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Influence of growing medium and sowing depth on seedling emergence and growth of *Polyalthia longifolia var. pendula* Sonn

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Abstract
An experiment was conducted at the Horticultural Nursery, Federal University of Agriculture, Abeokuta, Nigeria in 2009 and 2010 to evaluate seedling emergence and growth response of Polyalthia longifolia var. pendula Sonn to sowing medium and depth. Treatments consisted of three growing media (topsoil, sawdust and rice husk) and four sowing depths (2, 4, 6 and 8 cm) laid out in 3 x 4 factorial arrangement fitted into a Completely Randomised Design (CRD) with four replications. Data collected on percentage seedling emergence, seedling vigour, height, number of leaves per plant, root and shoot dry weight/plant were analysed using analysis of variance (ANOVA) and means were separated with LSD at $p \leq 0.05$. Seeds sown on topsoil and rice husk had the highest seedling emergence and vigour in 2009 and 2010 years, respectively. Highest number of seedlings emergence and vigour was observed in seeds planted at 2 cm depth. Seedlings from seeds sown at 2 cm depth were tallest with more leaves and greatest dry matter accumulation. Seeds sown at 2 cm depth in topsoil or rice husk performed better compared to those sown in sawdust. Therefore, rice husk is a better substitute for topsoil and 2 cm sowing depth was best for optimum seedling emergence and growth of P longifolia in the nursery.

Keywords: *Polyalthia longifolia,* urban greening, seed germination percentage, seedling vigour

Introduction

Polyalthia longifolia var. pendula commonly called Ashoka or Masquerade or Police tree is a tropical tree belonging to the family Anonnaceae. It is believed to have originated from India and Sri Lanka, but now widely cultivated in many countries of the world for environmental gratification, alleviating noise pollution (Singh *et al*., 1991), phytochemical and ethnobotanical purposes (Ogunbinu *et al*., 2007). Bark and leaf extracts as well as oil from the seeds of *P. longifolia var.pendula* are useful in the food, pharmaceutical and cosmetic industries (Oyedeji *et al*., 2011). The leaves are good for ornamental decoration and the plant can be cut in to form various shapes and maintained in required sizes as main attraction in gardens. In addition, *P. longifolia* var. *pendula* is widely used as street tree and as firewood by local people.

Seed germination and seedling emergence are affected by several factors such as soil temperature (Vozzo, 1983); sowing depth (Minore, 1985) and growth media (Mariappan *et al*., 2014). Sowing depth for plants varies depending on species and seed size (Broschat and Donselman. 1986); type of seed and environmental conditions (Agboola, 1996; McWilliam *et al*., 1998). Growing media mixtures are preferred to single materials for germination due to the presence of better physical and chemical characteristics that enhanced germination percentage compared to single materials. Also, when growth medium made up of appropriate mixture is used, the seeds can be sown deeper without negative effect on seedling (Minore, 1985).

New interest at all tiers of governments and among Nigerians to embrace urban greening perhaps to mitigate the consequences of global warming phenomenon, creates challenges for the nursery men to meet demand for ornamental plants. Recently several billions of naira was spent by Federal and State governments on various city greening and beautification projects. *P longifolia var. pendula,* which bears fruits once in a year, is one of the ornamental trees widely used to adorn Nigerian cities, thus the need to adopt propagation practices that would ensure sustainable availability of the seedlings. Sowing depth and growth media are important factors in seed germination and seedling emergence of ornamental crops. These can have inhibitory effect on growth and vigour of *P longifolia var. pendula* seedlings. Hence, adoption of appropriate sowing medium and depth could improve commercial production of masquerade tree seedlings for field establishment and for implementation of domestication programmes. There have been limited reports on effect of growing medium and sowing depth on seed germination and seedling emergence of *P. longifolia*. Thus this study examined the influence of growing medium and sowing depth, on emergence and seedling growth of masquerade tree.

Materials and Methods

The experiment was conducted in 2009 and 2010 at the Horticulture Nursery,Department of Horticulture, Federal University of Agriculture, Abeokuta (7^o 15' N, 3^o 25'E), Ogun State, Nigeria. Abeokuta is characteristically transitional rain forest ecology with a bimodal rainfall pattern, maximum temperature (34.7ºC) and relative humidity of 82%. Weather records were collected on monthly rainfall, relative humidity, mean maximum and minimum temperature in 2009 and 2010 (Table 2).

In each trial, 2000 fresh ripen fruits with purple or black colour were collected from matured trees at the National Centre for Genetic Resources and Biotechnology (NACGRAB), Ibadan, Nigeria and pooled together. One thousand two hundred (1200) seeds were randomly selected and planted in June 2009 and 2010 for the first and second trials, respectively. The experiment was laid out in 3 x 4 factorial arrangement fitted into a Completely Randomised Design (CRD) with four replications. The factors were growing medium (topsoil, sawdust and rice husk) and depth of sowing (2, 4, 6 and 8 cm) giving a total of twelve treatment combinations. There were forty eight calibrated 7 litres capacity pots and twenty five fruits were planted in each pot. Topsoil was collected with a shovel to a depth of 10 cm from the surface under the forest area (rainforest transition ecology of southwestern Nigeria) of the Federal University of Agriculture, Abeokuta. Rice husk and sawdust were collected from rice and saw mills, respectively in Abeokuta.

Pots were filled with topsoil, sawdust and rice husk to 3 litre points from where a ruler was used to determined 2, 4, 6 and 8 cm heights. Then, seeds were evenly sown on their sides, and covered with varying media to predetermined points on the pots to attain 2, 4, 6 and 8 cm depths. The weight of average seeds was 1.75 g determined by weighing 100 seeds and the average determined. Representative plants (3 plants) were tagged for observation. Data were collected on percentage seedling emergence, seedling vigour, height of seedling, number of leaves per plant, root and shoot dry weight/plant. Seedling emergence was determined using the formula reported by Fakorede and Agbana, (1983), thus;

Seedling emergence percentage: Number of seedlings that emerged x 100

Number of seeds planted 1

Seedling vigour was determined by % seedling emergence/100 x height of seedling (at 30 days after emeregence). Height of seedlings and number of leaves per plant was recorded at 2, 4, 6, 8, and 10 weeks after emergence. Three plant samples per treatment in each replicate were carefully removed from the growth medium by carefully placing under flowing water to wash off the medium particles from the roots. Then, fresh root and shoot samples were oven dried at 70 ºC to constant weight before weighing with the aid of the sensitive scale to obtain the dry weight. The data collected were analysed using analysis of variance (ANOVA) and Least Significant Difference (LSD) test was used to separate the significant means at $p \leq 0.05$.

Results

The result of the chemical analysis of the different growing media revealed that topsoil had 0.05% N, 0.19 mg/kg P, 0.16% K and 0.32% C. Rice husk had 1.03% N, P was 0.36 mg/kg, 0.2% K and 35% C while sawdust contained 1.06% N, 0.75 mg/kg P, 0.07 K and 33% C. The bulk density and total porosity for topsoil, rice husk and sawdust were 1.24 g/dm^3 and 55%, 0.15 g/dm^3 and 90%, 0.12 g/dm^3 and 92%, respectively (Table 1).

Table 1: Physical and chemical properties of the growing media

Growing media	N %	P mg/kg	K %	Ca mg/kg	Mg mg/kg	Cu mg/kg	Mn mg/kg	Zn mg/kg	Fe mg/kg	C %	Bulk Density g/dm^3	Total Porosity %
Sawdust	1.06	0.75	0.07	6050.0	1260.0	0.04	26.0	12.6	1239	33.01	0.12	92
Rice husk	1.02	0.36	0.2	333.0	1295.0	0.14	38.0	62.9	346	35.34	0.15	90
Topsoil	0.05	0.19	0.16	382	890	0.22	14.19	1.44	18.38	0.32	1.24	53

Table 2: Relevant Meteorological Information during the period of the experiments

	2009					2010				
	Mean Temp °C		Total Rainfall (mm)	Relative Humidity (%)	Sunshine Duration (hr)	Mean Temp °C		Total Rainfall (mm)	Relative Humidity (%)	Sunshine Duration (hr)
	Max	Min				Max	Min			
June	26.5	26	140.0	72.0	3.1	37.5	26.1	98.0	86.05	5.5
July	27.0	26.4	160.0	77.2	3.6	37.6	26.0	300.1	97.3	3.6
August	26.7	26.2	162.1	80.7	3.3	37.7	25.5	252.1	98.07	2.7
September	35.0	24	151.6	77.9	3.7	37.6	25.8	210.0	97.2	3.3
October	26.9	26.4	180.1	74.7	3.1	38.0	26.5	142.8	96.8	3.1
November	26.0	26.1	64.6	68.0	3.2	38.0	35.0	15.2	94.0	7.0

Table 3. Seedling emergence and vigour of *Polyalthia longifolia* as affected by growing medium and sowing depth

		2009					**2010**					
Growing medium	**Sowing Depth**	**Seedling emergence (%)**				**Seedling Vigour**	**Seedling emergence (%)**					**Seedling vigour**
		3*	**5***	**7***	**9***		**2***	**4***	**6***	**8***	**10***	
Rice husk	2	34	46	55	61	8.8	55	62	62	78	78	9.9
	4	17	28	42	46	7.31	43	58	58	73	73	9.1
	6	11	33	61.5	60	7.93	43	58	58	72	72	8.5
	8	0	4	25	44	5.02	18	60	60	82	82	9.6
Sawdust	2	65	74	79.5	82	11.60	28	50	50	53	53	6.1
	4	28	57	68	71	9.71	33	52	52	57	57	7.1
	6	20	47	56	62	7.54	10	30	30	50	50	5.7
	8	6	32	49	57	6.53	17	45	47	55	55	6.2
Topsoil	2	38	54	69	76	12.08	35	70	70	82	82	12.7
	4	21	38	56	72	10.32	22	27	33	40	40	5.1
	6	6	18	46	74	9.08	0	13	20	27	27	2.8
	8	0	15	40	57	6.89	0	0	20	27	33	3.9
LSD (P≤0.05)	GM*SD	10.6	12.1	17.4	19.0	3.1	ns	ns	ns	ns	ns	2.6
LSD (P≤0.05)	GM	5.3	6.0	8.7	Ns	1.5	13.9	8.9	11.0	10.7	10.8	1.3
LSD (P≤0.05)	SD	6.1	6.2	10.0	11.0	1.8	ns	10.2	12.7	12.3	12.5	1.5

*= Weeks after sowing, GM =Growing medium, SD= Sowing depth

Growing medium and sowing depth had significant ($p \leq 0.05$) effects on seedling emergence, vigour and growth (Table 3). In 2009, highest seedling emergence (30, 53 and 63%) was in seeds sown in sawdust at 3, 5 and 7 weeks after sowing (WAS), irrespective of the sowing depth. However, topsoil had highest emerged seedlings (70%), followed by seeds sown in sawdust

(68%) and least in rice husk (53%) at 9 WAS. Conversely, irrespective of the sowing depth highest percentage of seedling emergence (40, 60, 60, 76, 76%) was recorded from seeds sown in rice husk across the sampling period in 2010 (Table 3). Vigour of seedlings obtained from seeds sown in topsoil (9.6) and rice husk (9.3) was superior in the years 2009 and 2010, respectively compared to other treatments.

Seeds sown at 2 cm depth had the highest (46, 58, 68 and 73%) and (39, 62, 61, 71 and 75%) emerged seedlings in 2009 and 2010, respectively and least in those planted at 8 cm depth (2,17, 38 and 53%) at 3, 5, 7 and 9 WAS, respectively (Table 3). Sowing of seeds at 2 cm gave the best seedling vigour in both years.

Effect of interaction between growing medium and sowing depth interactions on percentage of seedling emergence and vigour was significant ($p \leq 0.05$). Seeds sown in sawdust at 2 cm depth had the highest (82%) seedling emergence in 2009. However, in 2010, highest seedling emergence (82%) was recorded in seeds sown in topsoil at 2 cm depth and rice husk at 8 cm depth. Generally, seeds sown at 2 cm depth had more emerged seedlings and less when sown at 8 cm across the three media except at 8 cm in rice husk and sawdust which had highest number of emerged seedlings than those sown at 2 cm depth at 10 WAS in 2010. Seedlings from seeds sown in topsoil at 2 cm depth had superior vigour than other treatments in both 2009 (12.08) and 2010 (12.7) trials. The poorest seedling vigour was observed in seedlings from seeds sown in rice husk and topsoil at 8 cm depth in 2009 and 2010, respectively

Table 4. Height, number of leaves, shoot and root dry weight of *Polyalthia longifolia* as affected by growing medium and sowing depth (mean of two trials)

Growing medium	Sowing Depth	Plant height (cm)			Number of leaves/plant			Dry shoot weight (g)	Dry root weight (g)
		8*	16*	24*	8*	16*	24*		
Rice husk	2	10.83	16.65	18.92	4.0	6.3	7.5	3.10	1.92
	4	12.68	16.45	18.88	3.5	6.5	7.5	3.04	1.97
	6	10.75	15.05	18.02	4.3	5.5	8.5	2.54	1.66
	8	7.62	13.35	15.68	3.0	4.8	7.3	2.16	1.04
Sawdust	2	11.27	14.00	14.75	4.3	5.3	7.0	2.13	1.7
	4	11.32	14.20	14.30	3.8	5.0	6.5	2.50	1.59
	6	9.40	12.33	13.42	3.0	4.3	5.5	2.52	1.43
	8	9.70	11.48	12.35	3.3	4	6.0	2.27	0.95
Topsoil	2	12.40	18.92	21.82	3.8	6.3	8.5	3.76	2.02
	4	11.05	16.95	19.55	3.5	5.8	8.0	3.72	2.07
	6	9.40	15.07	18.50	3	5.3	8.8	3.54	1.52
	8	9.72	14.88	17.78	3.5	5.8	6.8	3.79	1.63
LSD ($P \leq 0.05$)	GM*SD	ns	ns	Ns	ns	ns	ns	ns	ns
LSD ($P \leq 0.05$)	GM	ns	1.4	1.3	ns	0.5	1.1	0.6	ns
LSD ($P \leq 0.05$)	SD	1.3	1.6	1.5	0.5	0.6	ns	ns	0.5

*= Weeks after sowing, GM =Growing medium, SD= Sowing depth

Height, number of leaves per plant, root and shoot dry weight of *P longifolia* seedlings was significantly affected by growing media and sowing depth (Table 4). Plants from seeds sown on topsoil (17 and 19 cm) and rice husk (15 and 18 cm) were the tallest with more (6 and 8) leaves per seedling at 16 and 24 WAS, respectively. Similarly, root and shoot dry weight values were in order of topsoil (1.8 and 3.7 g) > rice husk (1.7 and 2.7 g) > sawdust (1.4 and 2.4 g). *P longifolia* seeds sown at 2 cm depth had tallest plants with highest number of leaves, root (1.9 g) and shoot (3 g) dry weight values than when planted at 6 and 8 cm depths.

Effects of growing medium x sowing depth interactions on height, number of leaves per plant, root and shoot dry weight of *P longifolia* seedlings was not significant ($p \leq 0.05$). Generally, seedlings from seeds planted at 2 cm depth were the best in terms of height, production of leaves and dry matter accumulation. However, highest shoot dry weight (3.8 g) was recorded for seedling sown at 8 cm depth in topsoil medium (Table 4).

Discussion

Both growing medium and sowing depth significantly influenced seedling emergence rate, percentage and vigour. Increasing the sowing depth more than thrice the thickness of the seeds negatively influenced percentage and rate of seedling emergence of *P longifolia*. The deeper the sowing depths, the longer the number of days for emergence, the fewer seedlings emerged with less vigour. The result of this experiment agrees with the observation made by Minore (1985) and Arnulfo and Mexal (2002) on fir and three pine species, respectively. In the traditional floricultural nursery under exposed environment, sowing seeds of *P longifolia* at 2 to 4 cm depths is a best option. Though it is possible to use the thickness of seeds to determine sowing depth for seeds, indiscriminately use for all plant species and growing conditions should be avoided. Usually under green house conditions, sowing depth at 1 time the thickness of the seed could be sufficient. It is important to note that in most common nurseries greater number of seeds can be easily washed away when sown at shallow depth (Rowan, 1980). Previous studies established that effect of sowing depth on seedling emergence is dependent on seed sizes and the media used for germination (Broschat and Donselman. 1986; Arnulfo and Mexal, 2002) . In this study, increasing sowing depth 2 to 4 times the thickness of seed affected the earliness and rate of emergence but percentage emergence for *P longifolia* was statistically similar at 6 and 8 cm depth.

Variation in the germination and seedling growth of *P longifolia* across the growing media used in this study could be traced to their physical and chemical properties. The capability of these growing media to support seedling emergence and growth differs. Superior seedling growth observed in topsoil might be linked to high K content which probably favoured early crop establishment. Differences in the time of germination across the media could be due to the extent of bulkiness. Early seedling emergence observed in medium with low bulk density and higher porosity such as sawdust and rice husk used in this study due to less physical barrier for radical and plumule penetration. The extent of ease of plumule penetration to get to the surface of the growing medium as observed in topsoil as a result of formation of a thin superficial crust which constitutes a physical barrier could delay emergence of seedlings. Bulk density and porosity of sowing medium affected availability of air and moisture required for seed germination. It is advisable to use coarser soil as growing medium to overcome this problem. However, seed sown at deeper depth requires more energy and time to emerge. This probably explains the delayed seedling emergence and vigour observed in *P longifolia* seed planted at 8 cm depth. Result from this study corroborates the earlier reports that environmental conditions had significant effect on germination and seedling growth of crops (Broschat and Donselman. 1986; Mariappan *et al*., 2014)

In conclusion, seedling emergence and growth was significantly influenced by growing medium and sowing depth. Sowing seeds of *P longifolia* at 2 cm depth resulted in faster seed germination and best seedling growth. Topsoil supported better seedling emergence and growth compared to sawdust. Therefore, *P longifolia* seeds should be sown in topsoil at 2 cm depth for optimum seedling emergence and growth in the nursery.

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