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Soil Seedbank in Four Contrasting Plantations in Ile-Ife Area of Southwestern Nigeria

S.O. Oke, T.O. Ayanwale and O.A. Isola
Department of Botany, Obafemi Awolowo University, Ile-Ife, Nigeria

Abstract: Soil seedbank was studied in four contrasting plantations (Citrus, Oil palm, Cashew and Cocoa). Ten replicates of top soil (0-15 cm) samples were collected from each plantation in March (dry season soil collection) and July (rainy season soil collection) and were subjected to seedling emergence for six months to determine the density of individuals and species composition of the study plantations. Simple percentages and density (seed m^{-2}) were used to establish various relationships between the seedbank density and species composition in the study plantations. The results indicated that more individuals and species emerged in Citrus plantation (Plantation A) in both season soil collections while the least number of individuals and species emerged in Cocoa Plantation. Herbaceous species dominated the seed bank consisting of 98% of the total seed density of the seedbank in each of the four study plantations and from both season soil collections. Only three woody species emerged and they were from the rainy season soil collection. There was no similarity between seedbank species composition and the species composition of the standing vegetation. Seedbank composition varies with season and rainy season soil collection had the highest seedbank composition compared to dry season soil collection.

Key words: Plantations, species, seedbank, season

INTRODUCTION

Plantation farming is a form of monoculture that consists of clearing larger acres of forest for the purpose of planting cash crops. The commercialization of forests is the primary cause of most large scale and rapid deforestation and the changing character of forests so they serve commercial interests rather than as the long standing home of indigenous plants. The replacement of natural forests by monoculture plantation also leads to a great loss of biodiversity in forests which has severe considerable consequences (Bandyopadyal and Shira, 1989). Furthermore, since forest ecosystems mean much more than wood to the local inhabitants, conversion of natural forests to single species plantations will as the natural forest areas diminish, Constitute form of deforestation in terms of loss of useful forest components like edible fruits nuts vegetables and medicinal plants. The wildlife population and diversity are also reduced in plantations.

The present study into the natural process which influence forest dynamics have shown that soil seedbank is one of the principal sources of recruitment for new individuals in the initial stages of forest succession (Butler and Chazdon, 1988; Hall and Swaine, 1980; Hopkins and Graham, 1983, 1987; Young *et al*., 1987) and is partially responsible for dynamic changes that may occur during the development of vegetation (Lunt, 1997). The species richness and abundance in seed banks may provide information on the potential of a community for regeneration (William-Linera, 1993).

The composition of seed bank reflects the richness of species present in the local vegetation or immediate vicinity (Saulei and Swaine, 1988). However, there is evidence that disturbance and

Corresponding Author: Dr. S.O. Oke, Department of Botany, Obafemi Awolowo University, Ile-Ife, Nigeria

fragmentation may influence species richness and abundance in the soil (Hopkins *et al*., 1987). The seedbank is an indicator of past and present seed populations buried by percolation, action of animals soil litter and physical methods that have persisted in the soil for several years.

This study is to determine the seed bank composition of each plantation, variation in seed bank composition between the various plantations and the effect of seasons on the seedbank composition.

MATERIALS AND METHODS

Study Sites

The study plantations used for this research work are located on the Agricultural Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife within latitudes 7° 30' to 70° 35' and longitude 4° 30' to 4° 35.6' and designated as A, B, C and D. A is a Citrus Plantation, B is an Oil palm Plantation, C is a Cashew Plantation while D is a Cocoa Plantation. The four plantations were established in 1968 and since then no fertilizer has been applied to any of the plantations.

The soils of the study site are of two series (Iwo and Gambari) formed from granite gneiss rock (Symth and Montgomery, 1962) classified as Ultisol (Okusami and Ojediran, 1985; Amusan and Ashaye, 1991). Ojanuga (1975) described soils of Iwo series as comprising well structure, strong brown to reddish soils with gravelly sand, clay loam to sandy clay texture within the upper horizon and generally slightly more claying in the subsoil. The soils are mostly slightly to moderately acidic.

Dominant plant species of the understorey vegetation of plantation A (citrus) is *Panicum maximum*, while that of plantation B (oil palm) are *Panicum maximum*, *Axonopus compressus*, *Starchytarpheta indica*, *Bracharia deflexa* and *Chromolaena odorata*. Plantation C (cashew) has *Panicum maximum* as the dominant species in its understorey vegetation while in plantation D (cocoa) no understorey was observed.

There are two prominent seasons: the rainy and dry seasons. The rainy season lasts from mid-March to late October and the rainfall is bimodal with peak periods in July and September. An annual rainfall of 1400 mm (five year mean) was reported by Oke and Isichei *et al*. (1997). The dry season lasts from November till March. Annual Temperature ranges from 27-34°C with the highest range being experienced in the dry season (Oke and Isichei, 1997).

Data Collection

Dominant plant species mainly herbs in each plantation were identified. The identification followed the Floral of Tropical West Africa (Hutchinson and Dalziel (1954-1972).

In each of the four plantations, ten replicate soil samples were randomly collected to a depth of 15 cm using a soil auger of diameter 8.5 cm. The soil samples were collected in March for the dry season collection and July for the rainy season collection. The samples were put in polythene bags and labelled and were then transferred to the laboratory where they were spread on tables to dry. The soil samples were transferred after drying into porous plates and placed in the screen house in April (dry season collection) and August (rainy season collection) where they were watered daily and monitored for seedling emergence. There were ten plates for each plot for each season making a total of 40 plates per season. As each plant germinated, the species in each plate were identified, the number of the same species in each plate was also counted and recorded. Once a plant is identified and counted, it was pulled out and the roots rinsed into the plate due to fact that the soil attached into the roots might contain seeds which might be discarded.

Once in a while, the soil in each plate was turned over and mixed so as to aid seed germination. In the course of identification, species whose identities were in doubt were taken to the Ife herbarium where proper identification was carried out. The seedling emergence tests were terminated at the end of 6 months for each soil collection from each plot.

The total number of individuals in each plate for each plot for both dry and rainy seasons collection was determined. The total number of species in each plate per plot for both the dry and rainy season soil collection was determined. The simple percentage was used to compare density of soil seedbank of each plot for the two seasons. The number of seed m^{-2} for each plot in both dry and rainy seasons soil collection was also calculated.

RESULTS

Seedling Emergence

In the dry season soil collections, a total of 382 seedlings or 6705 seeds m^{-2} emerged in Plantation A, 113 seedlings or 1986 seeds m^{-2} emerged in Plantation B, 108 seedlings or 1896 seeds m^{-2} emerged in plantation C and 55 seedlings or 967 seeds m^{-2} emerged in Plantation D (Table 1). In the rainy season soil collections, a total of 347 seedlings or 6088 seeds m^{-2} emerged in Plantation A, 185 seedlings or 3301 seeds m^2 emerged in Plantation B, 241 seedlings or 4229 seeds m^{-2} emerged in Plantation C and 110 seedlings or 1934 seeds m^{-2} emerged in Plantation D (Table 2).

In the dry soil collection a total of 27 species emerged in Plantation A, in plantation B 18 species emerged, 12 species emerged in plantation C and 8 species emerged in Plantation D and in all the four plantations, all the emerged species were herbaceous. In Plantation A, *Laportea aestuans* had the highest density in the seedbank (78 seedlings or 1368 seeds m^{-2}) or 20.42% of the total density of the seed bank while *Lindernia crustacea*, *Ludwigia decurrens*, *Marsilea* sp. and *Vernonia cinerea* had one (01) seedling each and contributed 0.30% to the total density of the seed bank. All other species had intermediate values. In Plantation B, *Mariscus alternifolius* had the highest density in the seed bank (22 seedlings or 386 seeds m^{-2}) or 19.5% of the seed bank while *Andropogon tectorum*, *Eragrotis tenella*, *Oldenladia corymbosa* and *Panicum maximum* had one (01) seedling each or 18 seeds m^{-2} or 0.88% of the seed bank density. In Plantation C, *Mariscus alternifolius* had the highest seed density in the seed bank with a total of 33 seedlings or 579 seeds m^{-2} or 30.56% of the seed bank density while *Laportea aestuans* and *Laportea ovalifolia* had one (01) seedling each or 18 seeds m^{-2} or 0.98% in the

Table 1: Density of species (Seedlings cm^{-2} and Seed m^{-2}) that emerged from the dry season soil collections in the four contrasting study plantations

	Plantation A (Citrus plantation)			Plantation B (Oil plantation)		
Species	Seedlings cm^{-2}	Seeds m^{-2}	SB (%)	Seedlings cm^{-2}	Seeds m^{-2}	SB (%)
Acalypha sp.						
Ageratum conyzoides	20	351	5.74			
Andropogon tectorum				01	18	0.88
Asystasia gangetica	03	53	0.91			
Axonopus compressus	30	526	9.06	15	263	13.3
Borreria ocymoides				04	70	3.54
Bracharia deflexa	05	88	1.51	03	53	2.65
Cana indica	02	35	0.60			
Chromolaena odorata				05	88	4.42
Coccorus urena	06	105	1.51	01	18	0.88
Commelina benghalensis						
Ctenum sp.	03	53	0.91			
Cypodon dactatylon	02	35	0.60			
Dissotis rotundifolia	17	298	15.04			
Evagrotis tenella	01	18	0.88	01	18	0.88
Euphorbia heterophylla						
Fimberstanum sp.				11	193	9.73
Laportea aestuans	78	1368	20.42	02	35	1.80
Laportea ovalifolia	16	281	4.83			
Ludwigia decurrens	01	18	0.30			
Lundernia crustacean	01	18	0.30			

Table 1: Continued

Species	Plantation A (Citrus plantation)			Plantation B (Oil plantation)		
	Seedlings cm^{-2}	Seeds m^{-2}	SB (%)	Seedlings cm^{-2}	Seeds m^{-2}	SB (%)
Mariscus alternifolius	31	544	8.12	22	386	19.50
Marsilea sp.	01	18	0.30	05	88	4.42
Mitracarpus villosus	02	35	0.60			
Oldenlandia corymbosa				01	18	0.88
Panicum maximum	15	263	0.91	01	18	0.88
Paspalum conjugatum	46	807	12.04			
Peperomia pellucida	68	1193	17.80	03	53	2.65
Platostoma africanum	03	53	0.91			
Pouzolzia guineensis						
Richardia brasiliensis	04	70	1.21	02	35	1.80
Scorparia dulcis				12	211	10.63
Setaria barbata	02	35	0.60			
Solenostermon monostachyus	02	35	0.60			
Spigelia anthelmia	05	88	1.51			
Synedrella nodifolia	03	53	0.91			
Talinum triangulare	03	53	0.91	07	123	6.2
Vernonia cinerea	01	18	0.30			
Total	382	6705	100	113	1986	100

Species	Plantation C (Cashew plantation)			Plantation D (Cocoa plantation)		
	Seedlings cm^{-2}	Seeds m^{-2}	SB (%)	Seedlings cm^{-2}	Seeds m^{-2}	SB (%)
Acalypha sp.	02	35	1.85	02	35	3.93
Ageratum conyzoides	07	123	6.48			
Andropogon tectorum						
Asystasia gangetica				01	18	1.82
Axonopus compressus						
Borreria ocymoides						
Bracharia deflexa						
Cana indica						
Chromolaena odorata	06	105	5.56	07	123	12.73
Coccorus urena						
Commelina benghalensis				01	18	1.82
Ctenum sp.						
Cypodon dactatylon						
Dissotis rotundifolia	18	316	16.67			
Evagrotis tenella						
Euphorbia heterophylla				01	18	1.82
Fimberstanum sp.						
Laportea aestuans	01	18	0.93			
Laportea ovalifolia	01	18	0.93			
Ludwigia decurrens						
Lundernia crustacean						
Mariscus alternifolius	33	579	30.56	01	18	1.82
Marsilea sp.	06	105	5.56			
Mitracarpus villosus						
Oldenlandia corymbosa						
Panicum maximum						
Paspalum conjugatum						
Peperomia pellucida	04	70	3.70	02	35	3.64
Platostoma africanum						
Pouzolzia guineensis	02	35	1.85			
Richardia brasiliensis						
Scroparia dulcis	03	53	2.78			
Setaria barbata						
Solenostermon monostachyus						
Spigelia anthelmia						
Synedrella nodifolia						
Talinum triangulare	25	439	23.15	40	702	72.73
Vernonia cinerea						
Total	108	1896	100%	55	967	100%

Table 2: Density of Species (Seedlings cm^{-2} and Seed m^{-2}) that emerged from the rainy season soil collections in the four contrasting study plantations

	Plantation A (Citrus plantation)			Plantation B (Oil plantation)		
Species	Seedlings cm^{-2}	Seeds m^{-2}	SB (%)	Seedlings cm^{-2}	Seeds m^{-2}	SB (%)
Acanthaceae						
Ageratum conyzoides	18	316	4.33			
Amaranthus sp.						
Anagalis djalensis						
Andropogon tectorum				01	18	0.67
Aspilia africana	06	105	1.73			
Asystasia gangetica	02	35	0.58			
Axonopus compressus	29	509	6.97	05	88	2.66
Borreria ocymoides	50	877	12.00	22	386	11.70
Bracharia deflexa	23	404	5.53	02	35	1.60
Centosema pubescence						
Chromolaena odorata	06	105	1.73	01	18	0.53
Cleom ciliate						
Commelina benghalensis						
Diodia sp				11	193	5.58
Dissotis rotundifolia				07	123	3.72
Emilia sanchifolia	01	18	0.29			
Fern sp.						
Ficus mucoso	01	18	0.29			
Haringana madagascariensis						
Indigotera sp.	01	18	0.29			
Justicia flava						
Laportea aestuans	03	53	0.72			
Laportea ovalifolia						
Mariscus alternifolius	73	128	17.55	15	263	7.98
Marsilea sp.						
Melanthera sp.						
Meremia sp.						
Mikannia cordata						
Mitracarpus villosus	01	18	0.29			
Momardica sp.	01	18	0.29			
Oldenlandia corymbosa	12	211	2.88	51	895	27.13
Oplismensus burmanni	02	35	0.48			
Panicum maximum	02	35	0.48	06	105	3.19
Peperomia pellucida	121	2128	29.09			
Platostoma africanum	13	228	3.13	11	193	5.85
Phyllanthus amarus	01	18	0.24			
Physalis angulata						
Piper umbellate						
Pouzolzia guineensis						
Scoparia dulcis	02	35	0.24	23	404	12.23
Setaria barbata	04	70	0.96			
Sida linifilis	01	18	0.24			
Sida rombifolia						
Solanum sp.						
Solenostermon monostachyus	05	88	1.20			
Spigelia anthelmia	27	474	6.49	07	123	3.72
Stachtapheta sp.				14	246	7.45
Talinum triangulare	05	88	1.20	02	35	1.06
Toremia sp.				09	158	4.79
Trema orientalis	01	18	0.24			
Tridax procumbens						
Vernonia cinerea	05	88	1.20			
Vernonia verbusifolia						
Ureara sp.						
Total	347	6088	100	185	3301	100

Table 2: Continued

Species	Plantation C (Cashew plantation)			Plantation D (Cocoa plantation)		
	Seedlings cm^{-2}	Seeds m^{-2}	SB (%)	Seedlings cm^{-2}	Seeds m^{-2}	SB (%)
Acanthaceae				05	88	4.55
Ageratum conyzoides	04	70	1.66			
Amaranthus sp.				02	35	1.82
Anagalis djalensis				01	18	0.41
Andropogon tectorum	04	70	1.66			
Aspilia						
Asystasia gangetica	05	88	2.07	01	18	0.41
Axonopus compressus						
Borreria ocymoides	09	158	3.73			
Bracharia deflexa						
Centosema pubescence	20	351	8.30			
Chromolaena odorata	19	333	7.88	13	228	11.82
Cleom ciliate	01	18	0.41			
Commelina benghalensis				02	35	1.82
Diodia sp	03	53	1.24			
Dissotis rotundifolia	24	421	9.96			
Emilia sanchifolia						
Fern sp.	07	123	2.90	05	88	4.55
Ficus mucoso	08	140	7.27			
Haringana madagascariensis	02	35	0.83	05	88	2.07
Indigotera sp.						
Justicia flava	02	35	1.82			
Laportea aestuans	02	35	0.83	12	211	10.91
Laportea ovalifolia				01	18	0.90
Mariscus alternifolius	43	754	17.84	04	70	3.64
Marsilea sp.	15	88	2.07	06	105	5.45
Melanthera sp.	02	35	0.83			
Meremia sp.	09	158	3.73			
Mikannia cordata	04	70	1.66	01	18	0.91
Mitracarpus villosus						
Momardica sp.				02	35	1.82
Oldenlandia corymbosa	28	491	11.62			
Oplismensus burmanni						
Panicum maximum						
Peperomia pellucida	17	298	7.05	01	18	0.91
Platostoma africanum	04	70	1.66			
Phyllanthus amarus						
Physalis angulata	01	18	0.41			
Piper umbellate				01	18	0.91
Pouzolzia guineensis	01	18	0.41			
Scoparia dulcis						
Scarparium dulcis						
Setaria barbata						
Sida linifilis						
Sida rombifolia				01	18	0.91
Solanum sp.				01	18	0.91
Solenostermon monostachyus				01	18	0.91
Spigelia anthelmia	03	53	1.24			
Stachtapheta sp.						
Talinum triangulare	08	140	3.32	30	526	27.27
Toremia sp.	06	105	2.49			
Trema orientalis	02	35	0.83	0.4	70	3.64
Tridax procumbens	02	35	0.83			
Vernonia cinerea						
Vernonia verbusifolia				01	18	0.91
Ureara sp.				05	88	4.55
Total	241	4229	100	110	1934	100

seed bank. In Plantation D, *Talinum triangulare* had the highest seed density in the seed bank with a total of 40 seedlings or 702 seed m^{-2} or 72.73% of the seedbank density while *Asystasia gangetica*, *Commelina benghalensis*, *Euphorbia heterophylla* and *Mariscus alternifolius* contributed one (01) seedlings each or 18 seeds m^{-2} of the seedbank density (Table 1).

In the rainy season soil collections 28 species emerged in Plantation A, 16 species emerged in Plantation B, 28 species emerged in Plantation C and 23 species emerged in Plantation D. Few woody species emerged in Plantations A, C, D and none emerged in Plantation B. Plantation A consist two (02) woody and 26 herbaceous species and the woody species that emerged were *Ficus mucuso* and *Trema orientalis* belonging to the families Moraceae and Ulmaceae respectively. *Peperomia pellucida*, herbaceous species, made the highest contribution to the seedbank of the plantation with a total of 121 seedlings or 2128 seeds m^{-2} or 29.09% of the total density while eight (8) other species: *Emilia sanchifolia*, *Ficus mucuso*, *Indigofera* sp., *Mitracarpus villosus*, *Mormodica* sp., *Phyllantus amarus*, *Sida vernonisifolia* and *Trema orientalis* contributed one (01) seedling each to the seedbank density (18 seeds m^{-2} or 0.29%). All other species contributed intermediate values to the seedbank density. In plantation B, all the emerged seedlings were herbaceous species and *Odenlandia corymbosa* had the highest seed density in the seedbank with a total of 51 seedlings or 895 seeds m^{-2} (27.13% of the seedbank density) while *Andropogon tectorum* and *Chromolaena odorata* had one (01) seedling each or 18 seeds m^{-2} in the seedbank density (0.67% of the seedbank density).

The 28 species that emerged in Plantation C had two (02) woody species and 27 herbaceous species and the two woody species that emerged were *Harungana madagscariensis* and *Trema orientalis* belonging to the families Cuttiferaceae and Ulmaceae respectively. *Mariscus alternifolius*, a herbaceous species made the highest contribution to the seedbank of the Plantation with a total of 43 seedlings or 754 seeds m^{-2} or 17.84% of the total seedbank density while four (04) other herbaceous species: *Cleome ciliata, Physalis angulata* and *Pouzolzia guinensis* had one (01) seedling each or 18 seeds m^{-2} in the seedbank density). The 23 species that emerged in Plantation D consist 21 herbaceous species and 02 woody species and the two woody species were *Ficus mucoso* and *Trema orientalis* belonging to the families Moraceae and Ulmaceae, respectively. *Talinum triangulare* also had the highest contribution with a total of 30 seedlings (526 seeds m^{-2} or 27.27% of the total seedbank density) while other nine (09) species had one (01) seedling each 18 seeds m^{-2} or 0.91% of the seed bank density.

Herbs dominated the seedbank in all the 4 study Plantations. Some of the emerged herbaceous species that were in all the 4 Plantations and in the two season were *Chromolaena odorata*, *Mariscus alternifolius* and *Talinum triangulare*. No woody species emerged in all the four plantations in the dry season soil collections. The few woody species that emerged from the soil collections emerged from the rainy season soil collections and they emerged from Plantations A, C and D and no woody species emerged from Plantation B (oil palm plantation).

The highest number of herbaceous seedlings emerged in Plantation A (Citrus plantation), both in the dry season and rainy season soil collections. Seedlings emerged first from Plantation B (oil palm plantation) and emerged last from Plantation D (Cocoa plantation) from the dry season soil collection while in rainy season, seedlings emerged first from Plantation A (Citrus plantation) and seedlings emerged last from Plantation B (Oil palm plantation). The monthly observation of emergence of seedlings revealed that the highest number of individuals and species emerged in Plantation A (Citrus plantation) in the 6th month (October) in the dry season soil collection (Table 3). The highest number of individual seedlings emerged in Plantation A (Citrus plantation) in the 2nd month (October) in the rainy season soil collection in Plantation A (Citrus Plantation and the highest number of species emerged in the 3rd month (October) in Plantation C (Cashew plantation) (Table 4).

Table 3: Periodic emergence of seedlings from dry season soil collection in the four contrasting study plantations

		Periodic							
Plots	Parameter	May	June	July	August	September	October	November	Total
A									
Citrus plantation	No. of individuals	1150	801	1185	802	467	1361	941	6705
	No. of species	8	5	5	5	10	11	6	
B									
Oil palm plantation	No. of individuals	123	281	53	367	333	825	-	1986
	No. of species	2	16	3	7	4	9	-	
C									
Cashew plantation	No. of individuals	53	333	246	175	737	351	-	1896
	No. of species	1	3	3	4	6	3	-	
D									
Cocoa plantation	No. of individuals	162	251	233	76	58	111	76	967
	No. of species	1	2	3	3	4	2	1	

Table 4: Periodic emergence of seedlings from rainy season soil collection in the four contrasting study plantations

		Period						
Plots	Parameter	August	September	October	November	December	Jan	Total
A								
Citrus plantation	No. of individual	427	1881	1725	1051	409	595	6088
	No. of species	5	15	19	10	9	6	
B								
Oil palm plantation	No. of individual	144	653	1440	323	579	162	3301
	No. of species	3	6	9	5	4	2	
C								
Cashew plantation	No. of individual	216	1062	1494	702	486	269	4229
	No. of species	4	11	20	10	5	5	
D								
Cocoa plantation	No. of individual	461	513	621	227	65	47	1934
	No. of species	4	10	12	5	4	2	

Seedbank and Standing Vegetation

The comparison of the plant species that emerged from the soil collections with the plant species encountered in the standing vegetation revealed that the seedlings of species of each of the four study plantations i.e., Citrus, Oil palm, Cashew and Cocoa seedlings were not seen among the emerged seedlings. None of the woody seedlings that emerged from the soil collections from Plantation A, C, D were seen in the standing vegetation of the plantations and some of the herbaceous species seedlings that emerged from the soil collections from the plantations were seen in the standing vegetation. All the herbaceous species encountered in the standing vegetation were represented in the seedling that emerged from the soil collections. Many herbaceous species seedlings that emerged from the soil collection had no representation in the standing vegetation.

DISCUSSION

The observed total seedbank densities of the Plantations in this study which ranged from 967-6705 seeds m^{-2} was higher than values reported for studies conducted in some tropical forests of the world (e.g., Dalling and Denshow (1998) in Panama, 55-243 seeds m^{-2} (Grombane-Guaratimi, 1993) in forest of neotropic Africa and Australia, 372-4700 seeds m^{-2}). The higher seed density obtained in this study can be ascribed to the preponderance of herbaceous species in the seedbank density of the study Plantations and longer time allowed for the seedling emergence which probably gave room for more seeds to overcome their dormancy and germinate. The duration of seedling emergence for other studies was shorter, for example Dalling and Denshow (1998) and Miller (1998) carried out seedling emergence for six weeks and 58 days, respectively for the analysis of seedbank.

In contrast Min *et al.* (1997) reported densities of 29,945 and 24,740 seeds m^{-2} respectively for two secondary forests dominated by *Macaranga denticulates* and *Trema orientalis* and these figures are comparably higher than the figures obtained in this study. This can be attributed to the fact that this study was done in Plantations which are monoculture whereas the work of Min *et al.* (1997) was done in forests and since there are various species in the forests, there may be more seed rain of different species than that of Plantations which is a form of monoculture.

Herbaceous species dominated the seed bank, constituting 98% of the total seed density of the seedbank in each of the four study plantations in both seasons. This observation could be due to the openings of the canopy of the study Plantations which enhances the dispersal of seeds of these herbaceous species to the Plantations. Dalling and Denshow (1998) asserted that a larger proportion of seeds from herbaceous species may have reflected an excessive input of herbaceous species from surrounding open, disturbed vegetation. The dominance of herbaceous species in the seedbank of forest soils has been reported by various workers (Miller, 1998) noted that dicotyledonous herbs were the most common growth form accounting for 53-71% of the identified seedlings in the tropical deciduous forest of western Mexico. The presence of few woody species in the seedbank of the study Plantations may be due to low seed production or the lack of definite (or no) dormancy mechanism in most woody species especially primary forest species (Dike, 1992). He observed that forest species often complete their germination processes within 84 days after dispersal at Omo and Sapoba forest reserves in Southern Nigeria, therefore few seeds remained in the soil seed stores.

The observed highest seedbank composition for both seasons in Plantation A (Citrus plantation) may be due to the large canopy gaps in the plantation which allowed for seed rain from neighbouring forests to reach the ground. The fewer seedbank composition observed in cocoa plantation may be due to the very close canopy of the Plantation which reduced the seed rain that may reach the ground and the exposure of these few seeds that reached the ground to predation because of the thick litter layer which prevent the seed from being buried in the soil easily. The highest emergence of seedlings (individuals and species) during the rainy season (October) for both collections may be due to the fact that the rainy season facilitates rapid germination as most germination requirements are met during the rainy season.

In all the four Plantations, there was no similarity between their seedbank woody species composition and the woody species composition of the standing vegetations. This is in agreement with the result of several workers e.g., William Linera (1993) who found no close similarity between the tree species composition of the buried seeds and the vegetation used for the study of soil seedbank in lower Montane forest of Mexico. Several other workers have also reported on the dissimilarity between the seedbank and the standing vegetation (Hill and Stevens, 1981; Pickett and Macdonell, 1989).

The method used to analyse the seed composition of the soil may also have introduced some variations. Thus, direct germination may underestimate the seedbank density and diversity if ideal conditions for germination are not available (Gross, 1990; Brown, 1992). Variations in temperature and solar radiation during the periods in which samples remained in the nursery may have also influenced the results obtained.

The reduction in plants, wildlife population and diversity in plantations call for the re-designing of the species composition and structure of our plantations in order to incorporate all the other forest components, including plant and animal species being threatened with extinction.

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