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EFFECT OF SOWING DEPTH ON THE GERMINATION AND EARLY SEEDLING GROWTH OF *Dialium guineense* WILLD

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ABSTRACT

This study was carried out to determine the effect of different sowing depths on seed germination and seedling growth performance of Dialium guineense. The experiment was laid out in a Completely Randomized Design (CRD) with 5 treatments: 0, 3, 6, 9 and 12 cm sowing depths. Fifteen viable seeds were sown into 15 polypots filled with bulked forest topsoil for each treatment and this gave rise to a total of 75 seeds sown for the 5 treatments. Observation on germination was made and recorded daily for a period of 30 days after sowing (DAS). Inception of plumule emergence was observed and germination percentage calculated for each of the sowing depths (treatments). Evaluation of early seedling growth was based on height, collar diameter and leaf number. Observation on seedling growth performance commenced one month after sowing (MAS) and continued bi-weekly thereafter up to 12 weeks after sowing (WAS). Plumule emergence was earliest at 0 cm sowing depth (10 DAS) and latest at the 12 cm sowing depth (16 DAS). Germination percentage was highest (80.00%) at 3 and 6 cm sowing depths and lowest (13.33%) at 0 cm sowing depth. Highest mean seedling height and collar diameter were observed at 3cm sowing depth while the lowest mean seedling height was observed at 12 cm sowing depth at all growth stages (4, 6, 8, 10, and 12 WAS). Highest mean leaf number was observed in 3 and 6 cm sowing depths at 4 and 6 WAS and in 3 cm sowing at 8 to 12 WAS while lowest mean leaf number was observed in 12 cm sowing depth at 4 to 12 WAS. Mean seedling height did not vary significantly (p>0.05) among 3, 6 and 9 cm sowing depths at all stages of growth. Collar diameter did not vary significantly (p>0.05) among 3, 6 and 9 cm sowing depths at 4 WAS, among all the treatments, at 6 and 8 WAS, and among 6, 9 and 12 cm sowing depths at 10 and 12 WAS. Seedling growth generally decreased with increase in sowing depth. It is recommended that seeds of D. guineense should be sown at shallow depths (from 3 to 6 cm) since best germination and seedling growth were observed at the two depths.

Keywords: *Dialium guineense*, sowing depths, germination, early seedling growth

INTRODUCTION

Dialium guineense commonly known as Black velvet is a multipurpose leguminous fruit tree species belonging to the family of Fabaceae and sub-family Caesalpinioideae (Besong *et al.*, 2016). According to Besong *et al.* (2016), the species is commonly known as "Icheku" in Igbo, "Awin" in Yoruba and as "Tsamiyarkurm" in Hausa Languages. Orwa *et al.* (2009) noted that it is an evergreen tree that grows up to 30m high with a densely leafy crown but often time shrubby in nature. It is widespread and commonly found in both temperate and tropical areas, and can grow in dense savannah forests, shadowy canyons and gallery forests (Orwa *et al.*, 2009; Moronkola *et al.*, 2017). The species is also known to have high medicinal value. The bark and leaves are used against several diseases. The fruit provides food for man. The thirst quenching, refreshing fruit pulp can also be soaked in water and drunk as a beverage (Orwa *et al.*, 2009). Leaves are edible but bitter (Moronkola *et al.*, 2017). The wood is hard, durable, heavy, light brown, with a fine

texture and can be used in the construction of vehicles, houses and flooring and also as firewood and charcoal (Orwa *et al.*, 2009).

Adeogun *et al.* (2012) stated that one of the problems facing afforestation program in the Sahel is the depth of sowing which imposes encumbering soil pressure during shoot up thrust. It is one of the most common errors that occur in nursery and plantation establishment, depending on the type and size of seed (Adeogun *et al.*, 2012). Agboola (1996) and McWilliam *et al*. (1998) stated that each species has a specified sowing depth requirement based on the type of seed and environmental conditions. Sowing depth is an important factor that contributes to achieving a good stand establishment and also higher yields in plants (Ali and Idris, 2015). Sowing in shallow depths can result in poor germination due to inadequate soil moisture at the top soil layer (Desbiolles, 2002) while sowing in deep depths can also significantly reduce germination and growth (Aikins *et al*., 2006).

Despite the numerous benefits of *Dialium guineense*, breeding and conservation of the species still remains a challenge. Although the species is known to grow from seeds in the forest, it has never been cultivated making the process of propagation unclear (Ogbu and Otah, 2017). Olajide *et al.* (2014) noted that attempts have been made to conserve this tree species, but these have been difficult to achieve because of paucity of information on their ecology and silviculture. There is no documented information on the effects of sowing depth on the germination and seedling growth performance of *Dialium guineense*. This study was conducted to fill this gap in knowledge.

The objective of this study therefore, was to ascertain the effect of different sowing depths on the germination and early growth of *D. guineense*. It is hoped that the information provided by this study will be very useful to foresters and farmers in the propagation and management of the species especially regarding the most suitable sowing depth for optimum germination and early growth.

MATERIALS AND METHODS

Study Area

This study was carried out at the forest nursery of the Department of Forestry and Wildlife Management., Faculty of Agriculture, University of Port Harcourt, Rivers State, Nigeria, between March and September, 2018. The University of Port Harcourt is located at Latitudes 4.90794 and 4.90809 N and Longitudes 6.92413 and 6.92432 E on a land area of about 400 hectares in Obio/Akpor Local Government Area of Rivers State (Chima *et al.*, 2017).

Seed Collection, Processing and Viability Test

The fruit was collected from mother trees at the Abuja Campus of the University of Port Harcourt. The seeds were processed manually and bulked to form a seed lot. Viability test was carried out using the floatation method where seeds were soaked in water for three hours. The seeds that sunk were regarded as viable and used for the study while the seeds that floated were discarded.

Experimental Design

The experiment was laid out in a Completely Randomized Design (CRD) with five treatments (sowing depths): (0 cm, 3 cm, 6 cm, 9 cm and 12 cm). A total of 75 randomly selected seeds (15 seeds per treatment) were used for the study. Each seed was sown into a polypot measuring 15cm x 15cm x 20cm (when flat) filled with forest topsoil. Topsoil was collected from 0 – 25 cm depth at the plant nursery using an auger. The collected topsoil was properly bulked to enhance its homogeneity in accordance with Chima *et al.* (2017). Each polypot was taken as a replicate of its own. Seeds were germinated under a 50% light propagator. A calibrated wooden dip stick was used to measure each sowing depth except for 0cm (control) in which the seeds were placed on the surface and covered slightly with soil according to Adeogun *et al.* (2012). The pots were watered twice daily, in the morning and evening. No fertilizers or bacterial and/or mycorrhizal inoculation was used. Weeding was carried out regularly and when required throughout the period of the experiment.

Data Collection

Observation on germination was made and recorded daily for thirty days. Germination percentage and emergence were calculated as:

Germination percentage (GP) =

$$\frac{Total\ germinated\ seeds}{Total\ seeds\ sown} x \frac{100}{1}$$ -------- Equation 1

Emergence (E) = Time of plumule appearance after sowing

Seedling growth data was collected on seedling height (cm), collar diameter (mm), and leaf number. The data collection began thirty (30) days after sowing and continued biweekly thereafter for a

period of 12 weeks. The seedling height was measured from the substrate level to the tip of the youngest leaf using a meter rule; stem collar diameter was measured at the collar position using a digital vernier caliper; while the numbers of fully expanded leaves were determined by direct counting.

Data Analysis

One way analysis of variance was used to test for significant differences in mean values of the measured seedling growth attributes among the different sowing depths (treatments) at $p \leq 0.05$. Duncan Multiple Range Test (DMRT) was used for the separation of means where significant differences were observed. The analysis of variance and mean separation were done using Statistical Package for Social Sciences (SPSS Version 18, SPSS Inc). However, due to poor germination percentage observed in seeds sown at 0 cm depth and the death of seedlings at this depth, 0 cm depth was not included in the analysis for growth parameters.

RESULTS

Effect of Sowing Depth on the Germination inception and germination percentage of *Dialium guineense*

Plumule Emergence

The inception of plumule emergence for the different sowing depths varied from 10 to 16 days after sowing (DAS) (Figure 1). The seeds of *D. guineense* sown at 0 cm depth exhibited rapid plumule emergence (10 DAS); followed by those sown at 3cm (11 DAS), 6cm (13 DAS), and 9cm and 12cm (16 DAS).

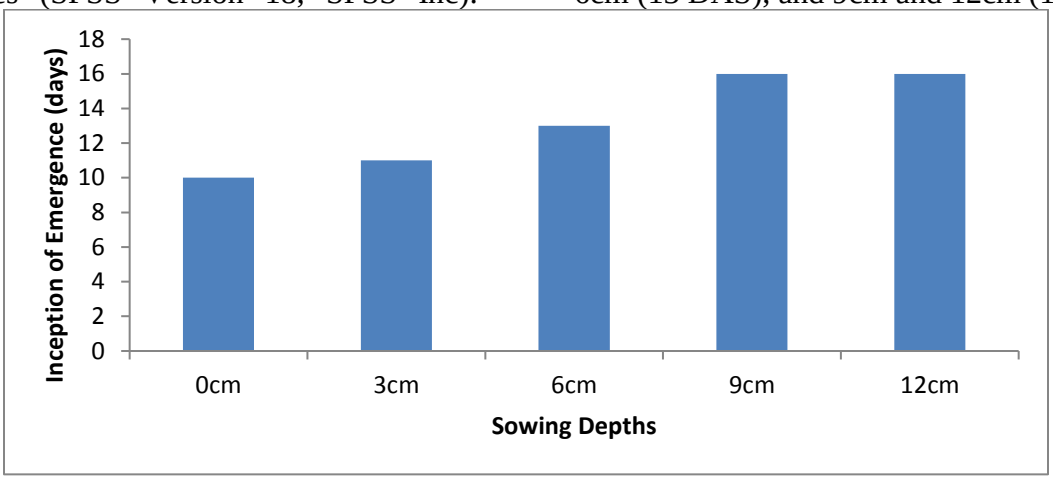

Figure 1: Effects of sowing depth on plumule emergence of *Dialium guineense*

Germination Percentage

Mean germination percentage (GP) varied from 13.33% to 80% (Figure 2). Seeds sown at 3 and 6 cm depths had the highest mean GP (80%), followed by seeds sown at 9 and 12 cm depths (53.33%) while seeds sown at 0 cm depth had lowest GP (13.33%).

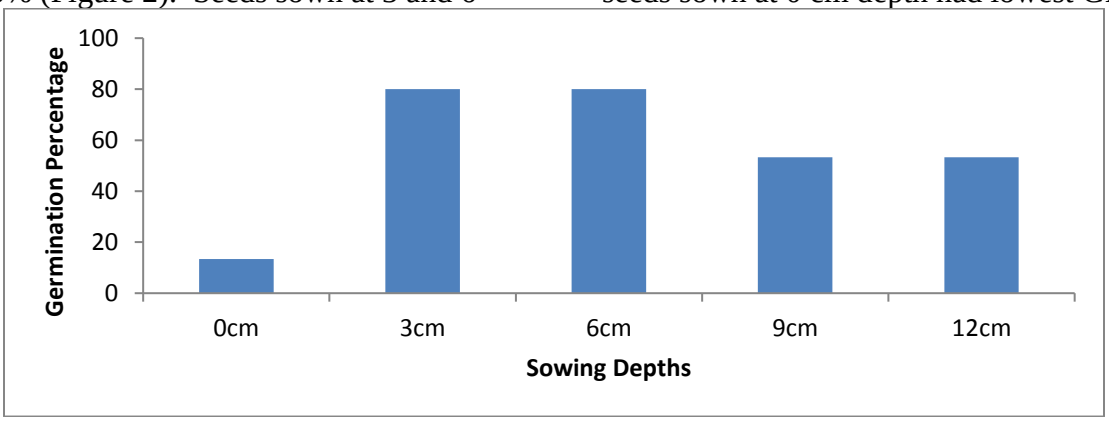

Figure 2: Effects of sowing depth on germination percentage of *Dialium guineense*

Effect of Sowing Depth on early growth performance of *Dialium guineense* seedlings

Seedling Height

Seedlings of *Dialium guineense* subjected to different sowing depths were significantly different ($P \leq 0.05$) in height (Table 1) at 4 to12 weeks after sowing (WAS). Overall mean seedling height 4-12 WAS varied from 7.00 cm at 4 WAS to 12.76 cm at 12 WAS. At weeks 4, 6, 8, 10 and 12, after sowing, seedlings from seeds sown at 3 cm depth had the highest mean height (10.81, 11.06, 11.33, 11.56, and 12.76 cm respectively), followed by seedlings from seeds sown at 6cm depth (9.97, 10.83, 11.16, 11.25 and 12.26 cm respectively), while seedlings from seeds sown at 12 cm depth had the lowest mean height (7.00, 7.80, 8.27, 8.50 and 8.62 cm respectively). However, seedling height did not differ significantly among 3, 6 and 9 cm depths at all stages of growth.

Table 1: Effect of sowing depth on mean seedling height (cm) of *Dialium guineense* seeds

	Seedling height (cm)				
Sowing Depth (cm)	**4 WAS**	**6 WAS**	**8 WAS**	**10 WAS**	**12 WAS**
3	10.81[a]	11.06[a]	11.33[a]	11.56[a]	12.76[a]
6	9.97[a]	10.83[a]	11.16[a]	11.25[a]	12.26[a]
9	9.57[a]	10.43[a]	10.73[a]	10.80[a]	10.90[a]
12	7.00[b]	7.80[b]	8.27[b]	8.50[b]	8.62[b]
Mean	9.74	10.40	10.72	10.59	11.24
P value	<0.001	0.004	0.005	0.005	0.001

Values in the same column with the same letter do not differ significantly ($P \geq 0.05$)
WAS = Weeks After Sowing

Collar Diameter

Seedlings of *Dialium guineense* subjected to different sowing depths were significantly different ($P \leq 0.05$) in collar diameter (Table 2) at 4, 10 and 12 WAS, but were not significantly different at 6 and 8 WAS. Overall mean collar diameter 4-12 WAS varied from 0.52 mm at 4 WAS to 1.15 mm at 12 WAS. At 4, 6, 8, 10 and 12 WAS seedlings from seeds sown at 3 cm depth had the highest collar diameter (0.73, 0.81, 0.95, 1.09 and 1.15 mm respectively), while seedlings from seeds sown at 12 cm depth had the lowest collar diameter (0.52, 0.74, 0.86, 0.95 and 1.01 mm respectively). However, seedling collar diameter did not differ significantly among 3, 6 and 9 cm depths at 4 WAS, among all the treatments at 6 and 8 WAS, and among 6, 9 and 12 cm depths at 10 and 12 WAS.

Table 2: Effect of sowing depth on mean seedling collar diameter (mm) of *Dialium guineense* seeds

	Collar diameter(mm)				
Sowing Depth (cm)	**4 WAS**	**6 WAS**	**8 WAS**	**10 WAS**	**12 WAS**
3	0.73[a]	0.81[a]	0.95[a]	1.09[a]	1.15[a]
6	0.72[a]	0.78[a]	0.91[a]	1.00[b]	1.07[b]
9	0.68[a]	0.77[a]	0.91[a]	1.00[b]	1.04[b]
12	0.52[b]	0.74[a]	0.86[a]	0.95[b]	1.01[b]
Mean	0.67	0.78	0.91	1.01	1.07
P value	0.003	0.551	0.439	0.004	0.008

Values in the same column with the same letter do not differ significantly ($P \geq 0.05$)
WAS = Weeks After Sowing

Leaf number

Seedlings of *Dialium guineense* subjected to different sowing depths were not significantly different ($P \geq 0.05$) in leaf number (Table 3) at 4, 6, 8 and 10 WAS, but were significantly different at 12 WAS. Overall mean seedling height 4-12 WAS ranged from 3.67 at 4 WAS to 5.57 at 12 WAS. At 4 and 6 WAS, seedlings from seeds sown at 3 and 6 cm depth had the highest mean leaf number (4.00), while seedlings planted at 12 cm depth had the lowest mean leaf number (3.67). At week 8, 10 and 12, seedlings from seeds sown at 3 cm depth had the highest mean leaf number (4.29, 4.86 and 5.57 respectively), followed by seedlings from seeds sown at 6 cm depth (4.14, 4,43 and 5.29 respectively), while seedlings planted in 12 cm depth had the lowest mean leaf number 3.67, 3.67 and 4.17 respectively). However, seedling mean leaf number did not differ significantly among all the treatments at 4 WAS; among 3, 6 and 9 cm depths at 6 WAS; between 6 and 9 cm depths at 8 WAS; among 6, 9 and 12 cm depths at week 10; and between 6 and 9 cm depths at 12 WAS.

Table 3: Effect of sowing depth on mean seedling leaf number of *Dialium guineense*

	Leaf number				
Sowing Depth (cm)	**4 WAS**	**6 WAS**	**8 WAS**	**10 WAS**	**12 WAS**
3	4.00[a]	4.00[a]	4.29[a]	4.86[a]	5.57[a]
6	4.00[a]	4.00[a]	4.14[ab]	4.43[ab]	5.29[ab]
9	3.83[a]	4.00[a]	4.00[ab]	4.00[b]	5.00[b]
12	3.67[a]	3.67[b]	3.67[b]	3.67[b]	4.17[c]
Mean	3.88	3.92	4.04	4.27	5.04
P value	0.207	0.063	0.069	0.023	<0.001

Values in the same column with the same letter do not differ significantly ($P \geq 0.05$)
WAS = Weeks After Sowing

DISCUSSION

Several factors affect emergence as well as germination percentage and sowing depth has been identified as one of such factors (Minore, 1985; Koger *et al.*, 2004). This explains what happened to the seeds sown at different sowing depths in this study where emergence was delayed by increasing sowing depth. This agrees with the reports of Koger *et al.* (2004) on *Caperonia palustris*, Arnulfo and Mexal (2005) on *Pinus brutia*, *P. greeggi* and *P. cembroides*, and Koffi *et al.* (2015) on *Lagenaria siceraria*. In their reports they observed that plumule emergence was delayed by increasing sowing depth. The possible reason for the delayed emergence at lower sowing depths could probably be as a result of the long distance the plumule has to contend with before reaching the soil surface (Raju *et al*, 2017). sown, the more strength it needs to push its shoots above the soil surface. According to Aikins *et al*. (2006), too shallow sowing results in poor germination due to inadequate soil moisture at the top soil layer and deep sowing can also significantly reduce plant emergence and yield. This explains the very poor germination percentage observed in seeds sown at 0 cm depth and the delayed emergence at 12 cm depth in this study.

Highest germination percentage observed in 3 and 6 cm depth than in 0, 9 and 12 cm depths implied that sowing at shallow depth generally stimulates more seed germination than when seeds are sown on the soil surface or deeper depths. This is because the former (shallow depth) provides a moist environment around them and prevents seeds and seedlings from drying out, as well as prevent damages by insects (Rusdy and Sjahril, 2015). This result concurs with that of Opande *et al.* (2017) and Chima *et al.* (2017) who noted that germination decreased with increase in sowing depths *in C. brevidens* and *A. muricata*, respectively. Ali and Idris (2015) observed that the deeper the seed is

Seedlings of *Dialium guineense* subjected to 3, 6, 9 and 12 cm sowing depths exhibited significant difference in height at 4 to 12 WAS, collar diameter at 4, 10 and 12 WAS, and leaf number at 12 WAS. Adeogun *et al.*, (2012) also reported significant

difference in seedling height, collar diameter and leaf number of some Soudano-Sahelian tree species subjected to different sowing depths in a containerised experiment. It was observed from the study that seedlings' height decreased with increasing sowing depth. This agrees with the findings of Umeoka and Ogbonnaya (2016) who reported that increasing sowing depths significantly reduced cumulative height growth of *Telfairia occidentalis* over time. Lower seedling height at deeper sowing depths might be due to the difficulty encountered by seedlings in pushing their shoots through a thicker soil layer (Rusdy and Sjahr 15 2015).

Seedlings from seeds sown at 3cm depth had the largest collar diameter followed by those sown at 6cm, 9cm and 12cm, depths respectively. This indicates that an increase in the depth of sowing will result in plants with thinner stems. This agrees with the findings of Adeogun *et al.* (2012) who reported that 3cm depth had better growth parameters than other depths on *Adansonia digitata, Acacia senegal, Delonix regia, Balanites aegyptiaca, Khaya senegalensis, Senna siamea, Prosopis juliflora, and Ziziphus spinachristi;* and Koger (2004) who observed that seedling collar diameter of *Caperonia palustri* decreases with increasing sowing depth.

Number of leaves per plant decreased as sowing depth increased. This implies that seedlings from deeper depth produced fewer amounts of leaves. Ali and Idris, (2015) also observed a decrease in leaf number as depth increases and noted that deep sowing has been shown to have a number of consequences on seedling growth. Similar observations on leaf number have been reported by Odeleye *et al,* (2007) on *Abelmoschus esculentus.* The reason why the 3 and 6 cm sowing depths produced highest leaf numbers could be attributed to the availability of nutrients to the seedling's root within such zone.

CONCLUSION

This study has shown that germination and early seedling growth of *Dialium guineense* are affected by sowing depth. Sowing seeds too deep into the soil has significant negative effects on germination and growth performance of *D. guineense* seeds and seedlings. The high seedling emergence, germination percentage as well as growth performance of *D. guineense* at 3cm and 6cm sowing depths, indicate that sowing depths within that range will generate optimum yield and has better silvicultural advantage. Therefore, foresters cultivating *D. guineense* are advised to use sowing depths between 3 and 6 cm.

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