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OCCURRENCE AND DISTRIBUTION OF *EUPHORBIA HETEROPHYLLA* LINN. ON THE MAIN CAMPUS OF THE UNIVERSITY OF ABUJA, NIGERIA

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ABSTRACT

The main goal of this study was to investigate the presence, distribution, and possible effects of Euphorbia heterophylla Linn. on the biodiversity at the main campus of University of Abuja in Nigeria, between June and October, 2023). One-meter-square (1m^2) quadrats were randomly selected from each of the five (5) sampling sites, namely: the Center for Distance Learning, the Faculty of Agriculture, the Education Trust Fund, the University Press, and the Female Hostel. The following five (5) parameters: weed density, frequency (actual number of occurrences of Euphorbia heterophylla) abundance, diversity, and relative frequency (percentage of the total occurrences), were collected and analyzed to determine the occurrence or distribution of a species. From the results, the Faculty of Agriculture had the highest density of Euphorbia heterophylla Linn (55. 0/m2), followed by University Press (30.3m^2). The highest percentage of weeds was found at the Faculty of Agriculture (55. 00 %), followed by the Education Trust Fund (34.33 %), University Press (30.25 %), and the female Hostel (00 %). Faculty of Agriculture (33.81 %) had the highest relative density, followed by University Press (31.68 %), Education Trust Fund (22.78 %), Female Hostel (22.42 %), and Center for Distance Learning (17.76 %). The lowest frequency was that of the Education Trust Fund, while the highest frequency was 100 % for the Faculty of Agriculture and the University Press. It is therefore, concluded that the high density and frequency of Euphorbia heterophylla at University of Abuja, suggests its successful establishment and potential dominance in the study locations, and hence, potential invasive, and possibility of outcompeting other species and altering the ecosystem's balance with implications to

reduce plant diversity and ecosystem healthiness. This paper recommends that in order to reduce soil seed bank and successfully mitigate Euphorbia heterophylla infestations, timely weed control should be implemented using appropriate and efficient techniques, especially integrated weed management

Keywords: ***Euphorbia heterophylla:*** **Species abundance and diversity: Weed density: University of Abuja**

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INTRODUCTION

Euphorbia heterophylla Linn, also referred to as milkweed, is a member of the Euphorbiaceae family of plants (Okeniyi *et al*., 2012). This weed is an annual with a 60-day life cycle and can go through multiple life cycles during a rainy season (Ipou *et al*., 2005; (Brusamarello *et al*., 2020). *Euphorbia heterophylla* is a persistent weed in a variety of agricultural systems (Brusamarello *et al.,* 2020; Bárrios and Copeland, 2021). It can be highly competitive,and cause the exclusion of native plant species, mainly due to its ability to establish dense populations and outcompete other species for essential resources, resulting in reduced plant diversity within an ecosystem (Pimental *et al.*, 2000). The weed exhibits variable seed dormancy and a high degree of cropping system adaptability (Kissman and Groth, 1993). Accordingly, it can germinate at any point during the growing season. *E. heterophylla* general resilience and resistance development allows it to adapt to various herbicide mechanisms and withstand their effects (Bárrios and Copeland 2021). The resistance of the weed to glyphosate herbicides makes it difficult to control and makes it more persistent in agricultural systems (Lamego *et al.,* 2022).

All parts of *E. heterophylla* contain latex: (leaves 0.42 %, stems 0.11 %, roots 0.06 % and whole plant up to 0.77 %), (Mosango, 2008). The weed also contains pentacyclic triterpenes and organic acids (Costa *et al.,* 2020) and carbohydrate (Pascal *et al*., 2019). Extracts from the fresh shoots of *Euphorbia heterophylla* produce inhibitory effects on early seed germination of some crops (Falodun *et al*., 2004), and is a common and highly competitive weed of upland rice in the Savanna zones of Africa (Johnson and Kent, 2002). This inhibitory effect is primarily due to the presence of an allelopathic compound (phenolic acids), which negatively affect seed germination and early seedling growth (da Silva *et al.,* 2018). Yields of crops can be reduced to zero by dense or even moderate infestations of *E. heterophylla*, and may cause difficulties at

harvest and reduce quality by contamination with sticky latex and adhering dirt and trash (Nester *et al*., 1979; da Silva *et al.,* 2018). It is a host of several plant viruses, (cassava mosaic virus; *Euphorbia* mosaic bigermini viru; tomato yellow leaf curl virus and mungbean yellow mosaic virus (Polston *et al*., 2014), a host of pests and may also be poisonous to mammals (Adedapo *et al.,* 2004;ARS, 2018; Rassam *et al*., 2011), hence the need for the study.

Statement of Research Problem

Studying the occurrence of *Euphorbia heterophylla* in ecosystems is crucial on both agricultural productivity and ecological balance, particularly because the weed is pervasive and thrives in varied habitats, including forests, Savannas, and cultivated lands, demonstrating its adaptability to significantly cause, ecological and economic challenges (Mendes *et al.*, 2020). Furthermore, the plant's adaptation to various environments may be an indication of its potential to alter local biodiversity, necessitating research. By studying its occurrence and abundance or distribution dynamics and ecological interactions, at University of Abuja Main Campus, more effective management approaches may be devised to prevent further occurrence and ecological disturbances. Also, this can inform adoption of more sustainable weed management practices and protection of the ecosystem for higher productivity.

Therefore, the overall objective of this study was to investigate the occurrence, distribution and assess the potential impacts of *Euphorbia heterophylla Linn* on main Campus biodiversity of the University of Abuja, Nigeria.

MATERIALS AND METHODS

The study was carried out at University of Abuja Main Campus, Abuja (8º 58' 50.8" N, and longitude 7º 10' 49.9" E). Five locations were purposely selected based on presence and density of infestation of *Euphorbia heterophylla*. The locations were: Faculty of Agriculture, University Press, Centre for Distance Learning, Education Trust Fund and Female Hostels). All the locations were selected based on observed presence and infestation of *Euphorbia heterophylla* (Table 1). Quadrats (1 m^2), were randomly thrown within the locations to determine selected parameters associated with occurrence or distribution dynamics (species abundance, frequency, relative frequency, density, relative density, species diversity). A Global Positioning System (GPS), was used to determine the coordinates of all the sample locations (Table 1).

The sample points at the study locations were as follows: 9 at Faculty of Agriculture, 12 each at University Press, Centre for Distance Learning Education Trust Fund and Female hostel respectively, Density was measured by placing a quadrat (1 m^2 sizes) randomly at the surveyed locations as outlined by Mahajan and Fatima,

(2017). Number of *Euphorbia heterophylla* observed within each quadrat was counted.

Species abundance

Species abundance measured the number of individuals of each species in a sampling unit or quadrat (Booth *et al*., 2003). Determined as:

Species abundance = Total number of *E. heterophylla* in all quadrats/ Total number of quadrats in which *E. heterophylla* occurred.

Frequency

Frequency was determined as the proportion of sampling units containing *E. heterophylla*, to reflect both a species' presence or absence or distribution within an area. It is a useful index for monitoring and comparing plant community changes over time (Bonham, 2013), and was calculated as:

$$\text{Frequency (\%)} = \frac{\text{Number of quadrats with Euphorbia heterophylla}}{\text{Total number of quadrats}} \text{ X } 100$$

Relative frequency

Relative frequency, was expressed as the percentage degree of dispersion of *E. heterophylla* in the sampling units in relation to number of other weed species occurring. Determined as:

$$\text{Relative frequency (\%)} = \frac{\text{Number of Euphorbia heterophylla occurred}}{\text{Number of all the weed species occurred}} \text{ X } 100$$

Density

Density measured the number of *Euphorbia heterophylla* per given study area (Tauseef *et al*., 2012), Determined as:

$$\text{Density} = \frac{\text{Number of Euphorbia heterophylla in a quadrat}}{\text{Total area of a quadrat } (1m^2)}$$

Relative density

Relative density expressed the numerical strength of *E.* heterophylla, in relation to total number of individuals of other weed species present (Yakubu *et al*., 2006). It was determined using the formula:

$$\text{Relative density} = \frac{\text{Total number of Euphorbia heterophylla}}{\text{Total number of all the weed species}} \text{ X } 10$$

Table 1: Study Locations, Sample Sizes, Number of Quadrats and Coordinates

S/N	Location	Sample Size	No. of Quardrats	GPS Coordinates	
				Latitude	Longitude
1	Faculty of Agriculture	8 m x 10 m	9	8º 59' 00.1" N	7º 10' 38.5" E
2	University Press	7 m x 10 m	12	8º 59' 00.8" N	7º 10' 43.1" E
3	Centre for Distance Learning	10 m x 10 m	12	8º 58' 44.1" N	7º 10' 50.2" E
4	Education Trust Fund	10 m x 10 m	12	8º 58' 40.3" N	7º 10' 45.3" E
5	Female Hostel	8 m x 10 m	12	8º 58' 33.6" N	7º 10' 32.4" E

Species Diversity

Species diversity was used to determine species richness or abundance of *Euphorbia heterophylla*. Determined as:

$$\text{Species diversity} = \frac{\text{Number of different weed species (species richness)}}{\text{Total number of weed species (species evenness)}}$$

$$\frac{\text{Number of different weed species (species richness)}}{\text{Total number of weed species (species evenness)}}$$

Shannon-Weiner Diversity Index

The Shannon-Weiner diversity index measures diversity of species in an area.

Denoted as H, this index is calculated as:

$$H = -\sum [(Pi) \times \ln (Pi)]$$

Where: Σ: A Greek symbol that means "sum", ln: Natural logarithm, Pi: The proportion of the entire community made up of species I, Pi – n/N where: n = individuals of a given species; and N = total number of individuals in a community. The higher the value of H, the higher the diversity of species in a particular community, conversely, the lower the value of H, the lower the diversity. A value of H = 0 indicates a community that only has one species.

Statistical Analysis

E. heterophylla was identified using the Handbook of West African weeds by Akobundu *et al.,* (2016). The data collected at all locations where *E. heterophylla* was identified were subjected to descriptive analysis using bar charts, pie charts and graphs.

Table 2: Classification Scheme of Shannon-Weiner Diversity Index (Fernando *et al.,* 1998)

Relative Values	Shannon-Weiner Diversity Index

Very High	3.50 and above
High	3.00 - 3.49
Moderate	2.5 - 2.99
Low	2.0 - 2.49
Very Low	1.99 and below

RESULTS

At Faculty of Agriculture. Sample point I had the highest population of *E. heterophylla* (116), followed by points II (92), and III, (68) respectively, while the least was observed at point VII (17), (table 3).

At University Press sample point X had the highest population of *E. heterophylla* (67), (table 3), while Points I, II, III, V, VI, VII, VIII, IX, XI and XII had 20, 14, 20, 15, 28, 54, 11, 38, 42 and 47, respectively. At Centre for Distance Learning the highest population (51) was observed at point (VI), (table 3); (figure 1).

At Education Trust Fund, *E. heterophylla* was not observed at points II, XI and XII, but it was observed at Point IX, which also, had the highest population (51), while point VIII had the lowest population of *E. heterophylla* (8), (Table 3); (figure 1).

At Female hostel, Point V had the highest population of *E. heterophylla* (53), point X had the lowest population (12), while point IV had zero population of *E. heterophylla*, (table 3); (figure 1).

The highest density of *E. heterophylla* was observed at Faculty of Agriculture (55/ m^2), (figure 2) followed by University Press (30.3/ m^2), and the lowest density was at Centre for Distance learning (23.3 / m^2).

Based on the results of study, the highest frequency of occurrence of *Euphorbia heterophylla* was observed at Faculty of Agriculture and University Press (100 %) while the lowest frequency was at Education Trust Fund (75), (figure 3).

Abundance

Weed abundance was observed to be highest at Faculty of Agriculture (55 %), followed by Education Trust Fund (34.33 %), University Press (30.25 %) and Female hostel (27.09 %), (figure 4). The lowest Abundance was at the Centre for Distance learning (25.36 %).

Total number of quadrats used (NQ), other weed species/quadrats (OS), number of all weed species (NW), total number of weed species (TW), number of quadrats with *Euphorbia heterophylla* (QE), number of *E. heterophylla* (NE), density of *E. heterophylla* (D), frequency of

E. heterophylla distribution (F), *E. heterophylla* abundance (A), relative density (RD), relative frequency (RF), species diversity (SD).

Table 3: Sample Points and Population of *Euphorbia heterophylla* at Sampled Locations at University of Abuja, Main Campus

Locations/Point	Number of *E. heterophylla* observed/point				
	Faculty of Agriculture	**University Press**	**Centre for Distance Learning**	**Education Trust Fund**	**Female Hostel**
1	116	20	13	24	25
2	92	14	34	0	13
3	68	20	23	41	38
4	30	7	15	33	0
5	50	15	48	0	53
6	43	28	51	28	18
7	17	54	31	0	42
8	24	11	30	17	23
9	55	38	16	51	13
10	0	67	16	42	12
11	0	42	2	38	41
12	0	47	0	0	20
Total	495	363	279	274	298

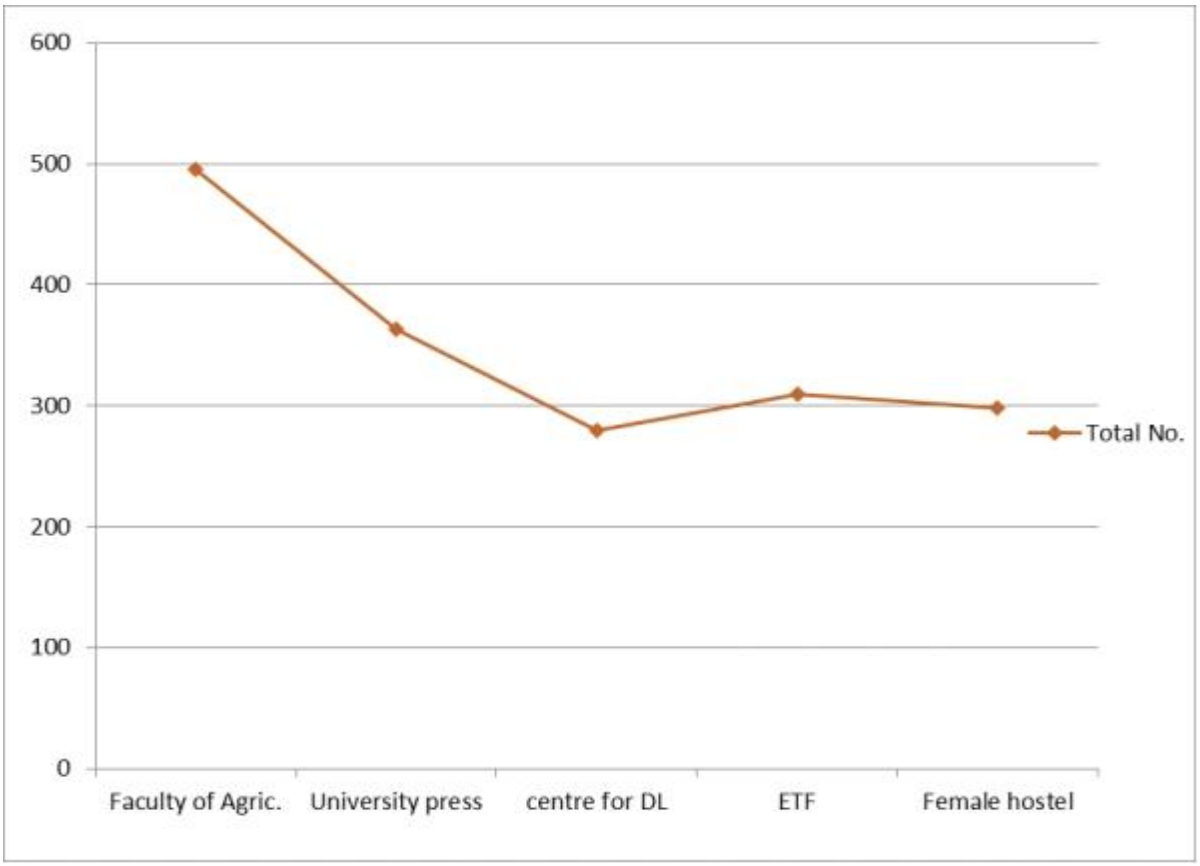

Figure 1: Graph Showing Population of *Euphorbia heterophylla* at the Selected Locations

TABLE 4: Density, Relative Density, Frequency, Abundance, Relative Frequency and Species Diversity of *Euphorbia heterophylla* Infestation at Selected Locations of University of Abuja, Main Campus.

S/N	Location	NQ	OS	NW	TW	QE	NE	D	F (%)	A	R.D (%)	RF (%)	SD
1.	Faculty of Agriculture	9	107.7	10	1464	9	495	55	100	55	33.81	49.50	0.01
2.	University Press	12	65.3	14	1146	12	363	30.3	100	30.25	31.68	25.92	0.01
3.	Centre for distance learning	12	107.7	12	1571	11	279	23.3	91.6	25.36	17.76	23.25	0.01
4.	Education Trust Fund	12	87.3	14	1357	9	309	25.8	75	34.33	22.78	22.07	0.01
5.	Female Hostel	12	85.9	16	1329	11	298	24.8	91.6	27.01	22.42	18.63	0.01

TABLE 4: Shannon-Weiner Diversity Index

Locations	No. of *E. heterophylla*	Total No. of individual	Proportion Pi (n/N)	In (Pi)	Pi x in (Pi)
Faculty of Agriculture	495	1464	0.34	-1.08	-0.37
University press	363	1146	0.32	-1.14	-0.36
Centre for distance learning	279	1571	0.18	-1.71	-0.31
Education Trust Fund	309	1357	0.23	-1.47	-0.34
Female hostel	298	1329	0.23	-1.46	-0.33

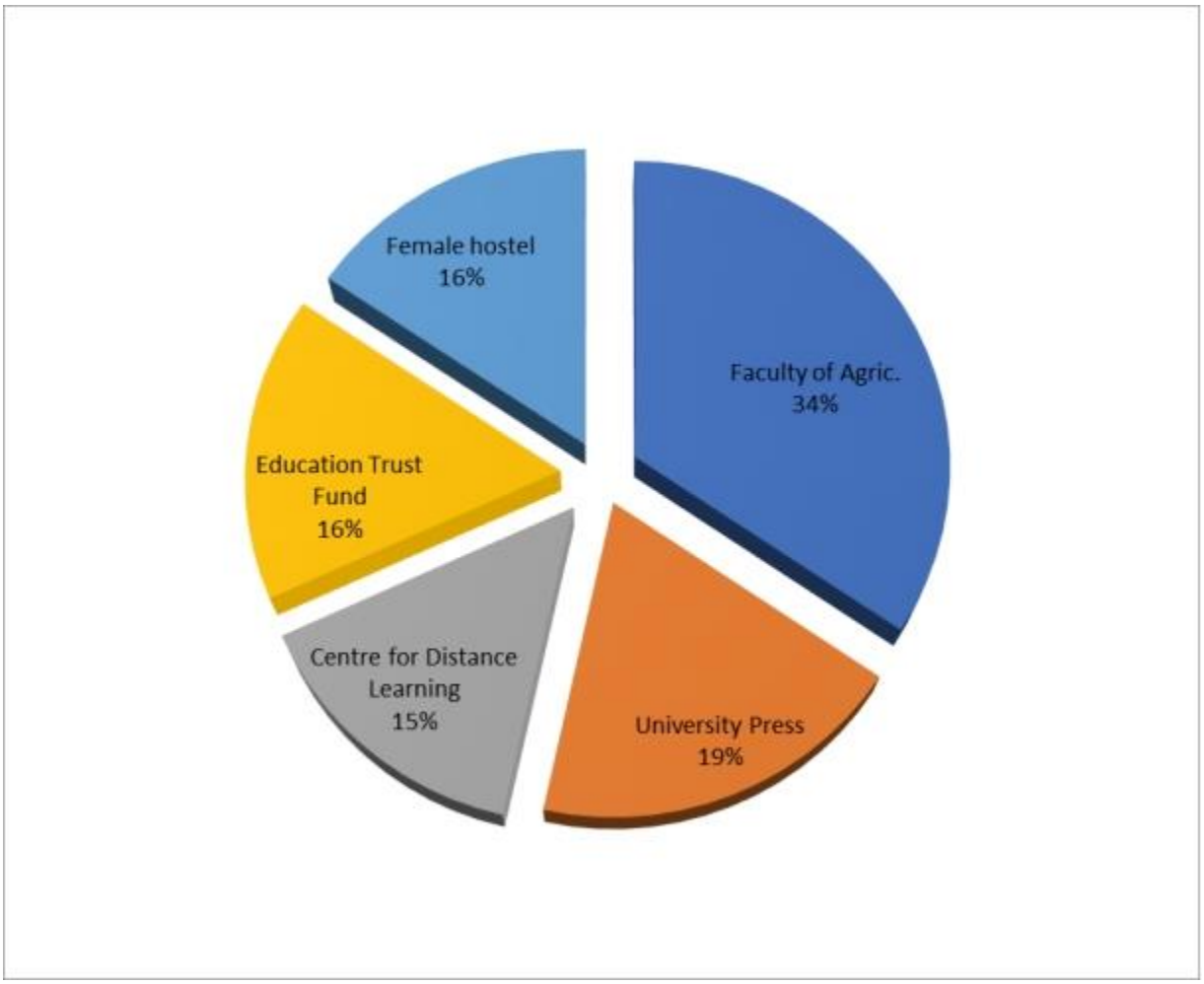

Figure 2: Density of *E. heterophylla* at the Selected Locations

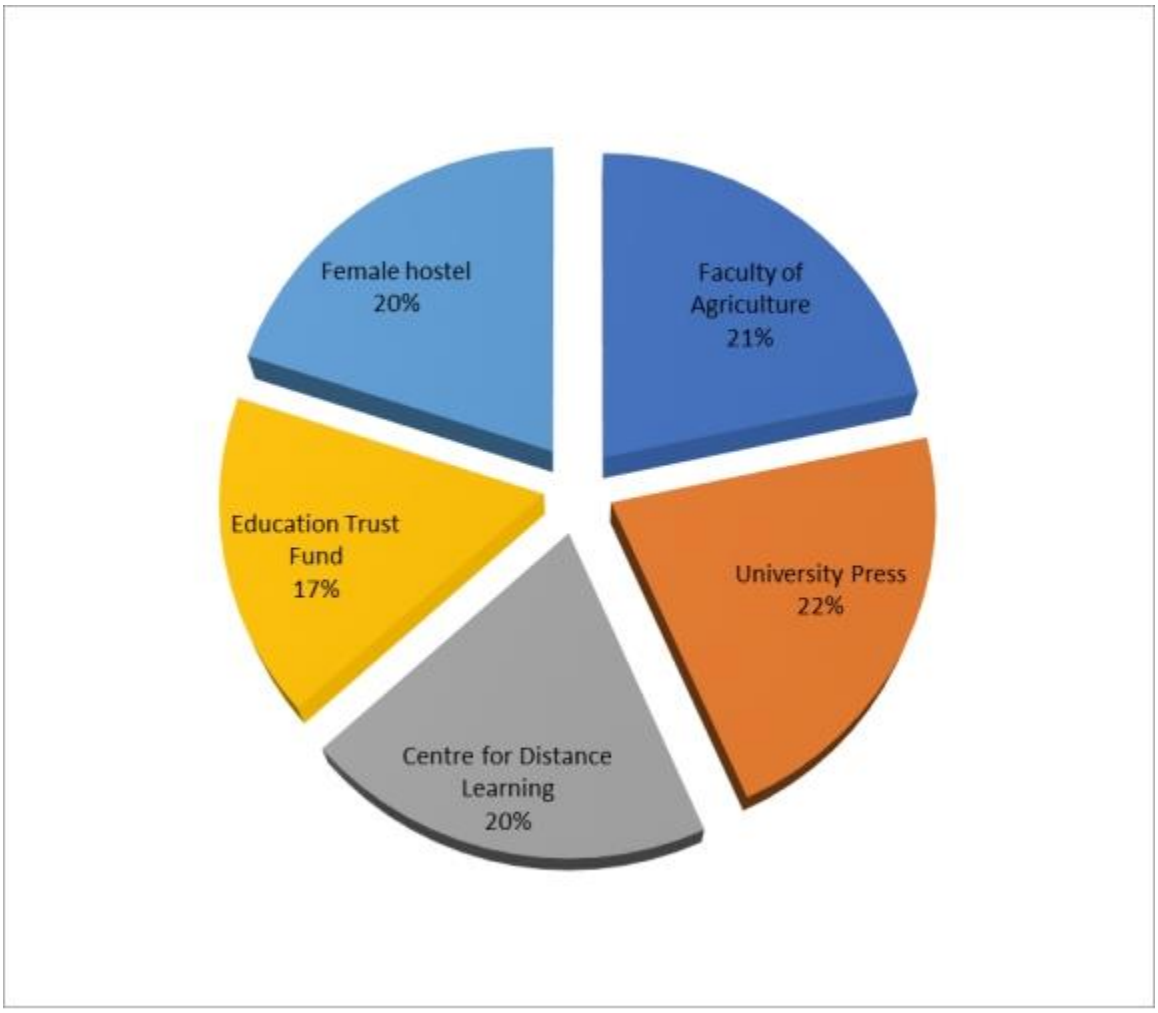

Figure 3: Frequency of Occurrence of *E. heterophylla* at the Selected Locations

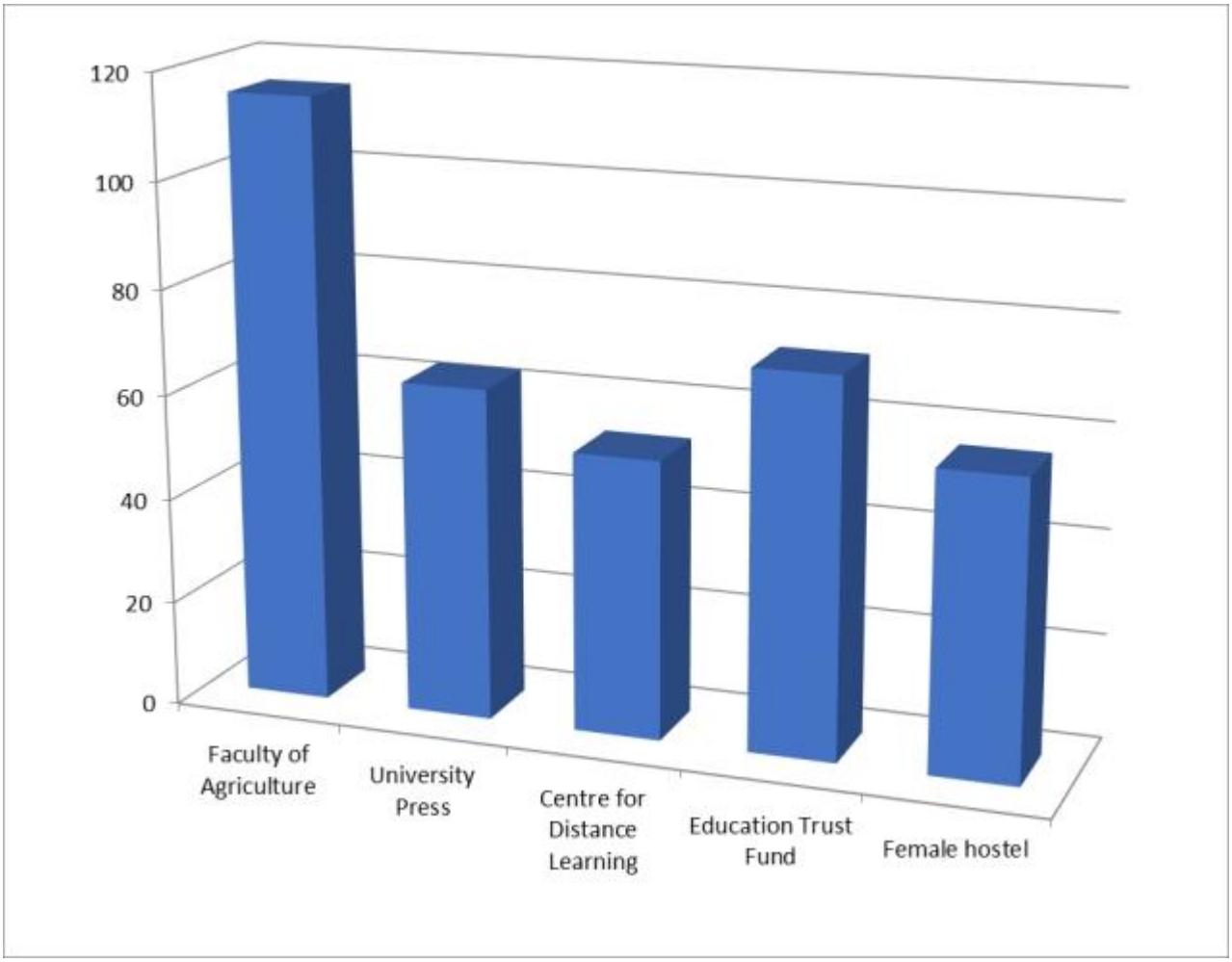

Figure 4: Abundance of *E. heterophylla* at the Selected Locations

DISCUSSION

The variations in species abundance, frequency of occurrence, population and density of *E heterophylla* across the selected locations of University of Abuja may be attributed to variations in edaphic conditions (soil water content, nutrient availability, pH, texture, soil seed bank soil depth), (Fried *et al*., 2008; Pinke *et al*., 2012; Brusamarello *et al.,* 2020), and the characteristic nature of *E. heterophylla to* exhibit a generalist strategy of superiority to in response to different soil fertility suggesting a greater response to resource availability, hence, greater plasticity (Yuguda *et al.,* 2016). Besides, its resistance to certain herbicides, allows it to spread across diverse agricultural landscapes. Moreover, *Euphorbia heterophylla* is a C4 plant, making it well-adapted to high-temperature and low-moisture conditions, which further enables its broad distribution even in semi-arid environments (Brusamarello *et al.,* 2020). And, it has been reported that C4 plants are more sensitive to water stress and have higher water-use-efficiency than C3 plants (Ozturk *et al.,* 1981; Falodun, *et al.,* 2004; Horn *et al.,* 2012). It is noteworthy to state that the locations of the selected based on *E. heterophylla* infestation were either areas of some kind of cultivation or

those adjoining roads, therefore, prone to influxes of nutrients or activities which had potential to affect soil fertility status, and therefore, promote its presence through enhanced ecological interactions (Brusamarello *et al.,* 2020). Parsons and Cuthbertson, (2001); Adedapo *et al.,* (2004); Horn *et al.,* (2012) and Vasconcelos *et al.,* (2024) earlier reported that *E. heterophylla* grows where weed community composition and structure SO, greatly influencing its abundance and limiting diversity. In many cases, being a broadleaf species, *E. heterophylla* tends to be more abundant (Streit *et al*., 2003). Several studies have reported that soil fertility has a strong impact on weed species' abundance and diversity (Nie *et al*., 2009; Cheimona *et al*., 2016). Soil fertility improves nutrient uptake, thus increasing modifications of weed communities (Allan *et al*., 20l5), hence, the abundance of *E. heterophlla* at the study locations.

The high frequency of occurrence of *E. heterophylla* at the selected locations may be associated with its potential to produce viable and large quantities of seeds with ability to germinate over a wide range of soils (Kissman and Groth, 1993; Salomao *et al.,* 2022). Once sprouted, these weeds grow rapidly and can be serious competitors with crops, generally out-competing crops for light, water and nutrients, thereby, inhibiting emergence or growth of desirable crops and other adjoining weed species (Salomao *et al.,* 2022), generally augmented by its significant genetic diversity, contributing to its ability to adapt to different environmental conditions and develop resistance (Salomao *et al.,* 2022). This variability makes it difficult to manage and promotes its spread (Kemboi *et al.* 2020). Almodovar-Vegal *et al.* (1988) and Horn *et al.* (2012), reported that allelopathic effect of *E. heterophylla* release exudates which may disrupt or inhibit growth of plants or other weed species within the same environment (da Costa *et al.,* 2020). Machado *et al*., (2016) also reported that *E. heterophylla* have unique survival mechanisms (ability to germinate from considerable depths 2-10 cm), of regrowth from lower nodes when total control is not achieved), a factor contributing to its aggressiveness.

The relatively higher occurrence of *E. heterophylla* at Faculty of Agriculture, was attributed to the frequently disturbed status (deposition of wastes that are potential sources of fertilizers, farming activities, hence, fertilization), and therefore, increased fertility status of the soils, Liebman *et al*. 2001; Streit *et al*., 2003; Varejão *et al.,* 2018; da Costa *et al.,* 2020;). Differentiation in the concentration and availability of plant nutrients may also affect weed populations (Murphy and Lemerie, 2006; Power, 2010). In particular, high levels of nitrogen (N) fertilizers influence species richness (Inouye and Tilman, 1995; Suding *et al.,* 2005) and change of the weed species composition, to favor specific species (Gu *et al*., 2007; Huang *et al*., 2013), in this case, favoring *E. heterophylla,* which as reported by Storkey *et al*. (2010), may suppress several rare or endangered weed species. The implication of the preponderance of *E. heterophylla* is that, it probably was exploitative of available soil nutrients, (especially nitrogen), hence, its dense growth and infestation of affected areas.

The comparatively low weed diversity at the study locations indicated is a key effect of infestations of *E. heterophylla* to reduce biodiversity within agroecosystems (Machado *et al*., 2016; Gibson *et al*., 2006; Power, 2010; Rassam *et al*., 2011). More so, as the locations studied are not areas with deliberate or systemic inputs for crop production. This agrees with reports by Gough *et al*., (2000); Suding *et al*., (2005), that weed communities tend to be more diversified in low than in high input systems. Generally, knowledge of weed species abundance and diversity could contribute to the

sound design and implementation of integrated weed management programs which in turn may lead to a decrease in the density of serious and noxious weeds (Murphy, and Lemerle, 2006) or increases in the overall balance of agroecosystems. According to the Classification Scheme of Shannon-Weiner Diversity Index (Fernando *et al.,* 1998), weed diversity was very low in the selected locations, associated with allelopathic effect of *E. heterophylla* on other weeds within their environment (SEPASAL, 2008). In conclusion, it is noteworthy that the occurrence of *Euphorbia heterophylla* at the different locations of University of Abuja Main Campus demonstrates a preference for different or specific ecological niches, generally, disturbed environments (roadsides, urban property sits), with altered soil composition. The altered soil composition at the selected locations of University of Abuja, *E. heterophylla* had might have influenced the different intensities of infestation, (density, relative density, frequency and abundance). It is therore, recommended that the University to restrict its spread by promoting management practices, implement regular monitoring to assess the distribution and population dynamics of *Euphorbia heterophylla* to identify new infestations and evaluate management effectiveness, provide information on identification, and management efficiency, support research initiatives that focus on understanding the ecological interactions of *Euphorbia heterophylla*, to prevent spread to other non-infested areas of University of Abuja.

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