Original Research Article

Phytosociology of the Herbaceous Flora of University of Ibadan Oil Palm Plantation, University of Ibadan, Ibadan, Southwest, Nigeria

ABSTRACT

Plantation agriculture perturbs ecosystems flora. This impacts vegetation biodiversity, though species invasion and shift in weeds population dynamics. Oil palm plantation can cause long-term flora changes, but there is paucity of knowledge on inventory and potential impacts of the plantation on community structure. This study investigated herbaceous flora diversity and phytosociology guide for sound management strategy in the University of Ibadan oil palm plantation. The study site is located in a lowland rainforest at the Teaching and Research Farm, University of Ibadan, Ibadan, Nigeria on 07°27'253''N and latitude 03°53'427''E. A systematic sampling was employed to enumerate herbaceous flora of a hectare mega plot. The hectare was laid along 100 m transects at 10 m intervals, with 10 m separating each transect. Each transect was laid to cut across middle of 9 m x 9 m x 9 m plant spacing for oil palm. Data were collectd on species composition, frequency and density for determination of relative importance value (RIV), species diversity, ordination and classification. The plantation consisted of flora 32 herbaceous in 15 families. *Commelina erecta* had the highest RIV (12.621) and *Fluerya ovalifolia* closely higher (RIV=12.721. Diversity indices indicated high species richness among (Simpson Index=0.909) and species co-dominance (D=0.091) Ordination biplots indicated four distinct vegetation structures (Secondary, wetland, dryland and fallow). Classification model showed *Commelina erecta* had widest coverage of 92% in distribution at the site followed by *Commelina benghalensis* at 88%. The Oil palm plantation is heterogeneous in species composition, and was not detrimentally invaded.

INTRODUCTION

Agriculture viz a viz conversion of forest land to cropland is one of the major contributor to land use change. This involves the agro-forestry practices including Teak, Oil palm, Gmelina as the case may be in Nigeria. Gibbs *et al*.(2010) reported that early palm plantations were thought to be replacing existing croplands and utilizing degraded land while it is evident that intact tropical forests have been, and will continue to be, a major source of new land for palm plantations

(Gibbs *et al*., 2010; Koh and Wilcove, 2008). However, natural forests are being lost at alarming rates, with grave consequences for carbon sequestration, sustainable development and biodiversity conservation, thus necessitating an integrated forest management strategy under which various forest-based land-uses are planned and sustained with the objectives of preserving primary forest, intensifying the use of non- timber resources, agroforestry (Adesina *et al*., 1999), and selective establishment and use of plantation forestry (such as Teak, Oil palm and Gmelina plantations).

Oil palm plantations lack forest trees, lianas (woody climbing vines), epiphytic orchids and indigenous palms (Danielsen *et al*., 2009).The oil palm (*Elaeis guineensis*) is one of the important economic crops in the tropics (Anyanwu and Anyanwu, 1982) belonging to the family Palmae *and* subfamily *Cociodeae.* The oil palm is a versatile tree crop with almost all parts of the tree being useful and of economic value. The fruit is edible and is usually harvested for its kernel in palm oil processing and industrial process. Palm oil has global production which has risen from 13.5 million tonnes in 1990 to 155.8 million tonnes in 2014 (FAOSTAT, 2016).The success of this great production is attributable to its low cost, and stability of the oil makes it the most attractive. Progressively, the worldwide average oil yield per harvested hectare oil palm is 2.5 t and national averages in Malaysia and Indonesia are close to 4 t (FAO, 2002a). Palm oil has many important uses including food, cosmetics, detergents, plastics, industrial chemicals, biofuels and medicinal purpose. Prescott *et al.* (2015) found 58 epiphytic species recolonizing palm plantations after deforestation, which are then typically removed in order to protect the intended crop. The impacts of oil palm plantations include species invasion, plant population dynamics, changes in the forest structure, and increasing habitat fragmentation and destruction emanating from use of dangerous chemicals, frequent anthropogenic pertubation. It is known that oil palm plantation also undermines the ecosystem services and functions (Nutrient cycling and Geo-chemicals, carbon sequestration (Koh *et al.*, 2011) and recreation etc). Similarly, in a monoculture of teak (*Tectona grandis*), the environmental challenges that might propounds from its expansion might include reduced biodiversity emanating from the clearing of undergrowth vegetation; soil erosion by fire treatment and litter raking; nutrient losses during harvesting; the spread of pests such as defoliators, the bee hole borer, skeletonizer; and the effects of water cycling (Niskanen, 1998; Pandey and Brown, 2000; Hallett *et al*., 2011). Fitzherbert *et al.* (2008)

found that oil palm supports fewer species than rubber, cocoa, or coffee plantations, although all plantation types decrease species richness when compared to intact forest.

Weeds are key components of agroecosystems because they support biological diversity within crop fields. Biodiversity in weedy population results from taxonomic diversity, as well as diversity in those weedy traits that affect the survival mortality and reproduction of the individual weeds (Harper, 1995). Since most of the output of oil palm plantation is targeted at palm oil production all over the globe, many factors has impeded the production yield, among which are age of palms (Kui, 2001), labour shortage and low level of mechanization (Jaafar and Sukaimi, 2001), poor crop management related to fallen palm oil prices and increased production costs (Anonymous, 2002b; Casson, 2000; Jaafar and Sukaimi, 2001). Other constraints identified include drought and fires in South East Asia (Casson, 2000), erosion and growing pest pressure. The acquisition and understanding of ecological information on any ecosystem is very essential for sustainable utilization and management of such ecosystem. Ecological indicators of weed diversity are usually assessed on a field scale, but weeds are distributed unevenly within fields. In Nigeria, many plant biologists had enumerated the weed flora of cultivated fields.

Komolafe (1976) surveyed cashew, cocoa and coffee plantations in the old Western Region of Nigeria and documented the weeds associated with them. Agbaka (1977) provided the checklist of weeds found in rubber plantations in Bendel state, now Edo and Delta states. There is however paucity of information on the weeds composition, diversity and the potential impacts on the ecosystem of oil palm plantation of University of Ibadan. This study therefore aimed at providing baseline information on the flora composition, vegetation structure of the oil palm plantation.

MATERIALS AND METHODS

Materials

The Garmin™ *ertrex 12* H model Global Positioning System (GPS) was used for geo referencing while SILVA plastic compass was used for obtaining a straight baseline and accurate direction for plots. A 50-meter tape measure was used to lay the plots in meters, one square meter ($1m^{2)}$ wooden quadrat was used for the sampling of herbaceous flora at individual plots and wooden pegs were used to demarcate the different plots from another with yellow colored ribbons were used as tag for identification of plots. The following data tools were used; Paleontological Statistics (PAST) 2.14 version software (Hammer, 2001), DECORANA and TWINSPAN

Software (Hill, 2012). Standard flora; handbook of West Africa weeds (Akobundu and Agyakwa, 1989) and West Africa weeds of Rice (Johnson, 1997) were also used and they are;

Study site

The floristic survey was carried out at the Oil Palm Plantation of the University of Ibadan located on longitude 07°27'253''N and latitude 03°53'427''E with a mean elevation of 180 metres above sea level.

Data collection and species identification

Each of the herbaceous flora encountered was identified using published flora of Akobundu and Agyakwa (1998) and Johnson (1997). Plants that were difficult to identify were coded and preserved in a plant press, and identified at the herbarium located at botany department of University of Ibadan. Data that were collected include; Species types by visual and use of standard flora, Count of individuals in quadrats and plots for abundance, frequency, density, species diversity using diversity indices calculations and Percentage cover using cluster analysis.

Flora Sampling Procedure

A systematic sampling was used to carrying out the enumeration of the herbaceous flora with the total area studied being 100 m × 100 m (10,000 m^2). The sample area was sampled with 1 square meter quadrats systematically laid at 10 m interval along transects, and with 10 m separating the transects. The layout area corresponded to the area of triangular planting configuration of 9x9x9 m for oil palm, with each tansect passing though the centre of the triangles. Data were collected on herbaceous flora composition, density and frequency of occurrence.

Data analyses

Data collected were arranged and analyzed for species abundance, Relative Importance Values (RIV) (Kent and Coker, 1992). Diversity indices were computed Shannon-Wiener diversity, Simpson's index for species richness, Dominance index, Evenness and Equitability indices Paleontological statistics Software (PAST 2.14) (Hammer *et al.,* 2001). Multivariate relationship of the flora was determined by ordination and classification procedures in Hammer *et al.,* 2001. They were presented as detrended correspondence and cluster analyses.

RESULTS

Herbaceous flora composition and Relative Importance Value of the Oil Palm Plantation of the University of Ibadan, Ibadan, Nigeria

The herbaceous flora enumeration conducted at the Oil palm plantation of University of Ibadan revealed presence of 32 herbaceous species (Table 1) variously distributed in 15 families (Table 2). Among the species encountered and their family groupings, four different families had the highest number of species composition; Fabaceae, Amaranthaceae, Asteraceae and Poaceae and followed by only the family Euphorbiaceae containing three species. Commelinaceae, Urticaceae and Acanthaceae families had two species each while the remaining seven (7) families (Cyperaceae, Convolvulaceae, Cucurbitaceae, Arecoideae, Malvaceae, Combretaceae and Araceae) compose of one species each (Table 2).

However, the relative frequencies and relative densities of the species encountered defined by their relative importance values (RIVs) projected *Commelina erecta* with the highest RIV of 12.641 and closely followed by *Fluerya ovalifolia* (RIV=12.147). *Fimbrystylis ferrugenia* (RIV=9.848*)* and *Commelina benghalensis* (RIV=7.200) had high RIV. *Pueraria phasioloides,* (RIV=6.703), *Alternanthera brasiliana* (RIV=6.402) and *Calopogonium mucunoides* (RIV=5.698) were of intermediate RIV; while *Hypoestes verticilata*, *Synedrella nodiflora*, *Ischaemum nigosum*, *Pennisetum purpureum* and *Achyranthes aspera* with RIVs of 4.532, 3.987, 3.784, 3.244, and 2.144 respectively were moderate RIV. The Low RIV-ranked species at the study site were *Desmodium scorpiurus* (RIV=1.680), *Andropogon tectorum* (RIV=1.022), *Cyathula prostrata* (RIV= 0.896), *Jatropha curcas* (RIV=0.864), *Colocasia esculenta* (0.608), *Larpotea austeans* (RIV=0.576), *Mallotus oppositifolius* (RIV=0.513), *Combretum hispidum* (RIV=0.351) and *Alchornea cordifolia* (Table 1). These species were rare in the plantation.

Table 1: Species Composition and Relative Importance Value (RIV) of the herbaceous flora of Oil Palm Plantation of University of Ibadan, Ibadan, Nigeria in 2016

S/No.	Species	Family	RIV
1	*Commelina erecta*	Commelinaceae	12.621
2	*Fluerya ovalifolia*	Urticaceae	12.147
3	*Fimbristylis ferruginea*	Cyperaceae	9.848
4	*Commelina benghalensis*	Commelinaceae	7.200
5	*Pueraria phasioloides*	Fabaceae	6.703

6	*Alternanthera brasilliana*	Amaranthaceae	6.402
7	*Calopogonium mucunoides*	Fabaceae	5.698
8	*Hypoestes verticilata*	Acanthaceae	4.532
9	*Synedrella nodiflora*	Asteraceae	3.987
10	*Ischaemum nigosum*	Poaceae	3.784
11	*Pennisetum purpureum*	Poaceae	3.244
12	*Achyranthes aspera*	Amaranthaceae	2.144
13	*Desmodium scorpiurus*	Fabaceae	1.680
14	*Alternanthera sessilis*	Amaranthaceae	1.617
15	*Melanthera scadens*	Asteraceae	1.599
16	*Tithonia diversifolia*	Asteraceae	1.441
17	*Evolvulus alsinoides*	Convolvulaceae	1.428
18	*Cynodon dactylon*	Poaceae	1.374
19	*Asystasia gangetica*	Acanthaceae	1.365
20	*Luffa cylindrical*	Cucurbitaceae	1.283
21	*Elaeis guinensis*	Arecoideae	1.216
22	*Chromolaena odorata*	Asteraceae	1.216
23	*Sida acuta*	Malvaceae	1.184
24	*Centrosema pubesens*	Fabaceae	1.153
25	*Andropogon tectorum*	Poaceae	1.022
26	*Cyathula prostrate*	Amaranthaceae	0.896
27	*Jathropha curcas*	Euphorbiaceae	0.864
28	*Colocasia esculenta*	Araceae	0.608
29	*Laportea aestuans*	Urticaceae	0.576
30	*Mallotus oppositifolius*	Euphorbiaceae	0.513
31	*Combretum hispidium*	Combretaceae	0.351
32	*Alchornea cordifolia*	Euphorbiaceae	0.288

Table 2: Summary of family categorization of the herbaceous flora of the Oil palm plantation of University of Ibadan, Ibadan, Nigeria

S/No	Family	Number of species present

1	Fabaceae	4
2	Amaranthaceae	4
3	Asteraceae	4
4	Poaceae	4
5	Euphorbiaceae	3
6	Commelinaceae	2
7	Urticaceae	2
8	Acanthaceae	2
9	Cyperaceae	1
10	Convolvulaceae	1
11	Cucurbitaceae	1
12	Arecoideae	1
13	Malvaceae	1
14	Combretaceae	1
15	Araceae	1

Multivariate Analysis (Detrended Correspondence Analysis) of the herbaceous floral of University of Ibadan Oil Palm Plantation in 2016

The detrended correspondence analysis of the herbaceous floral of University of Ibadan oil palm plantation shows varying degrees of relatedness in the distribution of the various species encountered at defining plantation ecosystem under study. The variation in the relatedness of the species in relevance to the sampling area accounted for 59.32% variability on axis 2, the strongest axis; and 51.07% variability on axis 3, following axis 2 in order of strength, and generally indicating close relatedness between the flora and habitat (Figure 1). Furthermore, four distinct vegetation structure were identified based on the habitat characteristic of the oil palm plantation. The habitat/vegetation components of the ecosystems include; secondary/regenerating forest vegetation, wetland vegetation, fallow vegetation and dryland/fallow vegetation. It was widely shown that the species belonging to the fallow vegetation with species of *Desmodium scorpiurus, Tithonia diversifolia, Pennisetum purpureum, Peureria phasioloides, Hypoestes verticilata, Andropogon tectorum, Commelina benghalensis, Fluerya ovalifolia, Ischaemum nigosum, among others.* The secondary/regenerating forest

vegetation comprises of *Melenthera scandens, Mallotus oppositifolius, Luffa cylindrica, Alchornea cordifolia and Combretum hispidum.* The species of wetland vegetation category (Figure 1) found were *Cynodon dactylo*n, *Elaeis guinensis and Calopogonium mucunoides*. However, among the dryland/fallow vegetation found were *Cyathula prostrata, Synedrella nodiflora, Centrosema pubescens, Larpotea austeans and Evolvolus alsinoides* (Table 1).

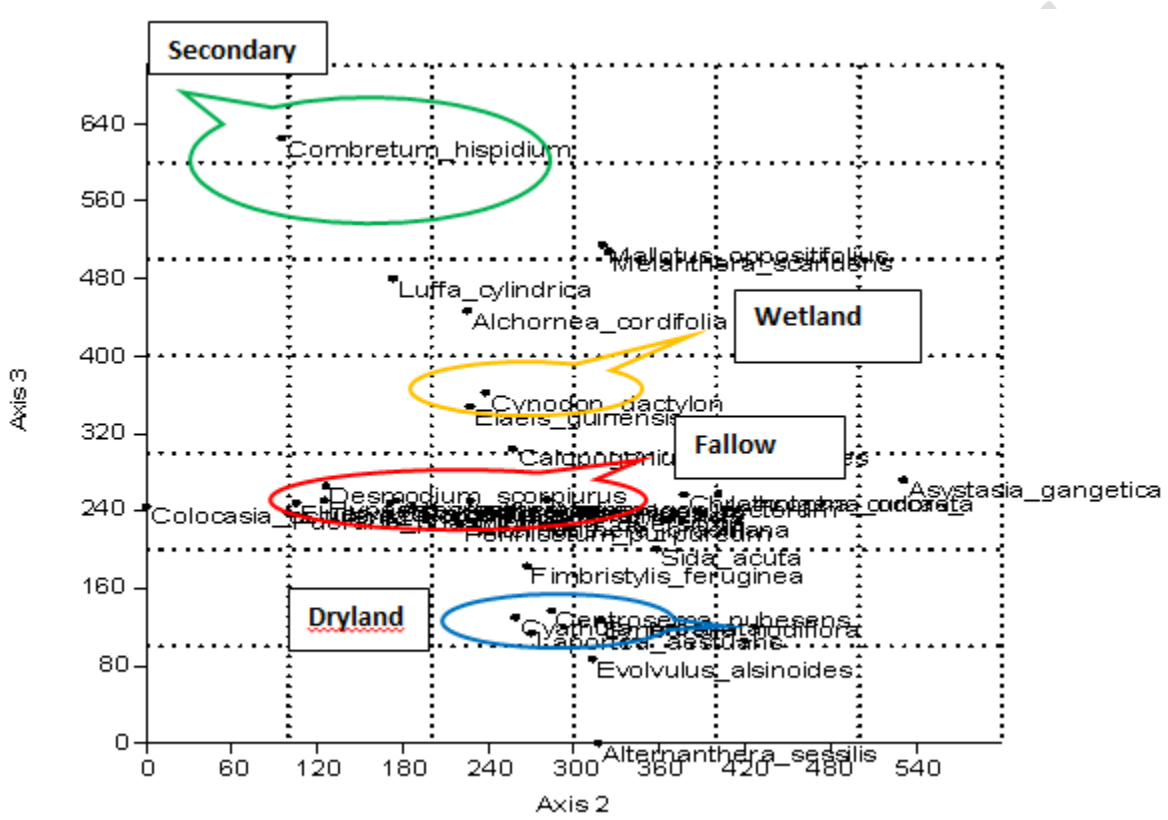

Figure 1: Detrended correspondence Analysis defining the herbaceous flora composition of Oil Palm Plantation of University of Ibadan in 2016

Species diversity of the herbaceous flora of the Oil Palm Plantation of University of Ibadan in 2016

The diversity indices of the herbaceous flora of Oil Palm Plantation of the University of Ibadan indicates that thirty two (32) species of herbaceous flora were encountered (Taxa = 32) and with the cumulative population (total density) of all the species encountered being two hundred thousand, eight hundred and thirty (2,830) based on counts across the sampled area (Individuals = 2,830) (Table 3). The Simpson index (0.933) was very high and tends to 1 suggesting that the site had high species richness and widely spread across each of the sampling point at the study

site hence interspecific association among the species. This was buttressed by the low dominance index value (0.091) indicating that there was no particular species prevalence at the study. The high evenness index (0.496) corroborated high incidence of spread of the different species encountered at the study site. The oil palm plantation was high in species diversity with occurrence and presence of high number of species co-dominance as indicated by high Shannon-weiner index of 2.764 (Table 3). There was randomness of occurrence of any species among the herbaceous flora at the site as indicated in the equitability index value being very high 0.867 (Table 3) and tends to 1 thus showed that the families (Table 2) contained a high level of different species (Table 1)

Table 3: Species diversity of the herbaceous floral component of Oil palm plantation of University of Ibadan in 2016

Diversity indices	Values
Taxa	32
Individuals	2,830
Dominance index	0.091
Simpson index	0.909
Shannon weiner index	2.764
Evenness index	0.496
Equitabiltiy index	0.867

Cluster Analysis of the Phytosociology of herbaceous floral of Oil Palm plantation of the University of Ibadan, Ibadan, Nigeria in 2016

The similarities among the herbaceous flora species occurrence and distribution of the oil palm plantation of University of Ibadan was revealed by the dendrogram output of cluster analysis (Figure 2).The species, *Commelina erecta* had the widest coverage of about 92% in distribution

at the site followed by *Commelina benghalensis* at 88%. It was clear that the two species markedly had distinct vegetation structure and formation. Associated closely with *Commelina erecta* at the study site were *Fluerya ovalifolia* (69%) and the co-associated species of *Pennisetum purpureum* and *synedrella nodiflora* both at 28% coverage. However, the species of *Fimbrystlis ferruginea (40%), Alternanthera brassiliana* (37%) and co-associated species of *Desmodium scorpiurus and Ischaeum nigosum (27%)* are closely distributed with *Commelina benghalensis* (Figure 2). At a higher level of agglomeration, *Pennisetum purpureum* was similar in occurrence and distribution and co-associates with *Fimbrystlis feruginea* and *Alternanthera brasiliana.*

Futhermore, at the were association and co-association with species; *Mallotus oppositifolius* with *Alchornea cordifolia and comretum hispidum* indicating shrublike and secondary forest vegetation (Figure 1) with a coverage of about 10% distribution. There were co-association between *Cyathula prostrata and Luffa cylindrica,* as well as *Chromolaena odorata* and *Andropogon tectorum at less than 10% coverage and typical of fallow vegetation pattern* (Figure 1) .

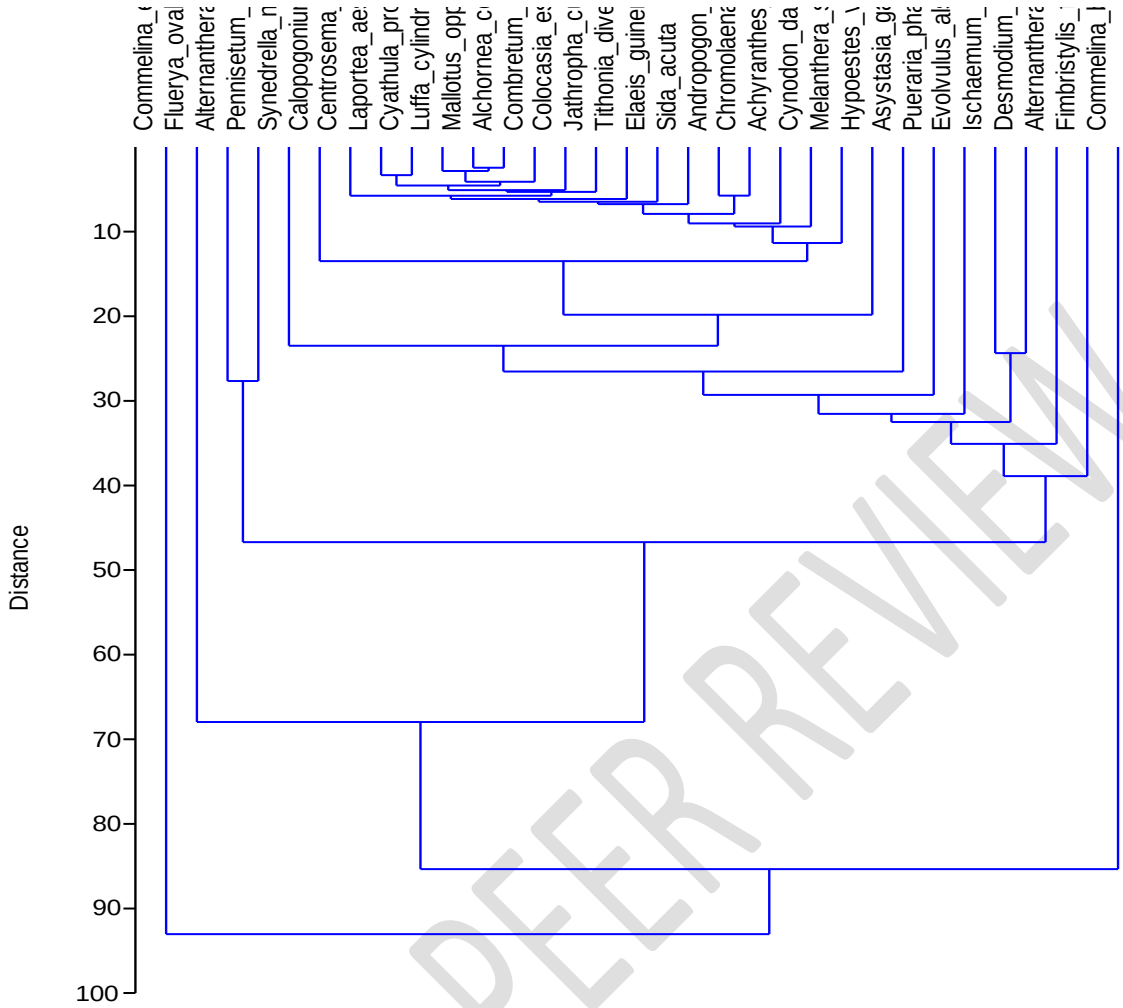

Fig 2. Hierarchical cluster analysis

DISCUSSION

From the result obtained from the floristic enumeration of the oil palm plantation of University of Ibadan in 2016, with indication of poor management practices in the plantation, it was observed that the herbaceous flora composition of the oil palm plantation was high with the presence of thirty two (32) species belonging to fifteen different families.

In comparison with other plantations, Emily *et al*. (2012) opined that Oil palm plantations support much fewer species than do forests and often also fewer than other tree crops. The

wetland biased flora of *Commelina erecta* and *Fluerya ovalifolia* were abundant and frequently occurred in many of the plots enumerated as showed by the relative importance values of the species (12.694 and 12.213 respectively) and they are most likely becoming environmental weeds based on trans-habitat spread. Well-established plantation undergrowth limits both, erosion (Beaufoy, 2000; Hashim et al., 1997; Ross, 1999; Fairhurst, 1996) and the insect pressure (Wahid et al., 1999; Mexzón and Chinchilla, 1996; Ho and Teh, 1999).
However, it could be said that the abundance of these two species (*Commelina* erecta and *Fluerya ovalifolia*) might be attributed to the ecological integrity and ecological processes at the study site. Mavraganis and Christopher (2001) have shown that genetic and ecological processes, many of which are dependent on size of the populations and degree of association between them, influence the demography of a natural populations.

The detrended correspondence analysis depicts four different vegetation structures (secondary/regeneration, fallow, wetland and dryland/fallow) at the study site. Vegetation communities including weeds evolve in response to different agronomic practices and environmental factors (Frick and Thomas, 1992) which might be as a result of varying factors including the environmental factors. Among the vegetation communities, there was high presence of fallow vegetation with many other flora (*Mallotus oppositifolius, Combretum hispidum, Luffa cylindrica and Alchonea cordiflora*) in secondary and regenerating forest vegetation hence indicative of ecological succession in the oil palm plantation.

The species diversity at the oil plantation was very high (Shannon weiner index= 2.764). According to clement *et al*. (1994) potential benefits of increased weed species diversity include more competition between the weeds, more niche for natural enemies of weeds, more weeds interactions, greater diversity of weed life histories including aggressive weeds species, greater community stability and reduced incidence of herbicide resistance. There was no species prevalent (dominance= 0.091) as the oil palm plantation was typical of weeds flora co-dominance thereby the spread of different species (Evenness index= 0.496) and richness of species (Simpson index= 0.909) at the study site. It was known that increase in the number of species composition in the study site is an indication of quality health of the ecosystem. The high diversity could also be due to high presence of humans and associated to anthropogenic activities suggesting poor management practices in the oil palm plantation. Environmental weeds are

neither cropped nor grazed by domestic animals but they are introduced plants that have become naturalized in ecosystem dominated by native plants (Grooves, 1991). The invasion of the ecosystem by weed flora actively impairs the ability of the ecosystem to perform all ecological functions and services.

Conversely, further advantages of plantation undergrowth are nitrogen fixation (Hartley, 1988; Turner and Gillbanks, 1974), buffering of leaching losses (Parrotta, 1992), amelioration of physical soil properties (Pini *et al*., 1999; Fairhurst, 1996) and reduction of diurnal soil temperature fluctuations (Fairhurst, 1996).

The dendrogram from the cluster analysis revealed that the distribution of the weed flora at the plantation depicts that *Commelina erecta* was dense at many plots and had the highest coverage of 92% among the species enumerated in close similarity to *Fluerya ovalifolia* at 69% as the positive preferential while *Commelina benghalensis* had a coverage of 88% closed in similarity with *Fimbrystylis ferruginea* had a coverage of 40%. The species of *Cyathula prostrata and Luffa cylindrica*, as well as *Chromolaena odorata* and *Andropogon tectorum* belonging to the fallow vegetation had the lowest density and coverage at less than 10%.

Also, Carr *et al*. (1992) pointed that most accounts of the impact of environmental weeds focus on the population or species level and describe changes in species richness, diversity, abundance and frequency.

The natural process of succession might be progressing although with current subtle/minimal impact on the oil palm plantation due to age. Therefore, it is recommended that the authorities of the Teaching and Research Farm of University of Ibadan should adopt the sustainable management practices at the oil palm plantation especially to prevent ecological succession and preponderance of environmental weeds.

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