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SYSTEMATIC EVALUATION OF SEED GERMINATION AND EARLY SEEDLING DEVELOPMENT OF *Monodora myristica* (GAERTN) DUNAL AND *M. tenuifolia* BENTH (ANNONACEAE)

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ABSTRACT

An evaluation of seed germination and early seedling development pattern of Monodora myristica and M. tenuifolia were investigated at the nursery, to provide useful classificatory tool to aid in the taxonomic identification of the species. Results showed epigeal cryptocotylar/durian germination types, with all possible germination occurring before 84 days after sowing (Rapid germination). The study is expected to provide additional morphological clue in the identification of seedlings of Monodora species during forest regeneration studies.

Keywords: Taxonomic, Classification, Epigeal Cryptocotylar, Durian, Regeneration.

INTRODUCTION

Traditional taxonomic practice have long recognized the role of employing a full range of characters from flowers, fruits, seed, seedlings and vegetative shoots in resolving taxonomic relationship at species level and improve classification systems. Seed germination and seedling development studies have been reported for many dicotlyedons (Onyeachusim, 1985; Okali and Onyeachusim, 1991; Ng, 1991; Essig, 1991; Umbere and Omolokum, 1998; Nwadinigwe and Onyekwelu, 2009), including a limited number in Annonaceae (Hayat, 1963; Corner, 1976; De Vogel, 1980; Mohana Rao, 1982; Finneseth *et al.*, 1998; Folorunsho and Olorode, 2008). However, no detailed study on seedling morphology has been recorded for most Annonaceous genera in Nigeria (Folorunsho and Olorode, 2008) particularly the genus Monodora. The two tree species under investigation; *Monodora tenuifolia* Benth and *M. myristica* (Gaertn) Dunal are widely known with the common name 'African Nutmeg' or 'False Nutmeg'. These species are sympatric taxa in their natural distribution range within the Nigeria high forest ecosystem. They are noted to be of high economic value, as the embedded seed is used as spices amongst several other uses of the plant parts. Keay (1989) recorded five tree species belonging to the genus: *M. myristica* (Gaertn) Dunal; *M. tenuifolia* Benth; *M. crispata* Engl & Diels, *M. unwnii* Hutch & Dalz and *M. brevipes* Benth.

Seedling morphology is often studied in conjunction with other systematic lines of investigation to provide insight into additional valuable taxonomic characters of species under investigation. Its practical relevance, however, in the field of forestry is providing clue to the correct identification of species during regeneration studies especially for plant species that exhibit dimorphic features at the seedling stage as reported for the small smooth seeds and the large non-smooth seeds of *Carapa procera* (Okali and Onyechusim, 1991).The purpose of this study therefore, is to compare the seedling development state of congeneric species group (*Monodora* spp) in a common environment where plastic responses to environment are minimized. This is to provide for easy identification and a useful classificatory tool in the delimitation of the taxa

MATERIALS AND METHODS

Study Area

Fruits of the respective Monodora species were collected from growing trees during their fruiting season in a secondary forest vegetation within the Forestry Research Institute of Nigeria, Ibadan (latitude 7^{o} 23' 15'' to 7^{o} 24' 00''N and longitude 3^{o} 51' 00'' N to 3^{o} 52'15''E). The rainfall pattern of the area of fruit collection is bimodal with peak around (June and July) and September to October. Mean total annual rainfall is 420.00mm in about 109 days. Mean maximum and minimum temperatures is about 34^{o}C and 24^{o}c respectively. Mean relative humidity ranges from 82% between June and September to approximately 60% between December and February (Adio *et al.*, 2011).

The fruit sizes averages 14cm by 12cm with about 205 seeds for *Monodora myristica* (Shape: Globose) and 4cm by 5 cm with about 41 seeds for *Monodora tenuifolia* (Shape: globose, non-apiculate). Seeds were extracted from matured and ripened (yellow) fruits. Seeds sizes averages 0.8cm by 1.4cm (dark brown) for *M. tenuifolia* and 1.3cm by 2.0cm (light brown) for *M. myristica* respectively. The seed size of *M. tenuifolia* is small relative to the large seed size of *M. myristica*. Fruits and seed sizes were measured using a digimatic electronic caliper. Extracted seeds were sown in washed sterilized river sand in batches of 25 seeds per plastic container. Sown seeds were placed under nursery shade (uniform environment and watered daily for observation of seed germination. Physiologically seeds are assumed to have germinated with the protrusion or emergence of the radicle but are not considered completed until the formation of the eophyll or primary leaves. Detailed description of germination type and morphology of early seedling development follows: De Vogel (1980) and Ng (1976, 1991). The authors described the various forms of germination patterns for vascular plant species. The epigeal crytocotylar germination pattern occurred when the cotyledon were shed within the remaining part of the seeds before seed coat abscission. While other variants, such as Durian germination pattern occurred for non-emerged seed coats. Ng (1976, 1991) described rapid germination as condition when all viable seeds of the species in question complete germination within 84 days (12 weeks) of seed fall or after sowing.

RESULTS

The result of the study of early seedling development of the *Monodora* species studied are presented in Table 1 and Plate 1A and B. Radicle emergence was observed between 14 – 21 days after sowing for *Monodora tenuifolia* Benth and 21 – 35 days for *Monodora myristica* (Geartn) Dunal. After penetrating the soil surface, the hypocotyl hook (green) elongated for both species. In a few numbers of cases, the seed coat containing the cotyledon remained subterranean (on the soil surface) but most often, the non-emergent cotyledons with possible remaining endosperm (enclosed within seed coat) was lifted up above the soil surface by the elongating hypocotyl. The raised seed coat remained for between 20-30days before seed coat abscission (Plate 1A). The first true leaves appeared at 40days after sowing for *Monodora tenuifolia*, at 50-60days after sowing for *Monodora myristica*.

The epigeal pattern of germination was recorded for the *Monodora* species examined as shown on Table 1. This pattern of germination has been classified as epigealcryptocotylar. Germination follows four developmental phases beginning from radical protrusion, hypotcotyl emergence, epicotyl elongation, seed abscission to seedling. However, a rare occurrence of a retained seed coat with developed exposed primary leaf was observed for a single *M. tenuifolia* seedling (Plate 1B). This phenomenon is known as durian germination type.

Germination rate observed for the *Monodora* species studied has been termed rapid germination. At three months, the seedling height differed significantly ($P \geq 0.05$) for the *Monodora* species studied. The species *M. myristica* was found to attain a mean seedling height of 13.6$\pm$ 1.6cm compared to 9.3$\pm$0.6cm for *M. tenuifolia*.

Table 1: Seedling Morphological Characters of *Monodora* Species Studied

Characters	*Monodora myristica*	*Monodora tenuifolia*
Germination rate	Rapid germination (76 DAS)	Rapid germination (54DAS)
Germination type	Epigeal	Epigeal
Hypocotyl	Well-developed enlongated hypocotyls	Well-developed enlongated hypocotyl
Root system	Well-developed root systems (tap/lateral roots) before opening of eophyll	Well-developed root system (tap/lateral roots) before opening of eophyll
Eophyll/ primary leaf	Simple, alternate, entire, petiolate (inflated), glabrous, unicostate-reticulate, Apex-acuminate to mucronate, base rounded, shape elliptic to obovate	Simple, alternate, entire, petiolate, glabrous, unicostate-reticulate, Apex-acuminate, base cuneate, shape elliptic.
Leaf Margin symmetry	Symmetrical	Symmetrical
Phylotaxy of seedling foliage	Distichous	Distichous
Growth form	Woody/sympodial	Woody/ sympodial
Average seedling height at 3months	13.6±1.6cm*	9.3±0.6cm

DAS: Days after sowing; *significant ($p \leq 0.05$)

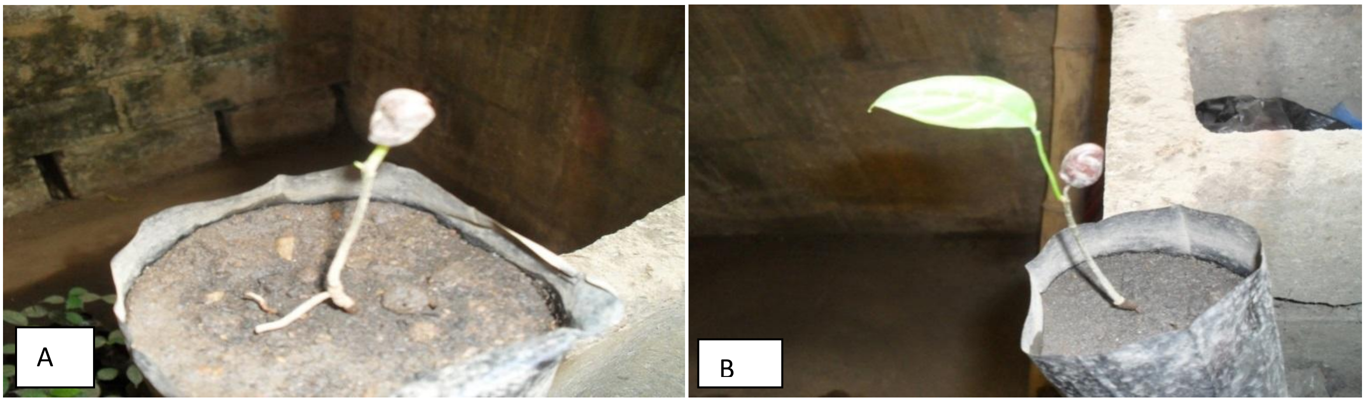

Plate 1A: Raised seed coat of *Monodora* species before seed abscission.
1B: Rare occurrence of non-emerged seed coat of *M.tenuifolia* Benth
Source: Forestry Research Institute of Nigeria (FRIN) Nursery

DISCUSSION

Monodora seeds had ruminate endosperm and small embryo (Sharma, 1993). This feature had earlier been recorded for other Annonaceous species (Hayat, 1963). The embryo is small relative to the large endosperm and seeds with this feature can be described as morphologically dormant. The cotyledon in such seeds often develops within the seeds prior to significant radicle growth (Finneseth *et al*., 1998).

Generally, the *Monodora* species studied exhibited more or less uniformity in their taxonomic morphological characters. Little variation may however be attributed to the genetic make-up and phylogeny of the respective species.

As recorded, the epigeal cryptocotylar germination pattern (De Vogel, 1980) occurred when the cotyledons were shed within the remaining part of the seeds. This germination was also been recorded for *Asimina triloba* (Annonaceae), the North American pawpaw species (Finneseth, *et al*., 1998). Similarly, the developmental stages of studied *Monodora* species also followed the same pattern as recorded for the North American species (pawpaw). Ng (1976, 1991) stated that rapid germination as observed, occurs when all viable seeds of the species in question complete germination within 84 days (12 weeks) of seed fall or after sowing. This is a common feature among rainforest tree species. Okali and Onyeachism (1991) reported that 80% of the 25 tree species sown germinated rapidly in the sense that all the germination that could occur was within 84 days.

As observed, a well-developed root system in both species may present some ecological advantage at the establishment phase. The ecological significance of height variation at the seedling stage (Table 1) may be attributed to differences in seed size, with *M. myristica* having a larger mean seed size (1.3cm x 2.0cm) compared to the small mean seed size (0.8cm x1.3cm) for *M. tenuifolia*. The wide differences in seed size among species however, was related to the ecological conditions in which plant establish, with species from open habitats having lower average seed mass than species from more closed habitats (Mazer, 1989; Kelly and Purvis, 1993). The differences in height beyond seedling stage have been reported (Nyananyo, 2006) to exist between the taxa. At field condition, *M. tenuifolia* was shorter (about 15m) relative to *M. myristica* (about 20m). Several other studies (Ng, 1976; Long and Jones, 1996; Bonfil, 1998) had confirmed that larger mean seed size confers advantage in terms of seedling growth (height) than small mean seed size for congeneric species group. Furthermore, the influence of seed size on seedling growth has been reported to hold more for mesic and hydric species than for xeric species (Long and Jones, 1996). Being a sympatric taxa (High forest species), the studied *Monodora* species can be inferred to belong to the mesic and hydric species group and thus, their difference in terms of height may be greatly influenced by variation in seed sizes than any other ecological factor.

CONCLUSION

Correct identification of plant species at seedling stage is imperative in enumeration work involving regeneration studies of undergrowth in any tropical forest ecosystems. This study provides insight into the taxonomic features and germination pattern of this taxonomic group (Monodora) in Nigeria. It is suggested that breeding experiment should be carried out in this important genus to further explore its economic potentials and resolve taxonomic problems to aid classification.

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