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Studies on Some Nursery Management Techniques for *Irvingia wombulu* (syn. *excelsa)* ex. Okafor

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ABSTRACT: Seeds of *Irvingia wombulu* (syn. *excelsa)* ex. Okafor were graded by weight into three size classes: S1: Small (< 9g.), S2: Medium (9-13g) and S3: Large (> 13g). In a factorial experiment the seeds were sown with the hilum (hilum of seeds) either turned UP (P1) or DOWN (P2) in order to test the effects of seed size and seed placement on seed germination and seedling survival. In another factorial trial, seedlings from the three size classes were grown in three different potting media: 1:1 topsoil/sawdust (M1), forest topsoil (M2) and sawdust (M3) to test the effects of seed size and potting media on seedling vigour. Seed size did not affect germination but seed placement significantly ($P<0.01$) affected germination. In general, mean percentage germination was low (28.88 ± 1.75 %). Seedling survival among P1 seeds was 32.80 ± 1.03% while none survived among the P2 seeds. In all the growth parameters considered and irrespective of the potting medium used, seedling growth performance as related to seed sizes was in the order S3 > S2 > S1. Seedlings grown in topsoil/sawdust (M1) potting medium performed best followed by those grown in the topsoil (M2) medium, while those grown in sawdust (M3) were least in all growth attributes . The interaction between seed size and potting media was significant in all the attributes except stem diameter.

INTRODUCTION

The decline in oil revenue in recent years and the Nigerian government's objective of increased self-sufficiency and self-reliance has necessitated diversification of the economy towards agricultural activities that can provide raw materials to industries and food to urban workers (Anon., 1986). This has necessitated exploration of priority under-exploited plant species with the aim of identifying and initiating ways to develop them as plantation crops. *Irvingia wombulu* belongs to this group of priority under-exploited plants.

Irvingia wombulu commonly grows in forest areas and farmlands throughout Southern Nigeria at an average density of 1.12 trees/ha. and 2.15-15.0 trees/ha. respectively (Okafor 1980).

It has been highlighted by various authors that *Irvingia wombulu* has high potentials for culinary, therapeutic and industrial purposes, and prospects in export trade development and in creating employment opportunity for the populace (Okafor 1980; Okolo 1994). Use of the seed as condiment in Nigeria is estimated at 78,815 tons per annum (Anon. 1986).

In spite of the prospects for *Irvingia*, available data on the propagation, productivity, and most especially, nursery management techniques are scanty. A good start in the nursery is vital for any plantation crop. The importance of the nursery period and the factors influencing seed germination, seedlings establishment and vigour have been highlighted by many authors (Chin 1980; Opeke 1987; Aiyelaagbe 1988). It is in the light of the foregoing that this study was conducted to understand some aspects of biology of germination and early seedling growth of *Irvingia wombulu*.

MATERIALS AND METHODS

The study investigated the effects of seed size and seed placement (with reference to seed hilum) on seed germination and subsequent seedling survival of *Irvingia wombulu*. Also, the effects of seed size and the different potting media on seedling vigour of the plant were investigated in another trial.

The planting unit of *I. wombulu* is the endocarp and the enclosed endosperm or kernel. The stony endocarp is embedded within the fibrous mesocarp pulp (Figure 1a).

Fruits of *I. wombulu* were collected from Okigwe, Imo State (latitude 5°55'N and longitude 7°10'E) in the South eastern Nigeria. The fruits were de-pulped and the seeds spread out in a single layer under shade for three days to air-dry. Bad seeds were screened from the seed lots by flotation method. The seeds were then graded by weight into three classes viz: Small; S1(< 9g), Medium; S2(9-13g) and Large; S3 (> 13g).

The following investigations were carried out.

Effects of Seed Size and Seed Placement on Seed Germination and Seedling Survival.

A factorial design which consists of 3 seed size classes x 2 seed placements fitted into a completely randomised design (CRD) (Gomez and Gomez 1984), was used in the experiment. Twenty five seeds were randomly allocated to each of the six treatment combinations and replicated four times. Seeds from each size class were sown in buckets (25cm diameter; 20cm deep) filled with forest topsoil. The scars of attachment of the seeds (Fig. 1B) were either turned upward (P1) or downward (P2). The buckets were arranged in the screen house and watered daily. The emergence of hypocotyl or endosperm at the soil surface was used to score seed germination. The total number of seeds that germinated per pot was recorded on 18, 22 and 26 days after sowing (DAS) when no additional germination was observed. This was used to compute the cumulative percentage germination. The treatments were compared using analysis of variance (ANOVA) followed by Fisher's least significant difference (LSD) (Gomez and Gomez 1984). Subsequent seedling survival was also observed and compared.

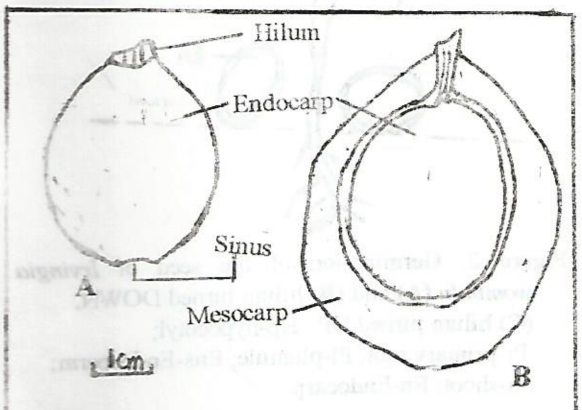

Figure 1: Morphology of fruit/seed of *Irvingia wombulu* **(A)** Entire Seed [side view]; **(B)** Longitudinal section of Fruit; **(C)** Monoembryonic Seed [endocarp opened]; **(D)** Polyembryonic Seed [endocarp opened].

Effects of Seed Size and Potting Media on Seedling Growth Performance.

Fifty seeds from each size classes were sown in trays filled with topsoil. The trays were adequately watered until all seeds had germinated on 26 DAS. Thirty seedlings were selected from each size class and randomly allocated to three potting media - 1:1 topsoil/sawdust (M1), forest topsoil (M2) and sawdust (M3) in a 3 x 3 factorial experiment replicated three times (Gomez and Gomez 1984). The potting media were filled into medium-sized polybags (25cm x 15cm x 8cm lay flat) and watered daily for two weeks to consolidate. The seedlings were transplanted one into a bag. After a year, the seedlings' growth were assessed by taking the measurement of height (using meter rule) and stem diameter (using veneer calliper). In addition, three seedlings were randomly selected from each replicate and destructively sampled for leaf area (using graphical method), and dry matter accumulation (using Mettler top loading balance). Analysis of Variance followed by Fisher's LSD were used to compare the treatment means of the various parameters (Gomez and Gomez 1984).

RESULTS

Effects of Seed Size and Seed Placement on Seed Germination and Seedling Survival.

Seed Germination

Germination was first observed in the medium-sized seeds turned upward on 17 DAS, while it commenced in others on 18 DAS. Germination continued until 26 DAS after when no further germination was recorded in all the treatments. The grand mean cumulative percentage germination at 26 DAS was 28.88 ± 1.75% (Table 1).

Table 1: Mean percentage germination of various seed sizes of *Irvingia wombulu* as affected by seed placement.

Treatment combinations	**Days After Sowing** 18	22	26
P_1S_1	12.30	22.78	32.78
P_1S_2	13.50	27.31	32.79
P_1S_3	13.91	25.12	32.82
P_2S_1	10.80	17.32	25.04
P_2S_2	12.17	22.13	24.84
P_2S_3	11.53	15.01	25.03
LSD (0.001)	NS	NS	1.47

P_1 - hilum turned UP
P_2 - hilum turned DOWN
S_1 – Small-sized seeds
S_2 - Medium-sized seeds
S_3 - Large-sized seeds

Mean cumulative percentage germination did not differ significantly among the three size classes. The mean percentage germination, however, differed significantly ($P<0.001$) between the two seed placement methods. Seeds with their hilum turned upward had a better overall percentage germination (32.80%) than those whose hilum were turned downward (24.97%). The interaction between seed placement and seed size was not significant. Polyembryony was observed in some seeds. Such seeds produced two seedlings. The stony endocarp of polyembryonic seeds of *I. wombulu* were divided into two chambers (Figure 1D), each accommodating an endosperm which produced a seedling.

Seedling Survival

In seeds sown with hilum turned upward, seedling survival was 32.80 ± 1.03% while it was nil among those sown with their hilum turned downward. It was observed that the hypocotyls got broken in the seeds whose hilum were turned down (Figs. 2A & 2B), whereas it remained intact in seeds whose hilum were turned up. In the latter seedlot the hypocotyls grew straight out of the soil to produce seedlings with straight stems (Fig. 2C). Seedling survival was independent of seed size.

Table 2: Effects of seed sizes and potting media on the performance of seedlings of *Irvingia wombulu*.

Treatment combination	Height (cm/plt)	Stem Diameter (cm/plt)	Leaf area (cm/plt)	Total Dry Weight (cm/plt)
S_1M_1	41.92	0.55	6.83	9.86
S_1M_2	41.70	0.51	5.09	7.72
S_1M_3	31.53	0.40	3.07	4.74
S_2M_1	52.62	0.72	10.94	17.20
S_2M_2	51.40	0.67	8.15	14.89
S_2M_3	39.59	0.52	5.92	8.26
S_3M_1	53.63	0.81	15.90	25.14
S_3M_2	52.67	0.75	11.85	21.77
S_3M_3	41.35	0.58	8.95	12.08
LSD (0.001)	2.56	0.15	2.56	1.90

S_1 – Small-sized seeds
S_2 - Medium-sized seeds
S_3 - Large-sized seeds
M_1 – 1:1 Topsoil:sawdust potting medium
M_2 - Topsoil potting medium
M_3 - Sawdust potting medium

Effects of Seed Size and Potting Media on Seedling Vigour

Seedling Height

The height growth was significantly ($P<0.001$) different among the treatment combinations (Table 2). The best average height growth (49.22 cm) was recorded in seedlings from large-sized seeds, followed by seedlings from medium-sized seeds (47.87 cm). Seedlings from small-sized seeds had the least mean height growth (38.38 cm). Height growth differed significantly ($P<0.001$) among the seed size classes (Table 3).

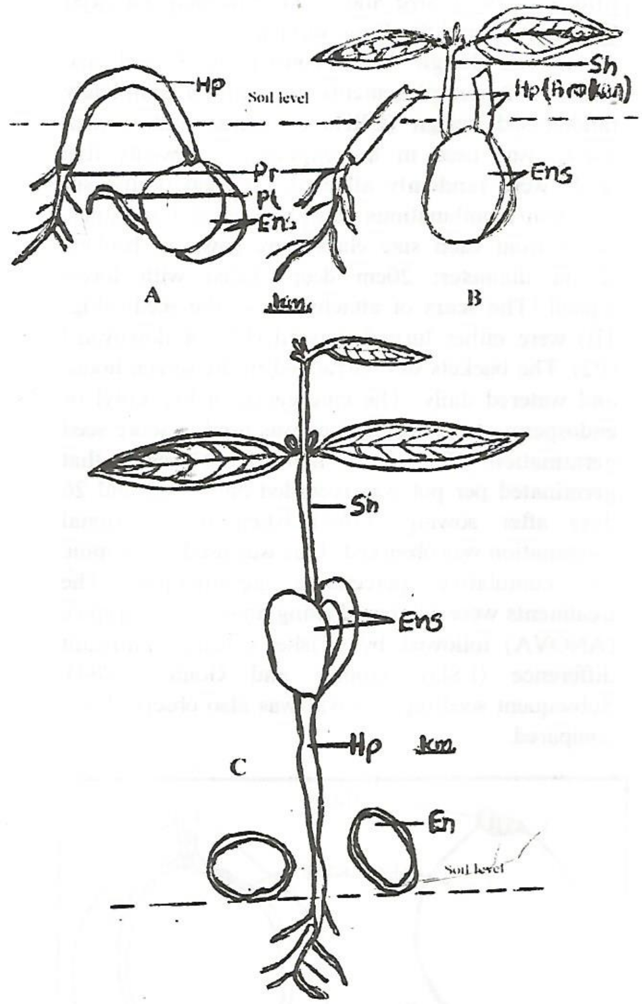

Figure 2: Germination of the seed of *Irvingia wombulu* **(A)** and **(B)** hilum turned DOWN, **(C)** hilum turned UP. Hp-hypocotyl; Pr-primary root; Pl-plumule; Ens-Endosperm; Sh-shoot; En-Endocarp.

Seedlings grown in sawdust/topsoil medium had the best mean height growth of 49.39 cm followed by those grown in topsoil (48.59 cm) while those in sawdust had the least height mean height growth of 37.49 cm. The mean height growth of seedlings grown in topsoil/sawdust and topsoil media did not differ significantly from one another but differed significantly ($P<0.001$) from those grown in sawdust (Table 2). The seed size x media interaction was significant ($P<0.001$) (Table 3).

Table 3: F-ratio value of effects of seed size and potting media on some growth parameters of seedlings of *Irvingia wombulu*.

Source of variation	Plant Height	Stem Diameter	Leaf Area	Total Plant Weight
Seed Size (A)	933.10***	56.47***	196.37***	1027.46***
Media (B)	184.21***	42.35***	103.17***	590.90***
A X B	4.21**	0.71 ns	3.43*	41.93***
cv (%)	1.28	7.33	9.09	4.25

ns – not significant; *; **; *** - significant at 5%, 1%, 0.1% levels of probability respectively.

Stem Diameter

Large-sized seeds produced seedlings with the best mean stem diameter of 0.71 cm followed by medium-sized seeds (0.64 cm), while the small-sized seeds produced seedlings with least stem diameter (0.49 cm). Stem diameter growth differed significantly ($P<0.001$) among the treatment combination (Tables 2 and 3).

Stem diameter of seedlings grown in the sawdust medium (0.50 cm) was significantly ($P<0.001$) lower than those grown in topsoil/sawdust medium (0.69 cm) and topsoil medium (0.64 cm) which did not differ significantly from each other. The interaction between seed size and potting media had no significant effect on stem diameter.

Leaf Area

The treatment combinations were significantly ($P<0.001$) different with respect to leaf area (Table 2). Seedlings from large-sized seeds had the largest total leaf area of 1223.05 cm^2, followed by those from medium-sized seeds with 832.81 cm^2 while those from small-sized seeds had the smallest total leaf area of 500.13 cm^2 per plant. The total leaf area per plant differed significantly ($P<0.001$) among the potting media. Seedlings grown in topsoil/sawdust medium had the largest leaf area of 1122.13 cm^2 per plant, followed by those grown in topsoil medium (836.00 cm^2) while those grown in sawdust medium had the least (598.28 cm^2) total leaf area per plant.

The interaction seed size x potting mixture was significant ($P<0.05$) (Table 3).

Total Dry Matter Accumulation

The total dry matter accumulation differed significantly ($P<0.001$) among the treatment combinations (Table 2). Dry matter accumulation was best in seedlings from large-sized seeds weighing 19.64g, followed by those from medium-sized seeds weighing 13.49 g. The dry matter accumulation was least in seedlings from small-sized seeds weighing 7.44 g. The dry matter accumulation differed significantly ($P<0.001$) among the three size classes.

Seedlings grown in topsoil/sawdust medium had the best total dry matter accumulation of 17.40 g, followed by those grown in topsoil medium with 14.77 g, while those grown in sawdust had the least dry matter accumulation of 8.40 g. The total dry matter accumulation differed significantly ($P<0.001$) among the potting media.

The interaction between seed size and potting media affected dry matter accumulation significantly ($P<0.001$) (Table 3).

DISCUSSION

The low mean percentage germination recorded in *I. wombulu* could be due to the recalcitrant nature of the seeds which, unlike orthodox seeds, do not conform with the rule of increasing longevity with fall in temperature and moisture content (Roberts 1973). Many tropical fruit crops such as cocoa, mango and citrus are also known to produce recalcitrant seeds (Chin 1980). Such seeds exhibit a short period of viability and cannot be stored over time (Roberts and King 1980). Oni (1984) reported similar low germinability in some tropical forest trees. Okafor (per. comm.) suggested early sowing of seeds of *I. wombulu* within a week of collection of ripe fruits because of the recalcitrant nature of the seeds.

The 100% seed mortality recorded when the seeds were placed with the hilum turned downward was due to severance of the root from the shoot as a result of the breakage of the hypocotyl in the bid to bring up the endosperms. Germination in the species is obligatorily epigeal. In this set of seeds, some shoots that managed to emerge survived for few weeks in spite of the breakage of their hypocotyl. The die-back could be due to the exhaustion of food reserve in the endosperms. The effect of placement on germination was not influenced by the seed size.

The positive response recorded between the seed weight and seedling vigour could be attributed to the quantity of food reserve in the endosperm. The large seeds should have more food reserve that could sustain the seeelings during the long process of root development. Similar relationships have been reported in jackfruit (Sonwalker 1951), mangosteen (Hume and Cobin 1948) and mango (Chin 1980). The likely origin of polyembryony in *I. wombulu* is zygotic (from meiotic cells), probably resulting from the presence of two ovary sacs. The presence of two endosperms which are physically separated within the same endocarp might explain this. In mango seeds (*Mangifera indica* L.), only one of the many resulting polyembryonic seedlings is zygotic, while all others are nucellar (from mitotic cells). Chin (1980) suggested that if the only zygotic embryonic seedling can be identified and excised or destroyed, a pure line seedlings (clonal population) may be obtained for standardization of rootstocks in mango graft production. Polyembryony in *I. wombulu* may not be useful in the standardization of rootstock, but in the production of more non-clonal seedlings.

The poor growth recorded in sawdust medium might be due to shortage or lack of nutrients needed to support growth. Also sawdust could not provide mechanical support to the seedlings because of its low compaction property. The general better growth recorded in topsoil/sawdust medium is probably a result of increased organic matter content in the medium brought about by decomposition of the sawdust. The presence of sawdust in the medium may also improve the water holding capacity of the medium and enhance its aeration and infiltration.

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