

**ECOLOGICAL STUDIES OF SEASONAL DISTRIBUTION OF WEEDS IN
OIL PALM (*Elaeis guineensis* Jacq.) PLANTATION AT AGBARHA-OTOR,
UGHELLI NORTH LOCAL GOVERNMENT AREA, DELTA STATE**



BY

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PG/LSC1817762

DEPARTMENT OF PLANT BIOLOGY AND BIOTECHNOLOGY

FACULTY OF LIFE SCIENCES

UNIVERSITY OF BENIN

MAY, 2021.

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**A RESEARCH PROJECT WRITTEN IN THE DEPARTMENT OF PLANT
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BENIN CITY, EDO STATE**

MAY, 2021.

CERTIFICATION

We certify that this project work was written by David Folorunso RASAAQ of the Department of Plant Biology and Biotechnology, Faculty of Life Sciences, University of Benin, Benin City, Edo State, Nigeria.

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DEDICATION

This thesis is dedicated to God Almighty, for his enablement and for giving me knowledge to comprehend what I was taught throughout my period of study. Also the memory of my late father Mr. Abioye Z. E. for laying a solid foundation for my academic development.

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ABSTRACT

Ecological study of seasonal distribution of weeds in oil palm plantation at Agbarha-Otor, Ughelli North Local Government Area of Delta State, Nigeria, was carried out during the rainy and dry seasons of 2020. Quadrats measuring 10 m² were laid at random and information on the weed species were gathered and used to generate diversity indices as well as other ecological statistics. During the dry season the taxa ranged from 27 - 50, individual abundance (376 – 2821), Dominance_D (0.1819 – 0.4248), Simpson index (0.5752 – 0.962), Shannon Wiener index (1.469 – 3.468), Evenness index (0.132 - 0.7635), Brillouin (1.437 – 3.268), Menhinick index (0.7073 – 2.116), Margalef index (3.569 – 6.914), Equitability (0.4301 – 0.9278), Fisher_alpha (4.705 – 8.632), Berger-Parker (0.07979 – 0.6424) and Chao-1 was (27.38 – 50.5). In terms of most abundant species, density, relative density and importance index value in dry season in decreasing order were Poaceae > Selaginellaceae > Arecaceae > Melastomataceae > Bromeliaceae > Asteraceae. Diverse families in decreasing order were Poaceae > Asteraceae > Fabaceae = Rubiaceae = Malvaceae > Amaranthaceae = Connaraceae > Acanthaceae = Cyperaceae = Euphorbiaceae = Polypodiaceae = Tiliaceae = Gentianaceae with 7, 6, 5, 5, 5, 3, 3, 2, 2, 2, 2, 2 and 2 species respectively. While in the rainy season taxa ranged from 32 - 57, individuals (312 – 2178), Dominance, Simpson, Shannon Weiner, Evenness, Brillouin, Menhinick, Margalef and Equitability indices were (0.04491 – 0.4904; 0.5096 – 0.9551; 1.488 – 3.454; 0.10390 – 586; 1.426 – 3.284; 0.7037 – 2.887; 4.061 – 8.706) respectively. Equitability (0.4182 – 0.866), Fisher_alpha (5.373 – 17.31), Berger-Parker (0.1197 – 0.6944) and Chao-1 were (32 – 62.08) respectively. In terms of most abundant species, density, relative density and abstractimportance value index in rainy season, six weed families namely Poaceae, Asteraceae, Fabaceae, Malvaceae, Rubiaceae and Connaraceae were predominant. Similarly, the most diverse families in decreasing order were Poaceae > Asteraceae, = Fabaceae, > Rubiaceae, = Malvaceae, > Connaraceae = Amaranthaceae, > Acanthaceae = Cyperaceae = Euphorbiaceae = Gentianaceae = Polypodiaceae = Tiliaceae with 7, 6, 6, 5, 5, 3, 3, 2, 2, 2, 2, 2 and 2 species respectively. The knowledge of weed flora will enable us to know the appropriate method to eliminate them from our agricultural farms to reduce competition with our valuable crops.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of Study

Weeds are undesired plants within certain place of interest to man, but share similar adaptation traits with crops. These give them the advantages and allow proliferation in disturbed environment whose soil or natural vegetative cover has been damaged. The differences in ecologies and disturbance influence weed composition (Hiyat and Kudus, 2010). Land cultivation and cropping pattern (agricultural practices) often mimic natural environments where weedy species have evolved. Weeds have excellent adaptive traits to grow and proliferate in human disturbed areas such as agricultural fields, lawns, road sides, constructions sites and water ways. The weedy nature of these species often gives them an advantage over more desirable crop species because they often grow quickly and reproduce quickly, have seeds that persist in the soil seed bank for many years, or have short life span with multiple generation in the same growing season (Barcelos *et al.*, 2015).

Different weed species have been identified with various crops. Preference for crops may stem from similarity in growth factors and conditions, infestation clues from crops (*Striga* and cereals), cropping system, crop plant architecture, plant spacing and season. The weather factors like, rainfall, humidity, temperature and wind also play significant roles in weed infestation of crop fields. Crop production is hampered by the advent of weeds in cropping systems. The interference of weeds results into considerable yield reduction in the entire cropping system and

efforts were being made by farmers to mitigate the menace of weeds and the attendant problems (Kalidas, 2012). Burning of field before land preparation, slashing, hoe weeding, weed pressing, fallowing, herbicide application and avoidance of noxious weeds are various weed control methods that have been used with positive response in terms of yield increase and stability. However, these methods are attended by various shortcomings (Sahebi *et al.*, 2015). None has been a panacea to weed infestation problems in agronomic settings. The infusion of modern technology in integrated weed management has been identified to be a sustainable weed management strategy. Weeds are a major constraint in crop production (Sahebi *et al.*, 2015). The knowledge of weed diversity and biology is of importance in weed management in agronomic setting. Aside low soil fertility that is a common problem in continuous cropping in most tropical agro ecologies; weed infestation is a hidden ‘crop yield eater’ that must be identified and managed appropriately. Farmers in rainforest/ savanna transition agroecology are faced with wide range of weeds and management challenges (Hushiarian *et al.*, 2013).

Weed is a major component in oil palm production system. The composition of weeds is a mixture of grasses, sedges, and broadleaves which often changes according to the crop growth stages which provide specific climatic and environmental conditions suitable for specific weed growth. The shade provided by the palm canopy influences the nature of weed composition, and grass species tend to dominate as the oil palms get bigger (Hushiarian *et al.*, 2013). The effect of weeds on oil palm is difficult to quantify because of their long economic life (i.e. 20-30 years) but they can affect the growth of crops or cause yield losses. Weeds in plantation are managed using several methods such as cultural, mechanical, integrated production system of using livestock to control the weeds, or chemical herbicides (Vollmann *et al.*, 2010). Weed

management with the use of chemical herbicides is the most common practice in oil palm plantations at some stages of crop development (Vollmann *et al.*, 2010). Broad spectrum herbicide, paraquat, was used for more than 40 years, and was the only mostly used herbicide in Malaysian plantations. The use of this herbicide, however, has been halted since 2002 by the Government of Malaysia, for reasons of toxicity and hazards to humans, but was lifted in 2006 to allow for more comprehensive study. The prohibition of paraquat use left an open option to users for replacement. Several other common broad-spectrum herbicides are available in the Malaysian market. Among these herbicides are glufosinate-ammonium and glyphosate (Rabbani *et al.*, 2011).

All these herbicides are foliar applied, with paraquat activity being through contact, glufosinate-ammonium being partially systemic and glyphosate being systemic. Most herbicide efficacy studies in oil palm plantation have reported on certain specific noxious weeds. Meanwhile, a study evaluating some new herbicides for general weed control in young oil palm was reported by Karkanis *et al.* (2011). However, a single predominant weed is rarely found under field condition. Instead, predominant weeds comprised of a few weed species (or rather it is a mixed weed situation) and weed population, particularly in crop areas, are never constant, but are in dynamic state of flux due to changes in climatic and environmental conditions, husbandry methods, and the use of herbicides (Aparicio *et al.*, 2010).

Species distribution in terms of species richness is measured as the number of species in a community. Distribution could be within or between communities. Two communities with an identical number of species can differ in terms of evenness, and hence it is also useful to know the proportion or relative abundance of species within the community (Aparicio *et al.*, 2010).

Intercropping is a predominant cropping system in developing countries which involves the practice of growing two or more crops at the same time, during the same season in the same piece of land. Intercropping has been reported to increase crop diversity, biological stability of the ecosystem and labour efficiency. Many tree crops notably oil palm, cocoa, coffee have been successfully intercropped with other trees and food crops. Intercropping of compatible plants also encourages biodiversity, by providing a habitat for a variety of insects and soil organisms that would not be present in a single-crop environment (Silva *et al.*, 2012). This biodiversity can in turn help to limit outbreaks of crop pests by increasing the diversity or abundance of natural enemies, such as spiders or parasitic wasps. Increasing the complexity of the crop environment through intercropping also limits the places where pests can find optimal foraging or reproductive conditions. Greater crop yield and less weed growth can be obtained more frequently in intercrops than in sole crops (Silva *et al.*, 2012).

In East Africa fruit crops are usually intercropped with annual crops; for example, banana is intercropped with food and/ or fodder crops, while in India bananas are intercropped with potato which had resulted in good returns (Garau *et al.*, 2009). Indices have been developed to combine species richness with proportional abundance within a single value. Examples include the Shannon index, the Simpson index and 'a' of the log series. Recent studies have shown that weed shift occur in continuously cultivated land, which may be as a result of bush burning, high tillage practice, cropping systems, weed control methods and other changes in the habitat. In order to determine weed control strategy for a successful weed control programmes in oil palm tree cropping systems, it is worthy to know the weed type and species composition (Souza *et al.*, 2006).

In order to meet both domestic and industrial needs of palm produce in Ghana as well as for export, various organizations have been encouraged to cultivate oil palm plantations. The support for oil palm promotion was operationalised as part of the Presidential Special Initiative (PSI) on oil palm through which out-grower support units were established. The PSI proposed to plant about 100,000 hectares of oil palm over a five-year period (2006-2007). Again, 12 nurseries across Ghana consisting of about 1.2 million seedlings were set up. However, weeds and weed problems continue to be important factors reducing yields. Improved oil palm varieties start production within three years after planting and have average economic life of about thirty years (Araujo *et al.*, 2012). However, growth, development and yield of the crop are adversely affected by weeds. In established oil palm plantation, noxious weeds such as *Chromolaena odorata*, *Mikania cordata* and *Mikania micrantha* compete with the oil palm for nutrients, moisture and sunlight and eventually cause yield depression. Palms that grow where there is *Imperata cylindrica* are generally stunted and retarded in growth. Other noxious grasses include *Chloris barbata*, *Pennisetum purpureum* and *Panicum maximum*. Generally, *Axonopus* sp., *Digitaria* sp. and *Paspalum* sp. are classified as soft weeds which maintain the balance of the weed flora and prevent weed succession by noxious species simply because base land for the noxious weeds to colonise is less available (Olorunmaiye *et al.*, 2011).

Studies on weeds in perennial crops have been conducted for various species including forest species, fruit trees and other crops. Some of these studies have evaluated the floristic composition of weeds and their effect on crop yield. The out-growers concept in Ghana which involves the attachment of small scale oil palm farmers to well established large plantations like Twifo and National oil palm plantations has gained enormous patronage as a result of the

improved yield returns. This concept was developed largely to address the poor management of oil palm plantations by small-scale farmers especially in the area of weed control (Mazmira *et al.*, 2011).

1.2 Aim and Objectives of the Research

The main aim of this research is to study the seasonal distribution of weeds in *Elaeis guineensis* (oil palm) plantation at Agbarha-Otor, Ughelli North Local Government of Delta State.

The research objectives are as follows to:

1. identify the weed species composition in *E. guineensis* plantation at Agbarha-Otor.
2. document the seasonal distribution of the weeds in oil palm plantation at Agbarha-Otor.
3. report the diversity indices of the weed flora in the oil palm plantation.
4. document the importance value index (I.V.I) of each of the weed flora present in the oil palm plantation.
5. document the species diversity, abundance, density, frequency, relative density and relative frequency and the importance value index (I.V.I) of the weed flora present in the oil palm plantation.
6. report the dominant and diverse weed families in the oil palm plantation.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Oil Palm Production as a Commodity

Oil palm (*Elaeis guineensis* Jacq.) is the commodity crop in some countries, especially Malaysia and Indonesia. Oil palm plantations in Indonesia covered an area of 12.3 million hectares in 2017, and is the world's major producer and exporter of palm oil (Mohamad *et al.*, 2017). The second producer, Malaysia, has some 5.85 million hectares of planted oil palm, covering more than 60 % of the agricultural land in 2018. The other producers include Thailand, Colombia, Nigeria, Papua New Guinea, Ecuador, and other countries, which account for 19 million hectares or 0.36 % of the world's agricultural land in total oil palm planted area. It is worth noting that 85 % of the world's palm oil is produced by Indonesia and Malaysia. On the other hand, the world's major consumers and importers of palm oil are India, China, the European Union (EU), the United States (USA), Pakistan, Bangladesh, Nigeria, Philippines, and other countries (Rees *et al.*, 2012). *Elaeis guineensis* is an oil palm species that originated from the tropical rainforest of West Africa. The palm tree is monoecious, where the male and female parts can be found on the same tree. It may grow up to more than thirty feet and start to produce fruit bunches from three years of age after planting. Their average productive span-life is about 25 to 30 years, where each tree can bear 8 to 12 fruit bunches per year. Due to their high yield in oil, palm oil is emerging as the most efficient vegetable oilseed crop in the world, whereby a hectare of oil palm plantation can produce ten times more oil compared to the other world-leading oilseed crops, including rapeseed, sunflower, and soybean (Petit *et al.*, 2012).

The world's primary oilseed production in 2017 are palm oil (68 million tonnes), soybean oil (54 million tonnes), rapeseed oil (25 million tonnes), and sunflower oil (19 million tonnes), where the one-third (34 %) of the world's oil and fats production is contributed by palm oil. Palm oil contains a balanced composition of saturated and unsaturated fatty acids with approximately 44 % of monounsaturated oleic acid, 10% of polyunsaturated linoleic acid, 40% of saturated palmitic acid, and 5 % of saturated stearic acid. It is free of cholesterol and *trans*-unsaturated fatty acids (Idris *et al.*, 2010). On another note, palm oil is rich in antioxidants in the form of vitamin E (tocopherols and tocotrienols), where 60 to 100 mg of vitamin E can be found in crude or unrefined palm oil and about half of it remains after refining. Palm oil has the richest tocotrienols content versus other oilseeds such as soybean, sunflower, corn and olive. These tocotrienols have been found effective in lowering bad cholesterol levels as well as protecting the brain against diseases. Palm oil is also rich in vitamin A (carotenoids), where 100 g of crude oil contains about 50 to 70 mg of carotenoids. Vitamin A plays an essential role in controlling the growth and functions of body tissues, stimulates the immune system, and promotes good vision (Said *et al.*, 2019).

2.2 *Elaeis guineensis* Jacq.

Elaeis guineensis is a species of palm commonly just called oil palm but also sometimes African oil palm or macaw-fat. It is the principal source of palm oil. It is native to west and southwest Africa, specifically the area between Angola and The Gambia; the species name *guineensis* refers to the name for the area, Guinea, and not the modern country which now bears that name (Buana *et al.*, 2014). The species is also now naturalised in Madagascar, Sri Lanka, Malaysia,

Indonesia, Central America, Cambodia, the West Indies, and several islands in the Indian and Pacific Oceans. The closely related American oil palm *Elaeis oleifera* and a more distantly related palm, *Attalea maripa*, are also used to produce palm oil. Human use of oil palms may date as far back as 5,000 years in West Africa; in the late 1800s, archaeologists discovered palm oil in a tomb at Abydos dating back to 3,000 BCE. It is thought that Arab traders brought the oil palm to Egypt (Ramli *et al.*, 2016).

2.2.1 Scientific Classification

Kingdom: Plantae

Division: Tracheophyta

Class: Angiospermae

Sub-class: Monocotyledonae

Order: Arecales

Family: Arecaceae

Genus: *Elaeis*

Species: *E. guineensis*

Botanical name: *Elaeis guineensis* Jacq.

2.2.2 Description of *Elaeis guineensis* Jacq.

Mature palms are single-stemmed and grow to 20 m tall. The leaves are pinnate and reach 3 - 5 m long. A young palm produces about 30 leaves a year. Established palms over 10 years produce about 20 leaves a year. The flowers are produced in dense clusters; each individual flower is small, with three sepals and three petals. The palm fruit takes 5–6 months to develop from pollination to maturity (Sundram *et al.*, 2015). It is reddish, about the size of a large plum, and grows in large bunches. Each fruit is made up of an oily, fleshy outer layer (the pericarp), with a single seed (the palm kernel), also rich in oil. When ripe, each bunch of fruit weighs between 5 and 30 kg (11 and 66 lb) depending on the age of the palm tree. *E. guineensis* is a species of the lowland humid tropics. In its native range, Azizah *et al.* (2015) reports that *E. guineensis* occurs wild in riverine forests or in freshwater swamps, though may be occasionally found at its ecological extremes from savanna to rainforest, otherwise mostly in tropical dry to tropical wet forest vegetation types. It does not regenerate or grow well in dense natural forests as it is apparently not very competitive with other forest species, and therefore tends to be found where other forest species do not grow well. It is shade intolerant, but needs adequate soil moisture and can tolerate periodic waterlogging (Alexander and Phin, 2014).

2.2.3 Biology and Ecology

E. guineensis is native to Africa and it is assumed that speciation took place in that continent. However, all related species classified in the subfamily Cocoideae have a South American origin, except perhaps the coconut, *Cocos nucifera*, thus the archetypal ancestor may have been indigenous to the Americas. A particular feature of the *E. guineensis* with considerable economic

consequences is the occurrence of (at least) three natural fruit types under monogenic control, which also form the basis for the classification of oil palms (Najihah *et al.*, 2015):

Dura: homozygous (sh+ sh+) for the presence of a relatively thick endocarp (shell 2 – 8 mm)

Tenera: heterozygous (sh+ sh-) with a relatively thin endocarp (0.5 – 4 mm)

Pisifera: homozygous (sh- sh-) for the absence of an endocarp.

There is also a *Macrocarya* form with the thickest endocarps 6–8 mm thick, being the most important type in West Africa and which forms a large proportion of the crop from Nigeria to Sierra Leone (Bivi *et al.*, 2016). The original Bogor palms and material derived from them were the thick-shelled, Dura types and as a population is generally referred to as Deli Dura. Pisifera is usually female-sterile and although the cause of this sterility is still unknown, it may be due to reduced protection of the developing embryo through absence of lignified endocarp tissue. Tenera is preferred as planting material because it has more oil-bearing mesocarp (60 - 90% per fruit weight) than Dura (20 – 65% per fruit weight). Within each fruit type, however, there is considerable variation apparently under polygenic control (Fabien *et al.*, 2014). Elucidation of single-gene inheritance of shell thickness caused interest in the Tenera fruit type (sh+ sh-) as commercial material obtained from a cross of Dura (sh+ sh+) with Pisifera (sh- sh-). Material segregating for the shell-thickness gene descended from a single Tenera palm (SP 540) in Sumatra was the major source of Pisifera for several breeding programmes (Nur-Sabrina *et al.*, 2012). This palm probably has a common origin with material in the breeding programme at Yangambi, Democratic Republic of Congo (formerly Zaire), descended from nine Tenera palms. By the 1960s, major breeding programmes in Sumatra and Malaysia concentrated primarily on

Deli Dura and 'Yangambi' Pisifera for the production of commercial planting material. Since then, extensive new introductions have been effected from various breeding programmes in West Africa (Côte d'Ivoire, Nigeria, Cameroon and the Democratic Republic of Congo). In the late 1970s and early 1980s, the Palm Oil Research Institute of Malaysia (PORIM) started a systematic programme of prospecting and collecting from oil groves in West Africa and from *E. oleifera* populations in South and Central America, significantly widening the basis for breeding programmes (Singh *et al.*, 2018).

2.2.4 Reproductive Biology

Flowers are unisexual, with female flowers grouped in clusters of 200–300 close to the trunk at the end of short heavy pedicels, with male flowers borne in spikes. Fruits are produced 3 – 4 years after planting, and fruits ripen 5 or 6 months after pollination. The physiological basis of sex differentiation is not yet well understood, except that empirical evidence suggests that physiological stress conditions seem to encourage maleness (Mekhilef *et al.*, 2011). Pollination is primarily by insects. One insect pollinator, *Elaeidobius kamerunicus*, was successfully introduced into Malaysia and subsequently Indonesia in 1979. Before this time, oil palms in the region were wind pollinated, often requiring artificial pollination in the first few years. *E. guineensis* seeds are dormant after harvesting though the physiology of this dormancy is not well known. Seeds usually require temperatures of 35°C or more in order to germinate, though germination is speeded up by dry heat treatment (40°C) for 80 days followed by cooling at higher moisture contents (Worrall *et al.*, 2018).

2.2.5 Physiology and Phenology

The stem has a single growing point from which a leaf primordium develops about every second week. Succeeding primordia are separated by a divergence angle of 137.5° (Fibonacci angle), causing leaf bases to be arranged in various sets of spirals, of which a set of eight parastichies is normally obvious. Rate of leaf production is up to 40 per year in the first 2 years, dropping to a rate of 18–24 per year from year 8 onwards (Singh *et al.*, 2013). From leaf primordium to fully expanded leaf (2–10 m²) takes about 2 years. The normal photosynthetically active life of a leaf is about 2 years, so under natural conditions up to 50 leaves are present per palm. In plantations, this number is usually kept at about 40. In the first 2 years, lateral growth of the trunk dominates, giving a broad base up to 60 cm in diameter. After that, the trunk starts growing in height, 35–75 cm per year, reducing its diameter up to 40 cm. The rate of height increment and rate of leaf production appear to be independent. All leaf bases contain inflorescence primordia, but the first fully developed inflorescence does not appear before leaf 20 and usually much later, some 3 years after germination (Elmer and White, 2018). The length of male and female phases in individual palms is very variable and irregular, but a population of palms shows clear seasonal trends. The mean interval between sex differentiation and anthesis is around 20 months, and between anthesis of female flowers and fruit ripeness 4–5 months. Fruit ripening on the bunch proceeds simultaneously from top to bottom and from outer to inner fruits and ripe fruits become detached. In well managed plantations in Malaysia and Sumatra, on soils with a reasonable availability of nutrients and a good water-holding capacity under uniform and adequate rainfall, yields of bunches of 24–32 t/ha are common (Ouda, 2014). Oil extraction rate from a bunch of *E. guineensis* fruit is 17–27% for palm oil and 4–10% for palm kernels, though figures for factory

extraction rates of oil related to bunch weight are 20 – 22 % which represents oil yields of 4.8 – 7 t/ ha, higher than in any other oil crop.

2.3 Environmental Requirements

The natural environment of oil palms is the lowland humid tropics. Rainfall in its native range is 1780 – 2280 mm per annum with 2 – 4 month dry period, and although it has been recorded in areas where annual rainfall is as low as 640 mm or as high as 4200 mm (Duke, 1983), these limits should be treated as exceptional. Mean maximum temperature of 30 – 32 °C and mean minimum of 21 – 24 °C provide suitable range, and growth may cease below 15 °C. It is generally a lowland species, and grows on a wide range of tropical soils if not too acid or alkaline (pH 4-8) if sufficiently moist (Mohammadinejad *et al.*, 2016). *E. guineensis* needs a good moisture supply and open areas as they cannot compete with faster-growing tree species. *E. guineensis* does not grow under continuous flooding but is tolerant of fluctuating water tables with periods of standing water. Hence, the natural habitats are considered to be swamps, riverbanks and other areas too wet for dicotyledonous trees of the tropical rain forest. Under cultivation, rainfall is often the main limiting factor on production. Major areas of oil-palm cultivation are in the equatorial belt where mean annual rainfall deficits do not exceed 600 – 650 mm annually (Singh *et al.*, 2016). Highest yields are achieved where rainfall is well distributed throughout the year with an optimum of 150 mm monthly. Little is known about temperature effects other than that oil palms grow less well at higher altitudes (above 500 – 600 m) and at higher latitudes (above 10°). In regions where minimum temperatures regularly drop below 20°C for prolonged periods, productivity and growth are severely reduced. *E. guineensis* is also

affected by high temperatures, with photochemical efficiency reduced above 35°C. *E. guineensis* can grow on a wide variety of soils ranging from sandy soils to lateritic red and yellow podzols, young volcanic soils, alluvial clays and peat soils (Deepa *et al.*, 2015). A major criterion for relative suitability seems to be water-holding capacity. As *E. guineensis* is responsive to soil nutrients, nutrient-release characteristics are also important as they affect efficiency of fertilizer use in plantations.

2.4 Social and Environmental Impacts

The social and environmental impacts of oil palm cultivation is a highly controversial topic. Oil palm is a valuable economic crop and provides a major source of employment. It allows many small landholders to participate in the cash economy and often results in the upgrade of the infrastructure (schools, roads, telecommunications) within that area. However, there are cases where native customary lands have been appropriated by oil palm plantations without any form of consultation or compensation, leading to social conflict between the plantations and local residents (Momodu *et al.*, 2017). In some cases, oil palm plantations are dependent on imported labour or illegal immigrants, with some concerns about the employment conditions and social impacts of these practices. Biodiversity loss (including the potential extinction of charismatic species) is one of the most serious negative effects of oil palm cultivation. Large areas of already threatened tropical rainforest are often cleared to make way for palm oil plantations, especially in Southeast Asia, where enforcement of forest protection laws is lacking. In some states where oil palm is established, lax enforcement of environmental legislation leads to encroachment of plantations into protected areas, encroachment into riparian strips, open burning of plantation

wastes, and release of palm mill pollutants such as palm oil mill effluent (POME) in the environment (Shams *et al.*, 2015). Some of these states have recognised the need for increased environmental protection, resulting in more environment-friendly practices. Among those approaches is anaerobic treatment of POME, which can be a good source for biogas (methane) production and electricity generation. Anaerobic treatment of POME has been practiced in Malaysia and Indonesia. Like most wastewater sludge, anaerobic treatment of POME results in dominance of *Methanosaeta concilii*. It plays an important role in methane production from acetate, and the optimum condition for its growth should be considered to harvest biogas as renewable fuel (Hiyat and Kudus, 2010).

Demand for palm oil has increased in recent years due to its use as a biofuel, but recognition that this increases the environmental impact of cultivation, as well as causing a food vs fuel issue, has forced some developed nations to reconsider their policies on biofuel to improve standards and ensure sustainability. However, critics point out that even companies signed up to the Roundtable on Sustainable Palm Oil continue to engage in environmentally damaging practices and that using palm oil as biofuel is perverse because it encourages the conversion of natural habitats such as forests and peatlands, releasing large quantities of greenhouse gases (Barcelos *et al.*, 2015).

2.5 Carbon Balance

Oil palm production has been documented as a cause of substantial and often irreversible damage to the natural environment. Its impacts include deforestation, habitat loss of critically endangered species and a significant increase in greenhouse gas emissions (Kalidas, 2012). The pollution is

exacerbated because many rainforests in Indonesia and Malaysia lie atop peat bogs that store great quantities of carbon, which are released when the forests are cut down and the bogs are drained to make way for the plantations. Environmental groups, such as Greenpeace, claim the deforestation caused by making way for oil palm plantations is far more damaging for the climate than the benefits gained by switching to biofuel. Fresh land clearances, especially in Borneo, are contentious for their environmental impact. Despite thousands of square kilometres of land standing unplanted in Indonesia, tropical hardwood forests are being cleared for palm oil plantations (Sahebi *et al.*, 2015). Furthermore, as the remaining unprotected lowland forest dwindles, developers are looking to plant peat swamp land, using drainage that begins an oxidation process of the peat which can release 5,000 to 10,000 years worth of stored carbon. Drained peat is also at very high risk of forest fire. There is a clear record of fire being used to clear vegetation for oil palm development in Indonesia, where in recent years drought and man-made clearances have led to massive uncontrolled forest fires, covering parts of Southeast Asia in haze and leading to an international crisis with Malaysia (Hushiarian *et al.*, 2013). These fires have been blamed on a government with little ability to enforce its own laws, while impoverished small farmers and large plantation owners illegally burn and clear forests and peat lands to develop the land rather than reap the environmental benefits it could offer.

Many of the major companies in the vegetable oil economy participate in the Roundtable on Sustainable Palm Oil, which is trying to address this problem (Vollmann *et al.*, 2010). For example, in 2008, Unilever, a member of the group, committed to use only oil palm oil which is certified as sustainable, by ensuring the large companies and smallholders that supply it convert to sustainable production by 2015. Meanwhile, much of the recent investment in new palm

plantations for biofuel has been funded through carbon credit projects through the Clean Development Mechanism; however, the reputational risk associated with the unsustainable palm plantations in Indonesia has now made many funds wary of such investment (Rabbani *et al.*, 2011).

2.6 Palm Biomass as Fuel

Some scientists and companies are going beyond using just the oil, and are proposing to convert fronds, empty fruit bunches and palm kernel shells harvested from oil palm plantations into renewable electricity, cellulosic ethanol, biogas, biohydrogen and bioplastic. Thus, by using both the biomass from the plantation as well as the processing residues from palm oil production (fibers, kernel shells, palm oil mill effluent), bioenergy from palm plantations can have an effect on reducing greenhouse gas emissions. Examples of these production techniques have been registered as projects under the Kyoto Protocol's Clean Development Mechanism (Karkanis *et al.*, 2011). By using palm biomass to generate renewable energy, fuels and biodegradable products, both the energy balance and the greenhouse gas emissions balance for palm biodiesel is improved. For every tonne of palm oil produced from fresh fruit bunches, a farmer harvests around 6 tonnes of waste palm fronds, 1 tonne of palm trunks, 5 tonnes of empty fruit bunches, 1 tonne of press fiber (from the mesocarp of the fruit), half a tonne of palm kernel endocarp, 250 kg of palm kernel press cake, and 100 tonnes of palm oil mill effluent. Some oil palm plantations incinerate biomass to generate power for palm oil mills. Some other oil palm plantations yield large amount of biomass that can be recycled into medium density fibreboards and light furniture (Aparicio *et al.*, 2010). In efforts to reduce greenhouse gas emissions, scientists treat palm oil

mill effluent to extract biogas. After purification, biogas can substitute for natural gas for use at factories. Anaerobic treatment of palm oil mill effluent, practiced in Malaysia and Indonesia, results in domination of *Methanosaeta concilii*. It plays an important role in methane production from acetate and the optimum condition for its growth should be considered to harvest biogas as renewable fuel (Silva *et al.*, 2012). Unfortunately, the production of palm oil has detrimental effects on the environment and is not considered to be a sustainable biofuel. The deforestation occurring throughout Malaysia and Indonesia as a result of the growing demand for this plant has made scarce natural habitats for orangutans and other rainforest dwellers. More carbon is released during the life cycle of a palm oil plant to its use as a biofuel than is emitted by the same volume of fossil fuels.

2.7 Economic Impact

The positive economic impact of *E. guineensis* to the national economies of at least 20 countries can be deduced from production data (Garau *et al.*, 2009). To this can be added lesser amounts from many other countries not listed to give an indication of the massive benefits to the global economy in general.

2.7.1 Social Impact

E. guineensis is a relatively labour intensive crop, with one worker required to maintain and harvest approximately each 4 ha of plantation, and this, in addition to peripheral and downstream opportunities, *E. guineensis* provides a significant means of employment for many

rural people in areas where it is grown . There are also many nutritional and custom benefits arising from local use of *E. guineensis* products (Souza *et al.*, 2006).

2.7.2 Environmental Impact

Negative impacts of *E. guineensis* are almost entirely related to the destruction of native rainforest in order clear land for new plantations, especially in recent years to meet the rising demand for biofuels. Negative environmental impacts from the invasion of escaped *E. guineensis* populations are, at least as yet, insignificant in comparison.

2.8 Uses of Oil Palm

2.8.1 Economic Value

E. guineensis is a major oil crop, taking second place in the world supply of vegetable oil after soya bean. World production and the area harvested for *E. guineensis* has increased steadily during the past 30 years to 139 million t and 11.4 million ha in 2003, respectively. South-East Asia is the main area of production with around 80% of the total world *E. guineensis* fruit production, and Malaysia dominates the palm oil market, with a total area under *E. guineensis* was 3.5 million ha in 2003 and exports were 12 million t of palm oil in 2003. Indonesia is the second major exporter, exporting 6.4 million t of palm oil in 2003 (Araujo *et al.*, 2012). *E. guineensis* fruit yields two types of oil: palm oil from the fleshy mesocarp, and palm kernel oil from the kernel, in the volume ratio 10:1 which differ in composition and properties and consequently, find rather different applications. Ninety percent of all palm oil has traditionally been used for human consumption. For domestic use, the liquid fraction palm olein is

satisfactory provided the ambient temperature is above 20°C. Main uses of exported palm oil are margarine, fat used in pastry production and in industrial frying of potato chips, instant noodles and snack foods. Fractions of palm oil are useful in confectionery (Olorunmaiye *et al.*, 2011). Palm stearin, the solid fraction of palm oil, is increasingly used in soap manufacture. Palm-derived fatty acids, mainly commercial grades of stearic and palmitic acids, form an alternative to the traditional products based on tallow. Palm kernel oil is a lauric-type oil similar in composition and properties to coconut oil. In Malaysia, increasing proportions of the palm-kernel oil are fractionated or hydrogenated for use in confectionery where the higher melting products are particularly useful. Palm kernel oil is also used for industrial purposes, either as an alternative to coconut oil in the manufacture of high-quality soaps, or as a source of short-chain and medium-chain fatty acids. These acids are chemical intermediates in the manufacture of fatty alcohols, esters, amines, amides and more sophisticated chemicals, which find a multitude of end-uses, for instance in surface-active agents, plastics, lubricants and cosmetics (Mazmira *et al.*, 2011).

Non-food uses include, from palm oil, soaps and candles, and extensively in the tin plate industry, protecting cleaned iron surfaces before the tin is applied, as a lubricant, and in textile and rubber industries, whereas palm kernel oil is used in the manufacture of soaps and detergents, and press cake, after extraction of oil from the kernels, is used as livestock feed, containing 5-8% oil. It is also occasionally grown as an ornamental tree. The central shoot or 'cabbage' is edible, leaves are used for thatching; petioles and rachices for fencing and for protecting the tops of retid walls, and waste from stripping bunches are used for mulching and manuring (Mohamad *et al.*, 2017).

Palm trunks available at replanting provide an excellent potential resource for paper and board production though this has not been exploited to date.

2.8.2 Social Benefit

Traditionally, plantation companies play a major role in *E. guineensis* production, however, in South-East Asia, government smallholder schemes have increased their share. In the native range of West Africa and less often where introduced, ‘palm wine’ is produced from extracted sap from male *E. guineensis* flowers, and it is an important product for local use (Rees *et al.*, 2012), trade and customs, and is an important source of vitamin B complex, and is worth twice the value of the oil to local people from a single tree. The same name is, however, used to describe a similar drink produced from a large number of palm species including coconut amongst others. Fresh extract is refreshing and non-alcoholic but even after a few hours, fermentation has begun and the drink has become at least mildly alcoholic, where as after a day it has become a strong drink, before it tends to turn to vinegar. Plant extracts is also reported to be a folk remedy for cancer, headaches, and rheumatism (Petit *et al.*, 2012).

2.9 Pests and Disease

Basal stem rot (BSR), caused by the fungus *Ganoderma orbiforme*, is the most serious disease of oil palm in Malaysia and Indonesia. Previously, research on basal stem rot was hampered by the failure to artificially infect oil palms with the fungus. Although *Ganoderma* had been associated with BSR, proof of its pathogenicity to satisfy Koch's postulate was only achieved in the early 1990s by inoculating oil palm seedling roots or by using rubber wood blocks (Idris *et al.*, 2010).

A reliable and quick technique was developed for testing the pathogenicity of the fungus by inoculating oil palm germinated seeds. This fatal disease can lead to losses as much as 80% after repeated planting cycles. *Ganoderma* produces enzymes that degrade the infected xylem, thus causing serious problems to the distribution of water and other nutrients to the top of the palm. *Ganoderma* infection is well defined by its lesion in the stem. The cross-section of infected palm stem shows that the lesion appears as a light brown area of rotting tissue with a distinctive, irregularly shaped, darker band at the borders of this area (Said *et al.*, 2019). The infected tissue become as an ashen-grey powdery and if the palm remains standing, the infected trunk rapidly become hollow.

In a 2007 study in Portugal, scientists suggested control of the fungus on oil palms would benefit from further consideration of the process as one of white rot. *Ganoderma* is an extraordinary organism capable exclusively of degrading lignin to carbon dioxide and water; celluloses are then available as nutrients for the fungus. It is necessary to consider this mode of attack as a white rot involving lignin biodegradation, for integrated control. The existing literature does not report this area and appears to be concerned particularly with the mode of spread and molecular biology of *Ganoderma* (Buana *et al.*, 2014). The white rot perception opens up new fields in breeding/selecting for resistant cultivars of oil palms with high lignin content, ensuring the conditions for lignin decomposition are reduced, and simply sealing damaged oil palms to stop decay. The spread likely is by spores rather than roots. The knowledge gained can be employed in the rapid degradation of oil palm waste on the plantation floor by inoculating suitable fungi, and/or treating the waste more appropriately.

Endophytic bacteria are organisms inhabiting plant organs that at some time in their life cycles can colonize the internal plant tissues without causing apparent harm to the host. Introducing endophytic bacteria to the roots to control plant disease is to manipulate the indigenous bacterial communities of the roots in a manner, which leads to enhanced suppression of soil-borne pathogens (Ramli *et al.*, 2016). The use of endophytic bacteria should thus be preferred to other biological control agents, as they are internal colonizers, with better ability to compete within the vascular systems, limiting *Ganoderma* for both nutrients and space during its proliferation. Two bacterial isolates, *Burkholderia cepacia* (B3) and *Pseudomonas aeruginosa* (P3) were selected for evaluation in the glasshouse for their efficacy in enhancing growth and subsequent suppression of the spread of BSR in oil palm seedlings (Sundram *et al.*, 2015). During a search for biological pest control agents, rhizosphere-derived microbes have been found to produce a multitude of anti-pathogen compounds including 6 not found before. These compounds act against a broad range of fungi and Gram-positive and Gram-negative bacteria, including *Xanthomonas campestris* pv. *oryzae* and *Ganoderma boninense*. The most promising from these was a new strain *Streptomyces palmae* CMU-AB204T, which was by itself highly active against several of the most common *E. guineensis* pathogens. Little leaf syndrome has not been fully explained, but has often been confused with boron deficiency. The growing point is damaged, sometimes by *Oryctes* beetles. Small, distorted leaves resembling those due to a boron deficiency emerge. This is often followed by secondary pathogenic infections in the spear that can lead to spear rot and palm death (Azizah *et al.*, 2015).

2.10 Weeds

Weeds are plants in the wrong place. For the purposes of this book any plant competing with cultivated plants or that in some other way interferes with man's legitimate activities is considered to be a weed. Aigae, mosses, liverworts, ferns and flowering plants all can qualify as weeds. Annuals, rarely biennials and both herbaceous and woody perennials may all be weeds. Crop plants become weeds themselves when they persist or regenerate in succeeding crops where they may act as sources of pests and disease pathogens (Alexander and Phin, 2014). Why control weeds? Early farmers probably harvested a mixture of several 'crops' including some species now regarded as weeds, but the unpleasant tasting, poisonous or least productive components of the mixture would soon have been actively discouraged. At first this was by hand pulling, then by hoeing, cultivation and crop rotation, and in very recent times by seed cleaning and the use of herbicides. But in many parts of the world the extent of cultivation is still determined by the area that each family can keep clean by hand during the critical early period of crop establishment (Najihah *et al.*, 2015).

2.10.1 Weeds Dispersal

Many weed species have moved out of their natural geographic ranges and spread around the world in tandem with human migrations and commerce. Weed seeds are often collected and transported with crops after the harvesting of grains, so humans are a vector of transport as well as a producer of the disturbed environments to which weed species are well adapted, resulting in many weeds having a close association with human activities (Bivi *et al.*, 2016). Some weed

species have been classified as noxious weeds by government authorities because, if left unchecked, they often compete with native or crop plants or cause harm to livestock. They are often foreign species accidentally or imprudently imported into a region where there are few natural controls to limit their population and spread.

2.10.2 Weeds as Adaptable Species

An alternate definition often used by biologists is any species, not just plants, that can quickly adapt to any environment (Fabien *et al.*, 2014). Some traits of weedy species are the ability to reproduce quickly, disperse widely, live in a variety of habitats, establish a population in strange places, succeed in disturbed ecosystems and resist eradication once established. Such species often do well in human-dominated environments as other species are not able to adapt. Common examples include the common pigeon, brown rat and the raccoon. Other weedy species have been able to expand their range without actually living in human environments, as human activity has damaged the ecosystems of other species. These include the coyote, the white-tailed deer and the brown headed cowbird (Nur-Sabrina *et al.*, 2012). In response to the idea that humans may face extinction due to environmental degradation, paleontologist David Jablonsky counters by arguing that humans are a weed species. Like other weedy species, humans are widely dispersed in a wide variety of environments, and are highly unlikely to go extinct no matter how much damage the environment faces.

2.10.3 Ecological Significance

Certain classes of weeds share adaptations to ruderal environments. That is to say: disturbed environments where soil or natural vegetative cover has been damaged or frequently gets

damaged, disturbances that give the weeds advantages over desirable crops, pastures, or ornamental plants. The nature of the habitat and its disturbances will affect or even determine which types of weed communities become dominant (Singh *et al.*, 2018). Examples of such ruderal or pioneer species include plants that are adapted to naturally occurring disturbed environments such as dunes and other windswept areas with shifting soils, alluvial flood plains, river banks and deltas, and areas that are burned repeatedly. Since human agricultural practices often mimic these natural environments where weedy species have evolved, some weeds are effectively preadapted to grow and proliferate in human-disturbed areas such as agricultural fields, lawns, roadsides, and construction sites (Mekhilef *et al.*, 2011). The weedy nature of these species often gives them an advantage over more desirable crop species because they often grow quickly and reproduce quickly, they commonly have seeds that persist in the soil seed bank for many years, or they may have short lifespans with multiple generations in the same growing season. In contrast, perennial weeds often have underground stems that spread under the soil surface or, like ground ivy (*Glechoma hederacea*), have creeping stems that root and spread out over the ground (Worrall *et al.*, 2018).

Some plants become dominant when introduced into new environments because the animals in their original environment, that compete with them or feed on them are absent; in what is sometimes called the “natural enemies hypothesis”, plants freed from these specialist consumers may become dominant. An example is Klamath weed, that threatened millions of hectares of prime grain and grazing land in North America after it was accidentally introduced, but was reduced to a rare roadside weed within several years after some of its natural enemies were imported during World War II (Singh *et al.*, 2013). In locations where predation and mutually

competitive relationships are absent, weeds have increased resources available for growth and reproduction. The weediness of some species that are introduced into new environments may be caused by their production of allelopathic chemicals which indigenous plants are not yet adapted to, a scenario sometimes called the "novel weapons hypothesis". These chemicals may limit the growth of established plants or the germination and growth of seeds and seedlings. Another of the ways in which the ecological role of a plant can make it a weed even if it is in itself inoffensive, is if it harbours a pest that is dependent on it for survival; for example, Berberis species are intermediate hosts for stem rust fungi, so that they promote serious damage to wheat crops when growing near the fields (Elmer and White, 2018).

2.10.4 Competition with Cultivated and Endemic Plants

A number of native or non-native plants are unwanted in a specific location for a number of reasons.^[10] An important one is functional: they interfere with food and fiber production in agriculture, wherein they must be controlled in order to prevent lost or diminished crop yields. Other important reasons are that they interfere with other cosmetic (Ouda, 2014), decorative, or recreational goals, such as in lawns, landscape architecture, playing fields, and golf courses. Similarly, they can be of concern for environmental reasons whereby introduced species out-compete for resources or space with desired endemic plants.

For all these reasons, horticultural (both functional and cosmetic) and environmental, weeds interfere by (Mohammadinejad *et al.*, 2016):

- competing with the desired plants for the resources that a plant typically needs, namely, direct sunlight, soil nutrients, water, and (to a lesser extent) space for growth;
- providing hosts and vectors for plant pathogens, giving them greater opportunity to infect and degrade the quality of the desired plants;
- providing food or shelter for animal pests such as seed-eating birds and Tephritid fruit flies that otherwise could hardly survive seasonal shortages;
- offering irritation to the skin or digestive tracts of people or animals, either physical irritation via thorns, prickles, or burs, or chemical irritation via natural poisons or irritants in the weed (for example, the poisons found in *Nerium* species);
- causing root damage to engineering works such as drains, road surfaces, and foundations, blocking streams and rivulets.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

This study was carried out between February 2020 and September 2020 in an oil palm plantation at Agbarha otor of Ughelli North Local Government of Delta state. It is accessible is the one adjacent to Michael and Cecilia Ibru University (MCIU). The study area is situated at 05°32'10"N and 06°3'47"E and at elevation range of 1 m to 34 m ASL. It has humid tropical climate and lies within a heavy rainfall zone with two distinct seasons, the dry season between October and January and the rainy season that is usually from February to September having two rainfall peaks in June and September. There is a short dry season period around August commonly referred to as the "August break". The temperature range comprises of high range that occur during the four dry months and the low range in the eight months of rainfall due to the cooling effect of the rain. Relative humidity is usually lowest in December and January which are the peaks of the dry season. The vegetation is mainly rainforest with areas of secondary growth

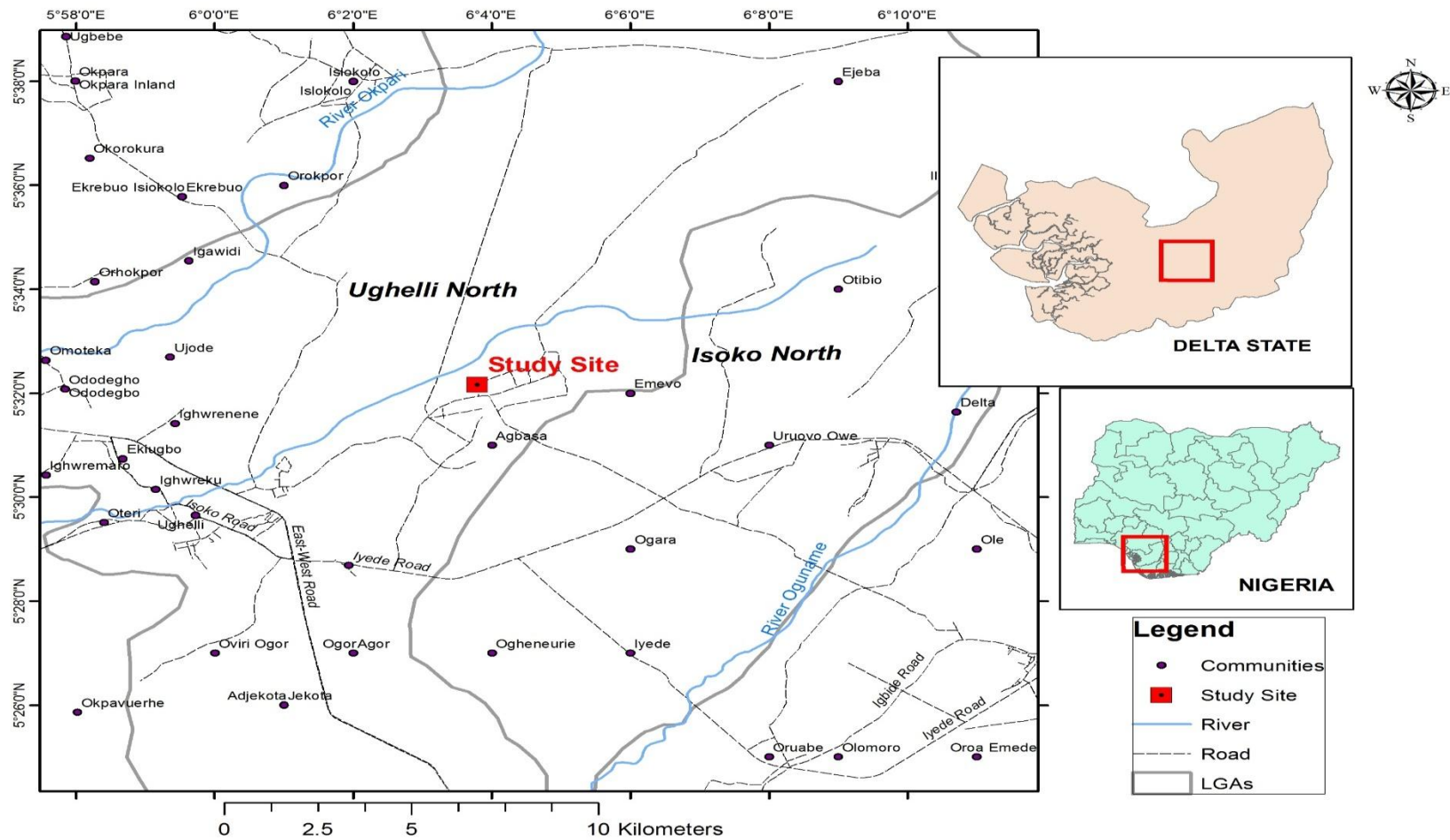


Figure 1: Map of study area

3.2 Sampling Approach

The method of carrying out this research is through sampling techniques. The method for the sampling of this plant community of oil plantation is completely random since the life form of the crop plant is phanerophytes. (The oil palm crop is a woody perennial with shrubs and epiphytes). The major weeds found are more of mesophanerophytes and microphanerophytes while few are nanophanerophytes and the count plot method was employed in the sampling of the weeds in this oil palm plantation (Bamidele and Akinnibosun, 2012).. This method will help in species counting, collection and measure within a specified defined area. This is widely employed in forest inventory and long term studies. It helps also to determine the density and basal area of oil palm trees.

The area of the entire oil palm plantation was measured and recorded. The total area was by 1128 m by 433.5 m and the completely randomized approach was chosen to determine the placement of quadrats samples within the plantation. In all, about fourteen quadrats were determined, measured and sampled out of the total area of the plot. The area of the quadrat squares was 10m by 10m each there were at least three oil palm trees in each of the quadrats. The distance between each quadrat varies from 2 m to 4 m

Each quadrat measuring 10 m X 10 m was measured using the measuring tape, pegged with wooden peg and twine and afterward the circumference of the oil palm trees were determined first using the tape rule. The GPS of the quadrat was taken too before the sample collection, identification and counting was done. The counting of each weed plant sampled was recorded in

the field notebook plus all other data collected like the GPS and circumference of the palm tree. This procedure was repeated until the whole plot was covered.

3.3 Materials Used for this Ecological Study

The materials that were used in carrying out the project are:

- A plant press: for mounting of herbarium samples
- A GPS (Global Positioning System): for geo-referencing the longitude, latitude and the elevation of each of the sampled quadrats.
- A quadrat made from twine and wood pegs: a wood peg and twine were used to make a square quadrat at random in the oil palm plantation
- A measuring tape: to determine the total area of the plot of oil palm plantation.
- Tape rule: used to determine the circumference of the trees in each quadrat before the diameter was calculated
- Sharp cutlass: to clear the pathways and also serve as means of protection against reptiles and other animals.
- A transparent polythene bag: For specimen collection before identification.
- Secateurs/ a knife: to cut the sample plant specimens from the parent plant.
- A pair of rain boot: For easy movement in the plantation and for protect against dangerous creatures.
- A crash helmet: to protect the head against falling objects from the trees/ ripe palm fruits.
- Masking tape: to mark and identify the sample plant specimen from each quadrat.
- Old newspapers: for collection and to preserve the plant specimens for herbarium.

- Field Notebook: for *in situ* data collection and documentation.
- Past 3 software (Hammer et al, 2001) was used to generate diversity indices, relative density and importance value index (I.V.I) of the weeds.

3.4 Herbarium Sample Collections

Herbarium samples of plant species were collected from each quadrat using secateurs or knife and nicely laid inside newspapers, stacked / mounted in wooden plant press on the field as described by Osawaru (2012); the *in situ* photographs of some plant species were taken with phone camera.

3.5 Plant Identification

Plant identification was done with the help of the Department of Plant Biology and Biotechnology as well as ecologists / taxonomists from the appropriate literatures (Akobundu *et al.*, 2016).

3.4 Data Analysis

Species abundance, diversity and distribution of the plant species were determined using the following species richness, diversity indices, Shannon – Wiener index and species evenness (E). Shannon – Wiener diversity index (H) was used to compare the diversity in species competition of the oil palm plantation. The Simpson index of similarity (Qs) was used to compare the species composition in all the ages. Species evenness in each quadrat was calculated using Shannon's index. Analytic vegetation characters (Community indices (Jaccard similarity index and

Importance value index (IVI) = summation of relative frequency, relative abundance and relative density) were assessed from section of the quadrats.

3.4.1 Frequency

Frequency: It is expressed as number of quadrats where species is/are found.

3.4.2 Density

Density: It is expressed as number of species per unit area. (Quadrat area = 1m²)

$$\text{Density} = \frac{\text{number of species}}{\text{area of quadrats}}$$

3.4.3 Relative Frequency

Relative frequency: This is expressed in terms of percentage occurrence. It is the degree of dispersion of individual species in an area in relation to the number of all the species that occurred.

$$\text{Relative Frequency} = \frac{\text{Frequency of species}}{\text{Total density of all species}} \times 100$$

3.4.4 Relative Density

Relative density: Is the study of numerical strength of a species in relation to the total number of individuals of all the species and can be calculated as:

$$\text{Relative density} = \frac{\text{Density of species}}{\text{Total density of all species}} \times 100$$

3.4.5 Importance Value Index

Importance value index: The index is used to determine the overall importance of each species in the community structure. Importance Value (IVI) = Relative Frequency + Relative Density + Relative Abundance

3.4.6 Abundance

Abundance: It is the study of number of individuals of different species in the community per unit area. It is represented by the equation:

$$\text{Abundance} = \frac{\text{Relative frequency} + \text{Relative density}}{2}$$

3.4.7 Dominance

Dominance: Dominance of a species is determined by the value of basal cover. It is expressed as:

$$\text{Dominance} = \frac{\text{Absolutely density of species}}{\text{Number of quadrats where species is found}} \times 100$$

3.4.8 Relative Dominance

Relative dominance: This is the coverage value of a species with respect to the sum of coverage of the rest of the species in the area. It is expressed as:

$$\text{Relative dominance} = \frac{\text{Abundant of species}}{\text{Total abundance of all species}} \times 100$$

3.4.9 Simpson's Index

Simpson's index: It measures the probability that two individual weed species randomly selected from a sample will belong to the same species (or category other than species).

$$\text{Simpson diversity index (D)} = \frac{\sum n(n-1)}{N-1}$$

Where n = the total number of weeds of particular species; N = the total number of weed of all species.



Plate 1: The Studied Oil palm plantation at Agbarha-otor, Ughelli North Local Government Area, Delta State



Plate 2: Researcher in the study area at Agbarha-otor, Ughelli North Local Government Area,

Delta State

CHAPTER FOUR

4.0 RESULTS

Table 4.1 shows the diversity indices of the weed flora of oil palm plantation during dry season. Using quadrat identity, diversity indices of the weed flora of oil palm plantation during dry season are as follows: Taxa_S range from 27 - 50, Individuals (376 – 2821), Dominance_D (0.1819 – 0.4248), Simpson_1-D (0.5752 – 0.962), Shannon_H (1.469 – 3.468), Evenness_e^H/S (0.132 - 0.7635), Brillouin (1.437 – 3.268), Menhinick (0.7073 – 2.116), Margalef (3.569 – 6.914), Equitability_J (0.4301 – 0.9278), Fisher_alpha (4.705 – 8.632), Berger-Parker (0.07979 – 0.6424) and Chao-1 (27.38 – 50.5) respectively. In terms of most abundant species, density, relative density and importance index value in dry season in decreasing order were Poaceae > Selaginellaceae > Arecaceae > Melastomataceae > Bromeliaceae > Asteraceae. Diverse families in decreasing order were Poaceae > Asteraceae > Fabaceae = Rubiaceae = Malvaceae > Amaranthaceae = Connaraceae > Acanthaceae = Cyperaceae = Euphorbiaceae = Polypodiaceae = Tiliaceae = Gentianaceae with 7, 6, 5, 5, 5, 3, 3, 2, 2, 2, 2 and 2 species respectively.

Table 4.1: Diversity indices of the weed flora of oil palm plantation during dry season

	Quadrat Identity													
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Diversity Indices														
Taxa_S	33	43	42	43	50	44	40	33	27	38	32	33	43	40
Individuals	1016	1088	376	2075	2821	1862	1606	937	1457	1454	1425	2073	2611	934
Dominance_D	0.3581	0.3132	0.3804	0.2523	0.1819	0.2131	0.2828	0.4248	0.3432	0.3419	0.3564	0.2535	0.2115	0.4209
Simpson_1-D	0.6419	0.6868	0.962	0.7477	0.8181	0.7869	0.7172	0.5752	0.6568	0.6581	0.6436	0.7465	0.7885	0.5791
Shannon_H	1.959	2.183	3.468	1.758	2.119	2.29	1.907	1.629	1.469	1.613	1.49	1.706	1.833	1.797
Evenness_e^H/S	0.215	0.2063	0.7635	0.1349	0.1665	0.2244	0.1683	0.1546	0.1609	0.132	0.1387	0.1668	0.1454	0.1507
Brillouin	1.895	2.109	3.268	1.722	2.085	2.242	1.859	1.569	1.437	1.567	1.451	1.676	1.803	1.723
Menhinick	1.035	1.304	2.166	0.944	0.9414	1.02	0.9981	1.078	0.7073	0.9966	0.8477	0.7248	0.8415	1.309
Margalef	4.622	6.007	6.914	5.499	6.168	5.711	5.283	4.677	3.569	5.081	4.269	4.19	5.338	5.702
Equitability_J	0.5603	0.5804	0.9278	0.4675	0.5417	0.6051	0.5169	0.466	0.4457	0.4434	0.4301	0.4879	0.4873	0.487
Fisher_alpha	6.53	8.94	12.11	7.674	8.632	8.082	7.435	6.662	4.705	7.141	5.812	5.573	7.312	8.494
Berger-Parker	0.5906	0.5515	0.07979	0.2892	0.2127	0.3222	0.3736	0.6403	0.4118	0.4127	0.4211	0.2894	0.2298	0.6424
Chao-1	33	44.5	42	43.6	50.2	44.43	41	33.38	27.38	38.14	33.5	33	43.08	50.5

Table 4.2 shows the diversity indices of the weed flora of oil palm plantation during rainy season. Using quadrat identity, diversity indices of the weed flora of oil palm plantation during were as follows: Taxa_S range from 32 - 57, Individuals (312 – 2178), Dominance_D (0.04491 – 0.4904), Simpson_1-D (0.5096 – 0.9551), Shannon_H (1.488 – 3.454), Evenness_e^H/S (0.10390 - 586), Brillouin (1.426 – 3.284), Menhinick (0.7037 – 2.887), Margalef (4.061 – 8.706), Equitability_J (0.4182 – 0.866), Fisher_alpha (5.373 – 17.31), Berger-Parker (0.1197 – 0.6944) and Chao-1 (32 – 62.08) respectively. In terms of most abundant species, density, relative density and importance value index in rainy season, six weed families of Poaceae, Asteraceae, Fabaceae, Malvaceae, Rubiaceae and Connaraceae were predominant. Similarly, the most diverse families in decreasing order were Poaceae > Asteraceae, = Fabaceae, > Rubiaceae, = Malvaceae, > Connaraceae = Amaranthaceae, > Acanthaceae = Cyperaceae = Euphorbiaceae = Gentianaceae = Polypodiaceae = Tiliaceae with 7, 6, 6, 5, 5, 3, 3, 2, 2, 2, 2, 2 and 2 species respectively.

Table 4.2: Diversity indices of the weed flora of oil palm plantation during rainy season

	Quadrat Identity													
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Diversity Indices														
Taxa_S	44	33	37	51	52	50	54	57	46	40	32	49	32	51
Individuals	405	864	483	312	2178	1681	543	1063	1572	934	1425	1460	2068	1482
Dominance_D	0.1554	0.4904	0.2093	0.06032	0.2289	0.2594	0.04491	0.3306	0.2944	0.4209	0.3564	0.3396	0.2548	0.3292
Simpson_1-D	0.8446	0.5096	0.7907	0.9397	0.7711	0.7406	0.9551	0.6694	0.7056	0.5791	0.6436	0.6604	0.7452	0.6708
Shannon_H	2.768	1.488	2.368	3.296	1.977	2.023	3.454	2.117	1.842	1.797	1.49	1.628	1.693	1.722
Evenness_e^H/S	0.3619	0.1342	0.2886	0.5297	0.1389	0.1512	0.586	0.1457	0.1372	0.1507	0.1387	0.1039	0.1699	0.1097
Brillouin	2.597	1.426	2.245	3.054	1.934	1.971	3.284	2.03	1.792	1.723	1.451	1.575	1.664	1.665
Menhinick	2.186	1.123	1.684	2.887	1.114	1.22	2.317	1.748	1.16	1.309	0.8477	1.282	0.7037	1.325
Margalef	7.162	4.733	5.825	8.706	6.635	6.597	8.417	8.036	6.114	5.702	4.269	6.588	4.061	6.848
Equitability_J	0.7314	0.4255	0.6558	0.8384	0.5004	0.5172	0.866	0.5235	0.4812	0.487	0.4301	0.4182	0.4885	0.4379
Fisher_alpha	12.56	6.801	9.329	17.31	9.574	9.686	14.91	12.88	8.876	8.494	5.812	9.774	5.373	10.24
Berger-Parker	0.3704	0.6944	0.4244	0.1603	0.2755	0.3569	0.1197	0.5644	0.3817	0.6424	0.4211	0.411	0.2901	0.4049
Chao-1	45.62	45	38.11	58.8	53.11	54.5	60.88	62.08	55	50.5	33.5	51.65	32	54.6

Table 4.3 shows identified species abundance, density, relative density, frequency, relative frequency and importance value index at the study site during dry season. A total number of 61 species comprising of 57 genera and 27 families were recorded. The weed species are *Abrus precatorius*, *Acalypha wilkesiana*, *Achyranthes aspera*, *Acroceras zizanoides*, *Ageratum conyzoides*, *Ageratum haustonianum*, *Alchornea cordifolia*, *Alternanthera brasiliana*, *Ananas comosus*, *Anthocleista libreschtiana*, *Anthocleista vogelii*, *Aspilia Africana*, *Asystasia gangetica*, *Axonopus compressus*, *Baphia nitida*, *Bysocarpus sp.*, *Calopogonium mucunoides*, *Centrosema pubescens*, *Chassalia kolly*, *Chromolaena odorata*, *Clappertonia ficifolia*, *Cnestis ferruginea*, *Commelina erecta*, *Costus afer*, *Cyathula prostrate*, *Cynodon dactylon*, *Diodea sarmentosa*, *Elaeis guineensis*, *Eleusine indica*, *Emilia praetermissa*, *Ficur sur*, *Glyphaea brevis*, *Ipomoea involucrate*, *Justicia insularis*, *Ludwigia abyssinica*, *Malvastrum sp.*, *Mangifera indica*, *Melastomastrum capitatum*, *Mussaenda littoralis*, *Nephrolepis biseratta*, *Oxyanthus racemosus*, *Panicum laxum*, *Panicum maximum*, *Phymatodes scolopendra*, *Pueraria phaseoloides*, *Rauvolfia vomitoria*, *Rhynchospora carymbosa*, *Rourea coccineus*, *Sabicea calycina*, *Scleria naumanniana*, *Selaginella myosurus*, *Setaria barbata*, *Sida acuta*, *Sida sp.*, *Spigelia anthelmia*, *Stachyterpheta cayenensis*, *Stigmaphyllum ovatum*, *Synedrella nodiflora*, *Tephrosia pedicellata*, *Triumfetta cordifolia* and *Urena lobata*.

Table 4.3: Identified species abundance, density, relative density, frequency, relative frequency and importance value index at the study site during dry season

Species Name	Family	Abundance	Density	Rel. Den.	Freq.	Rel. Freq.	I.V.I
<i>Abrus precatorius</i>	Fabaceae	27	0.27	0.24	6	1.11	0.676
<i>Acalypha wilkesiana</i>	Euphorbiaceae	62	0.62	0.56	8	1.48	1.019
<i>Achyranthes aspera</i>	Amaranthaceae	51	0.51	0.46	9	1.66	1.062
<i>Acroceras zizanoides</i>	Poaceae	81	0.81	0.73	10	1.85	1.289
<i>Ageratum conyzoides</i>	Asteraceae	239	2.39	2.16	12	2.22	2.187
<i>Ageratum haustonianum</i>	Asteraceae	121	1.21	1.09	10	1.85	1.470
<i>Alchornea cordifolia</i>	Euphorbiaceae	234	2.34	2.11	13	2.40	2.257
<i>Alternanthera brasiliana</i>	Amaranthaceae	25	0.25	0.23	4	0.74	0.482
<i>Ananas commosus</i>	Bromeliaceae	620	6.20	5.59	7	1.29	3.442
<i>Anthocleista libreschtiana</i>	Gentianaceae	45	0.45	0.41	10	1.85	1.127
<i>Anthocleista vogelii</i>	Gentianaceae	134	1.34	1.21	13	2.40	1.806
<i>Aspilia Africana</i>	Asteraceae	57	0.57	0.51	9	1.66	1.089
<i>Asystasia gangetica</i>	Acanthaceae	111	1.11	1.00	13	2.40	1.702
<i>Axonopus compressus</i>	Poaceae	1329	13.29	11.99	13	2.40	7.194
<i>Baphia nitida</i>	Fabaceae	40	0.40	0.36	6	1.11	0.735
<i>Bysocarpus sp.</i>	Connaraceae	23	0.23	0.21	3	0.55	0.381
<i>Calopogonium mucunoides</i>	Fabaceae	155	1.55	1.40	12	2.22	1.808
<i>Centrosema pubescens</i>	Fabaceae	101	1.01	0.91	11	2.03	1.472

<i>Chassalia kolly</i>	Rubiaceae	27	0.27	0.24	10	1.85	1.046
<i>Chromolaena odorata</i>	Asteraceae	196	1.96	1.77	13	2.40	2.085
<i>Clappertonia ficifolia</i>	Tiliaceae	46	0.46	0.41	8	1.48	0.947
<i>Cnestis ferruginea</i>	Connaraceae	2	0.02	0.02	1	0.18	0.101
<i>Commelina erecta</i>	Commelinaceae	147	1.47	1.33	11	2.03	1.679
<i>Costus afer</i>	Costaceae	76	0.76	0.69	11	2.03	1.359
<i>cyathula prostrate</i>	Amaranthaceae	51	0.51	0.46	11	2.03	1.247
<i>Cynodon dactylon</i>	Poaceae	198	1.98	1.79	13	2.40	2.094
<i>Diodea sarmentosa</i>	Rubiaceae	29	0.29	0.26	8	1.48	0.870
<i>Elaeis guineensis</i>	Arecaceae	1025	10.25	9.24	14	2.59	5.915
<i>Eleusine indica</i>	Poaceae	2060	20.60	18.58	14	2.59	10.582
<i>Emilia praetermissa</i>	Asteraceae	30	0.30	0.27	10	1.85	1.059
<i>Ficur sur</i>	Moraceae	83	0.83	0.75	9	1.66	1.206
<i>Glyphaea brevis</i>	Malvaceae	37	0.37	0.33	6	1.11	0.721
<i>Ipomoea involucrate</i>	Convolvulaceae	63	0.63	0.57	9	1.66	1.116
<i>Justicia insularis</i>	Acanthaceae	108	1.08	0.97	9	1.66	1.319
<i>Ludwigia abyssinica</i>	Onagraceae	41	0.41	0.37	8	1.48	0.924
<i>Malvastrum sp.</i>	Malvaceae	30	0.30	0.27	7	1.29	0.782
<i>Mangifera indica</i>	Anacardiaceae	39	0.39	0.35	7	1.29	0.823
<i>Melastomastrum capitatum</i>	Melastomataceae	647	6.47	5.83	8	1.48	3.657
<i>Mussaenda littoralis</i>	Rubiaceae	24	0.24	0.22	6	1.11	0.663
<i>Nephrolepis biseratta</i>	Polypodiaceae	70	0.70	0.63	7	1.29	0.963
<i>Oxyanthus racemosus</i>	Rubiaceae	3	0.03	0.03	2	0.37	0.198

<i>panicum laxum</i>	Poaceae	3795	37.95	34.22	11	2.03	18.128
<i>Panicum maximum</i>	Poaceae	3130	31.30	28.23	12	2.22	15.222
<i>Phymatodes scolopendra</i>	Polypodiaceae	11	0.11	0.10	7	1.29	0.697
<i>Pueraria phaseoloides</i>	Fabaceae	45	0.45	0.41	7	1.29	0.850
<i>Rauvolfia vomitoria</i>	Apocynaceae	38	0.38	0.34	7	1.29	0.818
<i>Rhynchospora carymbosa</i>	Cyperaceae	8	0.08	0.07	2	0.37	0.221
<i>Rourea coccineus</i>	Connaraceae	54	0.54	0.49	6	1.11	0.798
<i>Sabicea calycina</i>	Rubiaceae	42	0.42	0.38	7	1.29	0.836
<i>Scleria naumanniana</i>	Cyperaceae	54	0.54	0.49	9	1.66	1.075
<i>Selaginella myosurus</i>	Selaginellaceae	5444	54.44	49.09	12	2.22	25.655
<i>Setaria barbata</i>	Poaceae	55	0.55	0.50	11	2.03	1.265
<i>Sida acuta</i>	Malvaceae	69	0.69	0.62	12	2.22	1.420
<i>Sida sp.</i>	Malvaceae	31	0.31	0.28	6	1.11	0.694
<i>Spigelia anthelmia</i>	Loganiaceae	35	0.35	0.32	9	1.66	0.990
<i>Stachyterpheta cayenensis</i>	Verbenaceae	91	0.91	0.82	12	2.22	1.519
<i>Stigmaphyllon ovatum</i>	Malpighiaceae	156	1.56	1.41	9	1.66	1.535
<i>Synedrella nodiflora</i>	Asteraceae	48	0.48	0.43	9	1.66	1.048
<i>Tephrosia pedicellata</i>	Fabaceae	21	0.21	0.19	5	0.92	0.557
<i>Triumfetta cordifolia</i>	Tiliaceae	33	0.33	0.30	8	1.48	0.888
<i>Urena lobata</i>	Malvaceae	88	0.88	0.79	9	1.66	1.229

Rel. Den. = Relative Density, Freq. = Frequency, Rel. Freq. = Relative Frequency, I.V.I. = Importance Value Index

Table 4.4: Identified species abundance, density, relative density, frequency, relative frequency and importance value index at the study site during rainy season

Species Name	Family	Abundance	Density	Rel. Den	Freq.	Rel. Freq	I.V.I
<i>Abrus precatorius</i>	Fabaceae	23	0.23	0.14	9	1.43	0.786
<i>Acalypha wilkesiana</i>	Euphorbiaceae	56	0.56	0.34	10	1.59	0.966
<i>Achyranthes aspera</i>	Amaranthaceae	28	0.28	0.17	9	1.43	0.802
<i>Acroceras zizanoides</i>	Poaceae	71	0.71	0.43	14	2.23	1.330
<i>Ageratum conyzoides</i>	Asteraceae	205	2.05	1.24	13	2.07	1.657
<i>Ageratum haustonianum</i>	Asteraceae	121	1.21	0.73	11	1.75	1.243
<i>Alchornea cordifolia</i>	Euphorbiaceae	151	1.51	0.92	12	1.91	1.414
<i>Althenanthera brasiliana</i>	Amaranthaceae	39	0.39	0.24	8	1.27	0.755
<i>Ananas comosus</i>	Bromeliaceae	85	0.85	0.52	8	1.27	0.895
<i>Anthocleista libreschtiana</i>	Gentianaceae	39	0.39	0.24	12	1.91	1.074
<i>Anthocleista vogelii</i>	Gentianaceae	83	0.83	0.50	13	2.07	1.287
<i>Aspilia Africana</i>	Asteraceae	43	0.43	0.26	10	1.59	0.927
<i>Asystasia gangetica</i>	Acanthaceae	67	0.67	0.41	12	1.91	1.159
<i>Axonopus compressus</i>	Poaceae	755	7.55	4.58	14	2.23	3.407
<i>Baphia nitida</i>	Fabaceae	27	0.27	0.16	7	1.11	0.639
<i>Bysocarpus coccineus</i>	Connaraceae	21	0.21	0.13	9	1.43	0.780

<i>Calopogonium lucunoides</i>	Fabaceae	142	1.42	0.86	13	2.07	1.466
<i>Centrosema pubescens</i>	Fabaceae	69	0.69	0.42	10	1.59	1.006
<i>Chassalia kolly</i>	Rubiaceae	50	0.50	0.30	12	1.91	1.107
<i>Chromolaena odorata</i>	Asteraceae	171	1.71	1.04	13	2.07	1.554
<i>Clappertonia ficifolia</i>	Tiliaceae	43	0.43	0.26	9	1.43	0.847
<i>Cnestis ferruginea</i>	Connaraceae	10	0.10	0.06	5	0.80	0.428
<i>Commelina erecta</i>	Commelinaceae	80	0.80	0.49	11	1.75	1.119
<i>Costus afer</i>	Costaceae	128	1.28	0.78	14	2.23	1.503
<i>cyathula prostrate</i>	Amaranthaceae	31	0.31	0.19	8	1.27	0.731
<i>Cynodon dactylon</i>	Poaceae	79	0.79	0.48	12	1.91	1.195
<i>Diodea sarmentosa</i>	Rubiaceae	15	0.15	0.09	8	1.27	0.682
<i>Elaeis guineensis</i>	Arecaceae	434	4.34	2.64	14	2.23	2.432
<i>Eleusine indica</i>	Poaceae	1380	13.80	8.38	12	1.91	5.145
<i>Emilia praetermissa</i>	Asteraceae	30	0.30	0.18	11	1.75	0.967
<i>Ficur sur</i>	Moraceae	93	0.93	0.56	12	1.91	1.238
<i>Glyphaea brevis</i>	Malvaceae	35	0.35	0.21	10	1.59	0.902
<i>Ipomoea involucrate</i>	Convolvulaceae	113	1.13	0.69	9	1.43	1.060
<i>Justicia insularis</i>	Acanthaceae	49	0.49	0.30	9	1.43	0.865
<i>Ludwigia abyssinica</i>	Onagraceae	30	0.30	0.18	7	1.11	0.648
<i>Malvastrum sp.</i>	Malvaceae	31	0.31	0.19	7	1.11	0.651
<i>Mangifera indica</i>	Anacardiaceae	9	0.09	0.05	6	0.96	0.505

<i>Melastomastrum capitatum</i>	Melastomataceae	78	0.78	0.47	11	1.75	1.113
<i>Mussaenda littoralis</i>	Rubiaceae	34	0.34	0.21	10	1.59	0.899
<i>Nephrolepis biseratta</i>	Polypodiaceae	35	0.35	0.21	6	0.96	0.584
<i>Oxyanthus racemosus</i>	Rubiaceae	168	1.68	1.02	12	1.91	1.465
<i>Panicum laxum</i>	Poaceae	2930	29.30	17.79	10	1.59	9.691
<i>Panicum maximum</i>	Poaceae	3156	31.56	19.16	13	2.07	10.616
<i>Phymatodes scolopendra</i>	Polypodiaceae	15	0.15	0.09	8	1.27	0.682
<i>Pueraria phaseoloides</i>	Fabaceae	39	0.39	0.24	12	1.91	1.074
<i>Rauvolfia vomitoria</i>	Apocynaceae	53	0.53	0.32	9	1.43	0.877
<i>Rhynchospora carymbosa</i>	Cyperaceae	18	0.18	0.11	8	1.27	0.692
<i>Rourea coccinea</i>	Connaraceae	22	0.22	0.13	7	1.11	0.624
<i>Sabicea calycina</i>	Rubiaceae	20	0.20	0.12	9	1.43	0.777
<i>Scleria naumanniana</i>	Cyperaceae	44	0.44	0.27	10	1.59	0.930
<i>Selaginella myosurus</i>	Selaginellaceae	4384	43.84	26.62	14	2.23	14.424
<i>Setaria barbata</i>	Poaceae	46	0.46	0.28	11	1.75	1.015
<i>Sida acuta</i>	Malvaceae	52	0.52	0.32	9	1.43	0.874
<i>Sida spp</i>	Malvaceae	70	0.70	0.43	11	1.75	1.088
<i>Spigelia anthelmia</i>	Loganiaceae	37	0.37	0.22	11	1.75	0.988
<i>Stachyterpheta cayenensis</i>	Verbenaceae	87	0.87	0.53	11	1.75	1.140
<i>Stigmaphyllon ovatum</i>	Malpighiaceae	138	1.38	0.84	11	1.75	1.295
<i>Synedrella nodiflora</i>	Asteraceae	46	0.46	0.28	10	1.59	0.936

<i>Tephrosia pedicellata</i>	Fabaceae	28	0.28	0.17	8	1.27	0.722
<i>Triumfetta cordifolia</i>	Tiliaceae	57	0.57	0.35	12	1.91	1.128
<i>Urena lobata</i>	Malvaceae	77	0.77	0.47	12	1.91	1.189

Rel. Den. = Relative Density, Freq. = Frequency, Rel. Freq. = Relative Frequency, I.V.I. = Importance Value Index

CHAPTER FIVE

5.0 DISCUSSION

A total number of 61 species comprising of 57 genera and 27 families was recorded. A similar study conducted by Barcelos *et al.* (2015) on ethno- botanical survey in Biu local government area of Borno State. It was found that 27 plant species from 24 families in the plantation. The disparity in the number of weeds used could be on account of the different vegetation types. Garau *et al.* (2009) reported 73 plant species belonging to 38 families were identified. Hiyat and Kudus (2010) who reported the presence of 60 genera, 81 species and 40 families as the weed composition, but different from the report of Akinnibosun and Odiete (2007) and Akinnibosun and Odiete (2008) who reported the presence of 115 species, 104 genera and 58 families of weed flora in Utesi West, Edo State, Nigeria and 112 species, 102 genera and 58 families in a proposed exploration field in Edo State respectively. One of the main constraints to the use of improved control methods of weeds is their identification.

Knowing the composition of the weed flora and its evolution under the impact of environmental and phytotechnic factors is a basic prerequisite for any improvement or control. The most predominant families were Asteraceae, Poaceae, Fabaceae, Rubiaceae, Malvaceae, Amaranthaceae and Connaraceae. Five of these reported families (namely Asteraceae, Poaceae, Fabaceae, Amaranthaceae and Malvaceae) were similar to the report of Olorunmaiye *et al.* (2011) who recorded 11 dominant families in a *Citrus* Plantation in Ibadan, Oyo State Nigeria. The study of Bamidele *et al.* (2016) reported 49 species across 18 families with Poaceae and Asteraceae having the most dominant with a value of 11 and 8 species represented. The data

analysed for species composition revealed that plants with I.V.I greater than 10 were *Chromolaena odorata*. If the I.V.I generated in Bamidele *et al.* (2016) study should be compared with both I.V.I of dry season and rainy season of this study, it was discovered that the I.V.I of this study is far greater than 10. For dry season, the I.V.I. is 18.128 of *Panicum laxum* of the Family Poaceae while that of rainy season is 14.424 of *Selaginella myosurus* of the Family Selaginellaceae.

The study of Souza *et al.* (2006), stated a total of 22 plant species were encountered and documented, they were spread across the following families Cucurbitaceae, Malvaceae, Asteraceae, Piperaceae, Solanaceae, Lamiaceae, Amaranthaceae, Moringaceae, Apocynaceae, Melastomataceae, Gnetaceae, Fabaceae, Icacinaceae, Rubiaceae, Araceae, Portulacaceae and Meliaceae. Vollmann *et al.* (2010) reported that one hundred and thirty six weed species belonging to 101 genera and 44 families were identified in the flora of the oil palm plantation. Thirteen of the 136 weed species were found only in the matured oil palm plantation. Eight plant life forms were recognized amongst the weeds. These were herbs, herbaceous climbers, and shrubs, climbing shrubs, trees, small trees, ground and epiphytic ferns. The high diversity of weed species could also be due to the differences in seed production, dispersal, germination and seedling establishment (Araujo *et al.*, 2012), which promote high levels of co-existence among the weed species. The distribution of individuals among the species is given by evenness index, Evenness is highest when all species have the same number of individuals or are equally abundant (Barcelos *et al.*, 2015). Hence weed species were more equally abundant in the matured plantation than the young plantation. Tree crops usually produce shade which influences light intensity, temperature and humidity thereby restricting the species of weeds that can grow

under them. The closer the crops are, the more weed growth is suppressed; but as the crop closes its canopy, shade-tolerant weeds become common (Bivi *et al.*, 2016).

The oil palm does not close up its canopy early enough and can accommodate weeds with or without preference for shade for relatively longer period. This probably accounted for the presence of a wider diversity of weeds. Different crops and different cultivars of the same crop are capable of influencing the composition and growth of weeds. On most oil palm plantations in the far East, the cover that establishes itself is a mixture of the fern *Nephrolepis bisserata* with varying components of grasses such *Paspalum conjugatum* and *Axonopus compressus* (Fabien *et al.*, 2014) *Nephrolepis bisserata* provides herbage which rots rapidly to give a complex of decaying vegetation suitable for the growth of oil palm. Moreover, *Nephrolepis bisserata* provides a substantial cover for the soil and rarely grows to height that needs constant slashing. Weeds needed constant slashing especially in the young plantation due to its numerous underground nuts which produce fast and dense infestation. Annual broad leaved weeds of importance include *Spigelmia anthelmia*, *Ageratum conyzoides*, *Euphorbia heterophylla* and *Synedrella nodiflora*. (Kalidas, 2012) These were serious pests mainly in the newly established plantation due to their fast rate of growth and prolific production of seeds.

5.1 Conclusion

The ecological studies of seasonal distribution of weeds in oil palm plantation at Agbarha-otor, Ughelli North Local Government Area, Delta State, showed that there were many different weed species with many individuals in each weed species. A total number of 61 species comprising of 57 genera and 27 families were identified. The weed families derived from seven subclasses; the most diverse of the dicots were the Rosidae and Asteridae. The monocots present were from the

Commelinidae. In terms of abundance and distribution, weeds of Poaceae and Asteraceae were found to be far more invasive. *Chromolaena odorata*, *Aspilia africana* and *Melanthera scandens* of the Asteraceae, *Panicum maximum* and *Imperata cylindrical* of the Poaceae and *Mallotus oppositifolius* of the Euphorbiaceae were widespread and problematic. The diversity of weed species was high in the oil palm plantation at Agbarha- otor, Ughelli North local government area, Delta state.

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