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RESEARCH PAPER

Assessment of soil seed banks in relation to above-ground vegetation in three ecosystems within University of Ibadan, Ibadan, South Western Nigeria

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Abstract

Soil seed bank (SSB) is implicated in restoration of flora in an ecosystem and commencement of succession after disturbance. In the assessment of natural re-vegetation capacity of some ecosystems within the University of Ibadan, Nigeria, SSB contents were assessed and compared with the above-ground vegetation (AGV). Three ecosystems (Arable, Fallow and Plantation) were selected, with 25 x 25 m area marked out in each for random sampling, using XY-ordinate technique. Ten points were located for placement of wooden quadrat (50 x 50 cm). All plant species that rooted within each quadrat were enumerated. Soil samples were collected at 0-15 cm depth at the centre of each quadrat and bulked by site. One kilogram soil, replicated 12 times in each site, was monitored for seedling emergence for five months. Species richness (R), Shannon-Wiener index (H`) and Jaccard Similarity Index (J) were determined for AGV and SSB. Plant family Poaceae dominated AGV while Amaranthaceae dominated SSB in all ecosystems. The R in AGV and SSB ranged from 14-24 and 6-15 respectively. The H` in AGV were close (2.27–2.69) but ranged from 0.84 (plantation) to 2.27 (arable) in SSB. The J for SSB/AGV were 33.3%, 14.3% and 5.9% in arable, fallow and plantation ecosystem respectively, indicating the highest species resemblance in the most disturbed arable ecosystem.

Keywords: Alpha diversity, Community structure, Vegetation, Seed bank

Introduction

Soil seed bank is defined as the total number or density of viable seeds stored on the soil in a given period (Simpson *et al*., 1989; Zhang *et al*., 2015). The store of the seeds buried in soil (the seed bank) is composed in part of seeds produced in the area in a dormant condition (Baskin and Baskin, 1989). Seeds may then need to await stimuli or conditions before they can germinate or they may have further dormancy imposed upon them by the conditions they meet on or in the soil (Taye, 2006).

Seeds in the seed bank are continually added to by the seed rain and thus represent a record of past as well as present vegetation growing on the area and nearby (Fenner, 1985). The seed bank represents a source from which new vegetation may quickly arise if the existing stand is destroyed (Oke, 2013). The ways in which the buried seed population acquires its depth distribution are rather obscure. Some seeds, particularly small ones, undoubtedly move down the soil profile of loose-textured soils with percolating rain water. A few seeds possess self-burial mechanisms, e.g. species of the genera *Hordeum, Triticum, Avena, Erodium* but these are clearly in a minority among seed types and are mainly weedy species of disturbed habitats (Feast and Robert, 1972). The majority of seeds in cultivated soils in the upper 15 cm of soil profile can be found as deep as the soil is tilled, and as the intensity of tillage declines, the seed bank moves closer to the soil surface due to continuous stirring and inverting of the soil profile. In undisturbed vegetation, some burial of seeds occurs by the piling of successive layers of leaf litter on the soil surface after seed fall, the burying action of soil cast up by earthworms (Wilems and Huijsman, 1994) and moles and by the caching activities of birds and rodents. Some seeds may presumably also fall down earthworm burrows, the cavities left after root decay and cracks caused by drying-wetting cycles in the soil and by surface soil erosion covering seed.

Soil microflora may impair seed viability, as the most favourable environmental conditions for decay or seed rotting occur when germination is extremely slow or stressed. Likewise, seed can be lost by animal and insect predation. Also, seed germination is a source of loss of seeds from the seed bank and seedling recruitment is greater in cultivated fields than undisturbed soils (Feast and Roberts, 1972). The seed bank is therefore a valuable reference in studies of ecological impact (Perry *et al*., 2003), and in the conservation and restoration of the commoner arable flora, fallow land and plantation. Soil seed banks contribute to the diversity and dynamics of most plant communities. In some systems, they are critical for maintenance of species populations (Oladipo, 2003) or for restoration of native plant communities (Newmaster, 2006) as they provide an immediate source of propagules for recruitment after disturbance.

The present study was conducted to assess the soil seed bank of arable, fallow and plantation ecosystems within the University of Ibadan, Ibadan, Nigeria and to compare their species composition with the above-ground vegetation.

Materials and Methods

Location of the Study Sites

The University of Ibadan Teak plantation and Ajibode-Sasa farm (Arable and Fallow) are located within the University of Ibadan, a transition lowland rain forest/savannah vegetation zone in the Southwest Nigeria. The teak plantation lies on N07^{O} 27.354', E003^{O} 54.162' and elevation of 205 m above sea level and the Ajibode-Sasa farm: arable lies on N07^{O} 28.614', E003^{O} 54.161' and elevation of 201 m above sea level and fallow, that has been abandoned for over one year lies on N07^{O} 27.719', E003^{O} 54.115' and an elevation of 194 m above sea level (ASL).

Description and Features of the Study Sites

The University of Ibadan Forest reserve is composed of woody and herbaceous flora, a reflection of human interference, which has resulted in various land use types such as farmlands, wetlands, a rock outcrop, a grazing land and teak and gmelina plantations. It is bound to the North by Orogun river/Ajibode link road, to the South by Abadina College/University of Ibadan Junior Staff Residential Quarters, to the East by Orogun-Sasa link road, and to the West by Abadina Primary School and the University of Ibadan Dairy/Small Ruminant Livestock farm (Plate 1). The vegetation of the study area is composed of species physiognomy characteristic of a tropical vegetation pattern that is peculiar to a lowland rainforest comprising of trees, shrubs and herbaceous flora, but for the fact that the trees are dominated by teak and gmelina.

The Ajibode area is comprised of persistent human activities such as farming, bush burning, and recently, the estate development as extension of the University of Ibadan Campus. Vegetation is characterized by *Chromolaena odorata, Cassia fistula, Euphorbia hirta, Panicum maximum* and *Tithonia diversifolia*. In the marshy areas, there is gallery forest with plant species including bamboo, sugar cane, banana and other plants. Many economically important trees found in the area are oil palm, kolanut, baobab, locust beans and cultivated food crops like yam, cassava, cocoyam, maize and pawpaw (Moorman *et al*., 1997).

Climate of the study site

The climatic data is presented in Table 1

Table 1: Agro-meteorological parameters of University of Ibadan and environs in 2015

Parameters	Value
Mean Monthly Temperature	27^{O}C
Mean Monthly Relative Humidity	75%
Mean Monthly Wind	7.81 km/day
Mean Monthly Sunshine hours	3.97 hours
Mean Annual Rainfall	1,154 mm

Source: Data were obtained at the Ibadan Office of Nigerian Metrological Agency (NIMET) in 2015

Floristic Sampling Procedures

Layout of Sampling Area and Plots for Floristic Sampling

The standing vegetation was sampled in order to compare its floristic composition with that of the soil seed bank. On each site, 25 x 25 m area was marked out. Using XY- ordinate random sampling techniques, ten points were located for placement of wooden quadrat (50 x 50 cm) for plant species enumeration. Thus, a total of 30 quadrats were laid and used to describe the floristic composition in the University of Ibadan teak plantation and Ajibode sasa farm (arable and fallow). All weeds and other low- growing plants that rooted within each quadrat were identified using published flora (Akobundu and Agyakwa, 1998). Weeds that were difficult to identify were coded and preserved in a plant press, and sent to University of Ibadan Herbarium (UIH) located in the Department of Botany, University of Ibadan, for identification.

Seed bank sampling

Monitoring of the soil seed bank of the soil samples was done at the screen house of the Department of CPEB, University of Ibadan, Ibadan. Soil samples were collected at the depth of 0-15 cm at the centre of each quadrat using a soil auger of diameter 8.5 cm. The soil samples from each site were bulked, sieved and air-dried in the Ecology Research Laboratory, Dept. of CPEB. One (1) kg soil sample was spread in a perforated plastic seed tray (10 cm diameter x 4 cm depth) and replicated 12 times for each site. The germination trays were placed in a screen house and regularly watered with tap water (50 cl per tray every other day). At 2 weeks interval, emerging seedlings were identified, counted and removed. The seedlings that could not be identified were counted, transplanted and grown separately in nursery pots until they produced flowers that ensured correct identification. For each stand, the species composition, mean density (number of seeds/m^2) and mean relative density of the species that constituted the germinable soil seed bank were determined. After five months (April-September), the experiment was terminated as no new seedlings had appeared for several weeks.

Methods of Soil analyses

Soil analysis

The soil samples were air-dried by spreading them out in the Ecology Research Laboratory, CPEB department. The samples were thereafter sieved through a < 2 mm mesh sieve to remove pebbles or other unwanted materials. The thoroughly-mixed samples were transported to the soil science laboratory of the Agronomy Department, University of Ibadan, for analysis of particle size distribution, total nitrogen content, available phosphorus, organic matter content and soil pH. The soil analyses were used to compare the soil properties of the different ecosystems within the University of Ibadan. Soil organic matter was determined through the determination of carbon. The soil organic matter content was then calculated from the carbon content based on the assumption that soil organic matter contains 58% carbon. The soil pH was measured in 1:1 soil-water suspension, 1:2 0.01M $CaCl_2$ using glass electrode pH meter. Total Nitrogen was determined using the Kjedahl method. The available Phosphorus was determined using Bray-1 solution (Bray and Kurtz, 1945). Exchangeable cations were also determined by leaching the soil samples using 1 M NH_4OAc (Ammonium acetate) solution buffered at pH 7.0 as extractant (Richards, 1999) and exchangeable Sodium and Phosphorus were determined on the leachate by flame photometer and the Calcium by Atomic Absorption Spectrophotometer (AAS). Soil particle size distribution was determined by hydrometer method using 5% Sodium Hexametaphosphate as the dispensing agent (Van Reeuwijk, 1998).

Data Analyses

From the data, the measure of importance for each species in each site was determined as mean of relative density and relative frequency for each species.

[(RD + RF)/2] x 100 (Kent and Coker,1992; Das, 2011) where RD=Relative Density and RF= Relative Frequency

Absolute Density (D) is the number of individuals of a particular species per unit area.

Relative Density (RD) is the percentage value of density of a weed species relative to the total density of all species.

RD=d/D X 100   where d = the density of species; D = total density of all species.

Absolute Frequency (F) is the measure of the chance of finding a species within a quadrat. That is, the number of quadrats that has a particular species in relation to the total number of quadrats laid.

Relative Frequency (RF): The frequency of a species relative to the total frequency of all species.

Measures of Community Structure

A measure of community is a function of species composition and the distribution of each species (Harper and Hawksworth, 1995). The biological community structure as informed by the ecological diversity of the weed species was determined by alpha and beta diversity. The alpha diversity, which is the diversity of species within a particular community, was determined by Species Richness (R), Shannon-Wiener (H`), Evenness (J) and Dominance (D) indices using PAST software version 2.08 (Hammer, 2011; Awodoyin *et al*., 2013). The beta diversity, which is the expression of between-habitat diversity, was determined by Jaccard index (Spellerberg, 1993).

Species richness is the total number of species occurring within a specified area of the community; Evenness index is a measure of evenness with which individuals are distributed among all species present;

Shannon Wiener index of diversity is a function of species richness and the evenness with which individuals are distributed among species; and Dominance seeks to show if the community is dominated by a particular species (Kent and Coker, 1992; Spelleberg, 1993; Barbour *et al*., 1999; Elle, 2009; Hammer, 2011). Jaccard index of community similarity (SCj) determines community similarity, and it is based on the presence-absence relationship between the numbers of common species (Spelleberg, 1993).

The Shannon-Wiener index of species diversity is calculated as $H^i = \sum pi.\mathit{ln}pi$ where $pi = n/N$. pi is the proportion which is the number of individuals in a species (n) in relation to the total number of all individuals in a community (N), *ln* is naperian $\text{logarithm} = 2.303 \times \log_{10}$

The species equitability index (J) is calculated as $J = H^i / \mathit{ln}S$ where H^i is Shannon- Wiener index and S is total number of species in the community. The Dominance index (D) is calculated $D = \sum (pi^2) = \sum (n/N)^2$ where n is number of individuals of a particular species and N is the total number of individuals found in the community. Jaccard index of community similarity (SCj) is calculated as SCj (%) = (w/ A+B-w) x100. Where w is the number of common species; A is the number of species in community A; and B is the number of species in community B.

Results

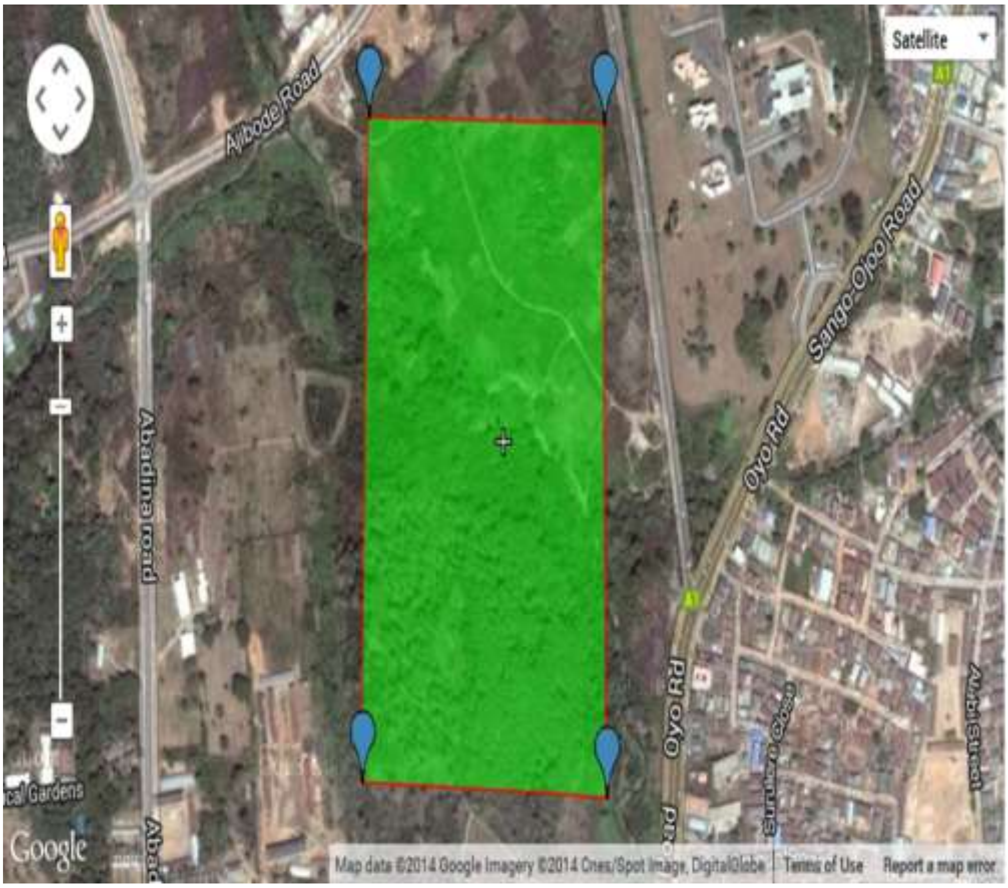

Plate 1: Aerial view of the sampling area within University of Ibadan, Ibadan in 2015 (Google earth © 2015)

Floristic Composition of Above- ground Vegetation

Combining the three ecosystems, a total of 36 plants species belonging to 16 families were found with 15, 24 and 14 species in arable, fallow and plantation, respectively (Table 2). Poaceae (7) and Asteraceae (5) had the highest number of species. Only four species were common to the three sites. They are *Chromolaena odorata, Imperata cylindrica, Panicum maximum* and *Tridax procumbens.* Common to arable and fallow are *Ageratum conyzoides, Laportea aestuans, Portulaca oleracea, Talinum fruticosum* and *Tithonia diversifolia.*

Panicum maximum had the highest Relative Importance Value (RIV) (28.45%) in the plantation, *Tridax procumbens* had the highest RIV (17.43%) in the arable ecosystem and *Ocimum gratissimum* had the highest RIV (14.95%) in the fallow ecosystem. (Table 3).

Fallow had the highest species richness of 24 followed by arable with 15 and the least was plantation was 14 (Table 4). Dominance (D) indices were 0.13, 0.10 and 0.18 in arable, fallow and plantation, respectively. For Shannon-Wiener indices, fallow had the highest value of 2.69, followed by arable with 2.27 and the least was plantation with 2.14. Evenness index values occurred as 0.65. 0.61 and 0.61 in arable, fallow and plantation, respectively (Table 4).

Table 2: Plant Species occurrence in the Floristic Survey carried out in three ecosystems within University of Ibadan, Ibadan in 2015

		Occurrence		
Family	Species	Arable	Fallow	Plantation
	Amaranthus spinosus	+	-	-
	Alternanthera sessilis	-	+	-
	Celosia spicata	+	-	-
Amaranthaceae (4)	*Gomphrena celosioides*	-	+	-
	Acmella brachyglossa	+	-	-
	Ageratum conyzoides	+	+	-
	Chromolaena odorata	+	+	+
	Tithonia diversifolia	+	+	-
Asteracea (5)	*Tridax procumbens*	+	+	+
Cleomaceae(1)	*Cleome viscosa*	-	+	-
Commelinaceae(1)	*Commelina benghalensis*	-	+	+
	Cyperus haspan	-	+	-
	Cyperus iria	-	+	-
Cyperaceae(3)	*Kyllinga pumila*	+	-	-
Equisetaceae(1)	*Equisetum arvense*	-	-	+
	Acalypha segetalis	+	+	-
	Euphorbia heterophylla	-	+	-
	Euphorbia hirta	-	+	-
Euphorbiaceae (4)	*Phyllantus amarus*	-	+	-
Fabaceae (3)	*Centrosema brasilianum*	-	+	-
	Centrosema pubescens	-	+	-
	Gliricidia sepium			
	Ocimum gratissimum	-	+	-
Lamiaceae (2)	*Tectona grandis*	-	-	+
Leguminosae-Mimosoideae (1)	*Mimosa invisa*	-	+	-
Malvaceae (1)	*Sida acuta*	-	+	-
Nyctaginaceae (1)	*Boerhavia diffusa*	-	-	+
Portulacaceae (2)	*Portulaca oleracea*	+	-	-
	Talinum fruticosum	+	+	_
Poaceae (7)	*Andropogon gayanus*	-	-	+
	Eleusine indica	+	-	-
	Imperata cylindrica	+	+	+
	Panicum maximum	+	+	+
	Panicum subalbidum	-	+	-
	Pennisetum pedicellatum	-	-	+
	Setaria barbata	-	-	-
Solanaceae (1)	*Physalis angulata*	+	-	-
Urticaceae (1)	*Laportea aestuans*	+	+	-

+ (Present); – (Absent)

Table 3: Relative Importance Value (%) of Plants Species in the floristic Survey carried out in three ecosystems within University of Ibadan, Ibadan in 2015

Species	Arable	Fallow	Plantation
Acalypha segetalis	13.09	-	-
Amaranthus spinosus	1.95	-	-
	13.59	-	-
Acmella brachyglossa	6.25	1.35	-
Ageratum conyzoides	-	1.96	-
Alternanthera sessilis	-	-	5.93
Andropogon gayanus	-	-	1.79
Boerhavia diffusa	6.53	-	-
Celosia spicata	-	1.23	-
Centrosema brasilianum	-	2.29	-
Centrosema pubescens	1.95	2.94	11.67
Chromolaena odorata	-	3.11	-
Cleome viscosa	-	1.55	13.93
Commelina benghalensis	-	1.55	-
Cyperus haspan	-	4.73	-
Cyperus iria	2.73	-	5.83
Eleusine indica	-	1.76	-
Euphorbia heterophylla	-	4.46	-
Euphorbia hirta	-	-	4.05
Equisetum arvense	-	2.29	-
Gliricidia sepium	-	4.12	-
Gomphrena celosioides	2.56	8.93	9.61
Imperata cylindrica	5.57	-	-
Kyllinga pumila	10.28	1.96	-
Larpotea aestuans	-	7.97	-
Mimosa invisa	-	14.95	-
Ocimum gratissimum	4.3	9.46	28.45
Panicum maximum	-	1.76	-
Panicum subalbidum	-	-	2.26
Pennisetum pedicellatum	-	4.05	-
Phyllanthus amarus	3.89	-	-
Physalis angulata	2.15	1.55	-
Portulaca oleracea	-	-	6.03
Setaria barbata	-	3.11	-
Sida acuta	4.76	1.55	-
Talinum fruticosum	-	-	1.79
Tectona grandis	5.53	10.4	-
Tithonia diversifolia	17.43	2.9	2.26
Tridax procumbens			

Table 4: Species Diversity of above- ground plants in the floristic Survey carried out in the three ecosystems within University of Ibadan in 2015

Diversity Indices	Sites		
	Arable	Fallow	Plantation
Taxa_S	15	24	14
Dominance_D	0.13	0.10	0.18
Shannon_H'	2.27	2.69	2.14
Evenness_e^H/S	0.65	0.61	0.61

Table 5: Species Diversity of germinated plant species of soil seed bank from the three ecosystems within University of Ibadan in 2015

Diversity Indices	Sites		
	Arable	Fallow	Plantation
Taxa_S	15	8	6
Dominance_D	0.13	0.20	0.64
Shannon_H'	2.27	1.82	0.84
Evenness_e^H/S	0.65	0.77	0.39

Table 6: Plants species occurrence in the soil seed bank from the three ecosystems within University of Ibadan in 2015

Family	Species	Occurrence Arable	Fallow	Plantation
Amaranthaceae (4)	*Amaranthus hybridus*	+	_	_
	Amaranthus spinosus	+	_	_
	Celosia leptostachya	+	_	_
	Gomphrena celosiodes	_	+	_
Asteraceace (2)	*Ageratum conyzoides*	+	+	+
	Tridax procumbens	+	_	_
Loganiaceae (1)	*Spigelia anthelmia*	+	+	+
Piperaceae (1)	*Peperomia pellucida*	+	+	_
Poaceae (2)	*Chloris pilosa*	+	+	+
	Eleusine indica	+	+	+
Portulacaceae (2)	*Portulaca oleracea*	+	+	_
	Talinum fruticosum	+	+	+
Urticaceae (1)	*Laportea aestuans*	+	_	+
Species total		12	8	6

Floristic Composition and Community Structure of Soil Seed Bank

Eleusine indica had the highest RIV (57.89%) in the plantation and in the fallow ecosystem (27.04%), while *Laportea aestuans* had the highest RIV (19.33%) in the arable ecosystem (Table 3). Amaranthaceae had the highest number of species. Five species were common to the three soil seed banks. They were *Ageratum conyzoides, Chloris pilosa, Eleusine indica, Spigelia anthelmia* and *Talinum fruticosum* (Table 5). Common to arable and fallow were *Peperomia pellucida* and *Portulaca oleracea*. Common to arable and plantation was *Laportea aestuans*.

Arable soil had the highest species richness of 15 followed by plantation 6 (Table 7). Dominance (D) indices were 0.64, 0.20 and 0.13 in arable, fallow and plantation respectively. For Shannon-Wiener indices,the arable community had the highest value of 2.27, followed by fallow with 1.82 and the least was plantation with 0.84. Evenness index was highest in fallow (0.77), followed by arable (0.65) and was least in plantation (0.39).

Flora diversity of Soil Seed Bank and Above-ground Vegetation

Of the 36 species recorded in the standing vegetation, only 13 species were present in the seed bank. Seven species were both similar in Arable for standing vegetation and soil seed bank. They were *Ageratum conyzoides, Amaranthus spinosus, Eleussine indica, Laportea aestuans, Portulaca oleracea, Talinum fruticosum and Tridax procumbens*. In the Fallow ecosystem, four species were similar in the standing vegetation and soil seed bank. They were *Ageratum conyzoides, Gomphrena celosioides, Portulaca oleracea* and *Talinum fruticosum.* Only one species, *Eleusine indica*, was similar in the standing vegetation and soil seed bank in the teak plantation.

The Similarities in Species Composition in the Soil Seed Bank and Standing Vegetation

Relating species contents of standing vegetation in the three ecosystems, Arable and Fallow had the highest similarity (25.0%) followed by Arable and Plantation (16.7%), and Fallow and Plantation had the least similarity (12.5%) (Table 7). Relating the species contents in soil seed bank of the three ecosystems, Fallow and Plantation had the highest similarity (55.0%), followed by Arable and Fallow with 53.8% similarity, while Arable and Plantation were least similar (50.0%) (Table 8). The similarity in species composition of the above ground vegetation and soil seed bank in the three ecosystems was highest in Arable (33.3 %) followed by fallow (14.3%), and the least was in the Plantation (5.9%) (Table 9).

Table 7: Jaccard's Index (%) relating Above-ground vegetation in the three Ecosystems

Ecosystem	Arable	Fallow	Plantation
Arable	-	-	-
Fallow	25	-	-
Plantation	16.7	12.5	-

Table 8: Jaccard's Index (%) relating Soil Seed Bank in the three Ecosystems

Ecosystem	Arable	Fallow	Plantation
Arable	-	-	-
Fallow	53.8	-	-
Plantation	50	55	-

Table 9: Number of Species and Jaccard's similarity Index relating above- ground vegetation and Soil Seed Bank in each of the three Ecosystems

Ecosystem	No of Species		Jaccard Similarity Index (%)
	Above-ground vegetation	Soil Seed bank	
Arable	16	12	33.3
Fallow	24	8	14.3
Plantation	12	6	5.9

Table 10: Soil physical and chemical properties in the three ecosystems within University of Ibadan in 2015

Parameters	Sites		
	Arable	Fallow	Plantation
pH (1:1) H_2O	6.69	7.6	7.56
Organic C (%)	1.07	1.34	1.24
Total N (%)	0.11	0.15	0.14
Av P (Mg/g)	196.85	27.73	8.18
Ca (Cmol/kg)	0.81	1.11	0.77
Mg (Cmol/kg)	2.88	1.69	1.03
K (Cmol/kg)	0.46	0.97	0.22
Na (Cmol/kg)	0.66	0.59	0.31
Sand (g/cm^3)	0.82	0.86	0.84
Silt (g/cm^3)	0.11	0.09	0.09
Clay (g/cm^3)	0.07	0.05	0.07
Textural class	Loamy Sand	Loamy Sand	Loamy Sand

Soil Analysis

The soil analysis revealed that the organic matter content was 6.69%, 7.60% and 7.56% in arable, fallow and plantation respectively (Table 10). The pH value shows that the soil from the arable ecosystem was slightly acidic and that of fallow and plantation tended towards alkaline.

Discussion

Soil properties are the major controlling agents for species distribution in a tropical ecosystem (Van Reeuwijk, 1998). The species composition can have significant effect on soil physical properties, which in turn can reflect the soil fertility of a given area. The physical and chemical properties of soil are also influenced by the ecosystem management. Begheijn (1996) reported that organic matter is necessary for the chemical well-being of the plant and soil fertility status because it is the source of nearly all the nitrogen and most of the phosphorus in some soils. By promoting aggregation, soil organic matter affects erodibility, infiltration (McGraw *et al*., 1987), water retention and shear strength of soil (Van Reeuwijk, 1998). Soils with high organic matter content tend to have larger, stronger and more stable aggregates that resist compaction. Soil low in organic matter tends to be more susceptible to compaction.

The soil analysis revealed that fallow and plantation soils are generally characterized by higher organic matter content than cultivated (arable) soil due to accumulation and decomposition of leaf litter and other plant parts. This agrees with the result of Begheijn (1996) who determined the organic and inorganic matter content in plantation soil. Soil pH values affect nutrient uptake, nutrient availability and plant growth. Some nutrients could be toxic or unavailable to plants when the value of the soil pH is at extremes (i.e. less than 4.0 or more than 8.5). At lower pH levels (4.5), aluminium, iron and manganese are readily available for plant uptake while at higher levels (7.5) calcium and potassium are over abundant (Richards, 1999). The chemical properties of the soil in the ecosystems under consideration showed that the pH ranged between 6.69-7.60, which indicated that the soil samples in the study ecosystems were either slightly acidic or tending towards alkaline. It could be noted from the result of the analysis, that the pH values of soil do not fall to the extremes, hence the soil could provide good growing conditions for plants to thrive. The results showed that the soil of the study area had moderate pH. This agreed with Richards (1999) who reported a slightly acidic soil for two natural ecosystems in lowland humid tropical rain forest in Nigeria and that the soil pH increased with soil depth. Richards (1999) have also reported that soil pH is strongly influenced by the nature of the vegetation and the amount of organic matter in the soil especially in the tropical environment.

Plant species diversity in arable and fallow communities was higher than in the plantation. This might be due to higher level of disturbances in the arable ecosystem as a result of anthropogenic activities such as farming activity and burn agriculture which involved continuous clearing of vegetation in the area. The low number of species in the plantation may be due to the fact that the disturbance was low for a long time. This agrees with the result of Newmaster *et al*. (2006) who observed that increased disturbance intensity may favour the invasion of herbaceous species.

Species richness in the three sites revealed that there was considerable variation in the plant species composition and abundance in all the three study ecosystems. The variation in the species composition of the study area might have been due to anthropogenic disturbances such as farming activities, collection of fuel wood, etc., which led to species attrition, thus leaving behind a less balanced community.

The study revealed that the fallow ecosystem with 24 species had the highest species richness value. This implied that fallow was less disturbed when compared to the arable site. Also, fallow is going through process of revegetation, which at early stage is characterized by high species richness. This agreed with the report of Oke and Isichei (1997), who observed that vegetation, was richer, heterogeneous and more diverse in less impacted sites.

The composition of soil seed bank reflects the richness of species present in the local vegetation or immediate vicinity (Falinska, 1999). Soil seed bank composition is commonly assessed using germination trials, in which soil samples are collected and set up so that the seeds they contain can germinate. This technique provides an estimate of the viable seed density in the soil based on the germination of seeds from soil samples maintained under conditions suitable for germination.

In general, the majority of the species recorded in the above-ground vegetation were not found in the seed bank flora. This implied that there were no close relationships between the seed banks and the aboveground composition of the three ecosystems within University of Ibadan. This agrees with the study of Oladipo (2003) which related the soil seed bank dynamics and regeneration of a secondary rainforest in Nigeria and reported that there were large discrepancies between standing vegetation and the seed bank composition and that only few of the seed bank species were found in the standing vegetation. This in turn confirmed the results obtained in different temperate tall-tussock grasslands of the world, where a very low degree of association was found between the composition of seed banks and that of the standing vegetation (Oke *et al*., 2007).

The results of this study revealed that the most abundant seed bank species such as *Chloris pilosa, Eleusine indica* and *Spigelia anthelmia* were not found in the above ground vegetation. This indicated that the seed bank contains not only species from existing vegetation, but also species from the surrounding vegetation as well as species that were present in the vegetation in former stage (Falinska, 1999). Future planning for rapid vegetation restoration on abandoned farm fields should be designed other than relying only on the soil seed bank. The soil seed bank cannot be depended upon to restore the majority of ecosystem plant species to a stand once they are lost from the above ground vegetation, therefore efforts should be intensified at the protection and sustainable management of the protected area, therefore efforts should be intensified at the protection and sustainable management of the protected area.

Conclusion

The study has documented the plant species contents in the above-ground vegetation and soil seed bank in three ecosystems at the University of Ibadan, Nigeria. The study revealed high similarity (33.3%) between the vegetation and seed reservoir in the most disturbed arable ecosystem, and low similarity in the fallow (14.3%) and plantation (5.9%), which indicates low vegetation recovery potential after period of disturbance. Therefore, concerted efforts must be put in place to produce appropriate forest tree seedlings for re-vegetation programme to restore the plant biodiversity integrity of the ecosystems. This will in turn restore the various ecological services offered by the ecosystems.

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