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Determination of seed bank depth and viability of *Monodoramyristica* at Ohiya in Umuahia South Local Government Area, Abia State, Nigeria

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Abstract

The study on soil seed bank of three stands of *Monodoramyristica* was carried out at Ohiya in Umuahia South Local Government of Abia State, Nigeria. A 3 x 3 factorial experiment in Randomized Complete Block Design (RCBD) with three blocks was conducted within three stands of *Monodoramyristica* located in Ohiya Autonomous Community (as block). The treatment factors were three soil depths and three distances away from the stem base of the trees. Three soil depths (0-5, 5-10 and 10-20 cm) were dug at three separate distances (0, 3, and 7 m) resulting to nine treatments. Soil samples were collected at the various soils depths (0-5cm, 5-10cm, and 10-20cm) along the three distances (0, 3, and 7 m) at four cardinal points from the trunk base of each stand. The soil samples were stored separately in well labeled bags to indicate soil depths and sampling distances. Soil bags from the same soil depth at a particular distance was emptied separately into each aluminum trays and the seeds of *Monodoramyristica* present in each tray were carefully identified, separated and counted. A viability test was carried out on the seeds. The total number of seeds deposited at the 0-5cm depth at 0m (8.583), 3m (14.250) and 7m (3.000) were significantly higher than those deposited within the 5-10cm (3.333, 5.917 and 0.833) and the 10-20cm depth (0.250, 1.750 and 0.000). Over 70% of the seeds of *Monodoramyristica* occurred within 0-5 cm depth, 25% was deposited at the 5-10 cm depth while the control had 5% seed occurrence. The highest number of seeds occurred at the distance of 3m while the control (7 m) had the lowest number of seeds. The highest level of interaction between distance and soil depth occurred within the 0-5cm at 3m.The viability test indicates that no germination occurred in any of the seeds planted in the poly-pots. Efforts should be made to collect the viable seeds after shedding from the parent plant so as to enhance easy germination and improve the status of the plant species.

Running Title: Seed bank of tropical species

Key words: *Monodoramyristica*, seed bank, soil depth, distance

Introduction

Soil seed bank is the beginning of vegetation process (Jiang *et al*., 2013) in the terrestrial ecosystem as it offers plants the possibility to disperse through time (Vandvik *et al*., 2016). Soil seed banks contributes to vegetation recovery by enabling species to overcome periods of environmental changes (Mandak *et al*., 2012) via building up large seed banks. In forest plantations, buried viable seeds are critical for terrestrial plants re-growth after clear-cutting as well as above-ground vegetation (Anderson *et al*., 2012; Enright *et al*., 2007). On ecological timescales, seed banks represent local ‘biodiversity reservoirs’ that can contribute to local population persistence and biodiversity maintenance through temporal storage effects (Faist *et al*., 2013; Plue and Cousins, 2013), remnant populations (Auffret and Cousins, 2011; Plue *et al*., 2013) and the maintenance of a functionally diverse below-ground species pool available for germination in response to environmental variability or change (Maren and Vandvik, 2009; Clark *et al*., 2007).

The importance of seed banks has also been recognized by applied ecologists who are particularly interested in potential contributions of seed banks to the conservation and restoration of threatened and declining plant populations (Vandvik *et al*., 2016; Ottewell *et al*., 2011; Eckstein *et al*., 2009; Adams *et al*., 2005) and communities (Faist *et al*., 2013; Kalamees *et al*., 2012; Fourie, 2008; Satterthwaite *et al*., 2007; Holmes and Cowling, 1997).

The rainforest of Nigeria used to abound in *Monodoramyristica* (nutmeg) whose seeds contribute to local diet in developing countries. The seeds are used as major food supplement such as condiment, edible oil, flavours, and in the treatment of ailments. They are also important sources of vitamins, minerals, fats and oil. The unavailability of the seeds of *Monodoramyristica* has resulted to decline in their consumption in many regions particularly in south eastern Nigeria. Presently, the status of *Monodoramyristica*is endangered due to poor germination ability of seeds and deforestation as a result of increasing human activities. Therefore, this study is aimed at understanding the pattern of seed occurrence of this important plant species in the soil in order to make appropriate recommendations on the need to protect the existing stands of the species and enlighten local farmers on the need for enrichment planting for its sustainability.

Materials and Methods

Study Area

The assessment of soil seed bank of *Monodoramyristica* was carried out at Ohiya in Umuahia South Local Government Area of Abia State, Nigeria. The 57 years old *Monodoramyristica* stands have a mean height of 15.6m and a mean diameter-at-breast height of 86.3cm. Ohiya which is within the lowland rainforest zone of Nigeria (Keay, 1959) lies on latitude $05^{\circ}17^{1}$N and longitude $07^{\circ}03^{1}$E. It has the following mean annual climatic data: rainfall of 2133mm distributed over eight months of rainy season period (March to October) with bimodal peak in July and September; minimum and maximum temperature is 21°C and 30°C, respectively with relative humidity of 60-70%. The soil is Ultisol (Source: Meterological Station, National Root Crops Research Institute (NRCRI) Umudike).

Sample Collection

A 3 x 3 factorial experiment I Randomized Complete Block Design (RCBD) with three blocks was conducted using three stands of *Monodoramyristica* located in Ohiya Autonomous Community as block. The treatment factors were (a) soil depths and (b) distances away from the stem base. Three soil depths (0-5, 5-10 and 10-20 cm) were dug at three separate distances (0, 3, and 7 m) resulting to nine treatments. Soil samples were collected at the various soils depths (0-5cm, 5-10cm, and 10-20cm) along the three distances (0, 3, and 7 m) at four cardinal points from the trunk base of each stand. The soil samples were carefully stored in well-labeled polythene bags to indicate soil depths and sampling distances. Each soil bag was moved to the Herbarium Laboratory

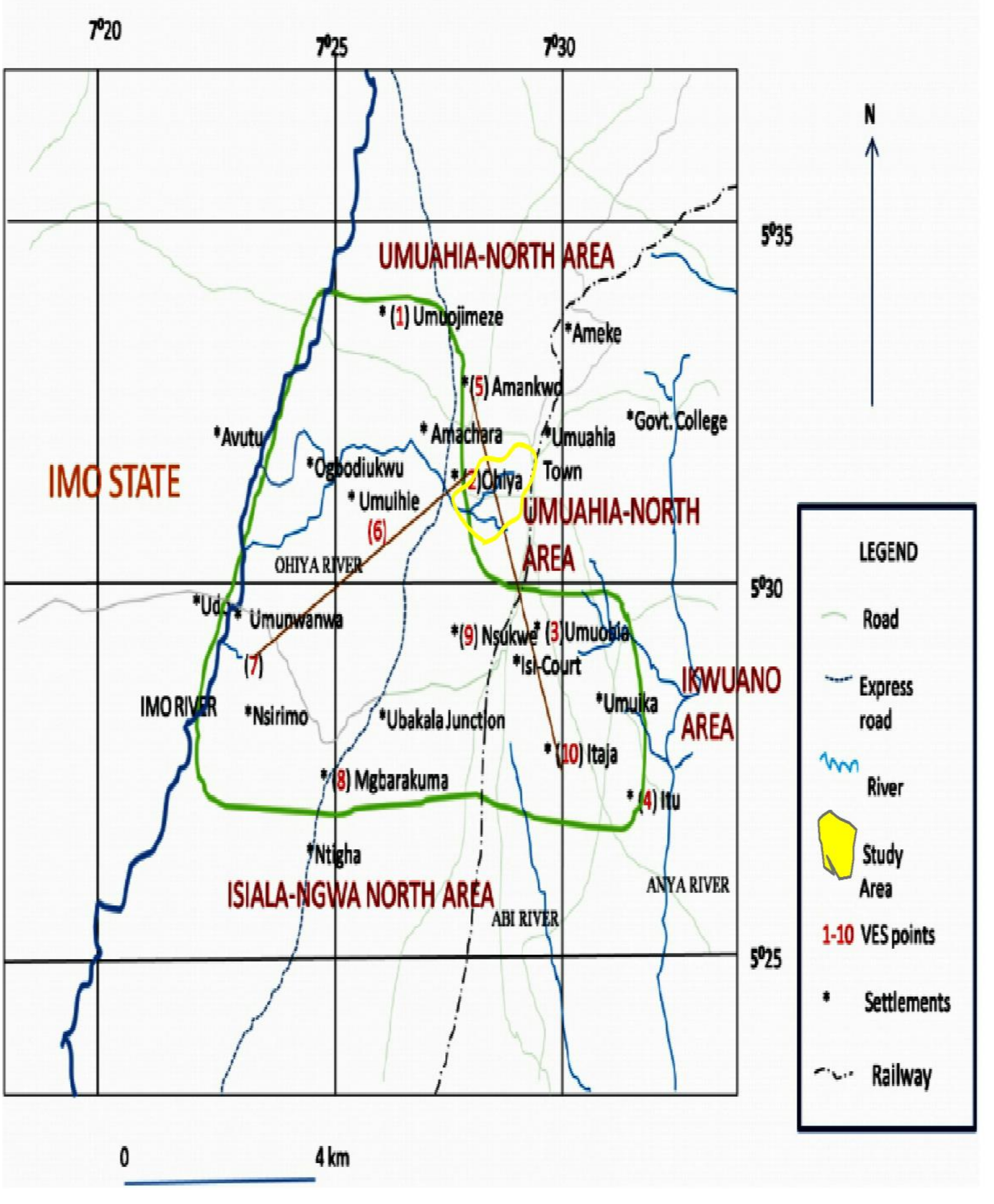

Figure 1: Map of study area

of the Department of Forestry and Environmental Management, Michael Okpara University of Agriculture Umudike, Nigeria where soils from each depth and distance were separately emptied into aluminum trays, bulked together and the seeds of *Monodoramyristica* present in each tray were carefully identified, separated and counted. A viability test was carried out on the seeds. The seeds were planted in polythene pots that contained soils from the trays and watered once daily. The data collected were subjected to analysis of variance, and means were separated by Duncan Multiple Range Test according to Steel and Torrie (1980).

Results and Discussion

Pattern of occurrence of soil seedbank of *Monodoramyristica* at different soil depth

The seed bank of *Monodoramyristica* at different soil depth is not similar. The total number of seeds obtained within the 0-5cm soil depth at 0m (8.583), 3m (14.250) and 7m (3.000) were significantly higher than that found within the 5-10 cm depth (3.333, 5.917 and 0.833) and the 10-20cm depth (0.250, 1.750 and 0.000), respectively (Table 1). The result is in line with the findings of Nzegbule and Nwachi (2008) who also observed the highest number of seeds within the 0-5 cm soil depth in their study of soil seed banks of *Canariumschweinfurthii*. The pattern of occurrence or deposition of the seeds within the various soil depths may be attributed to the size and shape of the seed of this tree species (*Monodoramyristica*). The seeds of *Monodoramyristica* are large and may not percolate easily through the soil to greater depths. Wang *et al*. (2009) in their study of soil seed banks of *Litseacubeba*in South China observed that seeds of large-seeded species only appear in the upper soil layer.

The result also indicate that 68.13% of the seeds of *Monodoramyristica* occurred within the 0-5cm depth and about 26.59% were deposited within the 5-10cm depth while the control (10-20)

Table 1: Number of seeds in seed banks of *Monodoramyristica* at different soil depths

	Soil depth (SD)				
Distances (DT) from tree (m)	0-5	5-10	10-20	Remark	SEM
0	8.583[a]	3.333[b]	0.250c	*	1.155
3	14.250[a]	5.917[b]	1.750[c]	*	1.961
7	3.000[a]	0.833[b]	0.000	*	0.757

a.b.c = means with different superscript are significantly different at P<0.05
* = significant difference

cm depth) had about 5.27% seed occurrence whatever the distance. From Table 1, the total number of seeds deposited at the various soil depths decreased progressively with increase in soil depth. This is in agreement with the findings of Holthuijzen and Boerboom (1982) and Tozer (1998) who observed that increase in soil depth resulted to decrease in number of seeds in soil seed banks of *Cecropia obtuse* and *Cecropiasciadophylla* and *Acacia saligna*, respectively.

Distribution of seeds at various distances from stem base

Total mean number of seeds of *Monodoramyristica* deposited at various distance from the tree stands is shown in Table 2. However, the mean numbers of seeds deposited at different distance from the stem base are not similar. The highest number of seeds was deposited at 3m (7.306) followed by the 0m (4.056) while the 7m (i.e. control) had the lowest (1.278). This result is in contrast with the findings of Nzegbule and Nwachi (2008) that obtained the highest number of seeds of *Canariumschweinfurthii* (Engl.) at 1m from the trunk base of their studied plant (*C. schweinfurthii*). The table shows that 32.09 % of the seeds of *Monodoramyristica* were deposited at 0 m and about 57.80 % at 3 m while about 10.11 % were deposited at 7 m (control).

In this study, the pattern of distribution of seeds with respect to distance may be attributed to the length of the branches and the height of the trees. When trees are tall (above 15 m), fruits that did not hit any lower branch when shedding from the parent plant will reach the soil surface with high velocity thus, dispersing its seed to several meters away from the stem base. The deposition

Table 2: Effect of distance on mean number of seeds of *Monodoramyristica* in the soil

Distance from trees (m)				
0m	3m	7m	Remark	SEM
4.056^b	7.306^a	1.278^c	*	1.990

a.b.c= means with different superscript are significantly different at P<0.05
* = significant difference

pattern of seeds of plant species at various distances from stem base may also be affected by the canopy cover of the trees (Dike, 2002; Nzegbule and Nwachi, 2008) since the branches of *Monodoramyristica* extend normally to about 4 m from the stem base.

The interaction effect of distances with soil depths

The interaction effect between the distances and the various soil depths from tree stem base were significantly different. The highest level of interaction between soil depths and different distances occurred within the 0-5 cm soil depth (14.250) at a distance of 3 m from the stem base (Table 3).A higher level of significant difference (8.583) also occurred at the same soil depth (0-5 cm) but at a distance of 0m (soil beside the stem base), which is followed by the 5-10cm depth (5.917) at a distance of 3m from the stem base. However, the least level of significant differences between the mean numbers of seeds occurred within the 10-20cm depth at the distances of 0m (0.250), 3m (1.750), and 7m (0.000).

Table 3: Interaction between distances and soil depths on soil seed bank of *Monodoramyristica*

	Distances from trees			
Soil depth (cm)	0	3	7	**Mean**
0-5	8.583^{b}	14.250^{a}	3.000^{d}	$\mathbf{8.611^{a}}$
5-10	2.917^{d}	5.917^{c}	0.833^{e}	$\mathbf{3.222^{b}}$
10-20	0.250^{f}	1.750^{e}	0.000^{f}	$\mathbf{0667^{c}}$
Mean	$\mathbf{3.917^{b}}$	$\mathbf{7.306^{a}}$	$\mathbf{1.278^{c}}$	

SEM DT = 0.317*
SEM SD = 0.317*
SEM DT x SD =0.548

a.b.c.d.e.f= Means with different superscripts are significantly from each other at (P<0.05). Means with the same superscript are not significantly different from each other at (P<0.05)
SEM = Standard error of mean
* = Significant difference
DT, SD, DT, X SD represents distance from tree stand; soil depth and interaction between distances from stand and soil depth respectively.

Viability of seeds of *Monodoramyristica*

The viability test indicates that no germination occurred in any of the seeds planted in the poly-pots. The failure of the seeds of *Monodoramyristica* to germinate after planting may be attributed to the ageing. Lack of desirable or viable seeds in the seed banks and unfavorable environmental conditions (Shono *et al*., 2006) can substantially limit seed germination of tree species. Similarly, factors such as ageing (Nzegbule and Nwachi, 2008), allelopathic substances, fungal and bacterial attack as well as predation (Nzegbule and Mbakwe, 2000; Tozer, 1998; Holmes and Moll, 1990; O'Connor and Pickett, 1992) may reduce the viability potentials of seeds deposited within the soil seed bank of plant species. Seeds are said to be viable only when they are able to germinate within a period of time under favorable condition.

Conclusion

The research has documented basic information on the pattern of occurrence of soil seed bank of *Monodoramyristica*. The study has shown that the seeds of *Monodoramyristica* have limitation in terms of range of distribution within the various soil depth and distance from the soil surface and stem base respectively. About

68.13 % of the seeds of *Monodoramyristica* occurred within the 0-5cm depth at a distance of 3m, thus, enhancing the gathering of seeds by rural dwellers. This, therefore, depleted the soil seed banks of *Monodoramyristica*. Effort should be made to collect the viable seeds after shedding from the parent plant so as to enhance easy germination and improve the status of the plant. It is also recommend that Government agencies such as Agriculture Development Program (ADP) should assist in raising improved seedlings varieties of *Monodoramyristica*, which should be given to farmers for enrichment planting of the remaining rainforests in south east Nigeria. This in turn, will ensure the conservation of *Monodoramyristica* in south east Nigeria.

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