

**AGRONOMIC RESPONSE OF MAIZE (*Zea mays* L.) TO THE APPLICATION  
OF NEEM (*Azadirachta indica* A. Juss) LEAF POWDER**

**BY**

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**A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF CROP  
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## CERTIFICATION

This is to certify that the work contained in this report titled “**Agronomic response of maize (*Zea mays* L.) to application of Neem (*Azadirachta indica* A. Juss) leaf powder**” was carried out by **Clare Imoitsemeh APEMIYE (Miss) (AGR2004335)** of the Department of Crop Science, Faculty of Agriculture, University of Benin, Benin City, Edo State, Nigeria.

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## **DEDICATION**

I dedicate this project report to God Almighty who has been the source of my strength, finance, provisions, wisdom, understanding and inspiration.

## ACKNOWLEDGEMENTS

First and foremost, I give thanks to God Almighty for the strength and resources granted throughout this project.

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## ABSTRACT

Maize (*Zea mays* L.) is a staple crop critical for global food security, yet its productivity is often constrained by soil nutrient deficiencies, pest infestations, and reliance on synthetic inputs. This study evaluated the agronomic response of maize to the application of neem leaf powder, an organic amendment derived from *Azadirachta indica*, as a sustainable alternative for enhancing soil fertility and plant performance. The study was conducted at the Teaching and Research Farm of the Faculty of Agriculture, University of Benin, Benin City. The experiment was laid out in a Randomized Complete Block Design (RCBD) and replicated five times. The treatment comprised four rates of *A. indica* leaf powder (0.0, 60.0, 120.0, and 180.0 Kg ha<sup>-1</sup>). Percent emergence, Percent establishment, Days to tasseling, Plant height, Number of ears harvested and Stover yield were evaluated. The results showed that the leaf powder significantly improved maize growth. The best performance was obtained from the plots incorporated with 180kg of *A. indica* leaf powder. The study concludes that *Azadirachta indica* leaf powder, is a viable and eco-friendly organic fertilizer for maize cultivation and reducing chemical dependency.

## CHAPTER ONE

### INTRODUCTION

Maize (*Zea mays* L.) is a staple cereal crop cultivated globally for food, feed, and industrial uses. It is a primary source of carbohydrates and provides essential nutrients to millions of people, particularly in Sub-Saharan Africa, including Nigeria. Maize also contributes significantly to income generation for smallholder farmers and serves as raw material for industries involved in food processing, brewing, and biofuel production (Iken and Amusa, 2004). Given its high yield potential and diverse applications, enhancing maize productivity remains a critical goal in crop research and agronomic practices.

Maize, like most cereals, requires substantial amounts of mineral nutrients, particularly nitrogen (N), phosphorus (P), and potassium (K), to support its vegetative growth, flowering, and grain filling stages. Deficiencies in these nutrients significantly reduce yield and compromise grain quality (Mengel and Kirkby, 2001). Consequently, adequate nutrient management plays a key role in maize production systems.

Inorganic fertilizers have traditionally been used to supply essential nutrients to crops. While they are effective and provide immediate nutrient availability, excessive or continuous use often leads to soil acidification, nutrient imbalances, and environmental degradation (Savci, 2012). Moreover, the rising cost of inorganic fertilizers poses economic constraints for smallholder farmers in developing countries.

Organic fertilizers are natural materials derived from plant, animal or mineral sources that contain moderate amount of plant essential nutrients. Organic sources of nutrients, such as compost, manure, and green manures, have gained attention as environmentally friendly alternatives. These materials improve soil structure, water retention, and microbial activity while slowly releasing nutrients for plant use (Ayoola and Makinde, 2008). Among such organic resources, *Azadirachta indica* (commonly known as neem) has attracted research interest due to its multipurpose role in agriculture.

Neem is a fast-growing evergreen tree native to the Indian subcontinent but widely grown in tropical regions. Its leaves, bark, and seeds are known for their pesticidal, medicinal, and soil-enriching properties. In crop production, neem-based products have been used for pest control, soil improvement, and nutrient supply (Isman, 2006). Neem leaf powder, in particular, contains essential plant nutrients and bioactive compounds that may support plant growth while suppressing soil-borne pests and diseases (Kumar and Chauhan, 2017).

Recent studies suggest that neem leaf powder may serve as a sustainable nutrient source for maize production. It contains appreciable amounts of nitrogen, phosphorus, potassium, calcium, and trace minerals (Subbalakshmi *et al.*, 2012). Furthermore, its slow-release properties reduce nutrient loss and enhance soil microbial activity (Sathya and Ramesh, 2013). The use of neem leaf powder as an organic amendment

offers a promising approach to reducing dependence on synthetic fertilizers and promoting agroecological farming systems.

### **1.1 Justification of the Study**

Given the environmental risks associated with inorganic fertilizers and the economic burden they pose, it is imperative to explore alternative sources like neem leaf powder. *Azadirachta indica* (neem) leaf powder offers a promising solution due to its dual role as a natural fertilizer and bio-pesticide. It contains essential plant nutrients and bioactive compounds that improve soil fertility, support plant growth, and suppress pests and diseases. Moreover, neem is widely available in tropical regions, making it an accessible input for sustainable agriculture. This study is important because it explores a low-cost, eco-friendly alternative to synthetic fertilizers in maize production. The findings may contribute to sustainable nutrient management, soil health improvement, and reduced production costs for resource-poor farmers. Additionally, promoting the use of locally available organic materials like neem leaf powder aligns with global goals for sustainable agriculture and environmental conservation.

### **1.2 Objectives of the Study**

The specific objectives of this study were to:

- i. To determine the nutrient composition of *A. indica* leaf powder and its suitability as a source of plant nutrient for maize

- ii. To assess the effects of *A. indica* leaf powder application on maize growth parameters
- iii. To compare the response of maize treated with *A. indica* leaf powder with a control

## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.1 *Azadirachta indica***

*Azadirachta indica* belongs to Meliaceae, a family of dicots mostly represented by trees and shrubs. The family includes about 51 genera and 550 species, with many of them prized for their wood, edible fruits and medicinal and ornamental qualities (Wiart, 2006).

It is a small to medium sized evergreen tree with a height of 15 m (30 m maximum), having a large rounded crown (10-20 m) with spreading branches and a branchless bole. The bark of the tree is thick, fissured, dark grey to red (inside) in colour, and it possesses a gummy colourless sap. The leaves are long (20-40 cm), alternate, pinnate, exstipulate and glabrous with a light green hue. The leaves have two pairs of basal glands with a subglabrous petiole and above, channeled rachis. Each leaf comprises 8-19 serrated, proximally alternate, ovate to lanceolate leaflets. Flowers of the tree are small (1 cm in diameter), white or pale yellow and sweet smelling. They are actinomorphic, pentamerous and bisexual or unisexual male in the same plant. The calyx of the flowers is imbricate, ovate, thin and puberulous from inside, while petals

are free, spreading, imbricate, spathulate and ciliolate from inside. Fruits are single (maximum of two) and small (1-2 cm) in size. They are greenish to yellow in colour and an ellipsoidal seeded drupe. The tree has a thin exocarp, pulpy mesocarp, and cartilaginous endocarp. Seeds are unwinged, oval or spherical structure with thin testa. The tree has a profound taproot system with widespread lateral roots. It may form suckers if roots encounter some damage (Hearne 1975; Csurhes, 2008; Hashmat *et al.*, 2012).

Although it thrives in a wide range of neutral to alkaline soils, it does best in shallow, rocky, sandy soils and areas where hard calcereous or clay pan is present below the surface. It thrives in soils with a pH between 6.2 and 7.0. Neem has demonstrated activity as a nitrification inhibitor, helping to slow the bacterial activity that is responsible for denitrification, hence decreasing the loss of urea from the soil (Mohanty *et al.*, 2008).

Neem contains melicians (generally known as neem bitters) of which Epinimbin, Diacetyl and Azadirachtin are the main fractions, which are responsible for nitrification inhibition action (Devakumar 2016).

The plant contains nutrients such as, N (2.0% to 5.0%), P (0.5% to 1.0%), K (1.0% to 2.0%), Ca (Calcium 0.5% to 3.0%), Mg (Magnesium 0.3% to 1.0%), S (Sulphur 0.2% to 3.0%), Zn (Zinc 15 ppm to 60 ppm), Cu (Copper 4 ppm to 20 ppm), Fe (Iron 500 ppm to 1200 ppm), Mn (Manganese 20 ppm to 60 ppm) (Schmutterer, 2002).

Neem plays an important role in both urban and rural landscape. It's well-formed crown and short deciduous period has made it a popular choice for shade planting around buildings and along roadside. It is also used on farms as pasture tree to shade livestock. It is used in windbreaks and shelterbelts to protect crops from wind damage and soil erosion. Because of these activities, neem has found enormous application making it a green treasure.

## **2.2 Use of Plant parts in Soil Fertility Improvement**

Soil fertility is a fundamental component of sustainable agriculture, and organic approaches using plant materials have been recognized as effective methods of maintaining or improving soil productivity. The use of various plant parts such as leaves, stems, roots, barks, pods, and green biomass as organic amendments is gaining traction due to their ability to supply nutrients, improve soil physical and biological properties, and reduce dependence on synthetic fertilizers.

Plant residues play a vital role in enhancing soil organic matter content, which in turn improves soil structure, water retention, and aeration (Palm *et al.*, 2001). When decomposed, plant parts release essential nutrients such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and micronutrients, making them bioavailable for plant uptake (Buresh and Tian, 1997). For instance, the application of leaf biomass from legumes like *Gliricidia sepium* and *Leucaena leucocephala* has been shown to improve nitrogen availability due to their high nitrogen content and faster decomposition rates (Giller and Cadisch, 1995).

Leguminous plants are especially valued in organic fertility enhancement due to their nitrogen-fixing ability and high-quality biomass. Green manuring with plants such as *Mucuna pruriens* and *Crotalaria juncea* contributes significantly to nitrogen enrichment in soils (Okalebo *et al.*, 2006). When used as leaf mulch or incorporated into the soil, legume residues improve nutrient cycling and help in maintaining nutrient balances in cropping systems.

Different plant parts vary in their decomposition rates and nutrient content. For example, leaves tend to decompose faster and release nutrients more rapidly compared to woody stems or bark. Research by Fasina and Adeyanju (2006) demonstrated that neem (*Azadirachta indica*) leaves significantly improved maize yield and soil nitrogen status when applied as mulch or powder. Similarly, banana stems, sugarcane bagasse, and coconut husks have been used to enhance organic matter content in tropical soils (Oti *et al.*, 2018).

The application of plant residues stimulates microbial activity in the soil by serving as substrates for microbial metabolism. Increased microbial biomass enhances the mineralization of organic matter and facilitates nutrient availability (Ayoola and Adeniyani, 2006). Mulches from plant materials, such as cassava peels and cowpea residues, have been reported to promote microbial proliferation, thereby improving soil biological fertility (Adekiya and Agbede, 2009).

Incorporating fibrous plant materials, such as maize stover or rice husks, can enhance soil structure and reduce bulk density. This leads to better root penetration, water

infiltration, and resistance to erosion (Obi and Ebo, 1995). These improvements are particularly important in sandy or degraded soils commonly found in tropical regions.

### **2.3 Use of *A. indica* in Soil Fertility Improvement**

Neem has proven use as a fertilizer, with the organic and inorganic compounds present in the plant material acting to improve soil quality and enhance the quality and quantity of crops. The waste remaining after extraction of the oil from neem seeds (neem seeds cake) can be used as a biofertilizer, providing the macronutrients essential for plant growth (Ramachandran *et al.*, 2007; Lokanadhan *et al.*, 2012).

Nitrogen is one of the main nutrients required by plants for their development, and urea is the main source of nitrogen fertilizer used worldwide to supply the nitrogen demand of crops. The control of urea hydrolysis and nitrification is one of the principal strategies employed to avoid nitrogen losses in agriculture (Ni *et al.*, 2014). Neem has demonstrated activity as a nitrification inhibitor, helping to slow the bacterial activity that is responsible for denitrification, hence decreasing the loss of urea from the soil (Musalia *et al.*, 2000; Mohanty *et al.*, 2008).

Manure is any animal or plant material used to fertilize land especially animal excreta for improving the soil fertility and thus promoting plant growth (Tiwari, 2002; Singh *et al.*, 2006). Neem manure is gaining popularity because it is environmentally friendly and also the compounds found in it helps to increase the nitrogen and phosphorus content in the soil. It is rich in sulphur, potassium, calcium, nitrogen, etc (Adeoye *et al.*, 2008). Neem cake is used to manufacture high quality organic or

natural manure, which does not have any adverse effect on plants, soil and other living organisms. It can be obtained by using high technology extraction methods like cold pressing or other solvent extraction. It can be used directly by mixing with the soil or it can be blended with urea and other organic manure like farm yard manure and sea weed for best results.

Neem and its part are being used to manufacture urea coating agent to improve and maintain the fertility of soil. Use of neem urea coating agent helps to retard the activity and growth of the bacteria responsible for denitrification (Bains *et al.*, 1971). It prevents the loss of urea in the soil. It can also be used to control a large number of pests such as caterpillars, beetles, leafhoppers, borers, mites etc. Urea coating is generally available either in liquid form or powdered form.

Neem seed granules or powdered seeds are used to manufacture the soil conditioner. It can be applied during sowing of seeds or can be sprinkled and raked into the soil. The process of sprinkling method should be followed by proper irrigation so that the product reaches the roots. It is a natural soil conditioner that helps improve the quality of soil, thereby enhancing the growth of plants and fruits (Smith *et al.*, 2001). This natural soil conditioner is also multi-functional and in the subtropical regions, it's application in plantation crops is known to be a soil enhancer that helps to increase it's fertility.

#### **2.4 Yield Performance of Crops when Fertilized with *A. indica* Leaf Powder**

Several studies have documented increased crop yields following the application of neem leaf powder. For example, Abubakar *et al.*, (2018) found that the use of neem leaf powder significantly improved the growth and yield of tomato (*Solanum lycopersicum*), attributing this to its nitrogen content and pest-suppressing properties. Similarly, Olabode *et al.*, (2019) reported that okra (*Abelmoschus esculentus*) treated with neem leaf powder showed higher fruit yield and reduced pest infestation compared to the control.

In cereal crops, neem leaf powder has been successfully applied to maize (*Zea mays*) production. Lawal and Amos (2020) observed that plots treated with neem leaf powder at 5 tons/ha recorded significantly higher grain yield and biomass than those without fertilizer. The study concluded that neem leaf powder serves both as a nutrient source and a growth enhancer.

In a comparative study, Yusuf *et al.*, (2022) found that maize plants treated with neem leaf powder alone had yields comparable to those treated with recommended rates of NPK, particularly when combined with other organic amendments.

In addition to improving yield through nutrient contribution, neem leaves contain azadirachtin and other limonoids known for their insecticidal and fungicidal properties (Isman, 2006). This dual action of nutrient supply and biopesticide effect helps improve crop health and productivity. Ganiyu *et al.*, (2016) showed that cowpea (*Vigna unguiculata*) fertilized with neem leaf powder had lower incidences of aphid infestation and better pod development.

Plant height is a growth parameter and indicates the influence of various nutrients on plant metabolism. The significant increase in the plant height of wheat by use of coated urea might be explained by the fact that neem and zinc coated urea played a major role in the shoot and root elongation due to the activation of auxin hormone in the wheat crop. (Shivay and Prasad 2012). Kumar *et al.*, (2016) also found that plant height was more enhanced when coated urea was combined with micronutrients. It can provide nutrients for the plant or aid in the transport or absorption of available nutrients resulting in better crop growth.

## **2.5 Yield Performance of Maize when Fertilized with *A. indica* Leaf Powder**

Application of neem leaf extract has been shown to positively influence maize growth metrics. According to Dwivedi *et al.*, (2022), the application of neem cake (0.57 t/ha), urea (130.5 kg/ha), zinc (5 kg/ha), and boron (0.5 kg/ha) was shown to be more productive and may be used by farmers to gain the most yield and financial returns from their maize crop. The maximum yield of green gram was achieved by Devakumar *et al.*, (1992) using an NPK rate of 20:40:00 kg/ha together with 1 t/ha neem cake. He attributed the higher yield to the positive effects of the treatment's higher growth parameters, the large amount of stored photosynthetic energy that was transferred into different yield attributes, the ongoing mineralization process and the availability of nutrients in accordance with the plant growth later stages.

Ano and Agwu (2015) argued that neem extract had the potential to increase yield in maize because it is rich in especially, Nitrogen and Phosphorus and some trace elements such as boron (B), magnesium (Mg), calcium (Ca) essential for the formation of cobs and grain in maize, hence a high concentration of the extract boost cob and seed formation. Additionally, neem extracts contained phytochemical properties, which repelled and contributed to the mortality of pests, which affects plant growth and yield (Doshi *et al.*, 2022). Lokanadhan *et al.*, (2012) also pointed out that *Azadirachta indica* used in the form of leaf extracts, seeds, cakes, oil and fruit extracts has insecticidal, antifeedant, hormonal, antifungal, antiviral and nematocidal properties. *Azadirachta indica* leaf powder and related neem products promote vegetative growth in maize by improving nutrient uptake and reducing biotic stresses. In pot experiments, neem seed powder (similar in application to leaf powder) at 71-106.5 g/pot combined with organic manure increased leaf area index (LAI) by up to 80% at 6 weeks after planting (WAP), enhanced number of leaves, and boosted straw biomass compared to controls (Dzomeku and Amegbor, 2013). Plant height and internodes were not significantly affected, but overall dry matter at harvest improved, attributed to suppressed parasitic weed (*Striga*) infestation.

Neem leaf extracts at concentrations of 200 g/L significantly enhanced maize height, stem girth, and leaf count, reducing pest damage and promoting early growth (Agyare *et al.*, 2024). Neem leaf extracts for pest control indirectly improved yields; 200 g/L

extract reduced fall armyworm damage, yielding 13.6-105.7% advantages over untreated plots (Agyare *et al.*, 2024; Agbodzie *et al.*, 2024).

## CHAPTER THREE

### MATERIALS AND METHODS

#### 3.1 Experimental Site

The experiment was conducted during the late cropping season (June - September) of 2025 at the Faculty of Agriculture Teaching and Research Farm, University of Benin, Benin City, Nigeria. The site is geographically located at coordinates 6.3996771 N, 5.6290233 E. The area is characterized by a humid tropical climate. It is within the rainforest agroecological zone of Nigeria. It has an annual rainfall of about 2000 mm per annum and average temperature of 27 and 41°C (Molindo *et al.*, 2010). Soil samples were collected prior to planting and analyzed to determine the initial physical and chemical properties of the experimental field. The soil texture analysis (72% sand, 23% clay and 5% silt) classified the soil as Sandy Clay Loam. Chemically the soil was strongly acidic, with a measured pH (H<sub>2</sub>O) of 4.6. It contained 1.05% Organic Carbon (OC) and Effective Cation Exchange Capacity (ECEC) of 2.94 cmol+/kg. Total Nitrogen content was 0.083%, available Phosphorus (Mehlich-P) was 22.68 ppm and Exchangeable Potassium content was 0.49 cmol+/kg. The site was dominated by *Mimosa pudica*, *Panicum maximum*, and other creeping weeds prior to planting.

#### 3.2 Maize Cultivar

Variety used was OP maize, cultivar Oba Super 6 (adapted to Southern Guinea savanna, Northern Guinea savanna and Sudan savanna ecologies, consists of pro-vitamin A, high yielding, drought tolerant, low soil nitrogen efficient, excellent plant

and ear aspect and yields of 8 t/ha) obtained from International Institute of Tropical Agriculture (IITA), Nigeria, for the study.

### **3.3 Experimental Design and Treatments**

The experiment was laid out in a Randomized Complete Block Design (RCBD) replicated five times. The treatment consists of four rates of *Azadirachta indica* leaf powder (0.0, 60.0, 120.0, 180.0 kg ha<sup>-1</sup>). Each treatment plot measured 2.25 m x 2.0 m. Two plots were separated by 0.50 m and two replications by 0.50 m.

### **3.4 *Azadirachta indica* Leaf Powder Preparation**

Fresh *A. indica* leaf were harvested and air dried for a period of two weeks. The dried leaves were then grinded into powder. Samples of the leaf powder was collected and analyzed to determine it's mineral constituents.

### **3.5 Land Preparation**

The land was cleared manually using cutlass and the debris were gathered and removed from the field without burning. This was done on the 24th May, 2025.

### **3.6 *Azadirachta indica* Leaf Powder Application**

*A. indica* leaf powder was applied once during the trial: at 1 week before sowing. The powder was incorporated into the soil along each plant row in a plot.

### **3.7 Sowing**

One seed was sown per hole on 14th June 2025 when the soil was sufficiently moist. The seeds were down at a depth of about 4 - 5 cm at a spacing of 75 cm x 25 cm to achieve a plant population of 53333 plants ha<sup>-1</sup>.

### **3.8 Armyworm and Bird Control**

A solution of neem leaves soaked in water was used to control armyworm. Thereafter, the solution was applied into the funnel of each maize plant. Application of the solution to maize began at emergence and continued at 7 days interval without skipping any application time until when the plants were fully tasseled. At the time the ears were fully silked and grain filling had progressed, each maize plant was wrapped with transparent nylon to prevent bird damage.

### **3.9 Weed Control**

Hoe weeding was carried out two times, at 2 and 4 weeks after sowing.

### **3.10 Data Collection**

Data was collected from a net plot, that is, the one central row containing 8 plants.

#### **3.10.1 Percent emergence**

The number of plants at two weeks after sowing and number of seed sown were used to calculate percent emergence by multiplying by 100.

#### **3.10.2 Percent establishment**

The ratio of the number of plants at the onset of flowering and the number of plants at two weeks after sowing was calculated and multiplied by 100.

### **3.10.3 Days to first tasseling**

The crop was observed every two days when tasseling initiation began, to record the number of days to when plants first tasseled in a plot.

### **3.10.4 Plant height**

The height of five consecutive plants along the middle row per plot was used. Plant height was measured in cm from the base of the plant to where tassel branching began on 5 plants along the middle row using calibrated tape measure expressed in cm at harvest and recorded.

### **3.10.5 Number of ears harvested**

The number of ears harvested was recorded.

### **3.10.6 Stover yield**

Stems, leaves and husks in a net plot were dried to a constant weight and recorded. These were added together and calculated as stover yield in kg/ha

## **3.11 Data Analysis**

The data was subjected to analysis of variance (ANOVA) using the PROC ANOVA procedure of SAS. Least Significant Differences (LSD) was used to separate means of significant difference at  $p=0.5\%$ .

## **CHAPTER FOUR**

### **RESULTS**

#### **4.1 Percent emergence and percent establishment**

There were no significant differences among the treatments for percent emergence (Figure 1).

Percent establishment was influenced by the treatment (Figure 1). As the rate of leaf powder increased, the number of plants that established increased.

#### **4.2 Days to tasseling and plant height**

Significant differences occurred among the various treatments for days to tasseling. (Figure 2). Plots incorporated with 180 kg of leaf powder had the shortest time interval to tasseling initiation, while plots incorporated with 0 kg of leaf powder had the longest interval to when tasseling began.

There were significant differences among the treatments for plant height. (Figure 3). With an increase in the rate of leaf powder incorporated, there was an increase in plant height.

#### **4.3 Number of ears harvested and stover yield**

Significant differences occurred among the treatments for number of ears per plant (Figure 4). Plot with higher rates of leaf powder had more no of ears at harvest.

For stover yield, differences also occurred among the treatments (Figure 5). Plots incorporated with 180 kg leaf powder had the highest stover yield while plots incorporated with 0 kg leaf powder had the lowest stover yield.

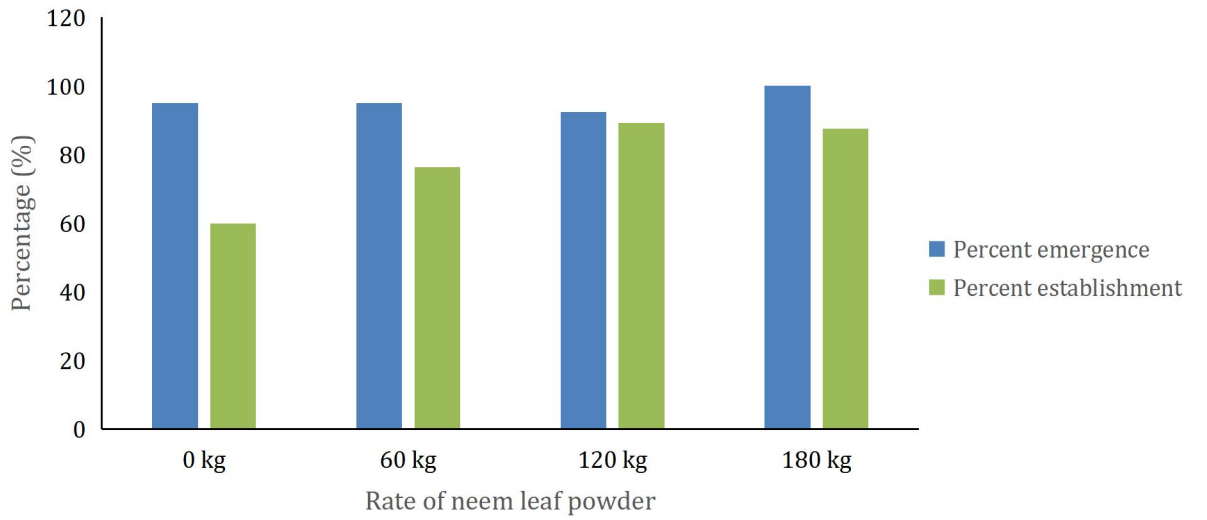


Figure 1: Percent emergence and percent establishment of maize fertilized with neem powder

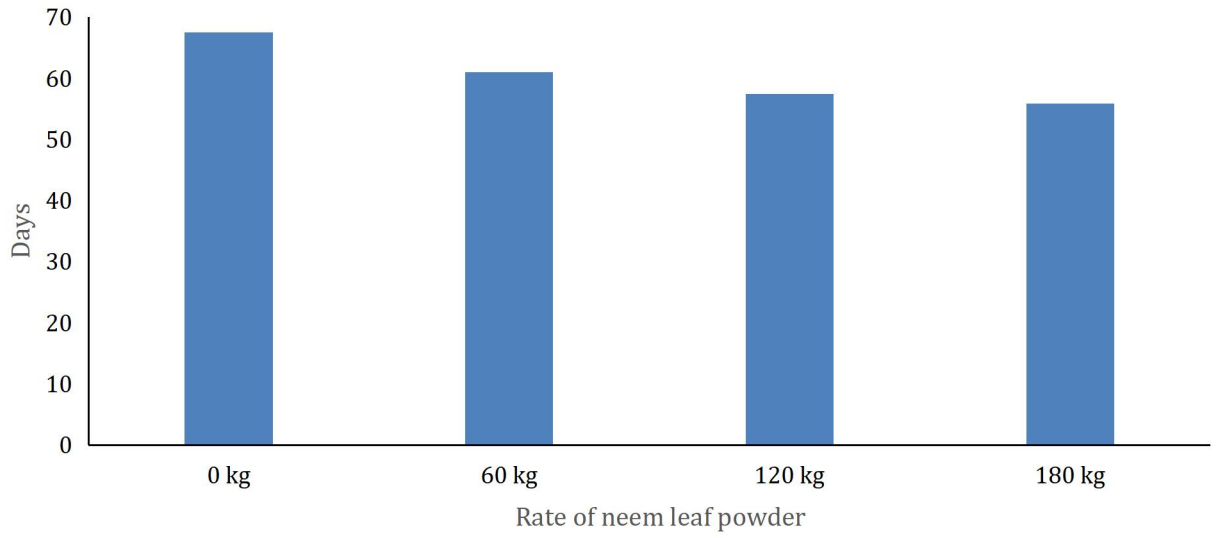


Figure 2: Days to tasseling of maize fertilized with neem powder

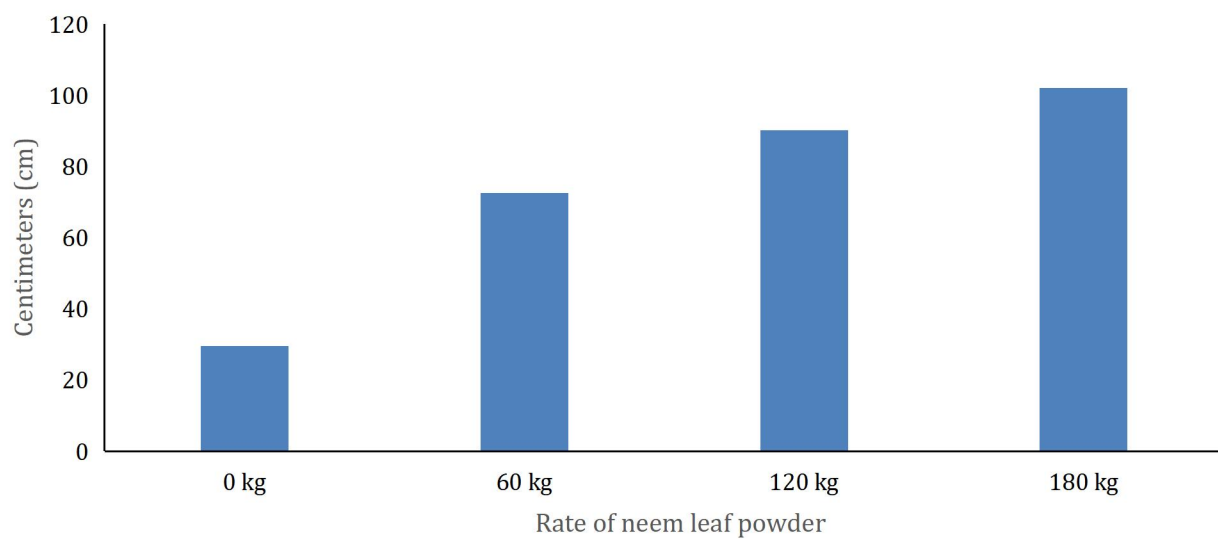


Figure 3: Plant height of maize fertilized with neem powder

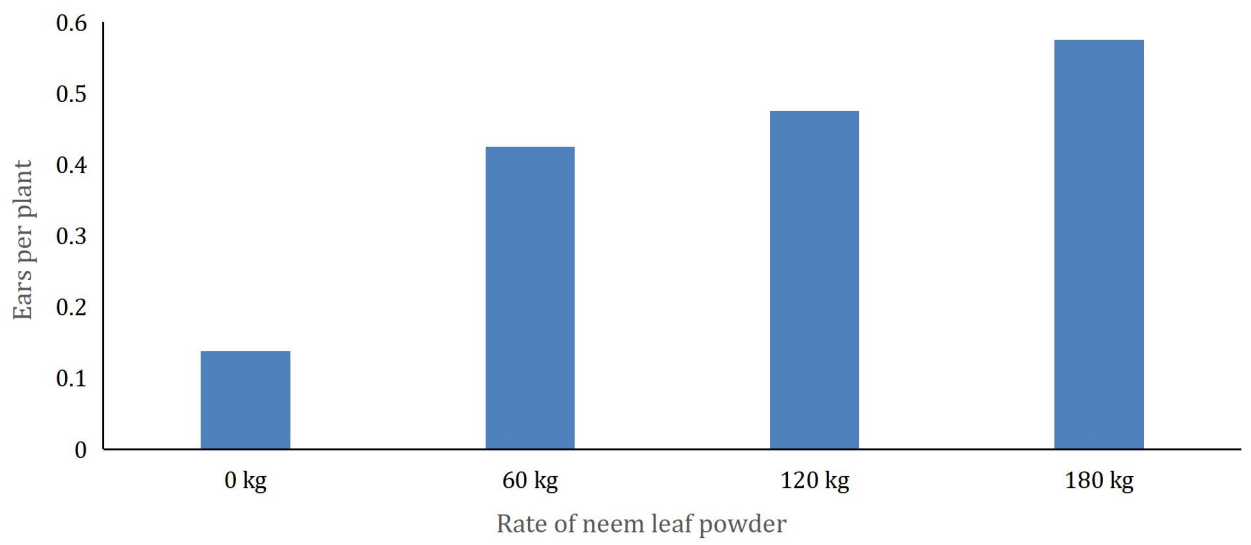


Figure 4: Number of ears of maize fertilized with neem powder

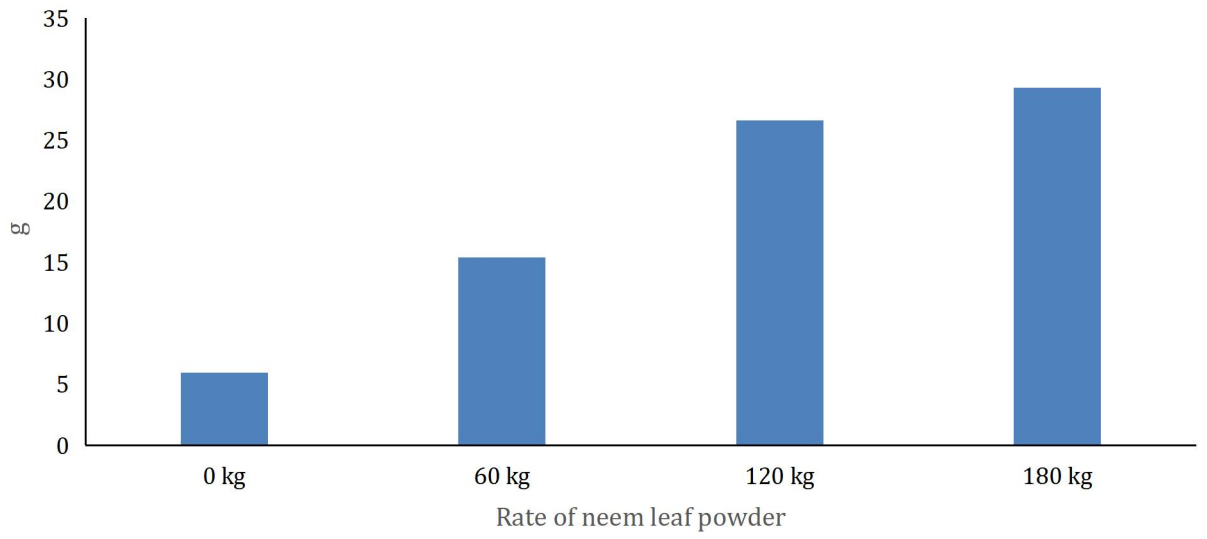


Figure 5: Stover yield of maize fertilized with neem powder

## CHAPTER FIVE

### DISCUSSION

This study focused on the use of different concentrations of *A. indica* leaf powder in improving the growth of maize. The application of *A. indica* leaf powder served as an organic amendment, significantly influencing several key growth and productivity traits in maize such as the percent emergence, establishment, tasseling, plant height, number of ears produced and stover yield.

The absence of significant effects on plant emergence across all treatments indicates that this parameter is largely governed by inherent seed quality and immediate post-planting environmental factors, rather than the applied amendment. This observation aligns with findings by Adhikary *et al.*, (2018), who reported no notable differences in germination rates of maize seeds treated with neem-based products, attributing this to the non-interference of neem compounds with the embryonic phase. At the plant establishment stage, the 120 kg rate recorded the highest values, followed by 180 kg, 60 kg, and 0 kg, suggesting an optimal dosage for early vegetative vigor. This could stem from moderated release of nutrients at intermediate levels, avoiding potential overload or allelopathic inhibition at higher rates. Comparable dose-response curves have been documented in neem leaf manure applications on maize, where 100-150 kg/ha equivalents improved seedling survival without phytotoxic effects (Moyin-Jesu, 2007). The shortened days to tasseling at 180 kg (followed by 120 kg, 60 kg, and 0 kg)

points to accelerated phenological development, likely due to enhanced nitrogen uptake from neem decomposition, which supports early reproductive initiation. This is corroborated by Amujoyegbe *et al.*, (2008), who observed reduced time to flowering in maize amended with neem-fortified poultry manure, linking it to improved photosynthetic efficiency from neem bioactive.

Plant height followed a consistent trend, with 180 kg yielding the maximum, succeeded by 120 kg, 60 kg, and 0 kg. Elevated height reflects superior meristematic activity fueled by neem-derived nutrients. The number of ears harvested was also maximized at 180 kg, followed by the descending order, reinforcing neem's yield-boosting potential through reduced insect damage and enhanced pollen viability. Neem's azadirachtin content acts as a natural antifeedant, minimizing losses from pests like stem borers, as evidenced in field trials where neem cake applications increased cob numbers by 15-20% (Verma *et al.*, 2017). Higher stover yield with an increase in neem leaf powder rates indicates increased biomass partitioning. Studies by Owolabi *et al.* (2004) on neem leaf extracts demonstrated up to 25% increases in maize dry matter accumulation at application rates of 150-200 kg/ha, attributed to better soil organic matter and microbial activity.

## **5.1 Conclusion**

*Azadirachta indica* leaf powder as an organic fertilizer has shown significant potential in enhancing maize agronomic performance. As the rate of neem powder increased, maize performance increased. This was due to the mineral composition of the leaf powder that was incorporated to the soil. Therefore, neem can be used to improve soil fertility for maize production.

## **5.2 Recommendation**

Based on the study, further research on the application of *A. indica* leaf powder to maize for good crop yield is recommended.

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