AGRONOMIC PERFORMANCE OF MAIZE (*Zea Mays* L.) MULCHED WITH *Chromolaena odorata* (L.) LEAF RESIDUES

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FACULTY OF AGRICULTURE

UNIVERSITY OF BENIN

BENIN CITY

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A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF CROP SCIENCE, FACULTY OF AGRICULTURE, UNIVERSITY OF BENIN, BENIN CITY, NIGERIA, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF AGRICULTURE DEGREE (B. AGRIC) IN CROP SCIENCE

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CERTIFICATION

This is to certify that the work contained in this project report titled "Agronomic performance of maize (*Zea mays* L.*)* mulched with *Chromolaena odorata* (L.) leaf residues" was carried out by Miss Gokeme Oboden (AGR1800207), of the Department of Crop Science, Faculty of Agriculture, University of Benin, Benin City, Edo State, Nigeria.

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Prof. S.U. Ewansiha   **Date**
Supervisor

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Prof. S.U. Ewansiha   **Date**
Head of Department

DEDICATION

This work is dedicated to God Almighty for grace He bestowed upon me to go through the higher institution successfully.

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And finally, to myself for showing up and showing out. I worked hard through the help of all my support systems and I'm proud of myself and the outcome.

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ABSTRACT

Maize (Zea mays) is one of the most important cereal crop worldwide. It contains starch, proteins, fibers, oils, and sugars. It plays a significant role in human and livestock nutrition. Nitrogen (N) is essential for crop growth and yield. The most common sources of nitrogen are NPK and urea. However, consistent usage of these inorganic fertilizers can have adverse effects on the soil which includes soil acidification, reduced soil microorganisms, alteration of soil PH, which in turn can affect the soil fertility. This has made it essential to utilize organic fertilizers like plant residues, which can improve soil fertility without causing damage to the soil.

Chromolaena odorata (L.) shows promise in boosting plant nutrient levels as mulch. Hence, this study is aimed to assess the agronomic performance of maize fertilized with C. *odorata.* The trial was conducted at the Faculty of Agriculture Teaching and Research Farm, University of Benin, Benin City, Nigeria. The experiment was laid out in a Randomized Complete Block Design (RCBD) replicated four times. The treatment involved the use of four rates of freshly cut C. *odorata* leaf residues (0, 1, 3, 5 kg m^{-2}). The variables studied were plant height, cob yield, grain yield and stover yield. Maize plant height and cob, grain and stover yields increased with increase in the levels of C. *odorata* plant residues (0-5 kg m^{-2}). Based on the present study, C. *odorata* residues has potential for use as a mulch in improving maize yield and soil quality.

CHAPTER ONE

INTRODUCTION

Maize (*Zea mays* L.*)* is the most important cereal crop after wheat and rice in respect of area and production (Shah *et al*., 2009). Maize grain contains starch (72%), protein (10%), oil (4.8%), fiber (5.8%), sugar (3.0%), and ash (1.7%) (Shah *et al*., 2009). In the sub-Saharan region, maize helps to reduce poverty and improve food security as it provides food for human and animal consumption (Zuma *et al*., 2018). Maize provides nutrients, and phytochemical compounds like carotenoids, phenolic compounds and phytosterols which play a crucial role in preventing chronic diseases (Rouf *et al*., 2016).

Nitrogen is an essential nutrient for maize and a key determinant in grain yield. Chemical fertilizers are now the primary source of nitrogen applied to cropland, although organic nitrogen from livestock manure remains important (Asibi *et al*., 2019). The repeated use of inorganic fertilizers may result in soil acidity, reduced crop yield, degradation of soil structure and increased erosion (Sharma *et al*., 2017). To minimize the negative impact of the persistent use of chemical fertilizers on the soil and crop, it is recommended to replace chemical fertilizers with organic fertilizers. The use of organic amendments such as farmyard manure, poultry manure, crop residue, and compost are an alternative to harmful effects of inorganic fertilizers (Diacono *et al.*, 2011). Green manure offers various benefits, such as regulating soil surface, temperatures with its substantial ground cover, enhancing soil organic matter, thereby improving soil physical properties, and serving to control soil erosion while conserving moisture during some parts of the year (Buckles *et al.*, 1998). Crop residues are major source of plant nutrients and recycled nutrients upon decomposition. Adding crop residues to farmland supports soil organic carbon, preserves soil fertility, moderates soil temperature, and enhances soil microbial activity (Cayuela *et al.*, 2009). Plant residues even contain up to eight times more nutrients than those provided by inorganic fertilizers, and they also include micronutrients that are absent in inorganic fertilizers (Odhiambo *et al.*, 2010).

Despite being an invasive species, *C. odorata* has been explored for its potential role in soil fertility. As a crop residue, C. *odorata* can be considered as a high biomass-producing plant (Quansah *et al.*, 2001). C. *odorata* is among the plant used as material for organic material and pesticide. It promotes the soil nutrients quality and leads to better soil texture and fertility. C. *odorata* also contributes to the vegetative growth of maize crops (Ahmad *et al.*, 2018). Application of C. *odorata* as mulch improves growth production, quality of forage of corn, while increasing Phosphorus and Nitrogen content in the soil (Kumalasari *et al.*, 2005). This study provides an understanding of the effect of C. *odorata* as fertilizer on maize yield and agronomic performance.

Therefore, this study was conducted to evaluate the agronomic performance of maize when mulched with *Chromolaena odorata* leaf residues and to determine the level of C. *odorata* leaf residue necessary for high grain yields.

CHAPTER TWO

LITERATURE REVIEW

2.1 *Chromolaena odorata*

Chromolaena odorata (L.) King and Robinson (Asteraceae), formerly known as Eupatorium odoratum L. is a weedy shrub, invasive and native to the Americas (Zachariades *et al.*, 2009). It is commonly referred to as "Awolowo," "Independence weed", Siam weed, triffid weed, bitter bush or jack in the bush. While originally from South and Central America, it has proliferated across the tropics including Nigeria (Ngozi *et al.*, 2009). Morphologically, C. *odorata* is a scrambling perennial shrub which grows 2-3 m in height with straight, pithy, brittle stems that branch readily. The arrowhead-shaped leaves are 6-12 cm in length and 3-7 cm in width, with three veins in a pitchfork appearance. The leaves grow in opposite pairs along the stems and branches. There are 15-25 tubular florets per head, each 10mm long and several colors such as white, purple, pink or blue. The color of the seeds is brown-gray to black and is 4-5 mm long with a pale brown pappus that is 5 or 6 mm long. The roots are narrow and fibrous and generally reach 0.3km in depth (Sirinthipaporn and Jiraungkoorskul 2017). C. *odorata* exhibits robust growth in diverse ecological settings, even beyond its native region. This adaptability is attributed to factors like the plant high reproductive rate, high nutrient assimilation rate, suppressive allelopathic effect on other plants, and its versatile growth in varying soil and climatic conditions (Olawale *et al.*, 2022).

2.2 Potential of C. *odorata* in crop production

C. *odorata* proves effective in improving soil physiochemical properties, suppressing weed growth, reducing soil temperature, conserving soil moisture and mitigating soil erosion leading to increased crop yield and enhanced crop quality (Mugwedi., 2020). In Ghana, Fening et al., (2009) observed increased maize Zea mays L. yield with C. *odorata* mulch (3t ha^{-1}) compared to the control (2.23 t ha^{-1}). C. *odorata* contains considerably high soil nutrients (21.94% N, 0.60% P, and 1.58% K), It is also considered as biomass holding the potential to restore soil fertility. This further improves the growth of plant (Ahmad *et al.*, 2018).

2.3 Nutrient concentration of maize plant

Maize being an exhaustive crop, requires a large quantity of nutrients during different growth periods. The intensive cropping system where nutrients are utilized in huge quantity which changes soil texture and structure alters the availability of nitrogen and phosphorus and it directly affects the yield of any crop (Khan *et al.*, 2014). For optimal growth and development of maize plants, essential nutrients like nitrogen, phosphorus and potassium are crucial. Following nitrogen, phosphorus holds the second most crucial position as a mineral nutrient in meeting quantitative plant requirement (Sandakiya and Sanodiya 2021). Nitrogen is essential for carbohydrate uses within plants and stimulates root and development as well as uptake of other nutrients while phosphorus is essential for inflorescence, grain formation; ripening and reproductive part of maize plant (Khan *et al*., 2014). Potassium plays a vital role in protein synthesis, enzyme activation, photosynthesis, regulation of plant stomata and many other processes (Sadiq *et al*., 2017). Other micronutrients like manganese, iron, zinc etc. are needed in small quantities and they affect directly or indirectly photosynthesis, vital processes such as respiration, protein synthesis, and reproduction stage (Salem *et al*., 2012)

2.4 Maize performance in nutrient rich soils

According to research compiled by Agegenehu *et al*., 2017, organic fertilizers can improve soil fertility and structure, which can subsequently enhance crop growth and development. Highly demanding of nutrients, maize thrives on effective nutrient management to reach its full yield potential. Unfortunately, ideal soils rich in nutrient are scarce. Organic manures offer a double benefit: not only do they provide essential plant nutrients, but they also enhance soil health. (Kannan *et al*., 2013)

2.5 Maize performance in nutrient poor soils

If the supply of nutrients does not align with the demand of the crops, such management practices can have adverse effects on both nutrients use efficiency and long-term crop productivity. Wang *et al*., (2010) analyzed a 15-year experimental data studying N, P, and K dynamics, crop yield, and nutrient uptake under nine different fertilization regimes. Their aim was to assess the impact of various fertilization strategies on crop yield, nutrient use efficiency and soil nutrient accumulation. They found that nitrogen and phosphorus were crucial for crop growth, as evidenced by significantly lower yields (approximately 2t ha^{-1} for wheat and 3t ha^{-1} for maize) observed in plots lacking supplementary N and P fertilizers. In a study carried out by Buchaillot *et al*., (2019), it was shown that the absence of N acts as a major roadblock to boosting cereal yields in regions of Sub-Saharan Africa.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Experimental site

The field experiment was carried out in the rainy season of 2023 on the Faculty of Agriculture Training and Research Field, University of Benin, Benin City, Nigeria (06^0 20 'E, 5^0 39' E; 78m asl) in the Rainforest of South-south of Nigeria with an annual rainfall of 2025 mm and annual average temperature of about 26.1 °C (Ogeh and Ukodo, 2012).

3.2 Maize cultivar

OP maize, cultivar Sammaz 52 (matures in 110 -120 days, which consists of intermediate levels of pro-vitamin A content, tolerant to maize streak virus, rust, leaf blight and auricularia leaf spot, yields 6 t ha^{-1} in Northern Guinea savanna) was obtained from Premier Seed Company Ltd, Zaria, Nigeria for the study.

3.3 Experimental design and treatments

The experiment was laid out in a Randomized Complete Block Design (RCBD) replicated four times. The treatment consisted of four rates of *Chromolaena odorata* leaf residues (0, 1.0, 3.0, 5.0 kg m^{-2}). Each treatment plot was measured at 2.25 m x 2.0 m. Two plots were separated by 0.75 m and two replications by 0.75 m.

3.4 Land preparation

At the beginning of experimentation, the land was cleared manually using cutlass. The debris was gathered and removed from the field without burning.

3.5 Sowing

Two seeds were sown 4-5 cm deep in a moist soil on the 7th of August 2023 at a spacing of 75 cm x 25 cm to achieve a plant population of 53333 plants ha^{-1}. Seedlings were thinned to one plant per stand two weeks after sowing.

3.6 *Chromolaena odorata* plant residues application

Freshly cut *Chromolaena odorata* plant parts (tender stems and leaves) was applied thrice during the trial: at sowing, 2 weeks after sowing (WAS) and 4 WAS. Each treatment was divided into three equal parts and a part was applied at each time of application.

3.7 Weed control

Weeding was carried out twice, 3 and 5 WAS sowing. At each time of weeding, weed density and weed weight was measured.

3.8 Data collection

Data was collected from a net plot.

3.8.1 Plant height

The height in cm of five consecutive plants from the base of the plant to where tassel branching began (pht) was determined.

3.8.2 Cob yield

The weight of harvested cobs after air-drying for one week was recorded.

3.8.3 Grain yield

The dried maize was threshed and weighed. The weight of grain was recorded. The grain DM per plant was calculated.

3.8.4 Stover yield

Leaf weight, husk weight and stem weight were added to calculate stover yield ha^{-1}.

3.9 Data analysis

Data was subjected to analysis of variance (ANOVA) using the PROC ANOVA procedure of SAS. Separate means using LSD test at p=0.5%.

CHAPTER FOUR

RESULTS

4.1 Plant height of maize mulched with C. *odorata*

Plant height at different plant residue treatment levels is summarized in Figure 1. Plants grew taller with increasing treatment levels, ranging from 113cm to 166cm, with plant height mean of 142.60. Significant differences occurred among the various levels of treatment. Interestingly, no significant height differences were detected between 3 and 5 kg m^{-2} treatment groups.

4.2 Cob yield of maize mulched with C. *odorata* residues

Cob yield significantly varied across treatment plots. Plants fertilized with the highest dose of C. *odorata* (5 kg m^{-2}) produced the most cob yield, while those receiving no fertility (0 kg m^{-2}) had the lowest yield. The cob yield ranged from 27 to 100 kg, with an average of 69.7 kg. There were no significant differences in cob yield of plants mulched with 3 and 5 kg m^{-2}. A similar trend was observed at 1 and 3 kg m^{-2}

4.3 Grain yield of maize mulched with C. *odorata* residues

Treatment plots showed notable variations in grain yield. The highest grain yield was observed in plants mulched with 5 kg of C. *odorata*, whereas plots with no fertilizer treatment (0 kg) recorded the lowest. The grain yield ranged from 19 to 74 kg with an average mean of 52.5 kg. No significant differences were noted in the grain yield between plants mulched with 3 and 5 kg m^{-2}.

4.4 Stover yield of maize mulched with C. *odorata* residues

Stover yield significantly differed among treatment groups. Plants fertilized with the highest dose of C. *odorata* (5 kg m^{-2}) produced the most stover, while those receiving no fertilizer (0 kg m^{-2}) had the least. The stover yield ranged from 24 to 66 kg with an average of 47.2 kg. There were no significant differences between 3 and 5 kg m^{-2} treatments.

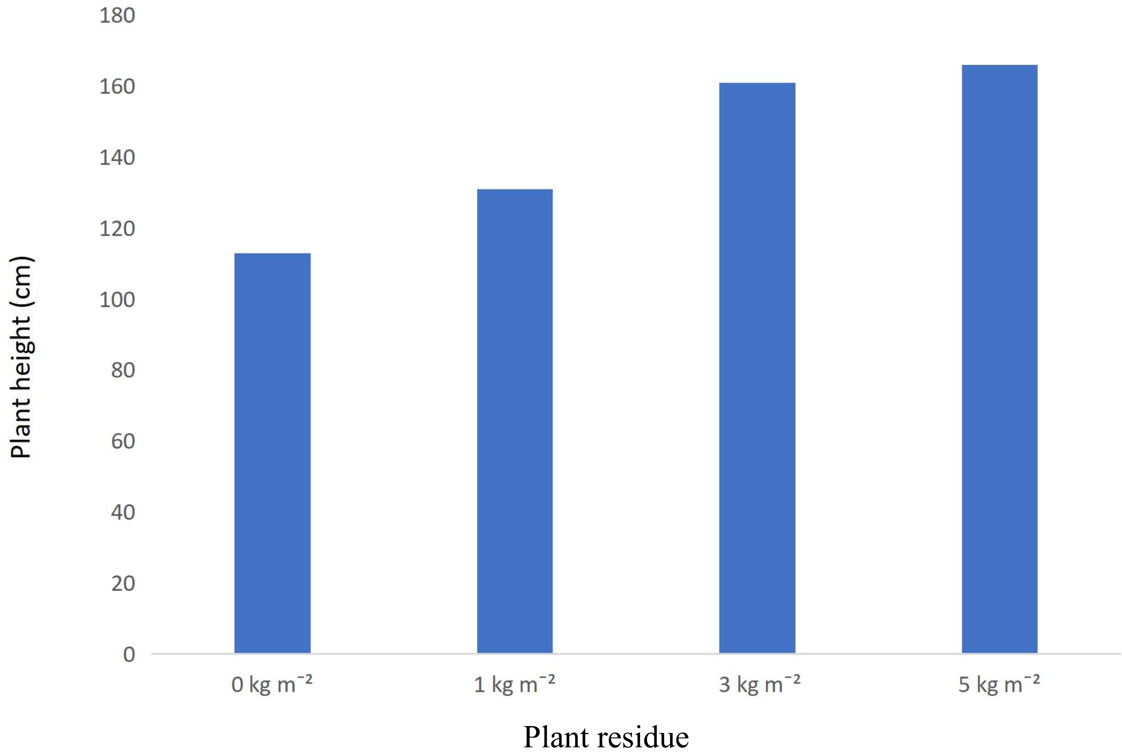
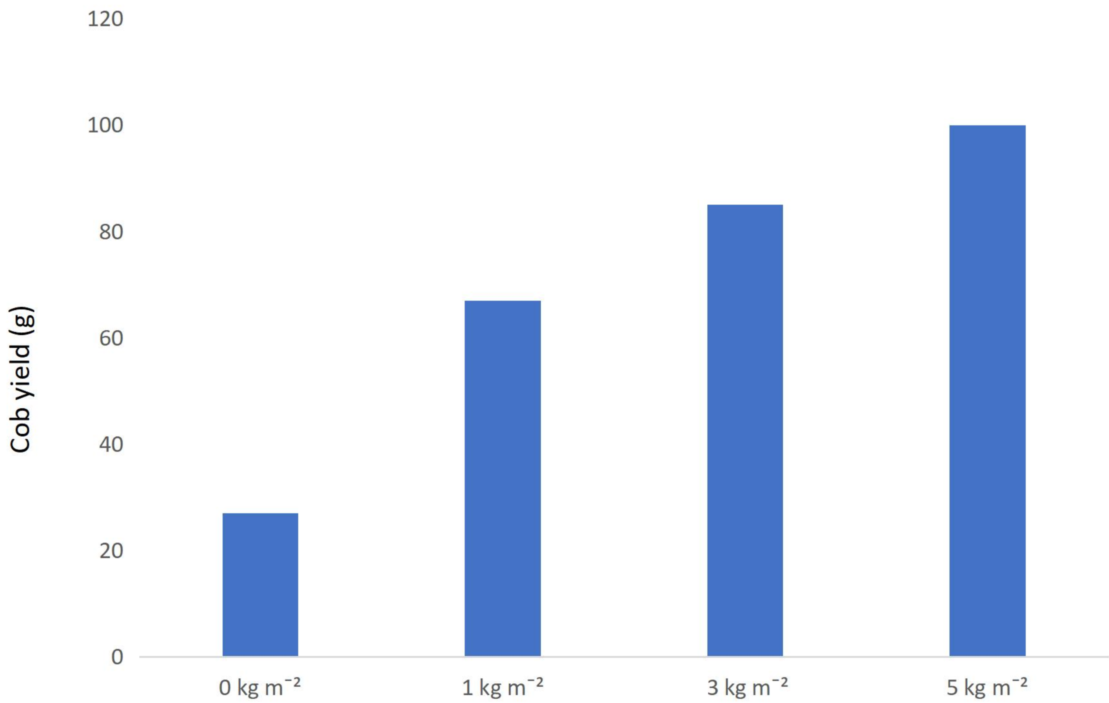


Figure 1. Plant height of maize mulched with C. *odorata* residue



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lant residue

Figure 2. Cob yield of maize mulched with C. *odorata* residues

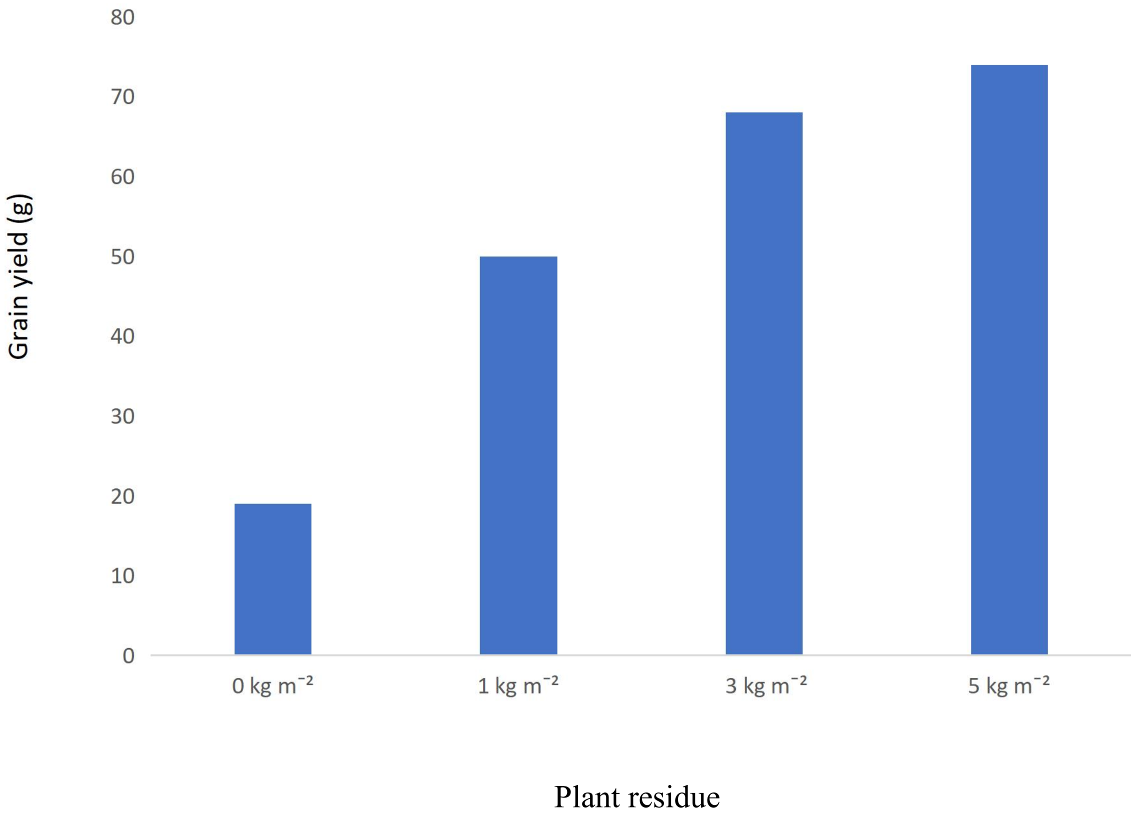

Figure 3. Grain yield of maize mulched with C. *odorata* residues

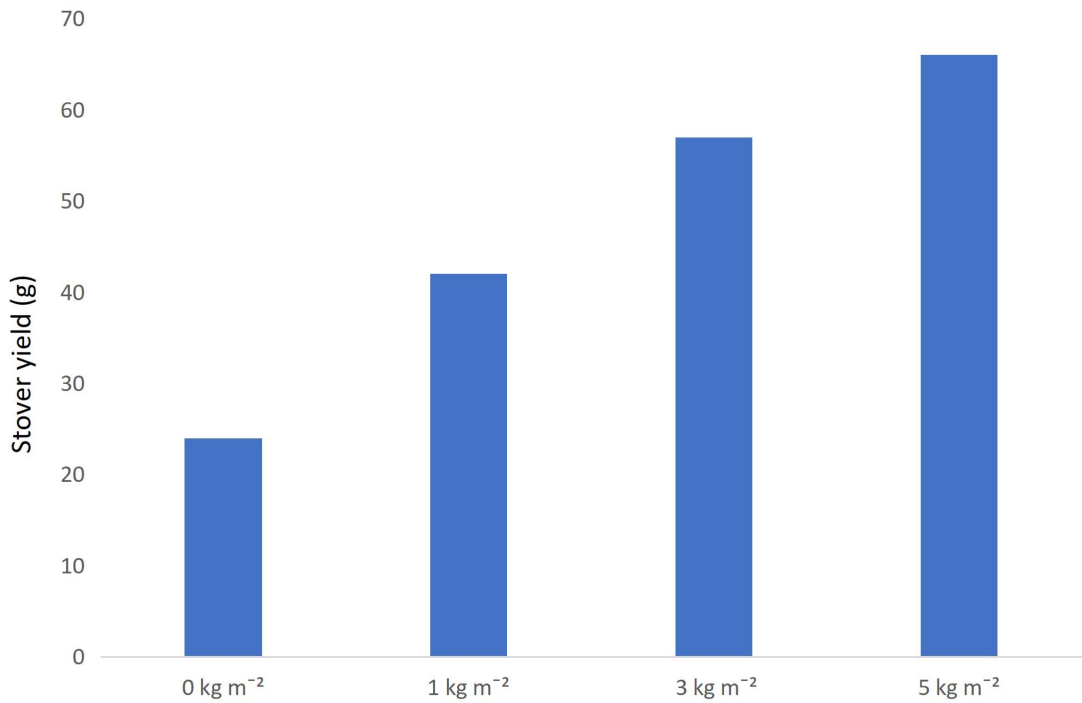

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Figure 4. Stover yield of maize mulched with C. *odorata* residues

CHAPTER FIVE

DISCUSSION

Plant residue influenced plant height, cob yield, grain yield and stover yield. Plant height, cob yield, grain yield and stover yield increased with increase in the level of applied plant residue. This suggests that *Chromolaena odorata* can furnish good plant growth and yield. This may be due to the release of N and other nutrients to soil as the mulch decayed. This suggests that the study effectively captured how maize responded to the four treatment levels (0,1,3 and 5 kg m^{-2}) of C. *odorata* residues. Notably, the soil responded positively, showing an increase in N concentration as the treatment level rose, with highest concentration observed at 3 and 5 kg m^{-2}. Findings of Fening *et al*., (2009), align with the positive impact of C. *odorata* mulch on maize. The considerable soil nutrient content of C. *odorata,* particularly its nitrogen concentration, provided agreement with the observed enhancement in maize productivity, as seen in the results of the experiment carried out.

Plant height significantly increased with increasing levels of C. *odorata* application, and there were no significant differences at plant residue levels of 3 and 5 kg m^{-2}. This aligns with Ahmed *et al.*, 2018 who discovered improved maize yield and performance with C. *odorata* residues.

Similarly, cob yield, grain yield and stover yield were significantly influenced by the four rates of application. The yields demonstrated an increase corresponding to the treatment level, with 5 kg m^{-2} yielding the highest results. These findings further support the notion that C. *odorata* improves growth production and quality of forage of maize (Kumalasari *et al.*, 2005).

Conclusion

Maize performance as measured by plant height, cob yield, grain yield and stover yield, significantly varied across treatment plots. Notably, plants receiving the highest dose of C. *odorata* residues (5 kg m^{-2}) consistently outperformed others in all studied parameters. It was also observed that there were no significant differences between treatment levels of 3 and 5 kg m^{-2}. This response strongly suggests that applying C. *odorata* residues as mulch holds significant promise for maintaining soil fertility and enhancing maize yield in the studied region.

Recommendations

Based on the study findings, C. *odorata* residues should be considered as mulch in maize cultivation at a recommended rate of 3 kg m^{-2} treatment.

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