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Assessment of frequency, density and abundance of weed species in different Cropping Systems

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Abstract
This study was conducted at the Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife, Nigeria to determine effect of cropping systems on weed diversity and weed seeds bank at various soil depths. Weed flora composition in different cropping systems were also correlated with land use history. Two broad cropping systems were considered namely; plantation cropping (cocoa, oil palm and cashew) and arable fields (maize, cassava/maize and a natural fallow which served as control. Twenty six weed families were recorded in all. Out of these 26 families, only two are grasses while the remaining were broadleaves. Oil palm and cashew plantations had the highest weed diversity. Using Shannon index (H>1.0), *Panicum maximum* (Poaceae) *and Vigna gracilis* (Papilionaceae) weeds were more frequently encountered across the cropping systems with diversity index H>0.5. Asteraceae, Papilionaceae, Rubiaceae were the broadleaves families widely distributed in the cropping systems. Results on the weed seed bank indicated that the number of weed seeds decreased as soil depth increased, the highest number of seeds was found in the soil layer of 0-8 cm.
Keywords: Cropping System, Seed bank, abundance, density

Introduction

Weeds compete with cultivated food crops for limited resources such as water, nutrients and light (Akobundu, 1987; Oudhia, 2004). Weeds infestation also encourage disease problems, serve as alternate host for deleterious insects and diseases, slow down harvesting operation, increase the cost of production, reduce the market value of crops and increase the risk of fire in perennial crops, plantation and forest reserves (Holm *et al.*, 1977; Oudhia, 2004). As in most plants, weed seeds is very vital in the life cycle of annual or perennial weed species that reproduces through seed alone (Gulden and Shirtliffe, 2009). Thus the quality and quantity of weed seeds in the soil bank determines the weed situation in a given farm land.. Weed seed bank has been described as the reservoir of viable weed seeds that are present on the soil surface and scattered in the soil profile (Gulden, *et al.*, 2003). Furthermore, it can also be defined as the place where weed seeds remain until germination. Weed seed banks are actually the sole source of future weed populations. The study of weed seed bank not only serves as a physical history of the past successes and failures of cropping systems, it can also help producers to predict the degree to which crop-weed competition will affect crop yield and quality (Davis *et al.*, 2005).

The nature of crop, cultural practices and cropping pattern/system, soil type, moisture availability, location and season have been reported to cause variation in the abundance or distribution of weed species that are found in a cropped field (Mohler, 2001; Sit *et al.*, 2007). However, not much of these studies have been done in Nigeria. Sine the importance of studying the weed dynamics in a cropping system has been reported to facilitate formulation of an appropriate management strategy (Derksen *et al.*, 2002), a clear knowledge about the existence of weed seed bank and different weed flora under different cropping systems is therefore needed to gain a better understanding in postulating appropriate weed management strategy for African farmers and most importantly Nigerian rural dwellers with not less than 80% of the rural populations engaging in crop production.

Although, numerous studies have been conducted to describe the size, distribution and dynamics of weed seeds in the seed bank (Cavers and Benoit, 2002) very few have attempted to study the variation in weed seedling emergence. It has been observed that one of the main problems with most seed bank studies is the imprecise estimate of seed number because the seeds usually have clustered distribution both horizontally and vertically (Benoit, *et al.*, 2004). The objectives of this study therefore were to determine the distributions of weed seed in the soil as influenced by different cropping systems, assess the weed flora composition in different cropping systems in the Teaching and Research Farm, Obafemi Awolowo University Ile-Ife.

Materials and Methods

The study was conducted at the Teaching and Research Farm, Obafemi Awolowo University (latitude 7^{0} 28' N and longitude 4^{0} 33' E) Ile –Ife, Osun State, Nigeria in the transitional zone between the humid and sub-humid tropical climates. The study site is characterized by bimodal rainfall pattern with peaks in June and September. The experiment was carried out between June and August 2011 in already established cocoa, cashew and oil palm plantations and arable fields of sole maize and maize/cassava intercrop. These plots were located in

the same general area and separated by alley of between 5-10 m from each other, The cropping histories of the cropping systems are shown in Table 1.

Table 1: Land use history of the different cropping systems.

	Maize plot	Cassava/maize plot	Oil palm plantation	Cocoa plantation	Cashew plantation
Field establishment date (year)	Continuous maize since 2005	Continuous maize/cassava intercrop sinc 2005	1974	1974	1974
Plot size (ha)	1.0	1.0	2.0	1.0	0.2
*Cultural practice/herbicide used	2,4 D and paraquat	Paraquat	Mowing and glyphosate	Hand weeding	Hand weeding
Time plots were weeded before start of this study	4 weeks after land cultivation	February/March 2011	June 2011	January/February 2011	January/February 2011
Time of cultivation	18th of May, 2011 by planter	May/June 2010	Year 1974	Year 1974	Year 1974

* All these practices were continuous since establishment on yearly basis especially for permanent crop fields
Data source: Obafemi Awolowo University Teaching and Research Farms, Ile-Ife.

An area of 10 m x 10 m was randomly chosen within each of the cropping systems. Soil cores were taken randomly within the marked out areas using soil auger at different soil depths (0 – 8 cm, 8 – 16 cm and 16 – 24 cm) and replicated three times. Soil clods were broken by hand before the soil samples (500 g) were put inside labelled polythene bags. The soil samples were air dried and were incubated in order to stimulate germination of seeds. The soil samples were divided into a plastic container for replication and arranged on a wooden slab in a complete block design. The soil samples were kept moist continuously throughout the study by adding 50 ml at every other day. A light turning of the each soil sample was carried out using spatula in order to stimulate seed germination. Emerged weed seedlings were counted and recorded at three, six, nine and 12 weeks after incubation.

Weed species compositions in the experimental fields were assessed by throwing 0.5 sq. m quadrat randomly in 10 different locations in each field. Weed species within each quadrat were pooled and identified with the aid of standard flora reference book produced by Akobundu and Agyakwa, (1987). Data on emerged weed seedlings were analyzed using the SAS statistical package version 8.2.

Weed abundance was determined by counting and recording the weed species within a 0.5 sq. m quadrat in each plot. Shannon-Wiener index (H) was calculated out using the formula:

$$H = \frac{N \log N - \sum fi \log fi}{N}$$

where N is the total number of abundance per location, fi is the abundance of individual specie. The similarity index of weed species in different cropping systems was determined using the method described by Ogbeibu in 2005. This was calculated by summing the lower relative abundance value for each of the specie present in both sites (species present in only one of the two sites out of the five cropping systems under consideration is ignored). The critical level = 50 % (i. e. > 50 % = similar, < 50 % = dissimilar). Density was calculated using the formula by Sharma (1998) as shown below:

$$D = \frac{\text{Frequency}/100 \times \text{Abundance}}{\text{Number of quadrats}}$$

Results and Discussion

The mean square values from the Analysis of Variance (ANOVA) for depth, treatment and interaction between depth and treatment on weed seedling emergence are shown in Table 2. There were significant ($P<0.05$) differences in the depth, treatment and interaction between depth and treatment of seedling emergence at 3, 6, 9 and 12 weeks. It was observed that the mean values of weed seedlings emergence increased as weeks increased irrespective of the location (replicate). This could be as a result of weed regaining its viability and overcoming its state of dormancy.

The means differential of weed seedling emergence in the study area were shown Table 3. Comparing the values obtained within different cropping systems, there was a significant ($P<0.05$) difference in the number of seedlings that emerged at the crop field of fallow when compared to other crop fields it was higher than five cropping systems; This is due to the fact that the land has been left uncultivated for years and the weed flux species growing on the that location are released on the soil without any human interference. The numbers of weed seedling emergence in the crop field of oil plantation and cocoa are not significantly ($P<0.05$) different (Table 3). This could be as a result of plant architecture and canopy effect which provide enabling environment for weed decay and also shade out most of the weed seeds that are able to germinate. The weed seedling germination increases as weeks of incubation increases (Table 3). This could be as a result of weed seed dormancy breaking point which invariable means a condition in which weed seed regains its viability after long period of being dormant and also the presence of conducive environment. Graphically, the number of seedlings which emerged from the soil core of the six different cropped fields is shown in Figure 1. It was observed that there existed an overlap between weed seedlings emergence of maize sole plot and cassava intercropped with maize which shows that number of weed seedlings emergence were not significantly different on both crop field. This is as a result of type and frequency of weeding operation (manual and herbicide usage) which is normally done in arable field since the crops were short duration species. Moreover, it was learnt that weeding was carried out on maize plot two weeks before seed bank sampling which was an indication that some of the weed seeds most especially at the top soil surface would have germinated and weeded away during crop normal crop field operations. On the other hand, cassava/maize plot field has been left unweeded for almost three months before seed bank sampling because ordinarily, intercropping as one of the

Table 2: Mean square values obtained from analysis of variance (ANOVA) of weed seedlings emergence at 3, 6, 9 and 12 weeks at the Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife.

Source	df	Week 3	Week 6	Week 9	Week 12
Replicate	2	112.0	147.0	2.5	97.0
Treatment	5	10654.0*	65539.0*	168641.0*	376768.0*
Depth	2	8846.0*	59509.0*	153549.0*	302549.0*
Treatment X Depth	10	1170.0*	5206.0*	9801.0*	21905.0*
Mean		38.4	131.0	275.9	481.3.0
CV		8.1	6.4	7.5	5.0
R^2%		99.0	99.0	98.0	99.0

* significant F-test at 0.05, CV = Coefficient of Variability (%).

Table 3: Weed seedlings emergence of six different crop field at 3, 6, 9 and 12 weeks after incubation at the Teaching and Research Farm, Obafemi Awolowo University Ile-Ife.

Crop field	Week 3	Week 6	Week 9	Week 12
Fallow land	46.5 a	66.6 a	91.1 a	114.8 a
Maize plot	30.0 b	50.8 b	61.0 b	80.3 b
Cassava/maize plot	20.5 c	40.3 c	57.8 c	76.3 c
Cashew field	13.5 d	33.3 d	52.5 d	73.3 d
Oil palm plantation	8.2 e	23.9 e	41.5 e	60.5 e
Cocoa field	5.3 e	20.8 e	38.7 e	55.2 e
LSD	3.6	6.1	3.5	2.9

LSD = Least Significant Difference (Fisher's LSD, P = 0.05) at 0.05 level of probability.
Means with the same letter are not significantly different: P = 0.05.

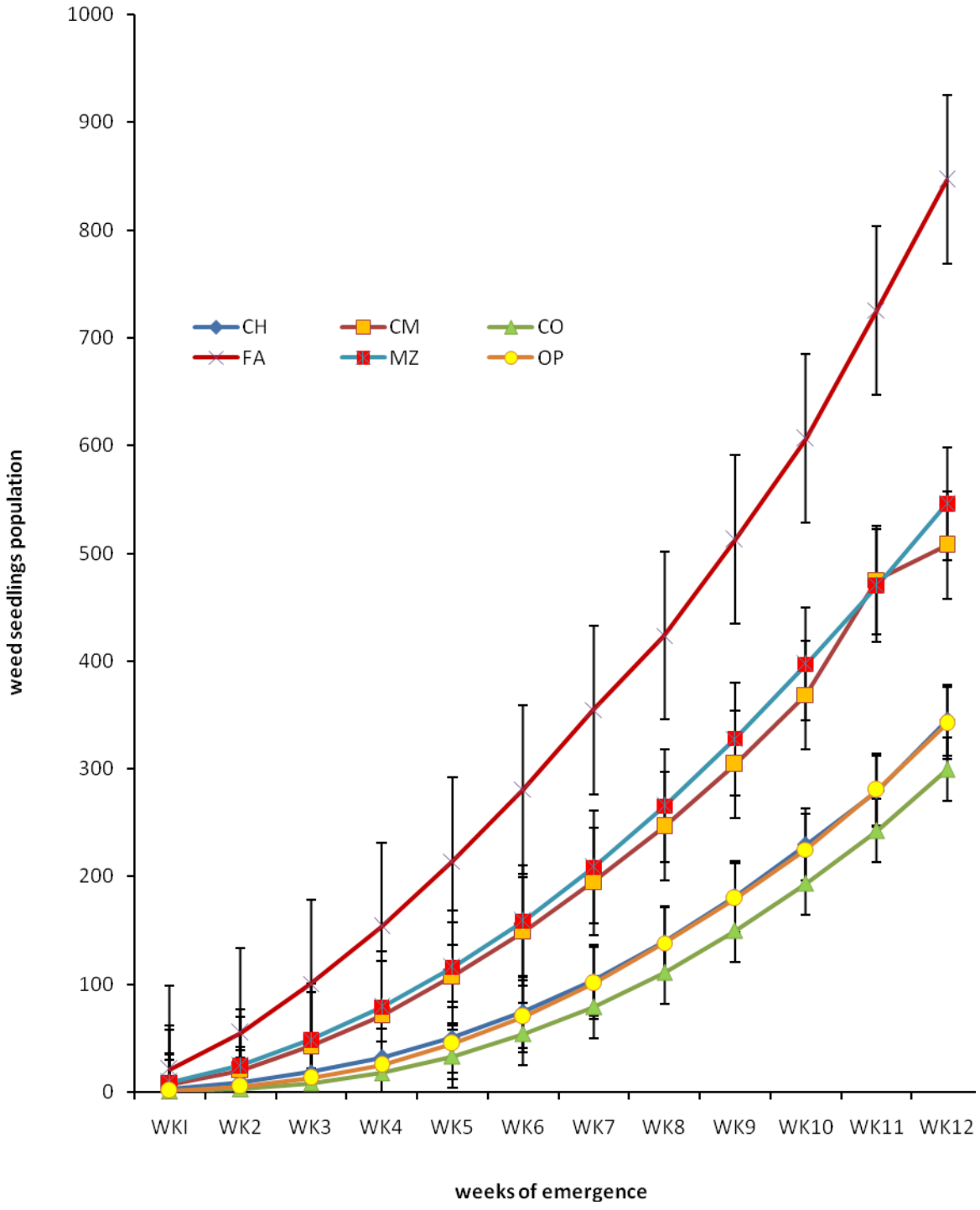

Figure 1: Total number of weed seedlings emergence at six (6) different crop fields, at the Teaching and Research Farm, Obafemi Awolowo University Ile-Ife. (CH = Cashew, CM = Cassava intercropped with maize, C = Cocoa, FA = Fallow land, MZ = Maize, and OP = Oil plantation).

cropping systems is meant to alter weed species composition because of the competition involved which directly or indirectly limit weed population. Amongst reasons for similarity in the trend observed in cocoa, cashew and oil palm plantation includes the effect of vegetation cover, complex architecture of plants and the effect of canopy which shade out most of weed seeds that are liable to germinate thus, considerably reducing weed seed population.

Figure 2 shows the effect of soil depth on the composition of weed species and with the result obtained at the first three weeks of weed seedling emergence. The depth were not significantly ($P<0.05$) different. The depth was not significantly ($P<0.05$) different because an overlap between 0 – 8 cm, 8 – 16 cm and 16 – 24 cm occurred. This could be because of the weed seeds state of dormancy is yet to be broken; a situation in which weed seed fails to germinate even under favourable condition which favors vegetative growth)

The depth (0 – 8 cm and 8 – 16 cm) at week six were not significantly ($P<0.05$) different while the depth 0 – 8 cm and 16 – 24 cm, were significantly ($P<0.05$) different. There was a wide deviation in the fallow field as compared to other cropping systems (numbers of weed seedling emergence were significantly ($P<0.05$) different). This was because the land has been left uncultivated for years and the land has harbour high concentration of viable weed seed in its seed bank. The result obtained in this study confirm the notion that there are variation in the depth distribution of weed seed in the soil bank because top soil contain a higher quantity of viable seed compared to the lower soil depth and this is in agreement with the findings of Malone (2005) who reported that 99.6% of all weed seeds was found in the upper 10 cm layer of soil with greater number in o-2.5cm layer than in the 2.5-10 cm layer.

On the above ground weed species data taken on all the experimental plots including fallow field, the frequency, abundance, and density of different weed species in different cropped areas as well as fallow land are shown in Table 4a and 4b.

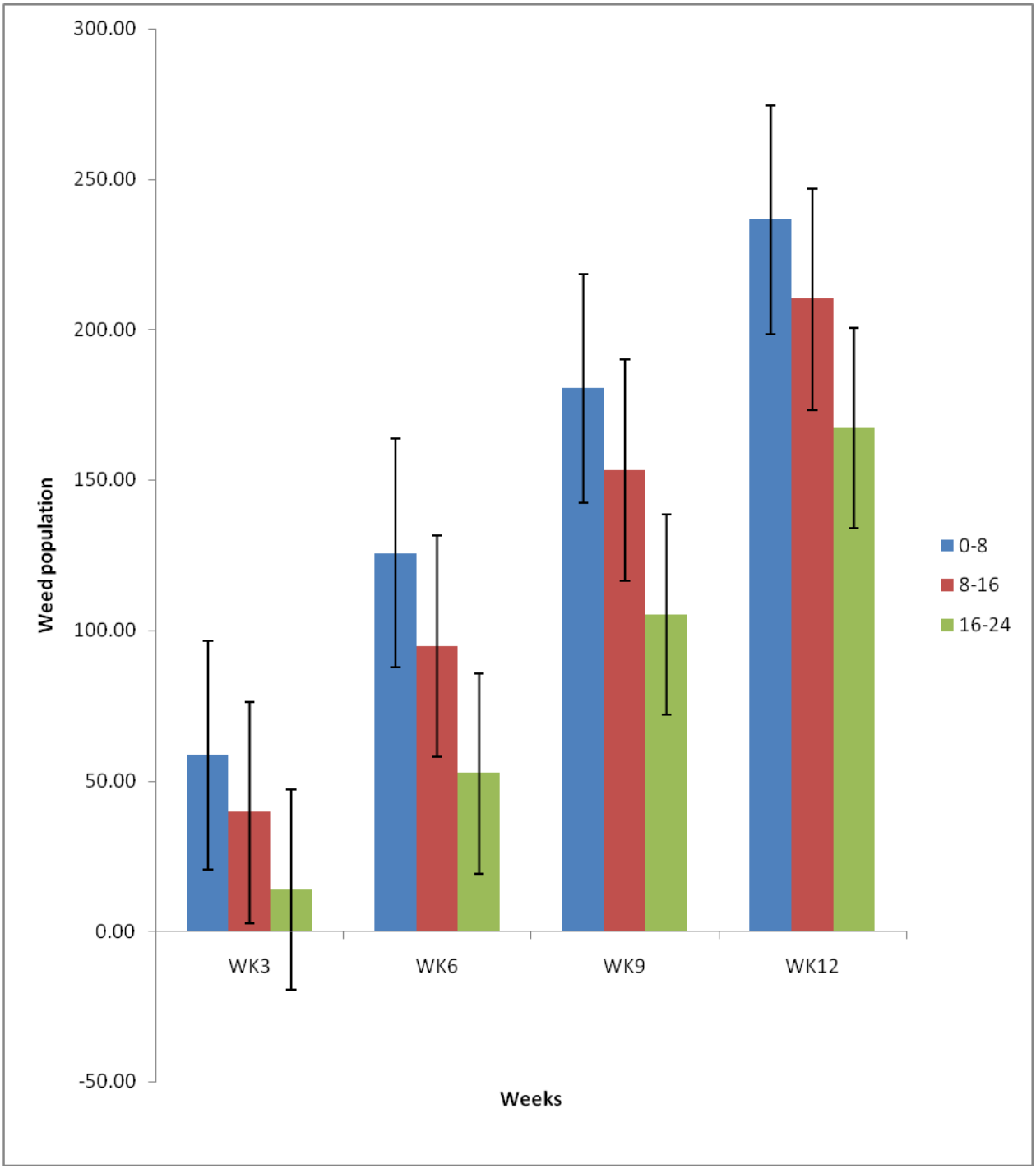

Figure 2: Total Number of weed seedling emergence at different soil depth (0 – 8 cm, 8 – 16 cm and 16 – 24 cm) at the Teaching and Research Farm, Obafemi Awolowo University Ile-Ife.

Table 4(a): The frequency, abundance, density and diversity of different weed species at the experimental site, Obafemi Awolowo University, Teaching and Research Farm, Ile-Ife.

Weed species	Fallow land			Maize Field			Cassava Field			H
	F	A	D	F	A	D	F	A	D	
Acalypha spp.	-	-	-	10	0.1	0.001	-	-	-	0.000
Adropogon tectorum	-	-	-	-	-	-	-	-	-	0.000
Agerantum conyzoides	-	-	-	10	0.6	0.006	80	4.8	0.384	0.250
Alchornea laxiflora	-	-	-	-	-	-	-	-	-	0.001
Aristolochia ringens	-	-	-	-	-	-	-	-	-	0.010
Aspillia Africana	-	-	-	-	-	-	20	0.3	0.006	0.300
Asyatasia gangetica	-	-	-	-	-	-	-	-	-	0.410
Anelienna beniniensis	-	-	-	-	-	-	-	-	-	0.000
Asystasia spp	-	-	-	-	-	-	-	-	-	0.001
Axonopus compressus	-	-	-	-	-	-	-	-	-	0.000
Calopogonium mucunoides	10	0.1	0.001	30	0.8	0.024	60	1.2	0.072	0.360
Celosia trigna	-	-	-	20	0.2	0.004	-	-	-	0.001
Chassalia kolly	-	-	-	-	-	-	-	-	-	0.000
Chromolaena odorata	30	7.1	0.213	-	-	-	80	2.0	0.160	0.515
Cissus spp.	-	-	-	-	-	-	-	-	-	0.291
Commelina benghalensis	-	-	-	-	-	-	-	-	-	0.455
Cythula prostrate	-	-	-	-	-	-	-	-	-	0.240
Dalbergia saxatilis	-	-	-	-	-	-	-	-	-	0.000
Desmodium scorpiurus	-	-	-	-	-	-	-	-	-	0.252
Diodia scadens	-	-	-	-	-	-	-	-	-	0.103
Dioscrea bulbifera	-	-	-	-	-	-	-	-	-	0.189
Diplazium sommati	-	-	-	-	-	-	-	-	-	0.001
Dissotis rotundifolia	-	-	-	-	-	-	-	-	-	0.206
Echinochloa colona	-	-	-	-	-	-	-	-	-	0.000
Euphobia heterophylla	-	-	-	-	-	-	40	1.2	0.048	0.000
Fluerya aestuans	-	-	-	-	-	-	-	-	-	0.000
Hippocratea indica	10	0.1	0.001	-	-	-	-	-	-	0.000
Ipomea involucrate	10	0.1	0.001	50	1.0	0.050	-	-	-	0.132
Ipomea mauritiana	-	-	-	-	-	-	-	-	-	0.000
Ipomea triloba	-	-	-	-	-	-	60	2.0	0.120	0.001
Melanthera scadens				-	-	-	-	-	-	0.299
Merremia spp.	10	0.4	0.004	-	-	-	50	0.5	0.025	0.299
Mimondia cherantia	-	-	-	-	-	-	-	-	-	0.000
Mondia whitei	-	-	-	-	-	-	-	-	-	0.010
Oldenlandia corymbosa	-	-	-	40	2.3	0.092	-	-	-	0.000
Panicum maximum	80	2.0	0.160	20	0.2	0.004	30	0.7	0.021	0.574
Parquetiria nigeriensis	-	-	-	-	-	-	-	-	-	0.000
Phyllanthus capillaries	-	-	-	-	-	-	-	-	-	0.000
Richardia brasiliensis	10	0.1	0.001	100	23.3	2.330	80	12.3	0.984	0.287
Rottoboellia cochinchinnensis	-	-	-	-	-	-	20	0.4	0.008	0.002
Senna occidentalis	-	-	-	--	-	-	-	-	-	0.000
Sida codifolia	-	-	-	-	-	-	10	0.1	0.001	0.000
Sida corymbosa	-	-	-	10	0.1	0.001	-	-	-	0.000
Spigelia anthelmia	-	-	-	10	0.5	0.005	10	0.2	0.001	0.259
Stachytapheta angustifolia	20	1.1	0.022	-	-	-	-	-	-	0.000
Starchytarpheta indica	-	-	-	-	-	-	-	-	-	0.002
Synedrella nodiflora	-	-	-	70	11.4	0.798	10	0.3	0.002	0.051
Tithonia diversifolia	50	7.4	0.370	-	-	-	-	-	-	0.000
Tridax procubens	-	-	-	-	-	-	10	0.5	0.005	0.001
Vernonia cinera	-	-	-	-	-	-	10	1.3	0.013	0.001
Vigna gracilis	60	0.6	0.036	80	2.1	0.168	60	1.0	0.006	0.663
Physalis angulata	-	-	-	10	0.1	0.001	-	-	-	0.000
(H)			0.625			0.574			0.866	

F - Frequency; A – Abundance; D – Diversity

Table 4(b): The frequency, abundance, density and diversity of different weed species at the experimental site, Obafemi Awolowo University, Teaching and Research Farm, Ile-Ife.

Weed species	Fallow land			Cocoa Field			Cashew Field			Oil Palm Field			H
	F	A	D	F	A	D	F	A	D	F	A	D	
Acalypha spp.	-	-	-	-	-	-	-	-	-	10	0.1	0.001	0.000
Adropogon tectorum	-	-	-	-	-	-	-	-	-	20	0.4	0.008	0.000
Agerantum conyzoides	-	-	-	-	-	-	-	-	-	10	0.2	0.002	0.250
Alchornea laxiflora	-	-	-	-	-	-	-	-	-	-	-	--	0.001
Aristolochia ringens	-	-	-	-	-	-	10	0.3	0.003	20	0.2	0.004	0.010
Aspillia Africana	-	-	-	--	-	-	-	-	-	50	1.0	0.050	0.300
Asyatasia gangetica	-	-	-	20	0.5	0.01	60	2.1	0.126	-	-	-	0.410
Anelienna beniniensis	-	-	-	-	-	-	10	0.1	0.001	30	0.5	0.015	0.000
Asystasia spp	-	-	-	-	-	-	-	-	-	30	1.0	0.003	0.001
Axonopus compressus	-	-	-	-	-	-	-	-	-	-	-	-	0.000
Calopogonium mucunoides	10	0.1	0.001	-	-	-	-	-	-	-	-	-	0.360
Celosia trigna	-	-	-	-	-	-	-	-	-	10	0.1	0.001	0.001
Chassalia kolly	-	-	-	-	-	-	-	-	-	60	2.6	0.156	0.000
Chromolaena odorata	30	7.1	0.213	-	-	-	50	1.5	0.075	-	-	-	0.515
Cissus spp.	-	-	-	20	0.3	0.006	40	0.5	0.020	40	0.8	0.032	0.291
Commelina benghalensis	-	-	-	20	1.1	0.022	10	0.5	0.005	-	-	-	0.455
Cythula prostrate	-	-	-	10	0.6	0.001	10	0.2	0.002	-	-	-	0.240
Dalbergia saxatilis	-	-	-	10	0.1	0.001	-	-	-	-	-	-	0.000
Desmodium scorpiurus	-	-	-	10	0.3	0.003	10	0.1	0.001	-	-	-	0.252
Diodia scadens	-	-	-	-	-	-	10	0.2	0.002	30	0.3	0.009	0.103
Dioscrea bulbifera	-	-	-	-	-	-	70	1.6	0.112	30	0.5	0.015	0.189
Diplazium sommati	-	-	-	-	-	-	-	-	-	40	3.4	0.136	0.001
Dissotis rotundifolia	-	-	-	-	-	-	20	0.8	0.016	20	1.0	0.070	0.206
Echinochloa colona	-	-	-	-	-	-	-	-	-	-	-	-	0.000
Euphobia heterophylla	-	-	-	-	-	-	-	-	-	-	-	-	0.000
Fluerya aestuans	-	-	-	50	2.6	0.130	-	-	-	-	-	-	0.000
Hippocratea indica	10	0.1	0.001	-	-	-	-	-	-	-	-	-	0.000
Ipomea involucrate	10	0.1	0.001	-	-	-	-	-	-	-	-	-	0.132
Ipomea mauritiana	-	-	-	-	-	-	10	0.1	0.001	-	-	-	0.000
Ipomea triloba	-	-	-	-	-	-	-	-	-	-	-	-	0.001
Melanthera scadens				20	0.7	0.014	20	0.6	0.012	-	-	-	0.299
Merremia spp.	10	0.4	0.004	-	-	-	-	-	-	-	-	-	0.299
Mimondia cherantia	-	-	-	-	-	-	10	0.1	0.001	-	-	-	0.000
Mondia whitei	-	-	-	10	0.3	0.003	-	-	-	-	-	-	0.010
Oldenlandia corymbosa	-	-	-	-	-	-	-	-	-	60	1.5	0.090	0.000
Panicum maximum	80	2.0	0.160	-	-	-	10	0.3	0.003	-	-	-	0.574
Parquetiria nigeriensis	-	-	-	10	0.1	0.001	-	-	-	10	0.1	0.001	0.000
Phyllanthus capillaries	-	-	-	-	-	-	-	-	-	-	-	-	0.000
Richardia brasiliensis	10	0.1	0.001	-	-	-	-	-	-	-	-	-	0.287
Rottoboellia cochinchinnensis	-	-	-	-	-	-	-	-	-	10	0.4	0.004	0.002
Senna occidentalis	-	-	-	-	-	-	-	-	-	-	-	-	0.000
Sida codifolia	-	-	-	-	-	-	-	-	-	-	-	-	0.000
Sida corymbosa	-	-	-	-	-	-	-	-	-	-	-	-	0.000
Spigelia anthelmia	-	-	-	-	-	-	-	-	-	-	-	-	0.259
Stachytapheta angustifolia	20	1.1	0.022	-	-	-	-	-	-	80	4.2	0.336	0.000
Starchytarpheta indica	-	-	-	-	-	-	-	-	-	-	-	-	0.002
Synedrella nodiflora	-	-	-	-	-	-	-	-	-	-	-	-	0.051
Tithonia diversifolia	50	7.4	0.370	-	-	-	-	-	-	-	-	-	0.000
Tridax procubens	-	-	-	-	-	-	-	-	-	-	-	-	0.001
Vernonia cinera	-	-	-	-	-	-	-	-	-	10	1.0	0.010	0.001
Vigna gracilis	60	0.6	0.036				70	1.3	0.091	-	-	-	0.663
Physalis angulata	-	-	-	-	-	-	-	-	-			1.061	0.000
(H)			0.625			0.810			1.035				

F - Frequency; A – Abundance; D - Diversity

Fifty-seven weed species were found in all the different cropped area including the fallow land. The type and number of weed vary in the different cropping systems studied. Maximum number of weeds was present in the oil-palm plantation (19), followed by cashew plantation (17) and maize/cassava plot (16), maize plot (13), fallow land (10) and cocoa plantation (10).

In the fallow land, 80% frequency of weed population was recorded for *Panicum maximum* while about 60% was recorded for *Vigna gracilis* and about 50% for *Tithonia diversifolia*. In cocoa plantation, *Fluerya aestuans* occurred with 50% frequency while *Asystacia gangetica*, *Cissus spp*., *Melanthera scadens* and *Commelina benghalensis* showed frequency of 20 %. In cashew plantation, frequency of 70% was observed for *Vigna gracilis* and *Dioscorea bulbifera*, while *Asystacia gangetica* had 60% frequency. In maize plot, maximum frequency (100%) was observed for *Richardia brasiliensis* while *Vigna gracilis* and *Synedrella nodiflora* recorded frequency of 80% and 70% respectively. The maize and cassava intercrop plot result showed that *Ageratum conyzoides, Chromolaena odorata and Richardia brasiliensis* had higher frequency (80%) while 60% frequency is observed for *Calopogonium mucunoides, Ipomea triloba and Vigna gracilis. Starchytapheta indica* is the most prominent weed in oil palm plantation with 80% frequency and the weed is only peculiar to this plantation. A 60% frequency of weed population was recorded for *Chromolaena odorata* and *Panicum maximum.*

The weeds with maximum abundance in fallow field, cocoa plantation, cashew plantation, maize plot, maize/cassava intercrop and oil palm are *Tithonia diversifolia* (7.4), *Fluerya aestuans* (2.6), *Asystacia gangetica* (2.1), *Richardia brasiliensis* (23.3), *Richardia brasiliensis* (12.3), and *Starchytapheta indica* (4.2) respectively. In the fallow field, the weeds that showed least abundance (0.1) in the fallow land are *Calopogonium mucunoides, Hippocrtea indica, Ipomea involucrata,*and *Richardia brasiliensis*. This is likely to be as a result of suppression by *Panicum maximum* that dominated the entire plot due to its wide spreading ability.

Acalypha spp., Aneilienna beninensis, Chassalia kolly, Dioscorea spp., Ipomea Mauritania, Mimondia cherantia, physalis angulata, Sida codifolia, Sida corymbosa and Leucaena leucocephala, all have the least frequency of 10%, abundance (0.1) and density (0.001). In the fallow land, *Tithonia diversifolia* showed maximum density (0.37). *Fluerya aestuans* had maximum density (0.37) in coaco plantation. Also in cashew, *Asystacia gangetica* has the maximum density (0.126). *Richardia brasiliensis* has a maximum density of (2.33) and (0.98) in maize and maize/cassava cropping system respectively while the maximum density (0.33) was recorded for *Starchytapheta angusifolia* in oil palm plantation.

The number of weed species in this study showed that the incidence of weed species depends on the canopy spread of crop planted. However, *Panicum maximum* was observed to suppress emergence of other weed species in the fallow land but the effect of tillage, use of chemicals, hand weeding, influence of canopy and other cultural practices affected weed species distribution in the different cropping systems studied. This is revealed in the higher frequency of *P. maximum* (80%) in fallow field when compared to other cropping systems studied. This was also reported by Froud Wiliams *et al*., (1983).

Cropping system practices give room for the emergence of broadleaf weeds, eliminating the suppressive effect of *Panicum maximum* observed in fallow field at the Teaching and Research Farm. Only two grass families (Poaceae and Cyperaceae) were observed in this study while the rest are broadleaves; this implies that emergence of broadleaves is highly influenced by cropping systems at Obafemi Awolowo University Teaching and Research Farms. Broadleaf seeds are left dormant in the soil seed banks until the soil is disturbed to break the seed dormancy for emergence.

It was observed that among the fifty-seven weed species, only two were almost present in all the fields (*Panicum maximum* and *Vigna gracilis*) except in cocoa plantation where they are absent. Three (*Hippocratea indica*, *Stachytapheta angustifolia* and *Tithonia diversifolia*) were present in fallow land only (Table 5).Weeds that were present in maize plot only are *Acalypha* spp., *Celosia trigna, Oldenlandia corymbosa*, and *Sida corymbosa*. *Anelienna beniniensis, Aristolochia ringens, Diodia scadens*, Ipomea *mauritiana*, and *Mimondia cherantia* are only present in cashew plantation. Two weeds (*Dalbergia saxatilis, Fluerya aestuans, Mondia whitei,* and *Parquetiria nigeriensis*) are specific to cocoa field while *Euphobia heterophylla, Ipomea triloba, Rottoboellia cochinchinnensis, Sida codifolia, Tridax procubens* and *Vernonia cinera*

Table 5:weed species occurrence in different cropping system at the Teaching and farm

Weed species	Fallow land	Coaco plantation	Cashew plantation	Maize plot alone	Maize/cassava plot	Oil palm plantation
Acalypha spp	–	–	–	√	–	–
Adropogon tectorium	–	–	–	–	–	√
Ageratum conyzoides	–	–	–	√	√	√
Alchornea laxiflora	–	–	–	–	–	√
Alternanthera sessilis	–	–	–	–	–	–
Aneiliena beniniensis	–	–	√	–	–	–
Aristolochia ringens	–	–	√	–	–	–
Aspillia Africana	–	–	–	–	√	√
Asyatasia gangetica	–	√	√	–	–	√
Asystasia spp.	–	–	–	–	–	√
Axonopus compressus	–	–	–	–	–	√
Calopogonium mucunoides	√	–	–	√	√	–
Celosia trigna	–	–	–	√	–	–
Chassalia kolly	–	–	–	–	–	√
Chromolaena odorata	√	–	√	–	√	√
Cissus spp	–	√	√	–	–	–
Commelina benghalensis	–	√	√	–	–	√
Cythula prostrate	–	√	√	–	–	–
Dalbergia saxatilis	–	√	–	–	–	–
Desmodium scorpiurus	–	√	√	–	–	–
Diodia scadens	–	–	√	–	–	–
Dioscrea bulbifera	–	–	√	–	–	√
Diplazium sommati	–	–	–	–	–	√
Dissotis rotundifolia	–	–	√	–	–	√
Echinochloa colona	–	–	–	–	–	√
Euphobia heterophylla	–	–	–	–	√	–
Fluerya aestuans	–	√	–	–	–	–
Hippocratea indica	√	–	–	–	–	–
Ipomea involucrate	√	–	–	√	–	–
Ipomea mauritiana	–	–	√	–	–	–
Ipomea triloba	–	–	–	–	√	–
Melanthera scadens	–	√	√	–	–	–
Merremia sp	√	–	–	–	√	–
Mimondia cherantia	–	–	√	–	–	–
Mondia whitei	–	√	–	–	–	–
Oldenlandia corymbosa	–	–	–	√	–	–
Panicum maximum	√	–	√	√	√	√
Parquetiria nigeriensis	–	√	–	–	–	–
Phyllanthus capillaris	–	–	–	–	–	√
Richardia brasiliensis	√	–	–	√	√	–
Rottoboellia cochinchinnensis	–	–	–	–	√	–
Senna occidentalis	–	–	–	–	–	√
Sida codifolia	–	–	–	–	√	–
Sida corymbosa		–	–	√	–	–
Spigelia anthelmia	–	–	–	√	√	–
Stachytapheta angustifolia	√	–	–	–	–	–
Starchytarpheta indica	–	–	–	–	–	√
Synedrella nodiflora	–	–	–	√	√	–
Tithonia diversifolia	√	–	–	–	–	–
Tridax procubens	–	–	–	–	√	–
Vernonia cinera	–	–	–	–	√	–
Vigna gracilis	√	–	√	√	√	√

√ = present, – = absent

were present only in the maize/cassava plot. *Adropogon tectorium*, *Alchornea laxiflora*, *Asystasia* spp. *Axonopus compressus*, *Chassalia kolly*, *Diplazium sommati*, *Echinochloa colona*, *Phyllanthus capillarys*, *Senna occidentalis* and *Starchytarpheta indica* were only present in the oil-palm plantation.

Panicum maximum and *Vigna gracilis* was observed to occur in all the fields with different frequencies except in cocoa field, showing that they can grow in any situation irrespective of shade. *Hippocrtea indica*, *Starchytapheta angusifolia*, and *Tithonia diversifolia* were only observed in fallow land, which revealed that they require full sunlight for their growth and development. Sit *et al.*, (2007) also reported the presence of some weed in fallow land alone indicating their need for sunlight in order to grow and develop.

Shannon's index of weed flora diversity was high in oil palm plantation (1.061) and cashew plantation (1.035). It was lower in maize plot (0.574). In this study, out of the 57 weeds species that were observed, 23 are limited in distribution in the cropping systems. They are shown in Table 4, with a Shannon's index value of 0. Two species that were found to be widely distributed at greater frequency in all the fields are *Panicum maximum* and *Vigna gracilis* except in Cocoa field where they were not found. These weeds showed Shannon's index value of >0.57 and >0.66 for *Panicum maximum* and *Vigna gracilis* respectively.

Oil palm plantation and cashew plantation showed the highest diversity in the cropping system with Shannon index (H > 1.0), *Panicum maximum* and *Vigna gracilis* are more diverse across the cropping systems with Shannon index (H >0.5). Also Asteraceae, Papilionaceae and Rubiaceae are the broadleaf families widely distributed in the cropping systems observed.

Maize plot shows a high similarity index (51.72) of weed flora with maize cassava intercrop (Table 6). Weed flora in other fields were dissimilar. However, the similarity index value of weed flora in fallow and oil-palm plantation is higher when compared to other fields (Table 6).

Weeds of the different cropping systems and fallow field show no similarity except for sole maize and maize/cassava plot which showed a significance (p>50%). This could be as a result of high light intensity in these cropping systems compared to other permanent cropping systems studied i.e. cocoa, cashew and oil palm plantation which has canopy effect. The dissimilarity (p>50%) in the permanent cropping systems could be due to weed species response to different percentage of light penetration according to Sit et al, (2007). Weed flora in maize plot and maize/cassava intercrop was dissimilar (5.25 and 15.56 respectively) as well as in oil plam plantation. The low light availability in maize plot and maize/cassava intercrop could be responsible for this.

The distributions of weed species in different taxonomic groups are shown in Table 7. 24 families of dicots and 2 families of monocots were observed during the study. The member of the family Hippocrateaceae was present only in fallow land, while Urticaceae, and Papilionaceae were observed in cocoa plantation. Aristolocaceae and Curcubitaceae were only present in cashew plantation while Cyperaceae, Mimosaceae, and Solanaceae were present in maize plot only. Athyreaceae and Caesalpinaceae were only observed in and oil palm plantation. Asteraceae and Papilionaceae were noticed in all the plots studied (Table 7). Dicots were observed to be dominat in all the plots studied. Poaceae and Cyperaceae are the only monocots noticed in the study. However, dicots dominated over monocots in the entire plantation studied. The luxuriant growth of dicots in the area could be as a result of favourable rainfall and temperature.

Table 6: Similarity index of weed species in the different cropping system at the Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife.

	Fallow field	Cocoa plantation	Cashew plantation	Maize plot alone	Maize/cassava plot	Oil palm plantation
Fallow field	100	0	20.46	5.25	15.56	24.36
Cocoa plantation		100	25.56	0	0	9.2
Cashew plantation			100	5.5	12.8	39.9
Maize plot alone				100	51.72*	6.92
Maize/cassava plot					100	15.9
Oil palm plantation						100

Table 7: Weed species of different botanical families in the cropping system at the Teaching and Research Farm, Obafemi Awolowo University, Ile-Ife.

Families	Fallow land	Coaco plantation	Cashew plantation	Maize plot	Cassava/maize plot	Oil palm plantation.
Monocotyledon	1	0	1	2	3	4
Cyperaceae	0	0	0	1	0	0
Poaceae	1	0	1	1	3	4
Dicotyledon	9	10	17	13	15	15
Acanthaceae	0	1	1	0	0	2
Amaranthaceae	0	1	2	1	0	0
Aristolocaceae	0	0	1	0	0	0
Asteraceae	2	1	2	2	6	3
Athyreaceae	0	0	0	0	0	1
Caesalpinaceae	0	0	0	0	0	1
Commelinaceae	0	1	2	0	0	1
Convolvulaceae	2	0	1	1	2	0
Curcubitaceae	0	0	1	0	0	0
Dioscoreaceae	0	0	2	0	1	1
Euphobiaceae	0	0	0	1	1	1
Fabaceae	0	1	1	0	0	1
Hippocrateaceae	1	0	0	0	0	0
Loganiaceae	0	0	0	1	1	0
Malvaceae	0	0	0	1	1	1
Melastomaceae	0	0	1	0	0	1
Mimosaceae	0	0	0	1	0	0
Papilionaceae	2	1	1	2	2	1
Periplocaceae	0	2	0	0	0	0
Rubiaceae	1	0	1	2	0	0
Solanaceae	0	0	0	1	0	0
Urticaceae	0	1	0	0	0	0
Verbanaceae	1	0	0	0	0	1
Vitaceae	0	1	1	0	0	0
Total	10	10	18	15	18	19

Conclusion

This study has demonstrated that cropping system is a significant factor in predicting the distribution of weed seed in the soil because of variations observed in the crop fields selected for this study. Moreover, soil depth mostly influences weed seed distribution in the soil because of the variations observed in weed seedling's emergence.The highest quantity of all weed species recorded was established on the top layer (0-8cm) because the top layer has access to air, light, nutrient and other growth factors that can aid weed seeds germination and weed seed numbers decreases as the soil depth increases irrespective of the location.

Finally, it was evident from this study that the land use effect such as tillage, chemical application, hand weeding, and other cultural practices affect the weed flora composition. The effects of canopy in some of the cropping systems also affect weed flora composition. Emergence of broadleaves is a common feature of any cropping system at Obafemi Awolowo University Teaching and Research Farms, Ile-Ife. Asteraceae and Papilionaceae which are broadleaves families were widely distributed in all the cropping systems. The presence of some weeds in almost all ares of study indicates that their growth and development can occur under different light conditions while restriction of some weeds to particular area shows their requirement for special condition in order to grow.

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