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# The Impact of Nitrogen Uptake on Growth of Maize & Sunflower as Influenced by Compost under Inter Cropping Systems

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**Abstract:** Nitrogen management in crop cultivation such maize and sunflower are critical in enhancing crop growth, productivity and nutritional quality. However, nitrogen (N) is a generally deficient element in all agricultural soils and cropping systems in Zambia. Adoption of the use of organic N sources such as compost manure can play an important role to sustain soil fertility and enhance crop productivity. Therefore, this study was conducted to examine N uptake and growth of maize and sunflower as influenced by compost manure under intercropping systems.

The study was carried out at Zambia Institute of Animal Healthy (ZIAH) Farm in Mazabuka District, Southern Province of Zambia. The experimental field was arranged in a Randomized Complete Block Design (RCBD) with six treatments, which included: *1. Mono cropping (Maize) + No compost; 2. Mono cropping (sunflower) + No Compost; 3. Mono cropping (Maize) + Compost; 4. Mono cropping (Sunflower) + Compost; 5. Inter cropping (Maize and Sunflower) + No Compost; 6. Intercropping (Maize and Sunflower) + Compost.* These treatments were replicated three times. The varieties of maize and sunflower used in this experiment were SC 303 and Milika, respectively because of being early maturing. The following parameters were used to determine plant growth: plant height, stem thickness, leaf width and leaf length. The investigational data of this experiment revealed that the growth of sunflower and maize increased with increased levels of N accumulation by the plant. For example, sunflower accumulated 0.395% N on average, while maize accumulated 0.385 % N, which positively influenced plant growth. Simple linear regression was used to test if nitrogen uptake significantly influenced growth of intercropped sunflower and maize with the use of compost manure. The overall regression for plant height was statistically not significant representing ($R^2$ =0.2828, F (1, 1) =0.39, p> 0.05) and ($R^2$ =0.1278, F (1, 1) = 0.15, p> 0.05) for sunflower and maize, respectively.

***Keywords**: Nitrogen uptake, Compost manure, intercropping, mono-cropping, Maize, Sunflower.*

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## I. INTRODUCTION.

Zambia is a land linked country in Southern Africa that borders eight countries: Botswana, Namibia, Zimbabwe, Angola, Tanzania, the Democratic Republic of the Congo (DRC), Malawi, and Mozambique. The country is characterized by political stability, strong economic growth, abundant fertile arable land, and generally favourable climatic conditions for agricultural production (Tembo and Sitko 2013). Agriculture has contributed strongly to the economic growth of the country's economy. In 2011, Zambia signed a Comprehensive African Agriculture Development Programme (CAADP) compact, committing to allocate at least 10 percent of national budget toward agricultural development, an increase from the 5 and 8 percent allocations in previous years ('Minister of Finance , Delivered To the National Assembly on', 2013). The sector contributes about 9 percent to Gross Domestic Product (GDP), but perhaps more importantly, it is the main livelihood for over 70 percent of the population in the country. Zambia`s agricultural sector is mainly based on crop production, where maize is the major crop. In the country, maize is a staple crop grown by both small-scale farmers (80%) and commercial farmers (20%) mostly for consumption (Mulenga, and Wineman, 2014).

Generally, maize is the third most important cereal crop in the world after wheat and rice and is the main staple food for hundred millions of people in developing countries, especially in Sub Saharan Africa including Zambia. In tropical Africa, nearly all the maize grain is used for human consumption. Maize grain is used for three main purposes namely: as a staple food; as livestock and poultry feed; and as a raw material for many industrial products (Chisanga, 2014).

On the other hand, Mulenga and Wineman, (2014) reported that sunflower in Zambia has also long been recognized for its potential benefits to smallholder farmers. The crop is fairly easily grown with relatively little use of inorganic fertilizers and it can be locally processed to near commercial quality oil and cake, either on the farm or at nearby processors. Moreover, sunflower is best grown on the same types of soils as maize, which is Zambia's staple crop. Sunflower is the world 's fourth largest oil-seed crop and its seeds are used as food and its dried stalk as fuel. It is already being used as ornamental plant and was used in ancient ceremonies as well (Harter *et al*., 2004; Muller *et al*., 2011). Medicinal uses of sunflower for pulmonary afflictions have been reported. In addition, parts of this plant are used in making dyes for the textile industry, body painting, cosmetics and other decorations. Sunflower oil is used in salad dressings, for cooking and in the manufacturing of margarine and shortening (Kunduraci *et al*., 2010).

In some countries sunflower seed cake that is left after the oil extraction is used as livestock feed. In the Soviet Union the hulls are used for manufacturing ethyl alcohol, in lining for plywood

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and growing yeast. The dried stems have also been used for fuel. The stems contain phosphorous and potassium which can be composted and returned to soil as fertilizer. Sunflower meal is a potential source of protein for human consumption due to its high nutritional value and lack of anti-nutritional factors (Fozia *et al*., 2008).

### Statement of the Problem

The application of nutrients, mainly N, is one of the most important preconditions for effective crop production. N management in crop production such maize and sunflower is critical in enhancing crop growth, productivity and nutritional quality. However, N is a generally deficient element in all agricultural soils and cropping systems in Zambia (Mohan *et al*, 2015; Togo jsuji, *et al*, 2005). Farmers apply chemical fertilizer to overcome the problem of N deficiency in an effort to increase crop yield. However, the chemical fertilizers are generally expensive and most smallholder farmers do not afford the cost, resulting in poor crop growth and productivity (Ahmad, 2000). In order to overcome these problems, compost manure and/or intercropping of some crops such as maize and sunflower can be used. Hence it is against this background that the researcher endeavored to examine the N uptake and growth of maize and sunflower as influenced by compost manure under intercropping systems.

### Justification of the study

The adoption of the use of organic N sources can play an important role to sustain soil fertility and crop productivity (Channabasanagowda *et al*., 2008). The use of compost manure is a rich source of plant nutrients such as N, which is essential for sustainable crop production. Complementing compost manure with good cropping systems, could result in increased crop productivity.

### Purpose of the study

The purpose of the study was to investigate nitrogen uptake and growth of maize and sunflower as influenced by compost manure under intercropping systems.

### Objective of the study

**Main Objective**

*The overall objective of the study was to investigate the nitrogen uptake and growth of maize and sunflower as influenced by compost manure under intercropping systems.*

**Specific Objectives**

I. *To determine the growth of maize and sunflower as influenced by nitrogen uptake under mono cropping system without compost*

II. *To determine the growth of maize and sunflower as influenced by nitrogen uptake under mono cropping system with compost*

III. *To determine the growth of maize and sunflower as influenced by nitrogen uptake*

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*under intercropping system without compost*

IV. *To determine the growth of maize and sunflower as influenced by nitrogen uptake under intercropping system with compost*

V. *To determine nitrogen accumulation by maize and sunflower at commencement of reproduction (90 days after emergency).*

## Hypothesis

$H_{01}$ =there is no significant impact of nitrogen uptake on the growth of maize and sunflower under mono cropping system without compost.

$H_{A1}$ = there is a significant impact of nitrogen uptake on the growth of maize and sunflower under mono cropping system without compost.

$H_{02}$ =there is no significant impact of nitrogen uptake on the growth of maize and sunflower under mono cropping system with compost

$H_{A2}$ = there is a significant impact nitrogen uptake on the growth of maize and sunflower under mono cropping system with compost

$H_{03}$ =there is no significant impact of nitrogen uptake on the growth of maize and sunflower under intercropping system without compost

$H_{A3}$ = there is a significant impact of nitrogen uptake on the growth of maize and sunflower under intercropping system without compost

$H_{04}$ =there is no significant impact of nitrogen uptake on the growth of maize and sunflower under intercropping system with compost

$H_{A4}$ = there is a significant impact of nitrogen uptake on the growth of maize and sunflower under intercropping system with compost

## Significance of the study

Declining land productivity as a result of soil fertility reduction is a major problem facing smallholder farmers today. This decline primarily results from a continuous cultivation without adequate addition of external nutrient inputs (MINAGRI, 2004). Improved fertility management through organic manure can enable efficient use of the nutrients applied and increase overall system productivity. Hence the study will help policy makers, agriculture extension service providers, fertilizer manufacturing companies and farmers to invest much knowledge and resource in the use of compost manure in an effort to reduce the cost of crop production. This will help increase the productivity of maize and sunflower in the district and the country at large.

## Scope of the study

This experiment was limited to Mazabuka district, at Zambia Institute of Animal Healthy (ZIAH) Farm in Southern Province of Zambia. The study only considered production of maize and sunflower with the use of compost manure.

## Conceptual Framework

The illustration below shows nitrogen uptake as a factor that influences growth of maize and sunflower as an independent variable on the left-hand side, cropping systems as moderating

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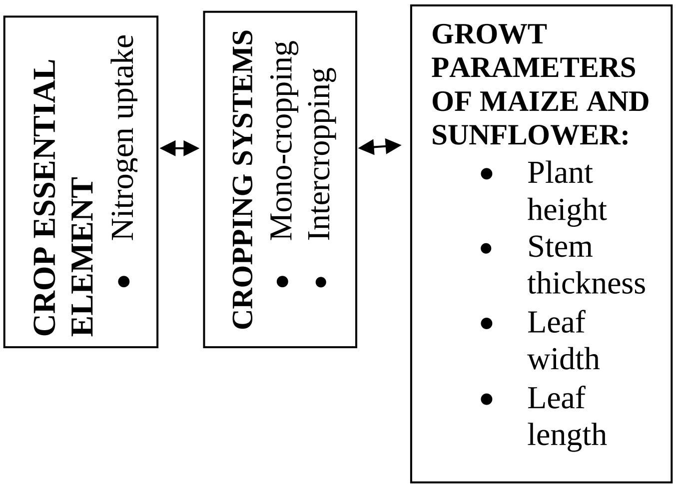
variables and/or growth parameters on the right-hand side as dependent variables. In the process of assessing each single factor in the selected study area, attention was given to the following: mono cropping of maize and sunflower without compost, mono cropping of maize and sunflower with compost, intercropping of maize and sunflower without compost and intercropping of maize and sunflower with compost.




### Ethical considerations

The research was presented before the Information and Communications University research committee for scrutiny to ensure it met research standards.

## II. MATERIALS AND METHODS

### Location of the study site

A field experiment was carried out in Mazabuka at Zambia Institute of Animal Healthy (ZIAH) Farm in Southern Province of Zambia. The mean annual rainfall of Mazabuka district is 760 to 890 mm, extending from mid-November to the end of March with an average annual temperature of 21.5°C. The soils of Mazabuka district fall into two main divisions, the plateau group of light textured soils and the upper valley group of medium to heavy textured soils. The older and more highly leached plateau group is mainly derived from acid igneous and metamorphic rocks.

The soil depth varies appreciably but is generally shallow, and has low inherent fertility. They carry lsoberlinia-Brachystegia woodland (miombo), interspersed with grassy, wet depressions (dambos). The upper valley group occurs in somewhat lower areas with less mature relief and is associated with calcareous sedimentary and basic igneous rocks.

Soils vary from sandy loams overlying sandy clay to clay loams and have a better fertility status than those of the plateau group. The lighter transitional soils of this group carry scrub woodland of Combretum, Terminalia, and allied species, interspersed with tall grass. The thorn soils of the group carry Acacia tree-grassland and have for long been considered the best maize soils in Zambia, although it should be recorded that some

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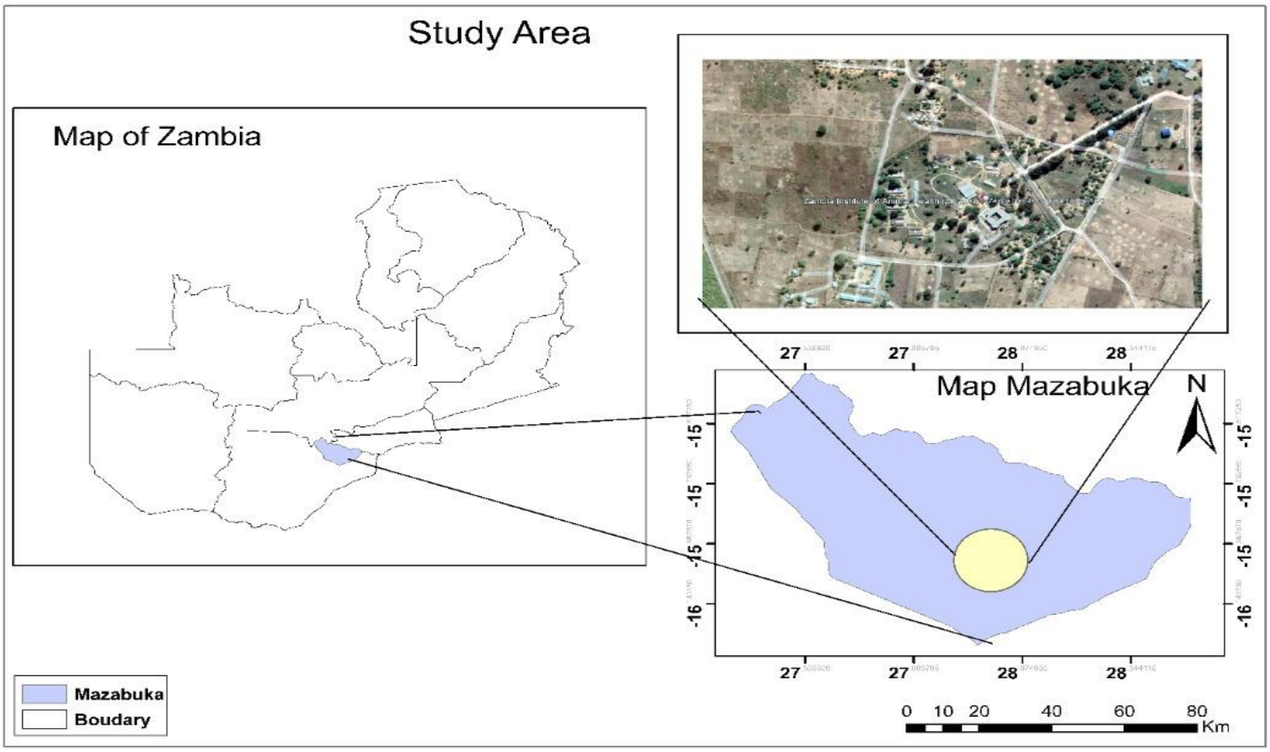
of the best maize crops in Zambia are now grown on the sandy veld soils of the Central Province. A favourable environment and the high potential of Mazabuka soils for maize production have been important factors in agricultural change, and, in this respect, the Plateau Tonga are particularly well favoured, compared with people in many other African savanna areas.

**Map of the study area**




**Experimental design and treatments layout**

The experiment was arranged in a Randomized Complete Block Design (RCBD) with six treatments replicated three times. Maize (SC 303) and sunflower (Milika) varieties were used because of being early maturing varieties. Recommended crop specific agronomic practices such as weeding, plant densities and fertilizer rates for both Maize and Sunflower were followed.

**Main treatments**

**Treatment 1:** Mono cropping (Maize) + No compost

**Treatment 2:** Mono cropping (sunflower) + No Compost

**Treatment 3:** Mono cropping (Maize) + Compost

**Treatment 4:** Mono cropping (Sunflower) + Compost

**Treatment 5:** inter cropping (Maize and Sunflower) + No Compost

**Treatment 6:** Intercropping (Maize and Sunflower) + Compost

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## Field Layout

**Block 1**

| | | |
|---|---|---|
| **Plot 1** Treatment 1: Mono cropping (Maize) + No compost | **Plot 2** Treatment 3: Mono cropping (Maize) + Compost | **Plot 3** Treatment 5: inter cropping (Maize and Sunflower) + No Compost |
| Plot 4 Treatment 4: Mono cropping (Sunflower) + Compost | Plot 5 Treatment 6: Intercropping (Maize and Sunflower) + Compost | Plot 6 Treatment 2: Mono cropping (sunflower) + No Compost |

**Block 2**

| | | |
|---|---|---|
| Plot 1 Treatment 4: Mono cropping (Sunflower) + Compost | Plot 2 Treatment 6: Intercropping (Maize and Sunflower) + Compost | Plot 3 Treatment 2: Mono cropping (sunflower) + No Compost |
| **Plot 4** Treatment 1: Mono cropping (Maize) + No compost | **Plot 5** Treatment 3: Mono cropping (Maize) + Compost | **Plot 6** Treatment 5: inter cropping (Maize and Sunflower) + No Compost |

**Block 3**

| | | |
|---|---|---|
| Plot 1 Treatment 6: Intercropping (Maize and Sunflower) + Compost | Plot 2 Treatment 2: Mono cropping (sunflower) + No Compost | Plot 3 Treatment 4: Mono cropping (Sunflower) + Compost |
| **Plot 4** Treatment 3: Mono cropping (Maize) + Compost | **Plot 5** Treatment 5: inter cropping (Maize and Sunflower) + No Compost | **Plot 6** Treatment 1: Mono cropping (Maize) + No compost |

## Planting and fertilization

Maize (SC 303) and sunflower (Milika) varieties were used as test crops. The planting date was on the 21st May, 2022 at the Zambia Institute of Animal Health (ZIAH) farm in Mazabuka District of Southern Province. Land preparation was done by using hoes, loosening a layer of up to 0-20cm depth. Planting holes were prepared where the soil and compost manure were mixed, respectively. Plot sizes were 3 m x 3 m with a spacing of 75 cm between the rows and 30 cm within the rows for both plants. Two seeds were planted per hole and thinned to one, 10 days after emergence.

At planting, compost manure was applied and incorporated in the planting holes. The second dose of manure was applied at 30 days after emergence and the third dose at 60 days after emergence. Manure was pre-weighed for each plot before going to the field and applied uniformly to all plots at a rate of 50 kg /ha from organic (compost). The organic source aerobic compost was used (manure made up of yard trimmings, leaves, and kitchen scraps). The trials were maintained weed free during the entire study period. All other cultural practices i.e., weeding, hoeing, irrigation were adopted uniformly as and when required.

Before sowing, a composite soil sample was collected from the field and analyzed for physical-chemical properties. Soil texture was determined by hydrometer method as described by Moodi *et*

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*al* (1959). Total N soil analysis was determined by Kjeldahl digestion method.

### Materials

In this research the following materials were used in the process of data collection: Global Positioning System (GPS) receiver (Map 78s Garmin) was used to obtain sampling site coordinates for each area of interest. Position format of decimal degrees and map datum (WGS 84) was used. The Camera was used to obtain pictures of sites and other notable observations, which were important to this research. A hoe, garden folk, shovel, rake and wheelbarrow were used to prepare the site and transport the manure from the dump site, respectively. A measuring tape was used to measure the width and length of the beds or plots and/or measure plant height, stem thickness, leaf width and length. A soil probe and soil auger were used to collect soil samples. A beam balance scale was used to weigh 15g soil samples, whereas test tubes, beakers and measuring cylinders were used to measure the chemicals and water to be used. A permanent marker, and pen were used to label every sampling plastic bag, before transporting to the laboratory in Lusaka at the Mount Makulu Research Centre. A notebook was also used to record data that was collected from the study site.

### Sampling Methods and Analysis

#### Soil Sampling and Analysis

Soil sampling was done at the beginning of the experiment (before planting) for analysis of initial soil properties. Another sample was collected at the end of the experiment for the purposes of evaluating soil property changes due to treatments. Oven dried 15g of the soil was sampled and analyzed for total N using the Kjeldahl digestion method at the beginning and at the end of the experiment.

### Parameters of data collection

Soil N content, plant growth parameters (plant height, stem thickness, leaf width and leaf length) were collected as follows:

1. Soil nitrogen content (before and at the end of the experiment i.e., commencement of reproductive stage)
2. Plant growth parameters (90 days after emergence - commencement of reproductive stage)

### Statistical analysis

All data was presented as mean values of three replicates. Data was analyzed statistically using simple linear regression at α = 0.05 level of significance following the method described by Gomez & Gomez (1984). Excel 2016 and STATA 14 computer software were used to carry out statistical analysis (Russel & Eisensmith, 1983).

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## III. RESULTS AND DISCUSSION

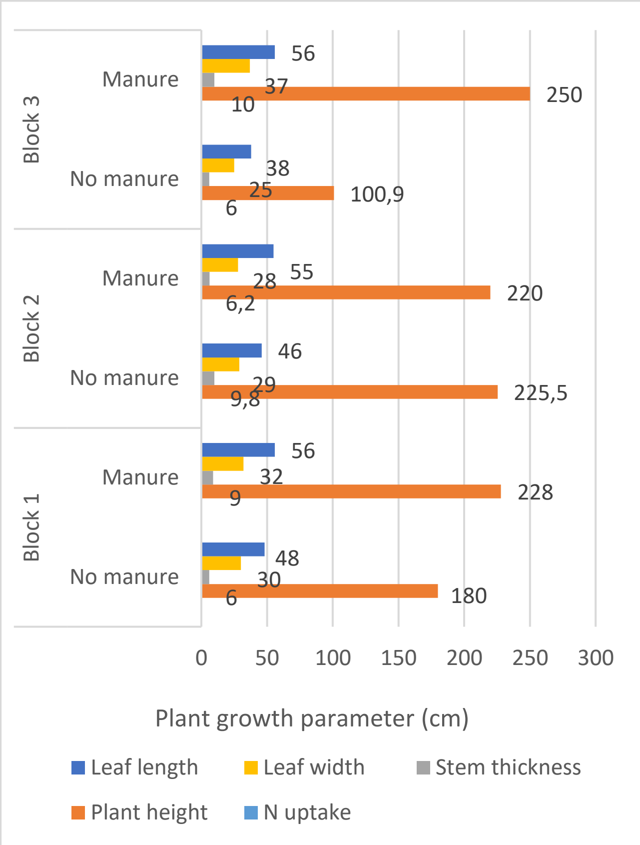
### Impact of nitrogen uptake on the growth of sunflower and maize under mono-cropping system

The experimental data revealed that plant height and stem thickness of sunflower and maize increased with increased levels of N accumulation by the crops. For instance, in block 1 (*table 1*), under manure application, sunflower accumulated 0.363% of N, which positively influenced plant height and stem thickness to the height of 228 cm and stem thickness of 9 cm, respectively. Similarly for maize (*table 2*), the increase in N accumulation (0.258%) observed in block 1 also positively influenced plant height and stem thickness to 80.1 cm and 8.1 cm, respectively.

***Table 1. Impact of nitrogen uptake on the growth of sunflower under mono-cropping system***

| | | **N uptake** | **Plant height** | **Stem thickness** | **Leaf width** | **Leaf length** |
|---|---|---|---|---|---|---|
| Block 1 | No manure | 0.076 | 180 | 6 | 30 | 48 |
| | Manure | 0.363 | 228 | 9 | 32 | 56 |
| ock 2 | No manure | 0.111 | 225.5 | 9.8 | 29 | 46 |
| | Manure | 0.359 | 220 | 6.2 | 28 | 55 |
| Block 3 | No manure | 0.073 | 100.9 | 6 | 25 | 38 |
| | Manure | 0.369 | 250 | 10 | 37 | 56 |

***Figure 1. Impact of nitrogen uptake on the growth of sunflower under mono-cropping system***



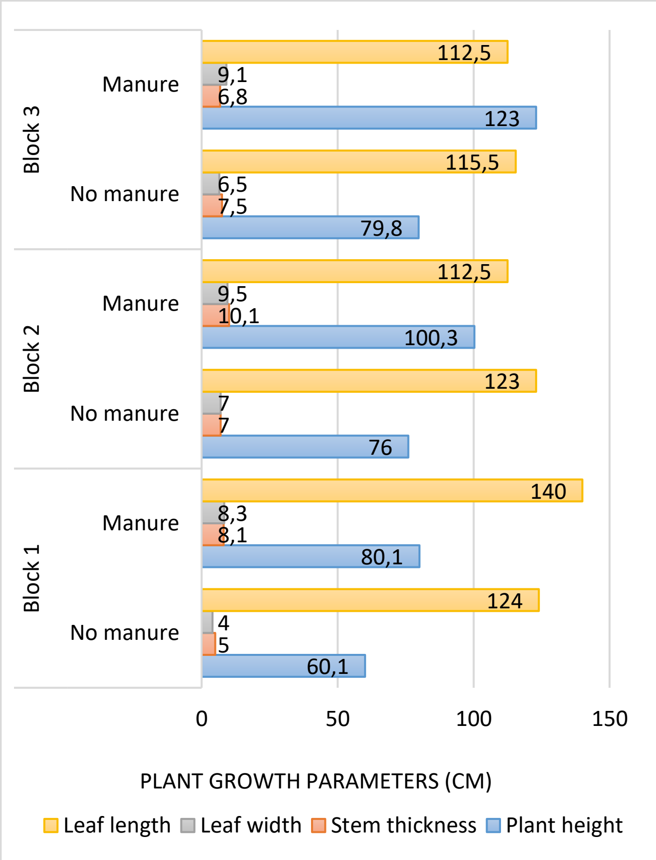

The trend was similar in all the blocks, where increased N accumulation led to increased plant height and thickness (*table 1 and 2*). This tendency agrees with Nasim *et al.* (2011), who reported that plant height positively correlated with increased levels of N. Further, the results of this study are in line with Montenegro, Magnitskiy and Darghan (2019), whose results indicated a positive correlation between increased N application and plant stem thickness. The positive relationship between plant height, thickness and N accumulation can be attributed to the fact that N greatly accelerates plant meristematic activity and cell elongation, which lead to progressive increases in internode length and stem thickness (Amin, 2011). Further, Hani et al. (2006) reported that N application remarkably increased plant height, stem thickness, leaf area index and dry matter production. This all agrees with this research findings.

N being an essential constituent of chlorophyll, protein, cell walls, nucleic acids, cytoplasm and vast array of other cell components plays a vital role in the vegetative growth of plants (Haque et al., 2001). To a large extent, increased N nutrition by plants during vegetative growth increases plant growth rate, as meristematic tissues have very active protein metabolism (Amanuuah et al., 2009).

***Table 2. Impact of nitrogen uptake on maize growth under mono cropping system***

| | | N uptake | Plant height | Stem thickness | Leaf width | Leaf length |
|---|---|---|---|---|---|---|
| Block 1 | No manure | 0.073 | 60.1 | 5 | 4 | 124 |
| | Manure | 0.258 | 80.1 | 8.1 | 8.3 | 140 |
| Block 2 | No manure | 0.029 | 76 | 7 | 7 | 123 |
| | Manure | 0.291 | 100.3 | 10.1 | 9.5 | 112.5 |
| Block 3 | No manure | 0.131 | 79.8 | 7.5 | 6.5 | 115.5 |
| | Manure | 0.196 | 123 | 6.8 | 9.1 | 112.5 |

***Figure 2. Impact of nitrogen uptake on maize growth under mono cropping system***




On the other hand, low levels of N uptake affected the growth of maize and sunflower. For example, as observed in block 1 (*table 1*), where there was no application of manure, Sunflower accumulated only 0.076%, which influenced plant height and stem thickness to 180 cm and 6 cm, respectively. The same was true with Maize in block 1 (*table 2*), which accumulated 0.073%. This influenced maize height and stem thickness to 60.1 cm and 5 cm, respectively. Generally, the results of the study showed that maize and sunflower growth increased as N uptake rates increased. However, it is worth noting that the increase in plant height and thickness was more in treatments where manure was added (*tables 1 and 2*).

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**Impact of nitrogen uptake on the growth of maize and sunflower under intercropping system**

The presence of other crops in an intercropping system can affect the availability of soil N. Jones et al., (2011), reported that N uptake varied among crops at different stages of growth, but generally plants require a balanced supply of N throughout their development (Jones and Jacobsen, 2001).

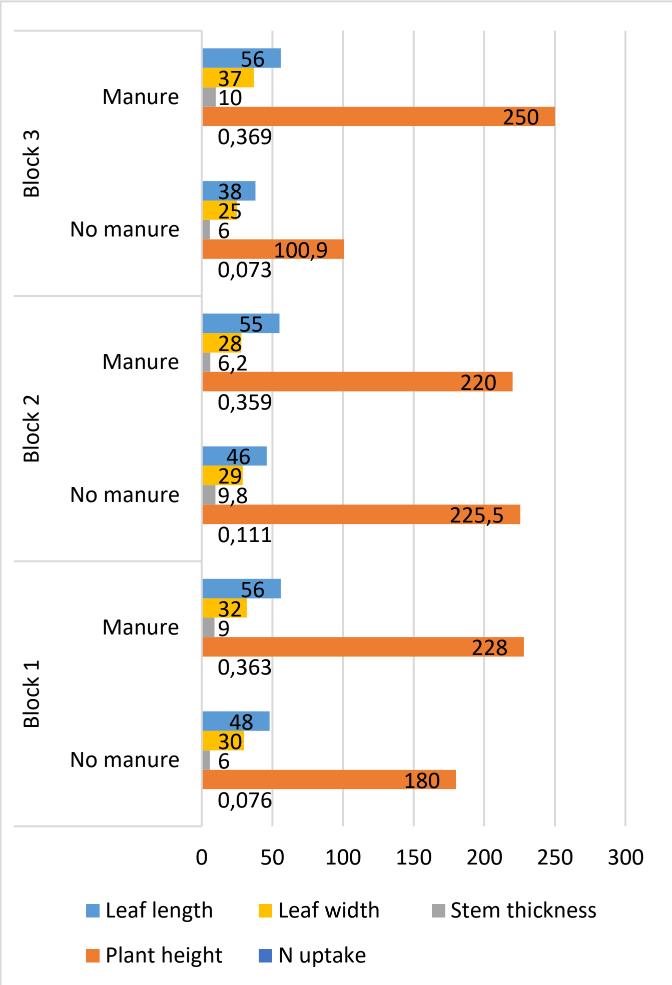
***Table 3. Impact of nitrogen uptake on the growth of sunflower under intercropping***

| | | N uptake | Plant height | Stem thickness | Leaf width | Leaf length |
|---|---|---|---|---|---|---|
| Block 1 | No manure | 0.051 | 200.3 | 6.8 | 26 | 38 |
| | Manure | 0.276 | 210 | 8.4 | 31 | 56 |
| Block 2 | No manure | 0.018 | 140 | 6 | 26 | 34 |
| | Manure | 0.281 | 220 | 7.2 | 31 | 55 |
| Block 3 | No manure | 0.134 | 240 | 8 | 30 | 44 |
| | Manure | 0.395 | 220 | 8 | 34 | 57 |

***Impact of nitrogen uptake on the growth of sunflower under intercropping***

The investigational data revealed that plant growth parameters such as height, stem thickness, leaf width and leaf length of sunflower and maize increased with increased levels of N accumulation by the plant. As can be observed from *table 3 and 4*, increased N accumulation resulted in increased plant growth in all the parameters under observation. For instance, in block 1 (***table 3***) under manure application, sunflower (intercropped with maize) accumulated 0.276% N which positively influenced plant height (210 cm), leaf width (31 cm) and leaf length (56 cm). The increase in N accumulation (0.256 % N) by maize (***table 4***) (intercropped with sunflower) also positively influenced the height (72.5 cm), stem thickness (6 cm), leaf width (7.8 cm) and leaf length (100.2).

***Figure 3. Impact of nitrogen uptake on the growth of sunflower under intercropping***

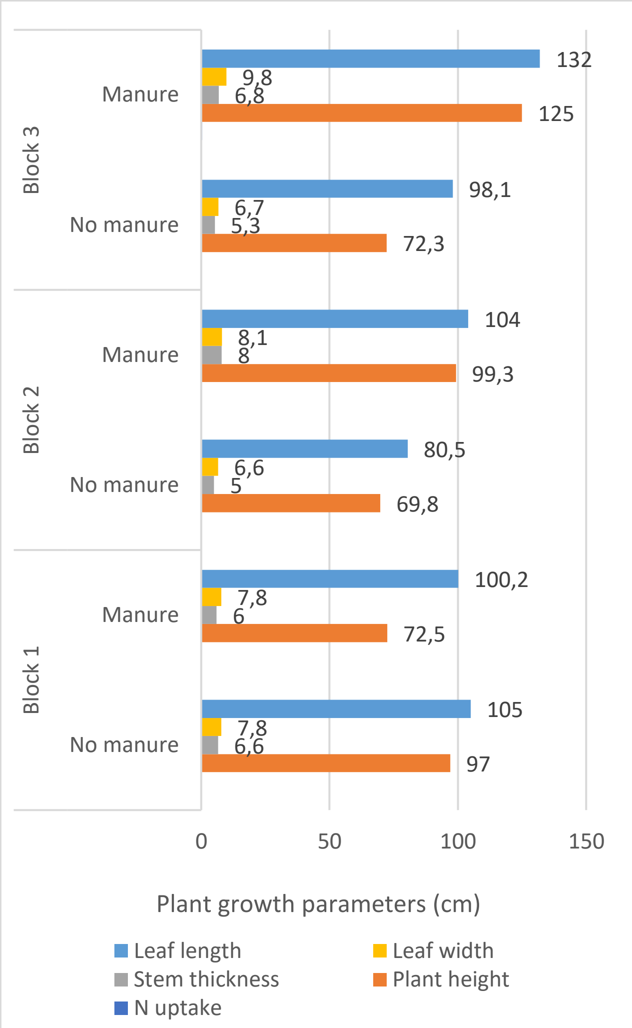



In block 3 sunflower (***table 3***) accumulated 0.395% N which positively influenced plant height (220 cm), leaf width (34 cm) and leaf length (57cm). The increase in N accumulation (0.385 %) by maize in block 3 also positively influenced the height (125 cm), stem thickness (6.8 cm), leaf width (9.8 cm) and leaf length (132). The findings correlate with Nasim *et al.* (2011), who reported that plant height and dry matter production is positively correlated with the increasing level of N dose. This is attributed to the effect of N on cell elongation, as well as N being the principal component of proteins, enzymes, hormones, vitamins, chlorophyll and it accelerates the meristematic activity of plant which leads to progressive increases in internode length, protein synthesis and photosynthetic area leading to higher plant height.

***Table 4. Impact of nitrogen uptake on the growth of maize under intercropping system***

| | | N uptake | Plant height | Stem thickness | Leaf width | Leaf length |
|---|---|---|---|---|---|---|
| Block 1 | No manure | 0.134 | 97 | 6.6 | 7.8 | 105 |
| | Manure | 0.256 | 72.5 | 6 | 7.8 | 100.2 |
| Block 2 | No manure | 0.074 | 69.8 | 5 | 6.6 | 80.5 |
| | Manure | 0.241 | 99.3 | 8 | 8.1 | 104 |
| Block 3 | No manure | 0.134 | 72.3 | 5.3 | 6.7 | 98.1 |
| | Manure | 0.385 | 125 | 6.8 | 9.8 | 132 |

***Figure 4. Impact of nitrogen uptake on the growth of maize under intercropping system***



## IV. DISCUSSION AND CONCLUSION

### Discussion

However, it is worth noting that plant height does not always correlate with productivity since modern hybrids with high productive potential are mostly of lower height (Cruz *et al*., 2008).

On the other hand, Alley *et al*, (2009), stated that maize must accumulate adequate quantity of nitrogen (N) for profitable production as the plant requires N soon after germination to initiate the growth of stems, leaves and ear structures. Significant amounts of N are transferred from leaf tissue to other parts of the plant in the growth process. Soil contained and applied N (nutrient) move from the roots to leaves in the process of xylem (drink to up) after absorption of roots, while foliar applied N are transported from leaves to roots by the process of phloem (living cells). In this study, it was observed that soil contained N led to increased plant height, stem thickness, leaf width and leaf length of maize and sunflower plants.

Jones, (1985) argued that progressive increases in internode length, protein synthesis and photosynthetic area leading to higher plant height could be affected by inadequate N availability during the first two to six weeks after planting. However, in maize production majority of N is needed during the period of maximum growth (month prior to Tasseling and Silking). Lack enough nitrogen at this stage can affect the growth of the plant (plant height, stem thickness and/or leaf size (Hammad et al., 2022).

### Conclusion

The main aim of this study was to examine the impact of N uptake on the growth of maize and sunflower as influenced by compost manure under intercropping systems. The results obtained in this study showed that: An increase in the N uptake, increases the growth of sunflower and maize. The data on intercropped sunflower and maize confirmed that the growth of sunflower and maize increased with increased levels of N accumulation by the plant. For example, sunflower on average accumulated 0.395% N, while maize accumulated 0.385 % N, which positively influenced plant growth (height, stem thickness, leaf width and leaf length). Simple linear regression was used to test if N uptake significantly influenced growth of intercropped sunflower and maize with the use of compost manure. The overall regression for plant height was statistically not significant, representing ($R^2$ =0.2828, F (1, 1) =0.39, p> 0.05) and ($R^2$ =0.1278, F (1, 1) = 0.15, p> 0.05) for sunflower and maize, respectively.

Equally under mono-cropped Maize and Sunflower with compost manure, an increase in the N uptake, increased the growth of Maize and Sunflower. The data revealed that the growth of Maize and Sunflower increased with increased levels of N accumulation by the plants. For instance, on average, Maize accumulated 0.248% N while, Sunflower accumulated 0.364 % N, which positively influenced plant growth (height, stem thickness, leaf width and leaf length). Simple linear regression was again used to test if N uptake significantly influenced growth of mono-cropped maize and sunflower with the use of compost manure. The overall regression for stem thickness was statistically significant representing ($R^2$ =0.9147, F (1, 1) = 10.73, p> 0.05) and ($R^2$ =0.8611, F (1, 1) =6.20, p> 0.05) for maize and sunflower, respectively.

In the mono-cropped, as well as intercropped plots of maize and sunflower without compost manure, it was observed that growth was influenced by the availability of N in the soil. The study revealed that plots with increased N uptake hard increased growth of maize and sunflower plants. For example, in the mono-cropped maize and sunflower plots without compost, on average, Maize accumulated %0.078 N while, Sunflower accumulated 0.087% N, which slightly influenced plant growth. On the other hand, in the intercropped plots, Maize accumulated 0.114% N while, Sunflower accumulated 0.068% N, which also slightly influenced plant growth.

### Limitations of the study

The study faced several limiting factors such as outbreak of pests and diseases, though controlled before causing damage to the crops, low pressure for irrigation water and/or very low temperatures from 10th to 15th June, 2022, which might have affected the nutrient uptake of maize and sunflower.

### Recommendations/suggestions for further research

- A comparative analysis research on the N uptake and growth of maize and sunflower as influenced by organic and inorganic fertilizers under intercropping systems should be done.

- Further research to be conducted for a longer period to examine the N uptake and yield of maize and sunflower as influenced by compost manure under intercropping systems.

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## VI. REFERENCES

[1]Ahmad, N. (2000). Fertilizer scenario in Pakistan: Policies and development In: Proc. of conf. Agric. and fertilizer use. 2000. Feb. 15-16, NFDC, Islamabad, 1999.

[2]Alley, M.M. and Vanlauwe B. 2009. The role of fertilizers in Integrated Plant Nutrient Management. International Fertilizer Industry Association, and Tropical Soil Biology and Fertility Institute of the International Centre for Tropical Agriculture, Retrieved from: WWW. Fertilizer.org.

[3]Amanullah, R.A., Khalta, K. and Khalil, S.K. (2009). Effect of Plant Density and Nitrogen on Phenology and Yield of Maize. J. Plt. Nutr., 32: 246-260.

[4]Black, C.A. 1965. Methods of Soil analysis part-II.

[5]CFI. (1998). Nutrient uptake and removal by field crops. Canadian Fertilizer Institute. Eastern Canada.

[6]Channabasanagowda, N., K.B. Patil, B.N. Patil, J.S. Awaknavar, B.T. Ninganur and R. Hunje. (2008). Effect of organic manures on growth, seed yield and quality of wheat. Karnataka J. Agric. Sci., 21: 366-368.

[7]Chikwanda (2013) 'Minister of Finance , Delivered To the National Assembly).

[8]Chisanga, C. B. (2014) "Evaluation of the Ceres-Maize Model in Simulating Maize (Zea mays): University of Zambia.

[9]Del Carmen Rivera-Cruz, M., Narcía, A.T., Ballona, G.C., Kohler, J., Caravaca, F. and Roldan, A., (2008). Poultry manure and banana waste are effective biofertilizer carriers for promoting plant growth and soil sustainability in banana crops. *Soil Biology and Biochemistry*, *40*(12), pp.3092-3095.

[10]Fozia A., Muhammad AZ., Muhammad A. & Zafar MK. (2008). Effect of chromium on growth attributes in sunflower *(Helianthus annuus L.)*. J Environ Sci (China) 20(12): 1475-1480.

[11]Gomez, K.A. and A.A. Gomez. (1984). Statistical procedures for agricultural research. Wiley, New York, 680 pp.

[12]Gross, E.M., Hupfer, M., Morscheid, H., Mählmann, J., Melzer, A., Poltz, J., Sandrock, S., Scharf, E.M., Schneider, S. and Van de Weyer, K., (2006). Restoration of submerged vegetation in shallow eutrophic lakes–A guideline and state of the art in Germany. *Limnologica*, *36*(3), pp.155-171.

[13]Harter, A. V., Gardner, K. A., Falush, D., Lentz, D. L., Bye, R. A. & Rieseberg, L. H. (2004).
Origin of extant domesticated sunflower in eastern North America. Nature 430(6996): 201-205

[14]Hammad, H.M. et al. (2022) 'Evaluating the Impact of Nitrogen Application on Growth and Productivity of Maize Under Control Conditions', Frontiers in Plant Science, 13(May), pp. 1–11. Available at: https://doi.org/10.3389/fpls.2022.885479.

[15]Hani, A.E., Muna, A. H. and Eltom, E.A. (2006). Effect of Nitrogen and Phosphorus Fertilizer on Growth, Yield and Quality of Forage Maize (Zea mays L.). J. of Agron., 5(3); 515-518

[16]Haque, M.M., Hamid, A. and Bhuiyan, N.I. (2001). Nutrient Uptake and Productivity as Affected by Nitrogen and Potassium Application Levels in Maize/Sweet Potato Intercropping System. Korean. J. Crop Sci., 46(1): 1-5.

[17]Jones, C. A. (1985). C4 grasses and cereals: growth, development, and stress response. John Wiley &Sons, Inc., New York.

[18]Jones C., Dinkins, C.P. and Olson-Rutz, K. (2011). Nutrient uptake timing by crops: to assist with fertilizing decisions. Montana State University, Mo. USA.

[19]Jones, C. and Jacobsen, J. (2001). Plant Nutrients and Soil fertility. Nutrient

Management
Module 2. Montana State University, Mo. USA

[20]Kunduraci, B. S., Bayrak A., & Kiralan, M. (2010). Effect of essential oil extracts from oregano (Origanum Onites L.) leaves on the oxidative stability of refined sunflower oil. Asian J Chem 22(2): 1377-1386.

[21]MINAGRI. (2004). Strategic Plan of Agriculture Transformation. Ministry of Agriculture and Animal Resources. Kigali-Rwanda.

[22]Mohamed El-Murtada Hassan Amin. Effect of different nitrogen sources on growth, yield and quality of fodder maize (Zea mays L.), Journal of the Saudi Society of Agricultural Sciences, Volume 10, Issue 1, 2011, Pages 17-23, ISSN 1658-077X,

[23]Mohan, S. Singh, M and Kumar, R (2015). "Effect of nitrogen, phosphorus and zinc fertilization on yield and quality of Khari fodder -A review," Agricultural Reviews, vol. 36, no. 3, pp. 218–226.

[24]Moodi, C.D., H.W. Smith and R.A. Mccreery. (1959). Laboratory Manual for Soil Fertility. State College Washington Mimeograph, 31-39.

[25]Muller, M. H., Latreille, M. & Tollon, C. (2011). The origin and evolution of a recent agricultural weed: population genetic diversity of weedy populations of sunflower (Helianthus annuus L.) in Spain and France. Evol Appl 4(3): 499-514.

[26]Mulenga B.P and Wineman. A (2014) "Climate Trends and Farmers' Perceptions of Climate Change in Zambia.

[27]Nasim, W., A. Ahmad, A. Wajid, J. Akhtar and D. Muhammad. (2011). Nitrogen effects on growth and development of sunflower hybrids under agro-climatic conditions of Multan. Pak. J. Bot. 43: 2083-2092

[28]Richard, L.A. (1954). Diagnosis and Improvement of Saline and Alkali Soils. Agric. Hand Book-60. pp. 101-129.

[29]Sanchez, C. A. and Doerge, T. A. (1999). Using nutrient uptake patterns to develop efficient management strategies for vegetables. Horticulture Technology 9(4): University of Arizona, USA.

[30]Tembo, S. and N. Sitko (2013). Technical Compedium: Descriptive Agricultural Statistics and Analysis for Zambia. I. A. P. R. I. (IAPRI). Lusaka, Zambia.

[31]Togo Tsuji, Austin Mambo, Lackson K. Phiri, Ronald Msoni, Sesele B. Sokotela & Olusegun A. Yerokun (2005) Studies on Nutrient Distribution in Some Zambian Soils with Special Reference to Sulphur Using GIS (Geographic Information Systems) II. Evaluation of Plant-Available Sulphur and Its Distribution in Major Zambian Soils, Soil Science and Plant Nutrition, 51:7, 943-952, DOI: 10.1111/j.1747-0765.2005.tb00132.x

[32]Vinod Kumar Bisht, Manoj Shashikant Chandorkar, Ramesh Chandra Uniyal, Janardan Manusukhlal Pathak and Santosh Baliram Dhutraj, 2019. Effect of Different Manure on the Plant Growth and Yield of Gymnema Sylvestre R. Br. Journal of Applied Sciences, 19: 223-228.