of both tree species (Glaser, 2002). The increased ratio of uptake to leaching due to charcoal application indicates a high efficiency of nutrients applied with charcoal (Lehmann *et al*, 2003)

Conclusion

The quality seedlings obtain from a nursery influences re-establishment in the field and eventual productivity of plant. Using ground charcoal as a nursery growth medium should be encouraged since the poor resource farmers can source them from their

various homes instead of dumping them in the waste bins.

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