INFLUENCE OF *Zea mays* CULTIVATION ON THE DEVELOPMENT OF WEED DIVERSITY IN A POTTED EXPERIMENT IN A FERRUGINOUS SOIL

BY

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A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF PLANT BIOLOGY AND BIOTECHNOLOGY, FACULTY OF LIFE SCIENCES, UNIVERSITY OF BENIN, BENIN CITY, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF SCIENCE (HONORS) DEGREE (B.Sc) IN PLANT BIOLOGY AND BIOTECHNOLOGY.

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CERTIFICATION

This is to certify that this work was carried out by Chibuikem Stephen NWAFOR, in the Department of Plant Biology and Biotechnology, Faculty of Life Sciences, University of Benin, Benin City.

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Mrs. F.N. Egbenoma **DATE**

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Prrof. E. O. Vwioko **DATE**

DEDICATION

I dedicate this project to God Almighty for his guidance and to my family for their great support.

ACKNOWLEDGEMENTS

I appreciate God Almighty for His guidance, spirit upliftment and strength to complete this research project. I also appreciate my project supervisor, Mrs. Egbenoma for her support as well as my Professor, Beckley Ikhajiagbe for his mentorship throughout this study. Thank you for stretching my abilities and for everything you've taught me. I acknowledge the Head of Department, Prof E. D. Vwioko for his leadership and accessibility to the students of the department; and my course advisor, Prof. Edegbai for his advice and support. Special appreciation to the people who raised me and taught me to always be the best I can be, Mr. and Mrs. Nwafor Stephen, for their love, protection and emotional and financial support. I love you and thank you for raising me the way that you did, to be exceptional. I appreciate my brothers, Nonso, Tochukwu and Chigozie and my Sisters Chioma and Mmesoma for being my top motivators. To my friends and project colleagues; Obanor Happy, Kalu Simeon, Omozusi Triumph, Osasenaga Godwin, Daniel Miracle, Ehizua Excellent, Dako Ibti, Akinyemi Mary and lots more, thank you for your love, encouragement and every moment spent with you. I feel blessed to have you all as a part of my journey in school. I want to also thank the entire ASYF UNIBEN community for teaching me all I know about God, leadership and for the opportunities they provided me. I am happy to have found you at the time that I did and I will always remember how you impacted me. In this time and age, I am grateful for life and companionship.

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ABSTRACT

This study examines the influence of maize cultivation on weed diversity and abundance in a ferruginous soil. A potted experiment was conducted to assess the effects of varying maize densities and soil iron amendments on weed population dynamics. The results indicate that increasing maize density significantly reduces weed population through competition for essential resources such as light, water, and nutrients. Conversely, soil iron amendments had a dual effect, with lower iron concentrations suppressing weed growth and higher concentrations favoring the proliferation of iron-tolerant species. The analysis of variance (ANOVA) revealed statistically significant differences in weed populations across the different treatments ($F = 7.99$, $p = 0.00117$ for maize density; $F = 6.27$, $p = 0.0169$ for iron amendments), confirming the substantial impact of these factors. These findings align with previous research on crop competition and nutrient-mediated weed dynamics. The study highlights the importance of optimizing maize density and soil nutrient levels as an integrated weed management strategy.

CHAPTER ONE

INTRODUCTION

1.1 Background of Study

Maize is a key food and industrial crop grown in over 160 countries, with the exception of Antarctica (Rahmawati *et al.,* 2021). Its global importance is based on its economic, nutritional, environmental, and cultural contributions (Tanumihardjo *et al.,* 2020). It is a staple food in many households, particularly in Southern and Eastern Africa, Central America, and Mexico (Ranum *et al.,* 2014; Mangani *et al.,* 2019). As the population grows, maize consumption in developing countries is predicted to double by 2050, while its production is expected to peak by 2025. Given its central role in food security for some of the poorest regions in Africa, Asia, and Latin America, it is essential to investigate the factors that limit maize production to ensure its sustainability.

Despite current management practices, diseases that affect maize health, productivity, and contamination of grains have been reported globally (Akanmu *et al.,* 2020; Enebe and Babalola, 2021; Ahmad *et al.,* 2012). In South Africa, various diseases such as bacterial stalk rot, black bundle disease, late wilt, charcoal rot, common rust, downy mildew, and northern corn leaf blight (NCLB) have been documented (Schoeman *et al.,* 2018; Okoth *et al.,* 2017). NCLB is marked by grey-green borders surrounding canoe-shaped lesions, which can range from 3 to 15 cm in length, often resulting in large, blighted patches.

Maize is a food and industrial crop that is cultivated in more than 160 countries and on every continent except for Antarctica (Rahmawati *et al.,* 2021). Its global relevance is hinged on its economic, nutritional, environmental, and cultural impacts (Tanumihardjo *et al.,* 2020). It is a cereal of choice in many house holds and is especially preferred in Southern and Eastern Africa, Central America, and Mexico (Ranum *et al.,* 2014, Mangani *et al.,* 2019). As a result of the population expansion, maize consumption in the developing countries has been predicted to double by 2050, while its output is projected to peak by 2025. Therefore, considering its position as the basis of food security in some of the world's poorest regions of Africa, Asia, and Latin America, there arises the need to investigate the factors limiting the production of this important cereal as to ensure the sustainability of its productions.[EK1]

Maize was domesticated from teosinte (*Zea mays* ssp. *parviglumis*), and this domestication event occurred ~9000 years ago (Matsuoka *et al*. 2002; Doebley 2004). The domestication resulted in original maize landraces, which were spread throughout the USA by native Americans and adapted to various environments. With maize landraces, crop breeders began to select maize inbred lines with specific alleles for hybrid breeding, which ultimately increased the maize yield and enhanced stress tolerance (Duvick 1977; Duvick *et al*. 2004). Maize domestication reduces plant genetic diversity, resulting in morphological and physiological changes (Yamasaki *et al*. 2005). The potentially homogenized changes for high yield are assumed to suppress soil microbial diversity (Pérez-Jaramillo *et al*. 2017). However, limited knowledge is available on the coevolutionary process of maize domestication with microbial recruitment in the rhizosphere and whether domestication indeed leads to a change in bacterial diversity that is relevant to plant performance.[EK2]

1.2 Maize Cultivation

1.2.1 Site selection and soil type

Maize is extremely vulnerable to water logging, and if the crop experiences water stagnation for longer than two days, significant production losses will result. Therefore, well-drained sandy-loam to silty-loam soil types are ideal for growing the crop.[kt3]

1.2.2 Planting period

June 20 to the end of July is usually the best time to sow. This will, however, depend on when the monsoon season begins. Early sowing is preferred in fields where water stagnation may occur so that the plant reaches a solid stand and prevents lodging from water logging.

1.2.3 Land preparation

For seed emergence and root growth, maize requires a finely ground, smooth, and well-pulverized field. Therefore, for effective field preparation and early season weed control, deep tillage utilizing a mold board plough, followed by two harrowing and one planking, is required. Using a happy seeder or a zero-till multi-crop planter, maize can also be effectively grown in zero-till circumstances.

1.2.4 Seed rate

About 8 kg of seed per acre should be used.

1.2.5 Seed treatment

Untreated seeds should be treated with fungicides and insecticides before sowing to protect it from seed and soil borne diseases and some insect-pests.

1. Bavistin + Captan in 1:1 ratio@2g/kg seed for Turcicum leaf blight, Banded leaf and sheath blight, Maydis leaf blight etc.
2. Apran 35 SD@4g/kg seed for Brown stripe downy mildew
3. Captan 2.5g/kg for Pythium Stalk Rot
4. Imidachlorpit@4g/kg or Fipronil @4ml/Kg seed for termite and shoot fly.

1.2.6 Method of sowing/Spacing

In *kharif* season crop, it is always desirable to go for raised bed planting to protect the crop from water logging. In raised bed planting, 70 cm wide ridges (40 cm ridge and 30 cm furrow) are prepared with the help of bed planter. Bed planter with incline plate seed metering system can precisely place the maize seed at required depth of 3.5-5.0 cm and does simultaneous operation of raised beds making and planting. One line of maize on each raised bed is desirable when sole crop of maize is planted keeping seed to seed spacing at 20 cm. Optimum plant density (30,000/acre) should be maintained to tap full potentials of hybrids. Southern side planting is advised on East-West oriented ridges (Indian Council of Agricultural Research. 2017). Happy seeder or zero-till bed planters with inclined plate to be used for crop establishment under zero tillage or for sowing under crop [kt4]residue.

1.2.7 Weed management

Weeds significantly reduce maize production and the critical period for crop-weed completion is 15-45 days after sowing.

1.2.8 Cultural control

a) Two manual hoeing at 15 and 30 DAS; b) Inter-cropping of one or two rows of fodder cowpea in between maize rows reduces weed problem considerably.

1.2.9 Mechanical control

Mechanical weed control in maize is possible through tractor drawn cultivator and rotary weeder; Self-propelled power weeder; and animal drawn blade harrow. Mechanical weed control using tractor mounted implements can only be done during the early crop stages because limited tractor and cultivator ground clearance damage the crop foliage at later growth stages. Working depth of weeding implements should be shallow to prevent plant roots damage.

1.2.10 Chemical control

Recommended dose of atrazine at pre-emergence followed by either of the post-emergence herbicide for effective weed control (mentioned below) is also equally effective.

1.3 Weed Diversity

Weed, general term for any plant growing where it is not wanted. Ever since humans first attempted the cultivation of plants, they have had to fight the invasion by weeds into areas chosen for crops. Some unwanted plants later were found to have virtues not originally suspected and so were removed from the category of weeds and taken under cultivation. Other cultivated plants, when transplanted to new climates, escaped cultivation and became weeds or invasive species. The category of weeds thus is ever changing, and the term is a relative one (Indian Council of Agricultural Research. 2017).

Weeds interfere with a variety of human activities, and many methods have been developed to suppress or eliminate them. These methods vary with the nature of the weed itself, the means at hand for disposal, and the relation of the method to the environment. Usually for financial and ecological reasons, methods used on a golf course or a public park cannot be applied on [kt5]rangeland or in the forest. Herbicide chemicals sprayed on a roadside to eliminate unsightly weeds that constitute a fire or traffic hazard are not proper for use on cropland. Mulching, which is used to suppress weeds in a home garden, is not feasible on large farms. Weed control, in any event, has become a highly specialized activity. Universities and agricultural colleges teach courses in weed control, and industry provides the necessary technology. In agriculture, weed control is essential for maintaining high levels of crop production.

The number of weed species that are typically found in conventionally managed crop fields is now a fraction of the levels recorded in the 1950-1970s, owing to increased fertilizer and herbicide use, simpler rotations and loss of field boundaries and semi-natural features in the landscape (Andreasen *et al.,* 1996; Fried *et al.,* 2009; Meyer *et al.,* 2013). For some, this loss of infield biodiversity is a concern, reflecting an erosion of the natural capital and ecosystem services on which sustainable production is founded. However, for others, it is seen as a measure of successful weed control and the concept of conserving weeds within cropped fields is, at best, incomprehensible and, at worst, an insult to the efforts of weed scientists over the past half-century to reduce the serious yield losses inflicted by weeds (Oerke, 2006). This divergence in peoples' perception of weeds represents a philosophical fault line running through the weed science community and often reflects differences in scientific background (ecology vs. agronomy). Here, we argue that, rather than perpetuating this dichotomy, we should recognise that the objectives of maintaining arable biodiversity and preventing cropping systems becoming dominated by a few highly competitive, herbicide-resistant weeds both rely on a common set of ecological and management principles that should unite our research.[kt6]

1.4 Research problem

This study shows the effect maize cultivation has on weed diversity is hindered by various factors, knowing that there are various strains of maize and different soil compositions and climatic effects in different environments; it therefore limits the product of this experiment to environmental and climatic differences. Maize cultivation is heavily influenced by pests and diseases, which are also hindrances to its production and may also affect the diversity of weeds around it.

1.5 Literature Review

1.5.1 Weed management in maize using crop competition

In more developed regions such as Australia, characterized by high agricultural inputs, farmers heavily rely on herbicides for weed control (CropLife/Grains Research and Development Corporation, 2008). Herbicides are an effective tool for managing weeds, and their proper application can reduce crop yield losses due to weeds by as much as 13 % (Oerke and Steiner, 1996). In the United States, genetically modified glyphosate-resistant maize (commonly known as Roundup® Ready maize) accounts for approximately 10 % of the total maize cultivation area (Gianessi, 2005). This modification enables the use of glyphosate to control weeds throughout the growing season. While glyphosate-resistant maize has proven to be cost-effective compared to traditional varieties, its adoption in Europe and some other regions remains low. Factors such as opposition to genetic modification, the availability of diverse crop options, and concerns about the environmental impact of herbicides contribute to this resistance (Gianessi, 2005).

Herbicides from different groups, including pre-emergent and post-emergent types, are highly effective in managing weeds throughout the crop cycle, ensuring a weed-free environment for better crop production (Mathers and Parker, 2013). Several studies have shown that herbicide use can be more cost-effective than mechanical weed control methods (Gianessi, 2014; Muoni *et al.,* 2013). However, excessive reliance on herbicides in developed regions has led to growing resistance among some weed species (Culpepper *et al.,* 2004; Hall *et al.,* 2014; Hull *et al.,* 2014), raising concerns about their long-term effectiveness. For instance, in New Zealand, weeds such as *Chenopodium album* L. and *Solanum nigrum* L. have developed resistance to the commonly used herbicide atrazine (Mathers and Parker, 2013). This resistance has prompted calls for higher herbicide doses, which may exacerbate environmental pollution (Koch, 2010; Reganold *et al.,* 2001). This issue is particularly significant with atrazine, as it persists in the soil for many years (Helling *et al.,* 1988).[kt7]

1.5.2 Allelopathic Effects of Maize

Plants produce various secondary metabolites that influence the growth and development of nearby plants and microorganisms through a process known as allelopathy. This process plays a crucial role in agroecosystems, impacting the growth, quality, and quantity of agricultural produce (Kohli *et al.,* 1998; Singh *et al.,* 2001). Allelochemicals, the substances responsible for allelopathy, can be found in different parts of the plant, including leaves, stems, and roots. The concentration of these allelochemicals is typically higher in rhizospheric soil compared to bulk soil.

Allelochemicals released by one crop species can affect the growth, productivity, and yield of neighboring plants, whether of the same or different species (Batish *et al.,* 2001). These chemicals act in various ways, such as inhibiting root or shoot growth, interfering with nutrient uptake, or disrupting natural symbiotic relationships, ultimately reducing the affected plant's ability to utilize resources. Allelopathy, whether through living or decomposing plants, involves the release of allelochemicals that often have detrimental effects on associated plants and play an important role in natural ecosystems (Fitter, 2003; Inderjit and Duke, 2003).

The impact of allelochemicals varies and can be observed through delayed or reduced seed germination, as well as inhibited root and shoot growth, which are among the most noticeable symptoms of allelopathic stress. Research on maize allelopathy has investigated the allelopathic potential of various plant parts. Maize and soybean are two crops commonly grown together, but studies suggest that maize (Minorsky, 2002) and soybean (Jimenez *et al.,* 1983) may exhibit allelopathic effects. Despite this, the allelopathic interactions between maize and soybean remain largely unexplored.

Given that allelopathy contributes to crop-to-crop interference, there is a need to better understand the potential allelopathic effects between maize and soybean. This research aimed to investigate these interactions, using water as the extracting medium since allelochemicals are typically water-soluble and are released into the environment through root exudates (Tawaha & Turk, 2003).[kt8]

1.5.3 Impact of Soil Nutrients on Weed Diversity

Weeds are a major challenge to crop production, with ecological weed management emerging as a key strategy to reduce reliance on herbicides and tillage. Community assembly theory, which examines how environmental filters like crop type, soil disturbance, and nutrient management affect weed species composition, has been used to understand weed responses to management practices (Booth and Swanton, 2002; Gaba *et al.,* 2017; Smith and Mortensen, 2017). While previous research has explored factors such as crop sequence and soil disturbance, limited studies have focused on how long-term nutrient management impacts weed community assembly. Nutrient management practices can influence weed diversity both directly, through seed immigration, and indirectly, by altering competition among weeds and crops. The application of manure increases the weed seedbank density, while composting manure can reduce weed seed viability (Larney and Blackshaw, 2003). Fertilizers, especially nitrogen (N), phosphorus (P), and potassium (K), also affect weed species differently, with nitrogen particularly favoring weeds like *Amaranthus retroflexus* and *Echinochloa crusgalli* (Blackshaw and Brandt, 2008; Moreau *et al.,* 2014).

The soil weed seedbank serves as a crucial indicator of long-term weed dynamics and management impacts. Seedbanks reflect both emerged weeds and those that will establish later, providing valuable insights into the legacy of farming practices (Cavers, 1995; Buhler *et al.,* 1997). Long-term studies have shown that soil nutrient levels can act as ecological filters, selecting for weeds that thrive in high or low fertility conditions (Ryan *et al.,* 2010). Fields with high nutrient concentrations tend to favor weeds adapted to fertile environments, while nutrient-poor soils select for more tolerant species (Tilman *et al.,* 1999; Ryan *et al.,* 2010). Research on organic and inorganic fertilizers has highlighted that manure treatments often result in higher weed seedbank densities due to seed immigration, while inorganic fertilizers affect weed communities by modifying soil conditions and nutrient availability (Fried *et al.,* 2008; Mahaut *et al.,* 2019). These findings underscore the importance of nutrient management in shaping weed diversity and promoting sustainable agricultural practices.[kt9]

1.5.4 Weed Management in Maize Systems

Weed management in maize systems is crucial for maintaining crop yields and quality, with traditional methods such as herbicide application and soil tillage commonly used. However, concerns about herbicide resistance and environmental impacts have led to the adoption of Integrated Weed Management (IWM) approaches, which combine cultural, mechanical, and biological methods. Practices like crop rotation, intercropping, and the use of cover crops can disrupt weed life cycles and reduce weed populations, while mechanical control methods like tillage and mowing, although effective, must be carefully managed to avoid soil degradation (Teasdale, 1998; Liebman *et al.,* 2000). Herbicide-resistant weed species, such as *Echinochloa crusgalli* and *Amaranthus retroflexus*, have led to the development of genetically modified (GM) herbicide-resistant maize, though concerns about long-term sustainability and environmental risks remain (Benbrook, 2012; Gianessi, 2005). Additionally, soil health management practices that promote beneficial microbial communities offer a promising direction for sustainable weed control (Cavigelli *et al.,* 2008).[kt10]

1.6 Research Aims Aim and Objective

1.6.1 Aim

To investigate the influence of maize cultivation on the development, diversity, and composition of weed species in a controlled potted experiment.

1.6.2 Objectives

i. To assess the effect of maize cultivation on weed species diversity in the rhizosphere.

ii. To compare the biomass and composition of weed species in maize-cultivated pots versus control pots without maize.

iii. To know the effect of Iron on weed population.

CHAPTER TWO

MATERIALS AND METHODS

2.1 Study area

This study was conducted in front of the botanical garden of the Department of plant Biology and Biotechnology, University of Benin (Ugbowo Campus), Benin City, Edo State.

2.2 Materials

Shovel, wheelbarrow, buckets, copper nano particle, hybrid maize, spray bottles, record book for taking readings, Data analysis applications.

2.3 Experimental design

The experiment was designed in a randomized full-block model with three well-spaced duplicates.

2.4 Research methodology

2.4.1 Soil collection

Reddish-brown soil was obtained from the Botanicalf Garden of the Department of Plant Biology and Biotechnology, University of Benin, Benin City. This soil was collected using a shovel from single area, uppermost part of the soil and wheelbarrow to transport the soil to the site of the experiment where it was mixed to obtain a homoginised mixture.

2.4.2 Site preparation

The experimental location was first cleared with cutlass to remove invasive species. This included cutting off surrounding branches that formed shades on some part of the site. 21 buckets where then lined up four (4) in a row with one extra as the control. These buckets were well spaced out to avoid clustering upon germination of the plants. The buckets where then filled with homogenized soil at equal proportions.

The Second experimental location was first cleared with a cutlass to remove invasive species. This included cutting off surrounding branches that provided shade on some parts of the site. Then the site was lined with a black tarpaulin. Layers of soil were then poured and spread on the tarpaulin. The purpose of this is for insulation, to help the polythene bag maintain a stable temperature; for anchorage, to help anchor polythene bags in place; for protection, to shield the polythene bag from damage by factors such as sunlight, pests or physical abrasion; and for weed control. 124 perforated polythene bags were then filled with the homogenised soil, labelled appropriately and mounted neatly on the site. The bags were arranged in 4 blocks and the treatments were randomised within these blocks.

2.4.3 Parameter score

The population study and weed identification of a potted experiment, number of weed in each bucket was collected and weed species were identified and given a voucher number to confirm the accuracy based on the herbarium makeup of the environment.

2.4.4 Planting sequence

The buckets were placed in a grid formation, four (4) in a row;

- The first row M1 and it’s three (3) replicates had no seeds in them creating a maize free environment in the bucket, serving as control.
- The second row M2 and it’s replicates had three (3) seeds each planted in a shallow holes.
- The third row M3 and it’s replicates had three (3) seeds each planted in three (3) shallow holes.
- The fourth row M4 and it’s replicates had three (3) seeds each planted in five (5) shallow holes.

- The fifth row M5 and it's replicates had three (3) seeds each planted in seven (7) shallow holes.

2.4.5 Treatment Designation

For the elevation of soil iron content level, I ESV, 2.5 ESV, and 4 ESV were adopted. The labels and their representations are as follows;

E_1 -Concentrations of Fe at I ESV

E_2 Concentrations of Fe at 2.5 ESV

E_3 Concentrations of Fe at 4 ESV

CNTRL-Without either treatment

2.4.6 Preparation of treatment

Two kinds of treatment were applied in this study: Elevation of the Ecological Screening Value (ESV) of Iron.

2.4.6.1 Elevation of the Soil's Ecological Screening Value (ESV) of Iron

The normal Ecological Screening Value (ESV) of iron (Fe) in the soil was increased by 1, 2.5 and 4 respectively. Therefore, the levels of ferrugenicity utilized in this study are IESV, 2.5ESV and 4ESV.

ESV of Fe is measured as 200mg of iron per kilogram of soil obtained. Since the soil in the treatment bags weighed 7kg, the amount of iron applied to the soil to get 1ESV was calculated as follows:

If ESV 200mg of Fe in 1kg of soil

Then, 7kg of soil needed 7 x 200mg

=1400mg of Fe or 1.4g of Fe.

For 2.5ESV,

Measurement for 1ESVx 2.5

=1.4g of Fe x 2.5

3.5g of Fe per 7kg bag of soil.

For 4ESV.

Measurement for 1ESVx 4

= 1.4g of Fe x 4

5.6g of Fe per 7kg bag of soil

For this particular treatment, the quantity of iron sulphate required to pollute or elevate the ESV for 5 bags of soil were measured together with a manual weighing balance and dissolved in 1 litre (1000ml) of water. The solution was then divided into 5 parts (1 part for each bag pertaining to the original measurements. 200ml of this solution was then measured into a container and water was added to make it up to 1000ml.

2.4.7 Data Analysis

A single-factor Analysis of Variance (ANOVA) was used to determine whether significant differences existed among the treatment groups. The test compared variance between and within groups to assess the impact of maize density on weed diversity. Since a significant effect was detected, a post-hoc Tukey's Honestly Significant Difference (HSD) test was conducted to identify which specific treatment groups differed significantly. Statistical significance was determined at a 95% confidence level ($p < 0.05$).

2.4.8 Planting and Treatment Application

The hybrid maize seeds (OBA SUPER-6) were checked entirely and sorted before being soaked for a few minutes in water. The nursery buckets were adequately watered before the maize seeds were placed in them, 1, 3, 5, 7 seeds per bucket. Twelve (12) weeks after planting, Readings were taken weekly as the plants were observed and watered regularly.

2.4.9 Experiment Management

The various practices were carried out at regular intervals

I. **Watering**

This was done twice a week in between varying periods of rainfall.

II. **Thinning**

This was done two weeks after germination after germination have occurred.

CHAPTER THREE

RESULT

The study demonstrated the varying effects of maize cultivation on both the population and diversity of weeds, with an increase in the number of maize plants per pot. The highest weed population was observed in M0, where no maize plants were present, with an average of 23.5 weeds. This population decreased slightly in M1, which had one maize plant, with an average of 19.75 weeds. The population further declined in M2, where three maize plants were present, with an average of 13 weeds. In M3, with five maize plants, the weed population decreased to 9.5. The lowest weed population was recorded in M4, which had seven maize plants, with an average of 7.25 weeds.

Table 1: Showing the mean population of weed in the experiment after 12 weeks.

POTS	Value
M0	23.5 ± 0.47
M1	19.75 ± 0.47
M2	13 ± 0.72
M3	9.5 ± 0.27
M4	7.25 ± 0.27

The analysis of variance revealed a statistically significant effect of maize plant population on weed diversity (F = 7.99, p = 0.00117). Since the F-value (7.99) is greater than the F-critical value (3.06), we reject the null hypothesis, indicating that at least one of the treatment groups differs significantly in terms of weed population. This suggests that maize density plays a crucial role in influencing weed diversity, potentially due to competition for essential resources such as light, water, and nutrients. This is shown in table 3.2 below.

Table 2: Analysis of variance of the effect of increased maize population on weed

ANOVA

Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Between Groups	753.3	4	188.325	7.99116	0.00117	3.055568
Within Groups	353.5	15	23.56667			
Total	1106.8	19				

The table presents the weed population (mean ± standard error) under different levels of elevated soil iron content (ESV). The control treatment, which consisted of only water, recorded a weed population of **16.00**. This serves as a baseline for comparison with the different iron concentration treatments.

At the lowest level of iron elevation (E1, 1 ESV), the weed population dropped to **9.33**, indicating a notable reduction in weed growth. The relatively higher standard error suggests some variability in the response among replicates. This decline in weed population at low iron levels may be due to iron toxicity, which could have inhibited the germination or growth of certain weed species.

In contrast, at a moderate iron level (E2, 2.5 ESV), the weed population increased to **20.33,** surpassing the control. The higher standard error in this treatment suggests variability in weed response, possibly due to differences in species tolerance to elevated iron. This result implies that while lower iron levels suppressed weed growth, a moderate increase in soil iron content might have created conditions favorable for certain weed species to thrive.

At the highest iron level (E3, 4 ESV), the weed population reached **21.33**, the highest among all treatments. The relatively lower standard error in this treatment indicates a more consistent response across replicates. This suggests that while lower iron concentrations initially suppressed weeds, higher levels may have benefited iron-tolerant species, leading to a resurgence in weed population.

Overall, the results indicate a non-linear relationship between iron content and weed population. At low iron levels, weed suppression was observed, likely due to toxicity effects. However, at moderate to high iron concentrations, the weed population increased, possibly due to improved nutrient availability or the selective advantage of iron-tolerant weed species.

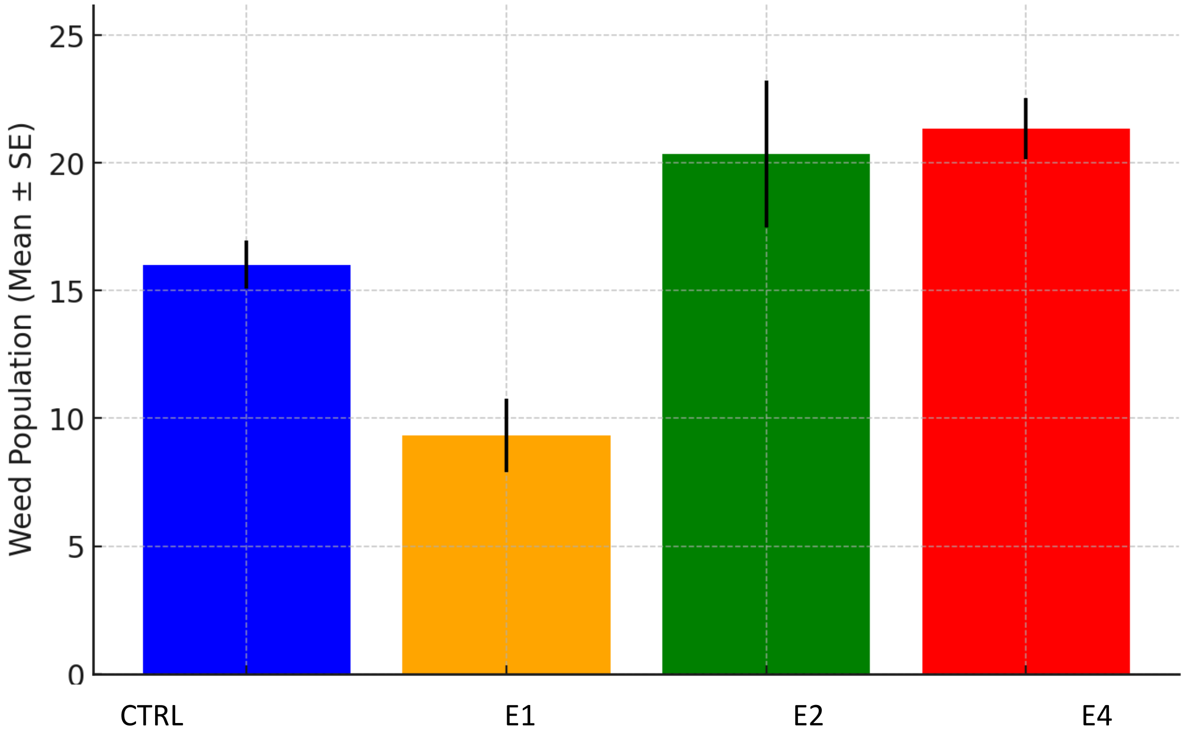

Figure 1: Effect of elevated soil iron content on weed population.

Where;

CTRL - Control (Water)

E1 - 1 Ecological Screening Value.

E2 - 2.5 Ecological Screening Value

E3 - 4 Ecological Screening Value

Table 3: The effect of different concentration of iron on the weed population

POTS	VALUE
CTRL	16.00 ± 0.94
E1	9.33 ± 1.44
E2	20.33 ± 2.88
E3	21.33 ± 1.19

The ANOVA results indicate a statistically significant difference in weed population among the different iron treatments. The mean weed population in the control was 16, while the treatment with 1 ESV (E1) reduced this to 9.33, showing weed suppression. However, higher iron levels, specifically in the 2.5 ESV (E2) and 4 ESV (E3) treatments, resulted in an increase in weed population to 20.33 and 21.33, respectively, suggesting that elevated iron levels favor weed growth.

In terms of variability, E2 exhibited the highest variance (37.33), indicating greater fluctuation in weed response, while E1 had moderate variability (9.33), suggesting some level of fluctuation in weed suppression. The control and E3 treatments had lower variances, indicating more consistent results in those treatments.

The F-value (6.27) exceeded the F-critical value (4.07), and the P-value (0.0169) was below 0.05, confirming that the differences observed were statistically significant and not due to random chance.

Therefore, the ANOVA analysis demonstrates that soil iron content significantly influences weed population. Lower iron levels (E1) suppress weeds, while higher levels (E2, E3) encourage growth. Given the significant F-value and P-value, it is clear that the variation in iron levels plays an important role in shaping weed diversity and abundance. This is shown in table 3.4 below.

Table 4: Analysis of variance on the effect iron on weed population

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	268.25	3	89.41667	6.274854	0.016979	4.066181
Within Groups	114	8	14.25			
Total	382.25	11				

The ANOVA results confirm that both iron treatments and maize density significantly affect weed population. Lower iron levels (E1) suppress weeds, while higher levels (E2, E3) promote their growth (**$F = 6.27$, $P = 0.0169$**). Similarly, increasing maize density leads to a significant reduction in weed population, with the highest maize density (m4) showing the lowest weed growth (**$F = 3.67$, $P = 0.0175$**). Given these significant differences, a post-hoc analysis (Tukey's HSD) may be necessary to determine which specific treatments differ significantly.

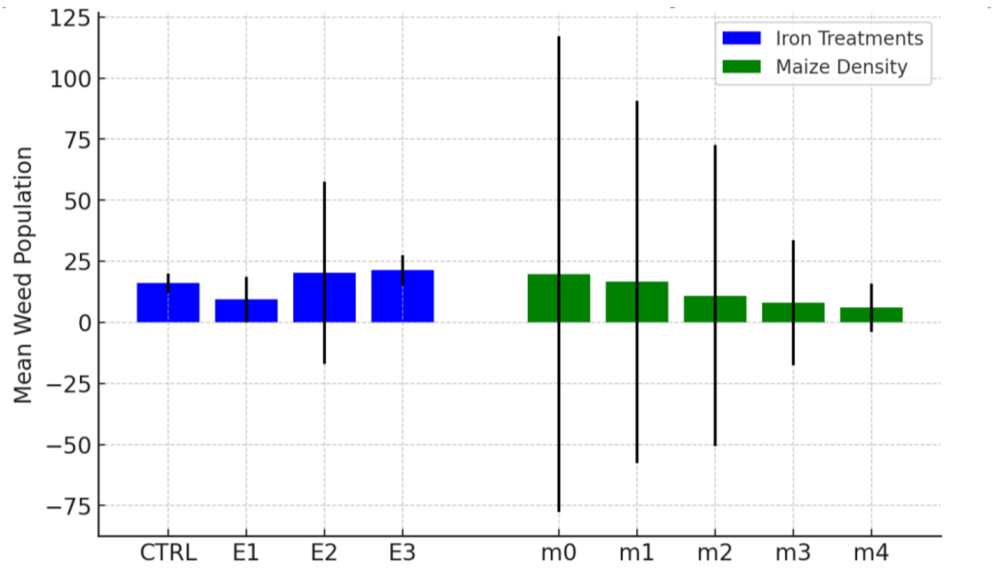

Figure 1: Comparison of iron treatment and maize density effects on weed population.

Table 5: List of Weeds Identified During the Experiment

Plant Name	Family	Herbarium Code
Platostoma africanum P. Beauv.	Lamiaceae	UBH-P487
Axonopus compressus (Sw.) P. Beauv	Poaceae	UBH-A513
Desmodium triflorum	Fabaceae	UBH-D654
Oldenladia corymbosa (Linn.)	Rubiaceae	UBH-O298
Lindernia crustacea (L.) F. Muell.	Linderniaceae	UBH-L524
Euphorbia heterophylla Linn.	Euphorbiaceae	UBH-E639
Cyperus rotundus	Cyperaceae	UBH-C458
Panicum maximum Jacq.	Poaceae	UBH-P245
Ludwigia abyssinica	Onagraceae	UBH-L544
Solenostemon monostachyus (P. Beauv) Brig.	Lamiaceae	UBH-S392
Peperomia pellucida [L.] H. B. & K.	Piperaceae	UBH-P602
Phyllantus niruri var. amarus [Schum. & Thonn.] Leandri	Phyllanthaceae	UBH-P406
Sida acuta	Malvaceae	UBH-S454
Syndrella nodiflora	Asteraceae	UBH-S303
Fimbristylis littoralis	Cyperaceae	UBH-F200
Gomphrena celosoides Mart.	Amaranthaceae	UBH-G203

(A)

(B)

(C)

(D)

(E)

Plate 1: Some weeds Identified in the experimental site

(a) *Desmodium triflorum* **(b)** *Gomphrena celosoides* Mart. **(c)** *Platostoma africanum* P. Beauv.*Lindernia crustacea* (L.) F. Muell. **(d)** *Euphorbia heterophylla* Linn. **(e)** *Oldenladia corymbosa* (Linn.)

Plate 2: Experimenal site after 21 weeks of experiment.

Plate 3: Experimental site 2 after 3 weeks of experiment.

CHAPTER FOUR

DISCUSSION

This research offers valuable perspectives into how maize cultivation influences weed diversity and abundance, particularly in a ferruginous soil environment. The findings revealed that increasing maize density effectively reduces weed populations due to competition for essential resources such as light, nutrients, and water. Similarly, iron amendment had a dual effect: lower iron concentrations suppressed weed growth, while higher levels promoted the proliferation of iron-tolerant weed species. These results align with previous studies on crop competition and nutrient influence on weed diversity.

The results demonstrated that as maize density increased, weed population declined significantly. This aligns with previous research by Mohler (2001), who reported that denser crop canopies effectively shade out weeds, limiting their access to light. Adeux et al. (2019) also observed similar trends, noting that higher crop densities reduce weed biomass and favor species that are more shade-tolerant. In this study, Panicum maximum and **C**yperus rotundus populations declined significantly in high-density maize plots, suggesting that these species rely on higher light availability to thrive. However, Ludwigia abyssinica persisted, which could be due to its ability to adapt to lower light conditions, as observed by Gibson et al. (2004).

Iron availability had contrasting effects on weed populations. While the lowest iron treatment (E1) suppressed weed growth, higher concentrations (E2, E3) led to an increase in weed abundance. This pattern is consistent with the findings of Siddiqui et al. (2012), who noted that micronutrient availability can influence weed germination and biomass accumulation. The increase in weed population at higher iron levels may be attributed to iron's role in enhancing plant enzymatic activities and chlorophyll synthesis, as described by Marschner (2011).

Furthermore, Pezeshki & DeLaune (2012) reported that iron amendments can alter soil microbial activity, potentially creating favorable conditions for iron-tolerant weed species.

The significant variance observed in weed responses across treatments suggests that certain weed species react differently to maize competition and soil iron enrichment. The high variance in the E2 treatment indicates that some species thrive under moderate iron levels while others are suppressed. This aligns with the research of Tilman (1999), who suggested that nutrient-enriched soils lead to heterogeneous weed growth patterns due to species-specific nutrient requirements.

The combined effects of crop density and soil nutrients on weed dynamics have been extensively documented in agronomic research. Chauhan & Johnson (2010) found that dense cereal crops suppress weeds by limiting access to key resources, a finding that is strongly supported by this study's results. Additionally, Bastiaans et al. (2008) emphasized that competition-based weed control favors certain weed species while suppressing others, which is consistent with the selective weed responses observed in this experiment. Similarly, Norsworthy & Oliveira (2007) highlighted that increased soil nutrients can enhance weed growth, particularly among nutrient-adaptive species, a pattern evident in the response of iron-tolerant weeds in this study.

CONCLUSION

This study highlights the dual role of maize population density and iron amendment in shaping weed diversity and abundance. While increased maize density suppresses weeds through competition, higher iron concentrations promote weed proliferation. These findings provide insights into integrated weed management strategies, emphasizing the need for balanced nutrient application and optimal planting densities to control weed populations effectively.

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