BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCE
DEPARTMENT OF CROP SCIENCE

# EVALUATING THE EFFECTS OF DEFOLIATION ON YIELD AND QUALITY OF ‘KAYLA PLUS’ PUMPKIN (*CUCURBITA MOSCHATA*)

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**(CROP SCIENCE)**

**SUPERVISOR Ms KAMOTA**

# Declaration

**BINDURA UNIVERSITY OF SCIENCE EDUCATION**

**FACULTY OF AGRICULTURE AND ENVIRONMENT SCIENCE**

The undersigned certify that they have read and recommended to the Department of Crop Science, this thesis entitled:

**Evaluating the effects of defoliation on yield and quality of 'Kayla PLUS' Hybrid pumpkin (*Curcubita moschata*)**

I, Dephine Kudakwashe hereby declare that this research project is the result of original work that had been researched and got submitted on fulfilment of the Bachelor of Agriculture Honours Degree majoring in Crop Science at Bindura University of Science Education.

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# Abstract

Pumpkin Kayla PLUS Hybrid is an annual crop belonging to the family Cucurbitaceous family, scientifically known as *Cucurbita moschata.* These pumpkins are particularly suited for both leafy vegetable production and fruit harvesting by the small holder farmers, providing nutrients for humans, making it a versatile choice for small holder farmers. The goal of the study was to evaluate the effects of different levels of defoliation which were no defoliation (control), light, moderate and severe on pumpkin yield and quality, assessing factors such as fruit number, fruit mass and fruit diameter. The study was conducted in an open field using a Randomized Complete Block Design (RCBD) with 4 treatments (defoliation levels: control, light, moderate, and severe) replicated 4 times to give a total of 16 experimental units (plots). Soil type was visually assessed as the blocking factor. The total number of mature fruits per plant and fruit mass were recorded across various treatments at the end of the growing season. The acquired data was analyzed using analysis of variance (ANOVA). The experiment indicated that there were highly significant differences ($P < 0.001$) in the pumpkin fruit number, fruit mass and fruit diameter among the different defoliation levels. No defoliation (control), had highest fruit number, mass and diameter, compared to light defoliation, moderate defoliation and severe defoliation respectively. Therefore, the farmers should use light defoliation that balances both leaf harvest and fruit development. Additionally, farmers should also prioritize harvesting lower leaves first.

# Dedication

This project is dedicated to Mkombwe family, who has worked tirelessly supporting my academic journey.

## Acknowledgements

I would like to start by expressing my sincere gratitude to Almighty God for providing protection and guidance across this project. I'm profoundly appreciative to my supervisor Ms Kamota for her tireless support throughout the entire research process. I'm also thankful to all lecturers from BUSE crop science department for their invaluable advice and academic support during the course of this project. I would also want to thank Bindura University of Science Education for allowing me to apply theoretical knowledge in practice. Additionally, I would like to express my deep gratitude to my brother Divine Kudakwashe for helping me with data collection and project management. Finally, I would want to convey my deepest appreciation to my parents for their financial support and uplifting words throughout the whole project.

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# List of abbreviations

| | |
|---|---|
| Kgs | Kilograms |
| cm | Centimeters |
| LSD | Least significant difference |
| RCBD | Randomized Complete Block Design |
| SED | Standard error of the difference |

# CHAPTER 1: INTRODUCTION

## 1.1 Background of study

Smith (2007) revealed pumpkins (*Cucurbita moschata*) as one of the most adaptable cucurbit species and widely cultivated globally. FAO (2020) also highlighted that it have become a globally significant crop, with production estimates reaching 22,900,826 metric tons annually .FAO (2019) cited that Asia and the Americas dominate global pumpkin production, whereas Africa accounts for 2,793,530 metric tons annually, with Algeria, Egypt, Malawi, and South Africa being leading producers . Adams et al. (2011) highlighted that beyond their economic significance, pumpkins hold substantial dietary importance, offering essential vitamins, minerals, and fiber that contribute to health and nutrition. According to (Maundu, 2015), in African cuisine, pumpkin leaves (commonly known as muboora) are a traditional delicacy and a key ingredient in numerous dishes.

Ndoro et al. (2007) cited that in Zimbabwe, pumpkin production thrives due to favorable climatic conditions, particularly in regions 1 to 2B, where fertile soils further contribute to yield output. Farmers cultivate a variety of pumpkin species, including Kayla Plus. There are some landraces varieties which are grown by small holder farmers in Zimbabwe and they include Nzunzu, Musatani, Ditimanga (Ndoro et al., 2025), for both domestic consumption and commercial purposes. Ndoro et al. (2007) reported that muboora, consumed regularly during the rainy season is valued for its versatility and nutritional benefits. However, unregulated defoliation practices among smallholder farmers, where leafy vegetables of the pumpkin are consumed 3 to 4 times in a week threaten crop yield, quality, and overall productivity Ndoro et al., (2007). Defoliation, as highlighted by Nerson (2000), requires careful timing and management to maximize both yield and fruit quality.

According to Marino et al. (2013), defoliation which is defined as the removal of leaves, is a widespread crop management practice aimed at enhancing fruit growth, improving sunlight penetration, and reducing disease susceptibility. While it offers benefits such as improved air circulation around fruits, its effects are highly variable depending on the timing and intensity of leaf removal Ibrahim et al., (2020). Ibrahim et al. (2010) also reported that for pumpkins, where leaf area directly correlates with photosynthetic capacity, inappropriate defoliation practices can diminish yields by reducing photosynthetic tissue needed for plant growth and energy production. Moreover, excessive defoliation disrupts the balance of hormones, proteins, sugars, starch, and chlorophyll in source leaves, negatively impacting growth rates and senescence Ibrahim et al., (2010).

Strategic defoliation practices, as noted by Pedigo et al. (1986), should align with plant growth stages, such as the cotyledon stage, which is most sensitive to improving photosynthetic rates in remaining leaves. Furthermore, reducing canopy size, as discussed by Yoshida (1980), can optimize light penetration and stimulate photosynthesis. Nevertheless, when leaf harvesting exceeds optimal levels, photosynthetic efficiency and branch development are compromised, resulting in reduced fruit and biomass yields Ibrahim et al., (2010).

### 1.2 Statement to the problem

Smallholder farmers in Zimbabwe are using random and uncontrolled defoliation practices when harvesting pumpkin leaves for consumption. These ineffective strategies weaken the health and productivity of the pumpkin plants, reducing fruit yields.

### 1.3 Justification

This research is essential for smallholder farmers in Zimbabwe who rely on pumpkin crops for both leaves and fruits. By resolving the matter of random and uncontrolled defoliation, the research will provide practical solutions to improve sustainable leaf harvesting techniques without compromising fruit production. This holds particular significance because the majority of these farmers depend on pumpkin leaves for regular consumption and pumpkins as fruits for income generation. By enhancing crop health and yields, the research will actively strengthen smallholder farmers to enhance their agricultural productivity, ensuring better economic outcomes and strengthening their livelihoods.

### 1.4 Objectives of the study

#### 1.4.1 Overall objective

- To evaluate the effects of defoliation on Kayla plus pumpkin yield and quality.

#### 1.4.2 Specific objectives

- To examine the effect of defoliation on average fruit quantity produced per pumpkin plant.
- To assess the mean fruit mass per pumpkin plant.
- To assess the average fruit's diameter per pumpkin plant.

## 1.5 Hypotheses (H0)

- There is no significant difference in the average total number of mature fruits per pumpkin plant after defoliation.
- There is no significant difference in the average mass of mature fruits per pumpkin plant.
- There is no significant difference in the average fruit diameter of pumpkin plants.

# CHAPTER 2: LITERATURE REVIEW

## 2.1 An overview of pumpkins

According to Gohari et al. (2011) pumpkins are believed to have originated in North America, where seeds from related plant species have been found in Mexico dating back to 7000 to 5500 B.C. Gohari et al. (2011) also insights that, the name pumpkin originated from a Greek word meaning a large melon which is Pepon. Due to language translation, Gohari et al. (2011) reviewed that the name Pepon was changed by the French language into Pompon then English language changed it to Pumpion and finally American colonists changed it to Pumpkin.

Gohari et al (2011) explained Pumpkin belongs to the family Cucurbitaceae and genus Cucurbita a widely grown vegetable. Furthermore, Caili et al (2006) exposed that pumpkin has species of Cucurbita moschata, Cucurbita pepo, Cucurbita maxima, Cucurbita mixta, Cucurbita facifola and Telfairia occidentalis. Therefore, Cucurbita pepo, Cucurbita maxima Cucurbita moschata are economically important species grown worldwide for human consumption, Caili et al (2006). PROTA (2018) outlined of Curcubita species being the greatest heat tolerant and well-known in tropical Africa.

According to Grubben and Ngwerume (2004) pumpkins are commonly used as a leafy vegetable, where the young leaves and shoots are cooked and eaten as a green vegetable. Pumpkin leaves are highly nutritious and are used as a leafy vegetable in many African countries. They are an origin of vitamins A, B, and C. Gibson and Hotz (2001) further explained these leaves offering body with phosphorus and potassium, which sustain energy production, muscle function, electrolyte balance, nutrient transportation, pH balance, and kidney stone prevention.

## 2.2 Pumpkin varieties

According to Avanos Seed Company (www.avanosseeds.com), Kayla variety offers many advantages over other traditional pumpkins. Its young leaves can be harvested as a leafy vegetable alongside the pumpkin fruits which come in a later stage of crop development, meaning that it is a dual purpose crop.

Avanos Seed Company (www.avanosseeds.com) also reported that Kayla plus being the first hybrid of its kind in Zimbabwe. It is highly adaptable to Zimbabwean growing conditions and offers many advantages over other traditional pumpkin. Its young leaves can be harvested as a leafy vegetable alongside the pumpkin fruits which come in a later stage of crop development. The mature fruit is tan with deep orange flesh and excellent eating quality, non-fibrous and sweet. It can be grown year-round, provided temperatures are conducive for crop growth.

According to Avanos Seed Company (www.avanosseeds.com), kayla takes about 100-120 days to mature, having an average fruit weight of 2-4 kg. The sowing time is year-round in frost free areas; September to February. This variety has an excellent flavour. The plant habit is a vine, having a very good uniformity and the plant spacing is 1m by 2m. Seed rate required per hectare is 1, 5 kg, having a plant population of 5000 plants and reported that the average number of fruits per plant is four and the potential yield per hectare is 40-60 mt.

According to Ndoro et al., 2025, Nzunzu, Musatani, Ditimanga, and Ndodo are widely recognized landraces in Zimbabwe. Ndoro et al., 2025, also highlighted that Ditimanga is widely valued for its fruit and leaves with early leaf harvest started 2 - 3 weeks after emergence, while the other landraces can begin around fourth week after emergence. Additionally, Musatani was cultivated mainly for leafy vegetable, available year-round, establishing it as an essential part in local diets.

## 2.3 Defoliation

Marino et al. (2013) reported that defoliation is a widespread agricultural management practice that includes the removal of leaves from plants. Isutsa and Mallowa (2013) insights defoliation as a common practice of crop leaf harvesting to support fruit growth and reduce disease susceptibility, however it can have harmful effects if not properly managed. Ibrahim et al. (2020) supported defoliation as a crop management concept of leaf harvesting towards enhancement of sunlight penetration and air circulation around fruits, though its effects can differ substantially based on the timing and magnitude of leaf harvesting. Furthermore, Ibrahim et al. (2020) reported that, within the framework of pumpkin cultivation, where leaf area is directly linked to photosynthetic capacity, understanding the magnitude of defoliation is essential for maximizing yield.

Pedigo et al. (1986) outlined that defoliation can be done for strategic crop management exercise where timing like cotyledon stage and moderate stages being most sensitive for increasing the photosynthetic rates in the remaining leaves. Furthermore, Yoshida (1980), insights defoliation as a principle of reducing the canopy size to allow closer plants to stimulates the photosynthetic capacity.

Contrariwise, Ibrahim et al. (2010) reviewed that, leaf harvesting reduced the photosynthetic area needed to drive branch growth, resulting in lower total number of branches in treatments where more leaves were harvested. Likewise, the photosynthetic machinery of the plant is formed by the leaves; hence their harvesting constitutes a reduction in photosynthetic tissue and photoassimilates needed in plant growth. Moreover, Ibrahim et al. (2010) conveyed that defoliation alters hormone balance, protein, sugar, starch and chlorophyll contents of source leaves, as well as senescence rate and stomatal resistance.

## 2.4 Effects of defoliation on pumpkins

According to Thomson et al. (2004), pumpkin are monoecious plants, which can separate allocation of male and female functions more easily, that is, leaf harvest intensity can induce flower abortion through the fact that leaf harvesting reduced photosynthetic area resulting in less assimilates being partitioned to the flowers for development. Kopondo et al. (2005) mensioned the depletion of resources through leaf harvesting which can be likened to folivory (leaf herbivory) differentially influences male and female functions. According to Kopondo et al. (2005), seed production in most indigenous leafy vegetables is low since most of the production is for leaf consumption and not seed production.

Madakadze et al. (2007) insights that, when leaves are harvested, the plant concentrates on recovering the lost leaf area, that is, essential for photosynthesis rather than reproduction, resulting in reduced seed yields. Older leaves left on the plant are less efficient in photosynthesis, thereby reducing seed yields. Achieving a balance between leaf and seed yields for a pumpkin plant, where the leaves are consumed requires both sound cultural practices and good leaf harvesting practices that do not reduce the active photosynthetic area of the plant to jeopardize seed yields. However, Madakadze et al. (2007) reported that more frequent harvesting at 7-day interval significantly reduced seed yields to 1.2, compared to 2.7 tonnes/ha obtained for 14- and 21-day intervals.

Leaves are essential for the photosynthesis process, providing the energy required for fruit development. According to Lassa et al., 2020 enhanced leaf persistence contributes to better fruit set; larger fruit size, and improved yield, therefore pumpkins with full foliage are likely to generate higher amounts of fruits per plant compared to defoliated ones. Juknevičienė et al., 2021, discovered that unpruned pumpkins produced more fruits than those exposed to trimming. Lassa et al., 2020, also highlighted that no defoliation enhances optimal nutrient uptake, leading to heavier fruits. Leaf area impacts fruit diameter, an increased number of leaves leads to improved synthesis of carbohydrates for fruit expansion (Poni, 2006). Lassa et al., 2020 also reported that defoliation stress found that, fruit diameter stayed unchanged at lower defoliation levels yet declined sharply under severe defoliation.

González et al. (2018) insights that show that light defoliation (typically 20-30% leaf removal) does not substantially decrease the number of leaves per plant. Additionally, González et al. (2018), stated that plants undergoing light defoliation sustained a sufficient leaf area to support photosynthesis and overall growth. Smith et al. (2020) mentioned of after light defoliation, remaining leaves may rise in size or photosynthetic productivity; make up for the lost leaf area.

Light defoliation can benefit the number of fruits per plant, Jones and Smith (2019), found that pumpkins exposed to 20-30% leaf removal had similar or grew fruit set contrasted to fully leafed plants. This is probably resulting to reduced competition for resources within developing fruits. Removal of some leaves plants may divert resources in the direction of fruit development, improving the potential for fruit formation. According to Khan et al. (2021) light defoliation can direct to a more advantageous environment for fruit set during essential growth phases. This can be ascribed to improved nutrient distribution and better light penetration to still existing leaves.

In respect of, photosynthesis and growth, numbers of leaves per plant are very important for photosynthesis, which energizes plant growth, Smith et al. (2020). González et al. (2018) highlighted that defoliation beyond 30% resulted in significant reductions in the number of leaves, harmfully affecting overall plant vigor and yield.

Smith et al., (2020), reported that defoliation exceeding 50% can lead to a sharp decrease in leaf number. The number of fruits per plant is strongly connected to the plant's overall health and photosynthetic ability, Jones and Smith (2019). According to (Khan et al., 2021), sustaining adequate leaf area during the flowering stage is essential for maximizing fruit production. N. IQBAL et al. (2012) reported that moderate leaf removal alters source-sink relations, influencing nutrient distribution and fruit development. The weight of each fruit is affected by the general well-being of the plant and its leaf area.

According to González et al. (2018), severe defoliation reduces the overall leaf area of the plant, which is vital for photosynthesis, furthermore, plants with over 50% leaf loss show a significant reduction in leaf number, impacting the plant's ability to produce energy. Miller et al. (2021), cited that the number of leaves per plant is directly correlated with photosynthetic capacity. Less foliage means diminished energy production, leading to stunted growth and reduced resilience. The timing of defoliation plays a crucial role. Jones and Smith (2019) highlighted that early defoliation negatively impacts fruit set more than defoliation occurring later in the growing season, as the plant's reproductive phase is more sensitive to leaf loss during this period. On reduction in fruit weight, Isutsa et al, (2017) highlighted that severe harvest of leaves compromises physiological functions that influence yields, also reported that the weight of individual fruits is significantly affected by defoliation. Munyoro, D.W (2017), cited that farmers in Kenya harvest leaves randomly and leave the plants to grow without any improvement in agronomic practices and as a consequence, the yields experienced remain suboptimal and poor in quality.

# CHAPTER 3: RESEARCH METHODOLOGY

## 3.1 Study area

This research was carried out at Mukodza plot 18, Dunervert farm, Guruve, located 6km north of Guruve growth point along the Mahuhwe road. Precisely, the farm is located in natural region 2b and is characterized by an average annual rainfall of 700 mm per annum. The area experiences some high temperatures of about 28 degrees Celsius during the cropping season and some low temperatures of about 18 degrees Celsius. The area is also characterized by clay- loam red soil. The GPS location includes latitude: 16.5203659 and longitude: 30.6464141.

## 3.2 Experimental design

The experiment was laid in a Randomized Complete Block Design (RCBD) with 4 treatments (defoliation levels: control, light, moderate, and severe) replicated 4 times to give a total of 16 experimental units (plots). Soil type was visually assessed as the blocking factor, using soil color and texture as an indicator of soil type variations. Given these findings, the field was divided into four blocks. In each block, all four defoliation treatments were applied, and the treatments were randomized to minimize bias in their placement (Fig. 3.1). Plot size was 3 m by 2 m, with inter-row spacing of 2 m and in-row spacing of 1 m, allowing for three pumpkin plants per plot.

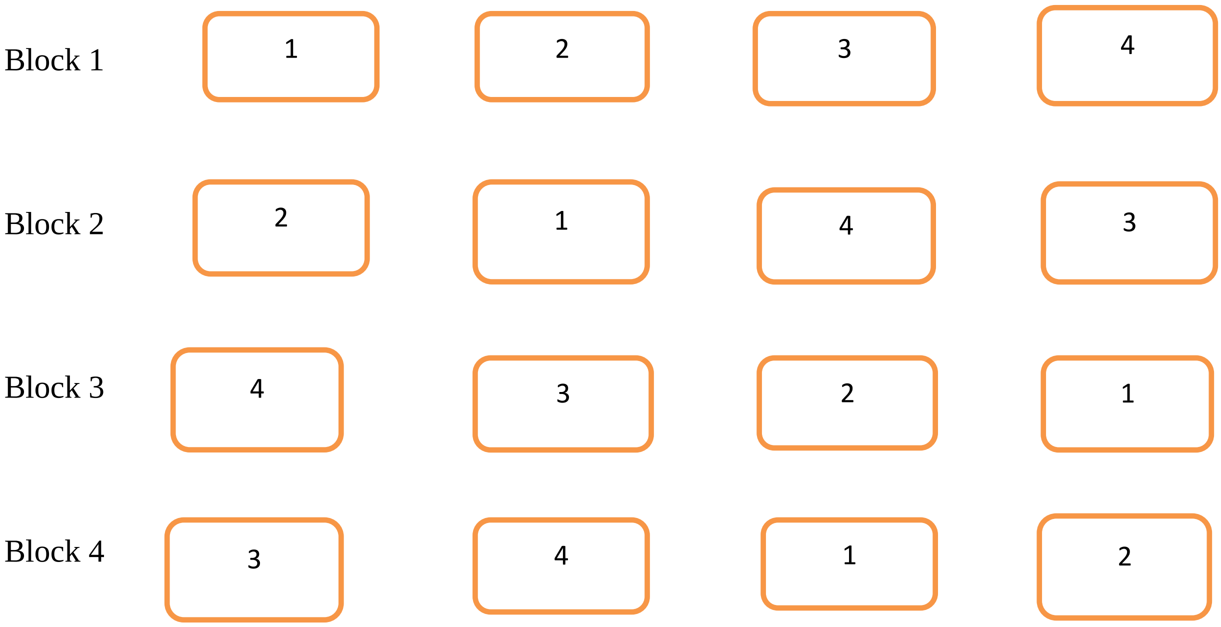


**Fig. 3.1**: **Field layout and design**

The four treatments were:

(i) Treatment 1 = no defoliation (control)

(ii) Treatment 2 = light defoliation (removal of 2-3 leaves per plant)

(iii) Treatment 3 = moderate defoliation (removal of 4-5 leaves per plant)

(iv) Treatment 4 = severe defoliation (removal of 6-7 leaves per plant)

- 3 plants per each treatment / plot
- 3 plants × 16 beds = 48 plants
- Treatment numbers were laid randomly

### 3.2.1 Materials and tools to be used

Drip irrigation system, kayla plus Seed (28.8 g), compound C basal fertilizer (9.6 kgs), Amonium nitrate 34.% top dressing (1.2kgs) , lambda, carbryl 85WP , mancozeb , hoe, garden line, pegs, metre rule, rake, digital scale, tap measure.

### 3.2.2 Pumpkin planting and crop management

Kayla plus hybrid (*Curcubita moschata* ) pumpkin variety was grown for the trial. The plant spacing was 2m ×1 m, in 12m² plots, giving a population of 6 plants per plot. The trial was established in the beginning of January 2025.

The experiment was conducted on 12m² plots, prepared by first clearing the land of debris and weeds using a hoe, one week before planting. A pre-emergence herbicide, Glyphosate (360g/L), was applied at a rate of 100ml per 12m² plots (5.55ml/m²) in 10L water, to control weeds. The herbicide was sprayed uniformly over the plots using a knapsack sprayer. The land was then divided into four blocks, which were further divided into four plots. The plot was measured and marked using a meter rule and garden line, with pegs placed at 1m intervals to guide the planting of KALYA HYBRIB seeds. The soil was loosened to a depth of 20cm using a rake and basal fertilizer (Compound C) was applied at 0.6k g per plot, approximately 100g per planting hole. Six seeds were planted 2m apart, 1m between rows, and covered with soil. Post- emergence weed control was done two weeks after planting using a hoe, removing weeds within the planting holes and between rows. Three weeks after planting, top-dressing with Ammonium Nitrate (AN) was applied through split application at 3,5,7 weeks after emergence at a rate of 0.12kg per plot, approximately 20g per plant. The rates which were used are the general recommendations since there were no soil analysis tests being done. Pest and disease management involved spraying Emamecting benzonate at 1ml per plot for aphid control, Lambda-cyhalothrin 5% EC at 2ml per plot for whitefly control, and mancozeb 20g per plot for powdery mildew control, all being applied at an interval of at 4 days. The plots were regularly monitored for pests, diseases, and nutrient deficiencies, with data being collected on plant growth and yield. All agricultural practices were carried out according to standard farming practices, with necessary safety precautions taken when handling chemicals.

### 3.2.3 Defoliation practice

Three plants per plot were randomly selected for defoliation (data collection and recordings). The selected plants from each plot were tagged and labeled for easy identification.

Defoliation was done by removing the designated number of leaves from each plant by hand (Fig. 3.2). At first, defoliaton was performed twice a week that is from week three after planting until flowering. For the light defoliation treatment, there was removal of 2-3 leaves per session. For the moderate defoliation treatment, 4-5 leaves were removed per session. For the severe defoliation treatment, there was removal of 6-7 leaves per session. During flowering, defoliation was performed three times a week until fruit setting, with the same number of leaves removed per session as during the first stage. To avoid damaging the plant and other leaves during the defoliation process, care was taken.

**Fig. 3.2: Defoliation procedure**

## 3.3 Data collection

The plants that were selected from each plot were then used for all subsequent data collection. Data collected for the light, moderate and severe defoliation treatment included:

### 3.3.1 Fruit count

The total number of mature fruits per plant was recorded at the end of the growing season. At harvest, the average number of fruits per plant was recorded across various defoliation treatments using manual counting sheets. Data was obtained from three selected plants per plot to assess fruit retention.

### 3.3.2 Fruit mass

The data on fruit mass was collected from a random sample of plants across different defoliation treatments. Mature fruits were harvested at the end of the growing season and weighed using a digital scale (Fig. 3.3) to determine the effects of defoliation on fruit mass. Data was collected and compared across different defoliation treatments.

**Fig. 3.3**: **Fruit mass measurement**

A total of 48 plants were used for the research, with 3 plants per each treatment. The collected data will be analyzed to evaluate the effects of defoliation levels (no defoliation (control); light; moderate; severe) on Kayla yield and quality.

### 3.3.3 Fruit diameter

The same harvested fruits whose masses were recorded were measured using a tape measure (Fig. 3.4) to determine the mean pumpkin fruit diameter among the different treatments.

**Fig. 3.4**: **Fruit diameter measurement**

## 3.4 Data analysis

The acquired data on fruit count, fruit mass and fruit diameter was subjected to an analysis of variance (ANOVA) using the GenStat Statistical package. The least significant difference (l.s.d.) was used for mean separation on tables while the standard error for the mean differences (s.e.d.) was used for making error bars on the graphs.

# CHAPTER 4: RESULTS

## 4.0 Introduction

This chapter serves with a research results data presentation and analysis. The data will be presented in form of tables and figures.

## 4.1 Effect of leaf defoliation on pumpkin fruit number

There were highly significant differences (P < 0.001) in the pumpkin fruit number among the different defoliation levels (Table 4.1). Highest pumpkin fruit number (5.75) was recorded under the control treatment (no defoliation) followed by the light defoliation and moderate defoliation treatments which had average fruit numbers of 4.5 and 3.25 respectively. Severe defoliation resulted in significantly lowest average fruit number of 2.25 (Table 4.1).

**Table 4.1: Effect of leaf defoliation on fruit number**

| **Treatment** | **Fruit number plant$^{-1}$** |
|---|---|
| Light defoliation | $4.50^{c}$ |
| Moderate defoliation | $3.25^{b}$ |
| Severe defoliation | $2.25^{a}$ |
| No defoliation | $5.75^{d}$ |
| Grand mean | 3.938 |
| Fprob | <0.001 |
| l.s.d | 0.5496 |
| CV% | 8.7 |

Means followed by a different superscript letter were significantly different at (P < 0.001)

## 4.2 Effect of leaf defoliation on pumpkin fruit mass

There were highly significant differences (P < 0.001) in the pumpkin fruit mass among the different defoliation levels (Fig. 4.1). Highest pumpkin fruit mass (3.175kg) was recorded under the control treatment (no defoliation) followed by the light defoliation and moderate defoliation treatments which had average fruit masses of 2.6kg and 1.925kg respectively. Severe defoliation resulted in significantly lowest average fruit mass of 1.3kg (Fig. 4.1).

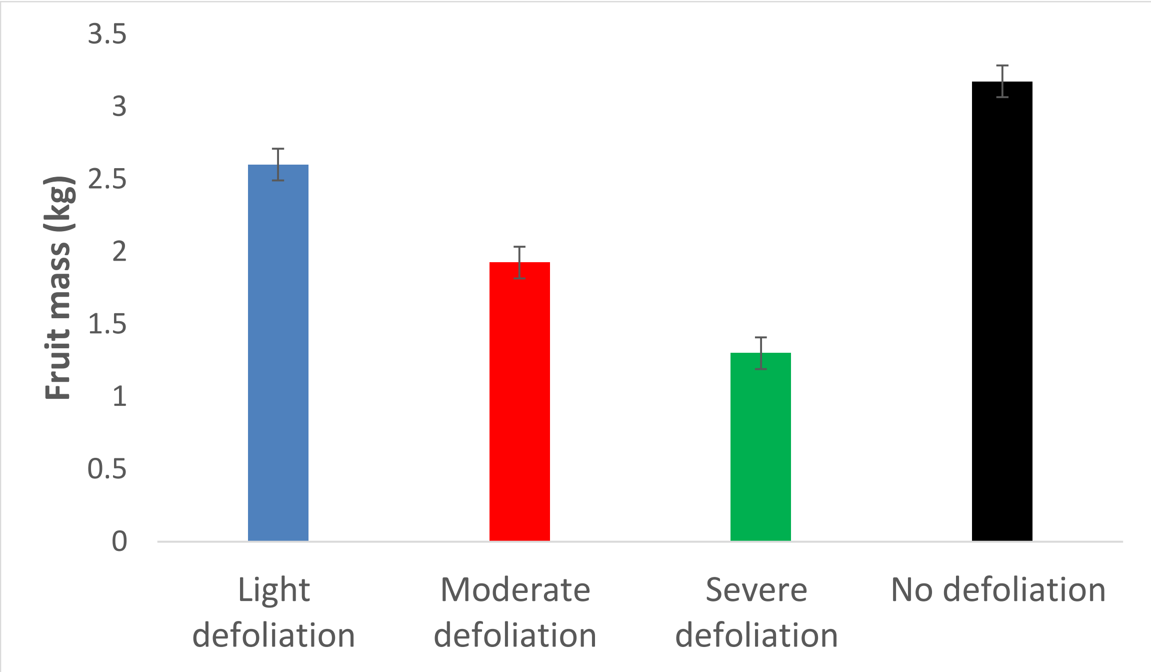


**Figure 4.1: Effect of leaf defoliation on pumpkin fruit mass**

## 4.3 Effect of leaf defoliation on pumpkin fruit diameter

Highly significant differences ($P < 0.001$) in pumpkin fruit diameter were observed among the different treatments (Fig. 4.2). Highest fruit diameter (21.95cm) was observed in the control treatment where there was no defoliation followed by the light defoliation treatment which had an average fruit diameter of 19.25cm, and then moderate defoliation which had an average fruit diameter of 16.9cm. The smallest fruit diameter (14.88cm) was recorded under the severe defoliation (Fig. 4.2).

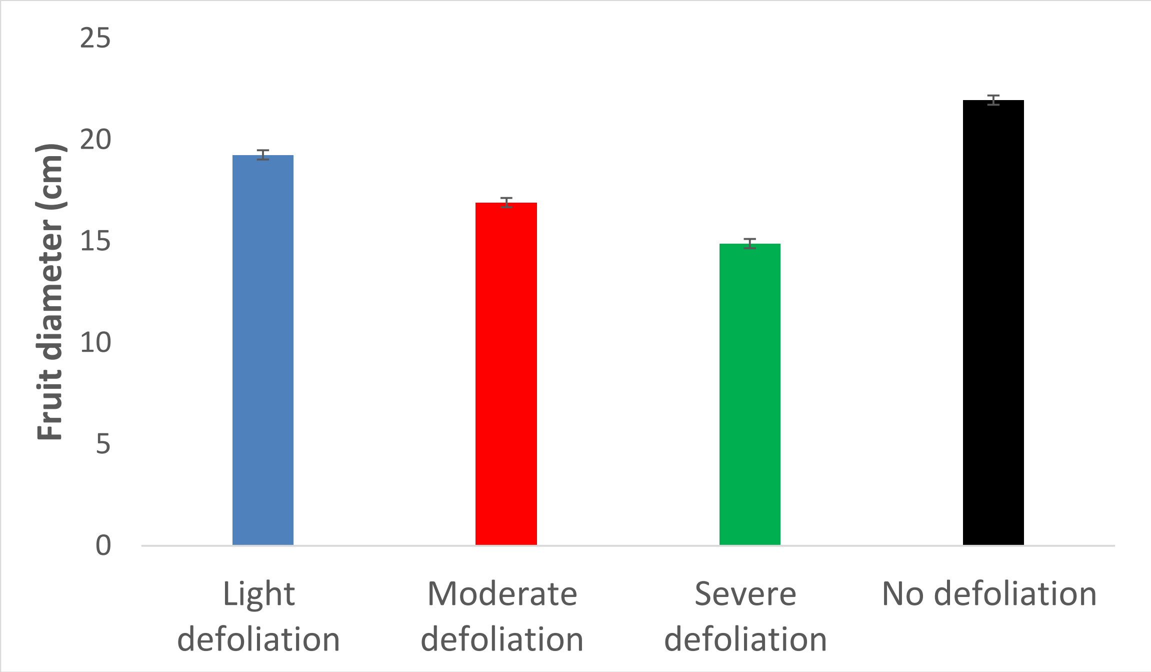


**Figure 4.2: Effect of leaf defoliation on pumpkin fruit diameter**

# CHAPTER 5: DISCUSSION

## 5.1 Effect of leaf defoliation on pumpkin fruit number

There were noticeable differences in pumpkin fruit number among different defoliation levels. Highest pumpkin number was recorded under control treatment (no defoliation), followed by light defoliation, moderate defoliation and severe defoliation respectively.

Highest fruit number obtained from the the control treatment can be attributed to highest growth rate which was experienced under the same treatment compared to the other treatments. This is likely due to maintenance of full leaf coverage, enhancing photosynthetic efficiency, since there is no leaf damage or loss and the plant has maximum photosynthetic capacity, generating enough carbohydrates to support fruit development (Isutsa et al., 2020). Iyuba Nenova, (2019) observed that leaves have a vital function in nutrient absorption and energy conversion, resulting in healthy fruit growth and retention and. Full foliage retention improves fruit setting, as the plant optimizes resource allocation to reproductive parts since the plant faces no internal stress, allowing it to direct energy toward flowering and fruiting instead of survival (Isutsa and Malowa, 2013).

Higher fruit number obtained from the the light defoliation treatment can be attributed to photosynthetic efficiency and optimized resource allocation (Muriithi et al., 2022). This may result from removal of a few leaves which may trigger regrowth in remaining leaves (Wekesa et al., 2021). The results on pumpkin number is consistent with the findings of Briske & Richards (2014) who observed that plants can optimize their photosynthetic rate to compensate for minimal leaf loss, sustaining relatively high fruit production. On the other hand, decreased leaf area slightly restricts carbohydrate synthesis, resulting in a slight decrease in fruit retention (Muriithi et al., 2022).

Lower fruit number obtained from moderate defoliation treatment can be attributed to reduced leaf area and its consequences on photosynthesis and nutrients allocation (Isutsa et al., 2020). This concurs with (www.thepharmajournal.com.) who observed that plants exposed to moderate defoliation show reduced fruit set because of lower energy availability for flowering and fruiting. Furthermore, hormonal imbalances caused by defoliation may interfere with fruit development, leading to reduced flower retention which affects fruit numbers therefore having lower yields (Maleki Khezerlu et al., 2016).

Pumpkin plants under severe defoliation have a lowest pumpkin fruit number since severe defoliation significantly affects pumpkin yield, as excessive leaf removal restricts photosynthesis, carbohydrate storage and nutrient uptake (Briske & Richards, 2014). Reduced foliage, nutrient uptake and transportation are compromised, restricting fruit development. Heidi Hawkins (2020), reported that plants exposed to severe defoliation experience stress-induced physiological shifts causing the plant redirect resources toward survival instead of reproduction, lowering fruit formation and enhancing fruit abortion rates. Moreover, water absorption and root development are compromised, further lowering yield potential (Isutsa and Malowa, 2013). Additionally, the plant becomes more susceptible to heat stress, diseases and pests (Wikkifarmer, 2024), further lowering fruit yield.

## 5.2 Effect of leaf defoliation on pumpkin fruit mass

There were noticeable differences in pumpkin fruit mass among different defoliation levels. Highest pumpkin mass was recorded under control treatment (no defoliation), followed by light defoliation, moderate defoliation and severe defoliation respectively.

Control treatments (no defoliation) have highest pumpkin mass. This is possibly caused by abundant leaves which maintain maximum photosynthetic efficiency, guaranteeing adequate carbohydrate production for development of fruits (Isutsa et al., 2020). Leaves act as the main source of energy and nutrient absorption, allowing for ideal fruit mass (Kherzerlu et al., 2016). This is inconsistent with the findings of Ramirez et al., (2022) on cucumbers, which observed that more defoliation lead to increased dry matter accumulation in leaves but reduced fruit weight. Pumpkin fruit mass is closely linked with leaf area, as increased leaf area improves nutrient uptake and formation of carbohydrates (Isutsa and Malowa, 2013). The results on pumpkin mass is consistent with the findings of Altaf et al. (2024) who observed that pumpkin plant with dense leaf cover exhibit higher fruit mass because of improved water retention and nutrient uptake.

The slight decrease in fruit mass under light defoliation may result from the removal of a small percentage of leaves, leading to small declines in photosynthetic activity (Isutsa and Mwaura, 2017). On the other hand, plants can make up for by increasing the efficiency of remaining leaves (Briske & Richards (2014), with declining fruit mass, the impact is slight, as the plant continues to hold sufficient energy stores. Briske & Richards, (2014) reported that light defoliation activates compensatory photosynthesis, as the remaining leaves enhance chlorophyll levels to offset leaf loss. The results on fruit mass is consistent with he findings of Yang et al. (2020) who found that pumpkin rootstock improves photosynthesis and fruit mass, indicating that light defoliation does not severely impact yield.

Plants under moderate defoliation have a lower fruit mass. This is likely due to substantially reduced leaf area, reducing light absorption and nutrient availability (Wang et al., 2021). The plant struggles to support its fruit yield, leading to lower fruit mass as a result of energy deficits (Maleki Khezerlu et al., 2016). Iqbal et al. (2012) mentioned that moderate defoliation reduces synthesis of carbohydrates, leading to lower fruit mass. According to Singh & Kumar (2020), pumpkin fruit mass decreases when nutrient uptake is weakened as a result of reduced leaf coverage. In general, moderately defoliated plants focus on survival over reproduction, redistributing resources to sustain fundamental physiological functions instead of investing in fruit formation (Briske & Richards, 1995).

The lowest fruit mass which was recorded under severe defoliation may result from a significant loss of the plant's photosynthetic organs, leading to sharp decreases in fruit mass (Xia, W. et al., 2024). According to University of Delaware Extension, (2009), without adequate leaves, the plant undergoes nutrient starvation, impacting hormonal balance and physiological activities essential for fruit growth. Briske & Richards (2014) reported that severe defoliation interferes with root growth, reducing nutrient and water absorption. Oklahoma State University (2019) highlighted that severe defoliation increases vulnerability to environmental stresses, weakening the plant's capacity to generate protective compounds like secondary metabolites and antioxidants, making it more vulnerable to diseases, pests, and environmental damage continuing to decrease fruit mass. This concurs with Ramirez et al., (2022) who observed a similar trend in their experiment on cucumbers.

## 5.3 Effect of leaf defoliation on pumpkin fruit diameter

There were noticeable differences in pumpkin fruit diameter among different defoliation levels. Highest fruit diameter was recorded under control treatment (no defoliation), followed by light defoliation, moderate defoliation and severe defoliation respectively.

Highest fruit diameter which was recorded under control treatment (no defoliation) is possibly caused by extensive leaf distribution which maintains optimal photosynthetic performance, ensuring sufficient carbohydrates synthesis for fruit development and also, leaves function as the main energy provider and nutrient assimilation, enabling optimal fruit expansion (Maleki Khezerlu et al., 2016). Study conducted by Singh & Kumar (2020) discovered that pumpkin fruit diameter is strongly like linked to leaf size, as larger leaf area optimizes nutrient uptake and synthesis of carbohydrates. Khodabakhshian (2012) highlighted that pumpkin plant with dense leaves exhibit larger fruit diameters because of improved water retention and nutrient uptake.

A slight decrease in pumpkin fruit diameter under light defoliation is probably because of removal of a limited portion of leaves, leading to slight decreases in photosynthetic activity (Maleki Khezerlu et al., 2016). However, plants can make up for by increasing the effectiveness of remaining leaves (Briske & Richards, 2014). As fruit diameter decreases, the impact is not intense as the plant still preserves adequate energy stores. Briske & Richards, (2014), also reported that light defoliation initiate adaptive photosynthetic responses, where remaining leaves boost chlorophyll levels to compensate leaf loss. Wang et al. (2021) discovered that pumpkin rootstock improves photosynthesis and fruit enlargement, indicating that light defoliation does not significantly impact fruit diameter.

Lower pumpkin fruit diameter which was recorded under moderate defoliation can be attributed to reduced leaf area, restricting photosynthesis and nutrient accessibility (Maleki Khezerlu et al., 2016). The plant might be experiencing difficulties to sustain its fruit load, resulting in reduced fruit diameter due to energy shortages (Briske & Richards, 1995). Hawkins (2020) revealed that moderate defoliation reduces the production of carbohydrates, resulting in lower fruit diameter. Oklahoma State University (2019) found that pumpkin fruit size reduces as nutrient absorption weakens due to reduced leaf coverage. According to Briske & Richards, (1995), moderately defoliated plants focus on survival over reproduction redistributing resources to sustain basic physiological functions instead of investing in fruit expansion.

Under severe defoliation the lowest pumpkin fruit diameter which was recorded is likely due to severe defoliation which deprives the plant from the majority of its photosynthetic organs, causing significant declines in fruit diameter since leaves are the main sites of light absorption (Maleki Khezerlu et al., 2016). University of Nebraska, (2022), reported that lacking enough leaves, the plant experiences nutrient deficiency, affecting metabolic functions and hormonal balance necessary for fruit growth. Briske & Richards (2014) reported that severe defoliation disrupts root development, reducing nutrient and water absorption. Oklahoma State University (2019) highlighted that excessive defoliation increases vulnerability to environmental stress, minimizing fruit diameter.

# CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

## 6.1 Conclusion:

The research produced highly significant results on fruit number, fruit mass and fruit diameter among different defoliation levels. No defoliation (control) treatment resulted in the highest fruit number, fruit mass, and fruit diameter followed by the light defoliation treatment, moderate defoliation treatment and severe defoliation treatment respectively due to high photosynthetic activity which ensured sufficient energy for fruit development.

## 6.2 Recommendations:

Rather than random and uncontrolled leaf removal, farmers are advised to practice light defoliation approach that balances both leaf harvest and fruit development. There are also advised to prioritize harvesting lower leaves first, as older leaves contribute less to photosynthesis but though provide nutritional value. Farmers should minimize the removal of young leaves and leave sufficient foliage on the plant to aid fruit development.

Additionally, farmers are advised to harvest leaves during the strong vegetative phase in the in early development, avoiding over-harvesting during the flowering and fruit setting stage. There are also recommend to reduce leaf harvesting as fruits begin to grow larger to allow maximum energy distribution toward fruit development. Farmers should consider sequential defoliation, where there is periodic leaf harvesting instead of removing large quantities at once.

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# APPENDICES

## Appendix 1: Analysis of variance (ANOVA) Tables

### Appendix 1.1: Analysis of variance for fruit count

| Source of variation | d.f. | s.s. | m.s. | F. value | F pr. |
|---|---|---|---|---|---|
| Block | 3 | 2.1875 | 0.7292 | 6.18 | |
| Treatment | 3 | 27.6875 | 9.2292 | 78.18 | <0.001 |
| Residual | 9 | 1.0625 | 0.1181 | | |
| Total | 15 | 30.9375 | | | |

### Appendix 1.2: Analysis of variance for fruit mass (kg)

| Source of variation | d.f. | s.s. | m.s. | F. value | F pr. |
|---|---|---|---|---|---|
| Block | 3 | 0.16000 | 0.05333 | 2.23 | |
| Treatment | 3 | 7.94500 | 2.64833 | 110.86 | <0.001 |
| Residual | 9 | 0.21500 | 0.02389 | | |
| Total | 15 | 8.32000 | | | |

### Appendix 1.3: Analysis of variance for fruit diameter (cm)

| Source of variation | d.f. | s.s. | m.s. | F. value | F pr. |
|---|---|---|---|---|---|
| Block | 3 | 0.1119 | 0.0373 | 0.35 | |
| Treatment | 3 | 111.6119 | 37.2040 | 350.38 | <0.001 |
| Residual | 9 | 0.9556 | 0.1062 | | |

| | | |
|---|---|---|
| Total | 15 | 112.6794 |