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Assessment of Storability and Shelflife Longevity in Selected Tomato (*Solanum Lycopersicum*) Cultivars Grown Under Various Fertilizers

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Abstract

This study investigated the assessment of storability and longevity in selected tomato cultivars grown under various fertilizers. Five popular varieties (Roma VF, Tengeru 97, Floridade, Rodade, and Money Maker) were evaluated under different fertilization treatments including cow dung, poultry manure, compost, and inorganic Compound D. The research applied a Randomized Complete Block Design (RCBD), a standard methodology for agricultural field trials ***(Gomez & Gomez, 1984)***. Results indicated significant differences in plant growth, yield, and postharvest quality, with organic fertilizers showing potential to improve shelf life and reduce postharvest losses, a finding consistent with previous research ***(Kumar & Sharma, 2020)***. Findings have practical implications for improving productivity and profitability for farmers, while ensuring better quality for consumers. Recommendations for future research and practical applications are discussed.

Tomato (Solanum lycopersicum) production is one of the most important components of Zambia□s horticultural sector and also plays a vital role in food security and income generation ***(Ministry of Agriculture, Zambia, 2021)***. Yet, the sector faces severe postharvest losses, with estimates suggesting up to 40% of total yield is lost due to poor handling and storage ***(Zambia National Farmers□ Union, 2022; Food and Agriculture Organization, 2019)***. It remains a major challenge for both farmers (growers) and consumers (buyers). For growers, high perishability leads to reduced incomes, as large proportions of harvested tomatoes spoil before reaching the market ***(Mwale & Phiri, 2018)***. For buyers, the problem manifests as quality deterioration, including changes in texture, colour, and firmness, resulting in financial losses and reduced consumer satisfaction ***(Kader, 2002)***. The short shelf life of tomatoes highlights the need for identifying tomato cultivars and management practices that can improve postharvest longevity.

This study aims to identify the best-performing tomato cultivar among five popular varieties□Roma VF, Tengeru 97, Floridade, Rodade, and Money Maker□under different organic fertilization regimes, focusing on postharvest shelf life, storability, and overall fruit quality.

Keywords: *Solanum Lycopersicum,* Storability and Longevity, Postharvest Shelf Life, Cultivar

Introduction

Tomato (*Solanum lycopersicum L.*) is an annual herbaceous vegetable crop that belongs in the *Solanaceae* family, grown for its edible fruit. The plant can be erect with short stems or vine-like with long, spreading stems. The stems are covered in coarse hairs and the leaves are arranged spirally. The tomato plant produces yellow flowers, which can develop into a cyme of 3-12, and usually, a round fruit (berry) that is fleshy, smoothed skin, and can be red, pink, purple, brown, orange, or yellow in color.

The tomato plant can grow 0.7□2 m (2.3□6.6 ft) in height and as an annual, is harvested after only one growing season. That is thought to have originated in South America's Andean area; its popularity in the last half-century has resulted in large-scale production. Tomatoes are a valuable crop, with a global yield of 177.04 million tonnes from 4.78 million hectares worth $95.62 billion. China tops the world in tomato production, with 56.42 million tonnes produced yearly, followed by India with 18.40 million tonnes. These may be eaten in a variety of ways. Fresh fruits are used in salads and sandwiches, as well as salsa, whereas processed fruits are used in pastes, preserves, sauces, soups, juices, and beverages. The crop is among the most widely cultivated vegetables globally, valued for their nutritional benefits and economic significance (FAO, 2021). In Zambia, tomatoes are cultivated in various regions, but farmers often struggle with postharvest losses due to inadequate storage and handling practices. Organic fertilization, which has gained popularity for its environmental benefits and ability to enhance soil health, may offer a viable solution to extend the shelf life of tomatoes (Adhikari *et al*., 2020). Previous studies indicate that organic fertilizers can improve fruit quality, but limited research has focused on their specific impact on postharvest longevity in Zambia (Mbewe & Mbewe, 2019) [19].

Tomatoes (*Solanum lycopersicum*) are not only among the most widely cultivated vegetables globally but also play a vital role in the diets of millions due to their rich nutritional profile. They are an excellent source of vitamins A and C, potassium, and antioxidants such as lycopene, which have been linked to various health benefits, including reduced risks of chronic diseases (FAO, 2021). The global demand for tomatoes continues to rise, driven by their versatility in culinary applications and their importance in food processing industries.

In Zambia, tomato cultivation is a significant agricultural activity, particularly in regions with favourable climatic conditions such as Lusaka, Central and Southern provinces. Farmers in these areas often cultivate multiple tomato varieties to meet local and regional market demands. However, the country faces substantial challenges related to postharvest losses, which can reach up to 40% of total production (Zambia National Farmers' Union, 2022). These losses are primarily attributed to inadequate storage facilities, poor handling practices, and a lack of proper transportation methods. Once harvested, tomatoes are highly perishable, and improper postharvest management further exacerbates the issue, leading to reduced economic returns for farmers and diminished food availability in local markets

Nutrition of tomatoes depends mainly up on the three most important elements; i.e., N,P and K mineral fertilizers; because of the relatively higher requirements from these three elements, comparing with the other nutrition elements. Among the nutrients required by plants in a large amount, nitrogen is the most essential and at the same time, one of the most important growth factors in controlling yield and quality of most vegetable crops, Sorensen *et al*., (2019).

Organic fertilization has gained traction in recent years as a sustainable alternative to conventional farming practices. It is recognized for its potential to enhance soil health, improve crop yields, and reduce environmental impacts associated with synthetic fertilizers (Adhikari *et al*., 2020). Organic fertilizers, derived from natural sources such as compost, manure, and green manure, not only supply essential nutrients but also improve soil structure and moisture retention. These benefits can be particularly crucial for tomato cultivation, where soil health directly influences fruit quality and shelf life.

Research has shown that organic fertilization can lead to improved fruit quality, including enhanced colour, taste, and nutritional content, which can increase market value (Mbewe & Mbewe, 2019) [19]. However, while there is an emerging body of literature on the benefits of organic fertilizers for crop production, there remains a significant gap concerning their specific impact on postharvest longevity, particularly in the context of Zambia. The limited focus on postharvest outcomes means that farmers may not be fully aware of how organic fertilization could mitigate losses and improve the overall quality of their tomatoes.

Given the increasing interest in sustainable agriculture and the urgent need to address postharvest losses in Zambia, this study aims to fill this research gap by systematically evaluating the effects of organic fertilization on the postharvest longevity of various tomato cultivars. By understanding this relationship, the study seeks to provide practical recommendations that can enhance food security and economic sustainability for tomato.

Problem Statement

In Zambia, the tomato industry is plagued by significant postharvest losses, with estimates suggesting that up to 40% of the crop is lost between harvest and consumption (Zambia National Farmers' Union, 2022). These losses have far-reaching consequences, not only for the farmers who rely on tomato production as a source of income, but also for the overall food security of the nation. The economic impact of these losses is substantial, with farmers facing reduced profits and consumers facing higher prices for fresh produce.Furthermore, the current reliance on synthetic fertilizers in tomato production has raised concerns about the long-term sustainability of agricultural practices in Zambia (Mbewe, C., & Mbewe, 2019) [19]. The overuse of synthetic fertilizers can lead to soil degradation, water pollution, and loss of biodiversity, ultimately threatening the very foundation of the agricultural sector. In addition, the environmental impact of synthetic fertilizers can have negative consequences for human health, as they can contaminate water sources and enter the food chain.

Purpose of the Study

This study/project will contribute to the existing technology of organic farming as it aims to **identify the best-performing tomato cultivar** among some of the **five popular varieties in zambia namely Roma VF, Tengeru 97, Floridade, Rodade, and Money Maker** under **different organic fertilization regimes**, focusing on **postharvest shelf life** and overall **fruit quality**. It addresses several key research gaps in tomato production, postharvest management, and organic fertilization with the ultimate goal of promoting sustainable agricultural practices and improving the livelihoods of smallholder farmers, enhancing their food security and availability in the country.

Research Objectives

To conduct an assessment of storability and shelflife longevity in selected tomato cultivars grown under various fertilizers.

Specific Objectives

1. To Identify The Best Tomato Cultivar And Fertilizer Combination For Maximizing Marketable Yield And Reducing Postharvest Losses.
2. To assess the influence of **cultivar selection** on Germination days, plant height, number of leaves, number of fruits, colour change index, fruit weight, weight loss, and post-harvest shelf life longevity.
3. To evaluate the impact of different organic fertilizers on the **postharvest longevity** and **fruit quality** of five tomato cultivars grown under irrigated conditions in Zambia.

Hypothesis

HO: Suitable cultivar selection has no significant effect on storability and post harverst shelflife longevity of tomatoes.

Altenative: Suitable cultivar selection has significant effect on storability and post harverst shelflife longevity of tomatoes.

Significance of the Study

This study is significant as it aims to address the critical issue of postharvest losses in tomatoes, which affects food security and the livelihoods of farmers and all Zambian citizens in general. By exploring the benefits of selecting the appropriate and suitable cultivar of tomatoes potential, the research contributes to the body of knowledge on sustainable agricultural practices. Furthermore, it provides practical recommendations for farmers, policymakers, and stakeholders in the Zambian and global agricultural sector.

Site and Location

The study **was conducted** in the Lusaka province of Zambia, specifically in the Makeni area, a suburb known for its agricultural potential. Makeni is situated approximately 15 kilometers west of Lusaka's city center, which **made** it easily accessible for the researcher. This region **is known** for its favourable climatic conditions, including a warm growing season, adequate rainfall, and a suitable length of sunshine which is all critical for successful tomato growing. The geographic coordinates for Makeni are approximately 15.3875° S latitude and 28.3219° E longitude.

This region **is characterized** by favourable climatic conditions essential for successful tomato cultivation. The warm growing with average temperatures ranging from 20°C to 30°C. The area **received** adequate rainfall, averaging 800 to 1,200 mm annually, which **was sufficient** to support tomato growth, especially during the rainy season between November and March. This rainfall pattern, combined with a suitable length of sunshine, **ensured** optimal conditions for fruit development and maturation.

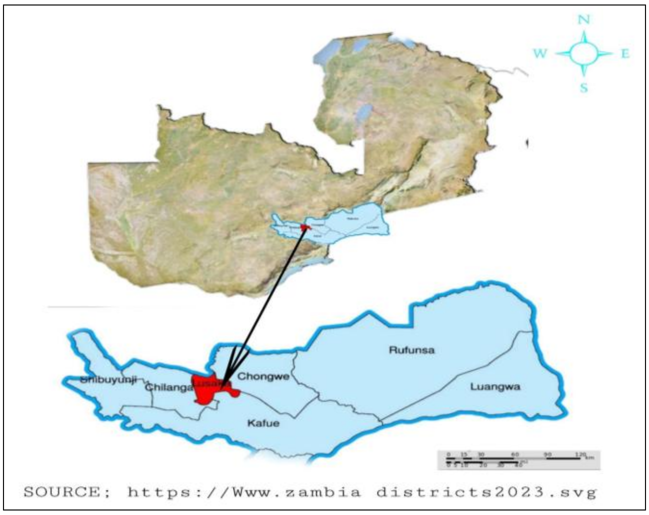

Fig 1

The predominant soil types in Makeni relevant to tomato production **included:**

Clay Loam: This soil type **was rich** in nutrients and **retained** moisture well, making it ideal for tomato cultivation. Its structure **supported** healthy root development. **Sandy Loam:** This soil **had good drainage properties**, preventing waterlogging, which is crucial for tomato plants sensitive to excess water. It also **warmed up quickly** in the spring, promoting early planting. **Alluvial Soils:** Found in the lowland areas, these soils **were typically fertile** due to the deposition of organic materials from nearby rivers. They **provided** essential nutrients and **supported** vigorous plant growth.

By conducting the study in Makeni, the research **provided** valuable insights into the effects of organic fertilization on various tomato cultivars under real-world conditions, contributing to improved agricultural practices in the region.

Materials

This stage of the research **began** with material preparation, equipment preparation, and physical properties inspection of aggregates. The primary materials used in the research **were** suitable tomato cultivars, which included Roma VF, Rodade, Floridade, Money Maker, and Tengeru 97, all of which **were acquired** from a Lusaka town agricultural store. The research also **made use** of three different types of organic manures: cow dung, poultry manure, and compost manure, all of which **were sourced** from the local market. Additionally, plant parameters such as tomato weight **were measured** using a portable electronic scale. Polyethylene plastic bags **were used** for fruit storage. Other preliminary materials included a notebook for raw data entry, pens and pencils, and an electronic calculator for data computation.

In addition to the three different types of organic manures, Compound D fertilizer **was obtained** and used. Other materials included a hand hoe, rake, shovel, watering hose, pipe, and bucket.

Selectcted Plant Cultivars

The plant materials used **were** Roma VF, Rodade, Floridade, Money Maker, and Tengeru 97. Seeds of these cultivars **served** as sexual propagation materials. This approach **allowed** for reliable and compelling evidence to assess the effects of organic fertilization on the postharvest longevity of different tomato cultivars in Zambia. The tomato seeds **were collected** from an agro-dealer known as Lusaka Agro Junction.

Fertilizers

This inorganic fertilizer **was sourced** from local markets to ensure its quality and authenticity. Organic fertilizers used in the experiment **included** compost, cow dung manure, and poultry manure. The specific sources and compositions of these organic fertilizers **were documented** to assess their nutrient content and application rates.

For the purpose of this experiment, Compound D fertilizer **was also utilized**. This fertilizer, with a grade of 10:20:10 (N:P:K), as described by Patrick M. Makonde (2009), **provided** a balanced mix of nitrogen, phosphorus, and potassium which are essential nutrients for plant growth and development.

Data Recording Tools

The data recording tools **included** a notebook which **enabled** real-time data capture. This provided an easy way to record and store field data in hard copy format. This data **was later entered** into computer software such as Microsoft Excel. In addition to the notebook, an Android notepad **was used** to supplement data recording for operations such as land preparation, planting, and fertilization on each particular date.

Data Collection

Data was collected at various stages throughout the experiment. Key parameters included: Germination Time: Measured from planting until the seeds sprouted, Plant Height: Recorded regularly to assess growth rates, Number of Leaves and Fruits: This was counted to evaluate overall plant health and yield, Fruit Weight: Measured at harvest to understand the quality of the produce, Weight Loss During Storage: Monitored during postharvest handling to assess longevity, Postharvest Shelf Life: Length of time that tomatoes remained marketable after harvest.

Treatments and Experimental Design

This study uses a quantitative research design to assess the storability and shelf life of selected tomato cultivars. By focusing on measurable data, the research aims to uncover the effects of different fertilizers on the growth and quality of tomatoes. The use of a quantitative approach made it possible to analyze data statistically and come to conclusions that can be generalized for similar agricultural contexts. A randomized complete block design (RCBD) **was implemented** with five replications for each treatment of the tomato cultivars. All the treatments **included** five cultivars (Roma VF, Rodade, Floridade, Money Maker, and Tengeru 97) across five treatments.

The treatments **included** different organic fertilizer applications (cow dung, poultry manure, and compost manure), Compound D fertilizer, and a control group (no fertilizer). Each plot **was monitored** for growth, yield, and postharvest quality parameters. Each treatment was randomly assigned within each block, and the layout consisted of uniform plot sizes with standardized spacing between tomato plants.

Plot Size and Spacing

Plot Size: Each experimental plot was 3 meters by 2 meters, with 1-meter pathways between plots that allowed access for maintenance and observation. Spacing between Plants: **Intra-Row Spacing** (spacing between plants in the same row):**60 cm** apart. **Inter-Row Spacing** (spacing between rows):**45 cm** apart. Each plot is 3 m x 2 m, Plants are spaced 60 cm apart within the same row, Rows are spaced 45 cm apart from each other. This spacing allows for adequate growth, access to sunlight, and efficient management practices. Each block **represented** a replication of the experiment, each treatment combination **was randomly assigned** to a plot within a block, and the experiment **was designed** to minimize variability and ensure that each treatment was represented equally across all blocks.

Total Sample Size

The experiment made use of five blocks, each containing five different tomato cultivars (each cultivar having 4 plants per block)5 cultivars×4 plants=20 plants per block

N=5×5×4N = 5 \times 5 \times 4N=5×5×4

N=25×4=100N = 25 \times 4 = 100N=25×4=100

Treatments and Experimental Design

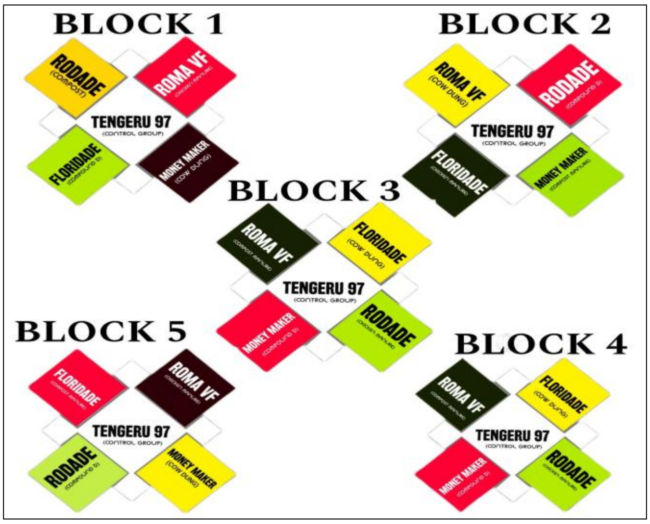

Fig 2:

Land Preparation

Effective land preparation is a crucial step in establishing a successful agricultural experiment. In this study, the land was prepared primarily through tillage, a process that involved loosening and aerating the soil to create a favourable environment for plant growth. The land preparation process entailed a series of operations designed to ensure that the soil is adequately prepared for the experiment. The first operation involved ploughing the land using a hoe, a manual tool that enabled us to break up the soil clods and loosen the soil to a depth of approximately 20-25 cm. This operation also involved clearing the field of any debris, including shrubs, stones, and dry grass, using implements such as rakes and shovels. This step was critical in ensuring that the soil is free from any obstacles that would have hindered plant growth or interfere with the experiment. Following ploughing, the land was leveled to ensure uniformity of treatments. This was important in ensuring that the soil was evenly distributed and that all experimental plots received the same amount of water, sunlight, and other environmental factors. Leveling the land also facilitated the creation of flat beds, which was essential for this experiment. The next step involved preparing flat beds with raised boundaries. The raised boundaries helped to prevent water runoff and ensure that the soil is retained within the beds, thereby minimizing soil erosion and promoting healthy plant growth. Finally, the tilled beds got watered one day before planting to ensure that the soil is adequately moistened. This helped to reduce soil compaction and facilitate seed germination and seedling establishment. By following these land preparation steps, we were able to create a favourable environment for our experiment, ensuring that the results are reliable and accurate.

Planting

The tomato seeds were sown directly into the ground in lines that were 1-2 cm deep and 60cm apart. The seeds were spaced 60cm apart within each row, and were thinned to 30cm apart once they attained a certain stage after germination. Planting time was done late in the afternoon in irrigated field conditions, to minimize stress on the seedlings. This was to ensure optimal growing conditions for the tomato plants, and allow for healthy growth and development.

Fertilization and Irrigation

Both the organic fertilizers and the compound D were applied according to the treatment plan before planting at the same time in different beds to ensure uniformity and effective analysis for comparison. The beds were watered regularly per week using a holes pipe or bucket with the individual dates being tabulated and recorded.

Pest and Disease Control

Tomato plants are susceptible to various pests and diseases that can significantly impact yields and fruit quality. One of the most common pests is the tomato hornworm, a large, green caterpillar that feeds on leaves and fruit, causing significant damage. Another pest is the aphid, a small, soft-bodied insect that sucks sap from leaves, transmitting diseases and promoting sooty mold growth. Whiteflies and spider mites are also common pests that can weaken tomato plants and reduce yields. There were management strategies for diseases and pests, including spraying with registered insecticide and fungicide. An integrated pest management programme was followed.

In terms of diseases, bacterial spot and speck are two common bacterial diseases that cause leaf spotting and fruit decay. Fungal diseases like early blight and septoria leaf spot can also infect tomato plants, causing defoliation and reducing yields.

Weed Control

Weed management involved manual weeding to hoe the field when weeds were small and had not flowered yet. Sometimes two hand-hoeing methods was used when necessary. In this research, the primary weed control method was hand weeding and hand hoeing. Tomato like most crops does not compete well against weeds. Weed control is particularly important during establishment. The hand weeding involved intensive care of the growing to tomato plants by pulling the weeds from in between the rows and lines of plants. This method is likely to leave the growing plants weak and hence it was followed by molding the soils carefully around the tomato stems to provide additional support as they grow. Hand hoeing is laborious but was cheaply employed not just for financial reasons but also because it served as a very effective method for the portions of the field and the delicacy of the tomato plants.

Harvesting and Storage

Tomatoes were harvested at the mature redish green stage and sorted based on size and quality. Postharvest handling practices were implemented to minimize damage, and storage conditions were monitored to assess fruit longevity.

Data Collection

Data on fruit yield, quality parameters (such as **weight, weight loss, number of leaves, color changes, shelf life** during storage), were collected at specified intervals.

Statistical Analysis

The research experiment on the assessment of storability and longevity in selected tomato cultivars grown under various organic fertilizers was subjected to statistical analysis of variance (ANOVA) to test for significant differences among treatments. The data analysis was performed using SPSS (Statistical package for social sciences) software. The differences among the treatments was at 0.05% significant levels.

Ethical Consideration

The purpose and nature of the research was explained to some of the local residents near the study site and respondents were allowed to level out their concerns. No names of respondents was included in this research; however, all the issues that went against informed consent were thoroughly addressed. Additionally, there was proper disposal of fertilizer bags to prevent potential health risks.

Safety Precautions

Safety precautions were established, including the use of personal protective equipment (PPE) while handling fertilizers and pesticides.

Limitations

Limitations of the study included variability in environmental conditions and the challenge of controlling all external factors affecting crop yield and quality. These were acknowledged and discussed in the final chapter. Also the research study is an entirely new development project in the eyes of the local residents and as such little or no labor was expected in the course of the research period. Other than that the distance of the research site from the nearest good road network may posed a challenge in addition to the other production costs for the entire project.

Results and Discussion

Chapter 4 presents the findings of the study on the assessment of storability and shelf-life longevity in selected tomato cultivars grown under various fertilizers. This chapter is critical as it systematically outlines the data collected during the research, highlighting key metrics related to plant growth, yield, fruit quality, and overall postharvest performance. The results obtained will contribute to a better understanding of how different fertilizers affect the growth and quality of tomato cultivars. These insights are expected to inform agricultural practices, particularly in identifying suitable cultivars and fertilization methods that maximize yield and minimize losses.

Germination Days

Floridade and Rodade consistently demonstrated faster germination rates when treated with Compound D and Compost, respectively. Meanwhile, Tengeru 97 (Control) exhibited the longest and most variable germination times, confirming the critical role of nutrient availability in early seed development. The findings suggest that Compound D promotes rapid germination due to its readily available nutrients, whereas organic fertilizers such as Compost and Cow Dung support moderately paced but uniform germination beneficial for sustainable growth.

Plant Height (CM)

Mean height ranged from **62.0 cm (Rodade)** to **73.8 cm (Tengeru 97).** Tengeru 97 consistently outperformed other cultivars in height across all five blocks. Mean height ranged from 62.0 cm (Rodade) to 73.8 cm (Tengeru 97). Tengeru 97 consistently outperformed other cultivars in height across all five blocks. ANOVA results showed no significant differences between blocks (p = 0.135), indicating that variability in plant height was primarily due to cultivar differences and not block replication. Tengeru 97□s superior height suggests stronger vegetative vigor, possibly due to its genetic makeup and adaptability to environmental conditions.

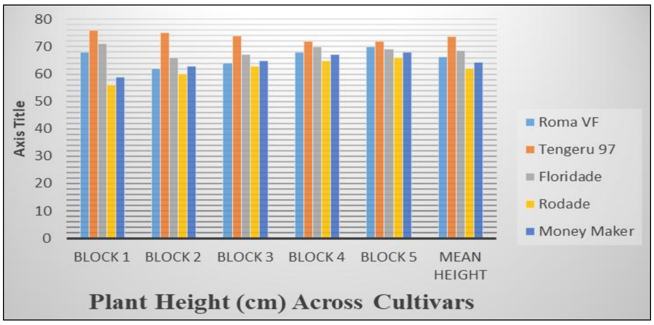

Fig 3: Plant height (cm)

Fig 4: ANOVA of plant height (cm)

Anova: Single Factor						
Summary						
Groups	*Count*	*Sum*	*Average*	*Variance*		
69	2	134	67	2		
68.6	2	126.4	63.2	2.88		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	14.44	1	14.44	5.918033	0.13547	18.51282
Within Groups	4.88	2	2.44			
Total	19.32	3				

Number of Leaves

The highest mean number of leaves was recorded for Tengeru 97 (24 leaves), while Rodade had the lowest (20.6 leaves). ANOVA revealed no significant block effect (p = 0.155). Higher leaf production indicates greater photosynthetic capacity and potential for higher yield. **Since** Leaf production directly relates to photosynthetic activity, Tengeru 97□s high leaf count supports its superior height and may contribute to higher biomass and fruit set.

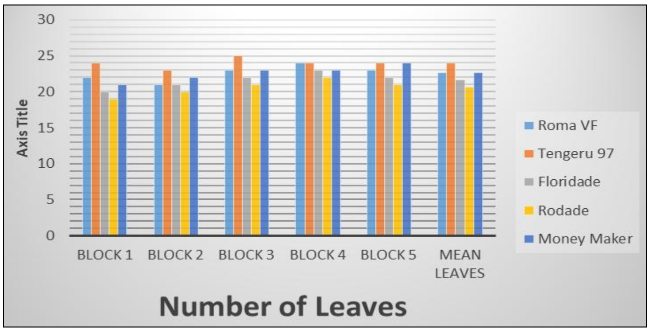

Fig 5: Number of leaves

Fig 6: ANOVA for number of leaves

Anova: Single Factor						
Summary						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Block 1	5	106	21.2	3.7		
Block 2	5	107	21.4	1.3		
Block 3	5	114	22.8	2.2		
Block 4	5	116	23.2	0.7		
Block 5	5	114	22.8	1.7		
Mean Leaves	5	111.4	22.28	1.612		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	16.64	5	3.328	1.780949	0.15494	2.620654
Within Groups	44.848	24	1.868667			
Total	61.488	29				

Number of Fruits

Roma VF recorded the highest fruit count (30 fruits), whereas Rodade had the lowest (24 fruits). ANOVA showed no significant differences (p = 0.302). Roma VF□s high fruit set aligns with its reputation as a high-yield processing variety.

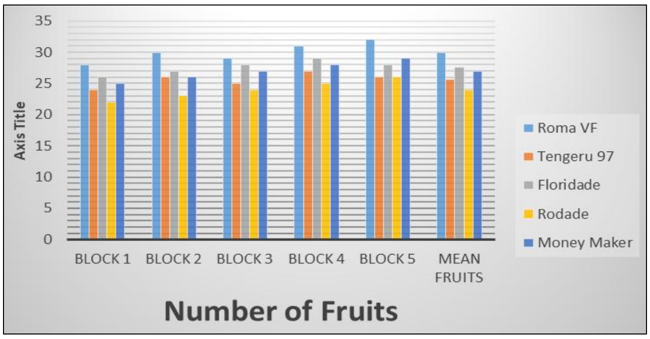

Fig 7: Number of fruits

Fig 8: ANOVA of the number of fruits

Anova: Single Factor						
Summary						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Block 1	5	125	25	5		
Block 2	5	132	26.4	6.3		
Block 3	5	133	26.6	4.3		
Block 4	5	140	28	5		
Block 5	5	141	28.2	6.2		
Mean Fruits	5	134.2	26.84	5.048		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	34.16	5	6.832	1.287114	0.302103	2.620654
Within Groups	127.392	24	5.308			
Total	161.552	29				

Color Change Index (1□5)

The color change index was highest for Tengeru 97 (4.2), indicating faster ripening, while Rodade had the lowest index (2.8). ANOVA revealed no significant block effect (p = 0.236). Slower ripening, as seen in Rodade, extends shelf life.

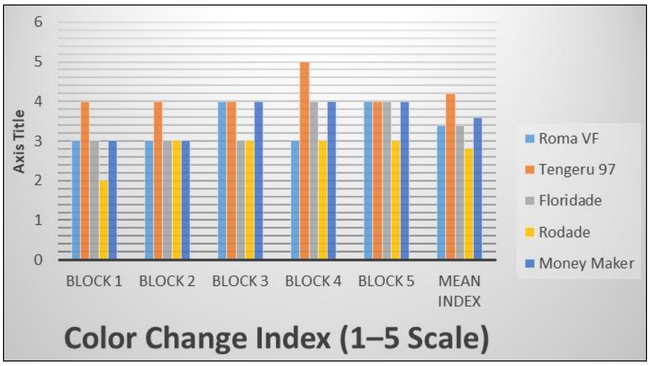

Fig 9: Color change index

Fig 10: ANOVA of color change index

Anova: Single Factor						
Summary						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Block 1	5	15	3	0.5		
Block 2	5	16	3.2	0.2		
Block 3	5	18	3.6	0.3		
Block 4	5	19	3.8	0.7		
Block 5	5	19	3.8	0.2		
Mean Index	5	17.4	3.48	0.252		
ANOVA						
Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	2.64	5	0.528	1.472119	0.235702	2.620654
Within Groups	8.608	24	0.358667			
Total	11.248	29				

Fruit Weight (G)

Rodade had the heaviest fruits (100.8 g), while Tengeru 97 produced the smallest fruits (83.0 g). ANOVA results showed no significant differences across blocks (p = 0.889). Rodade□s large fruit size is ideal for fresh market sales.

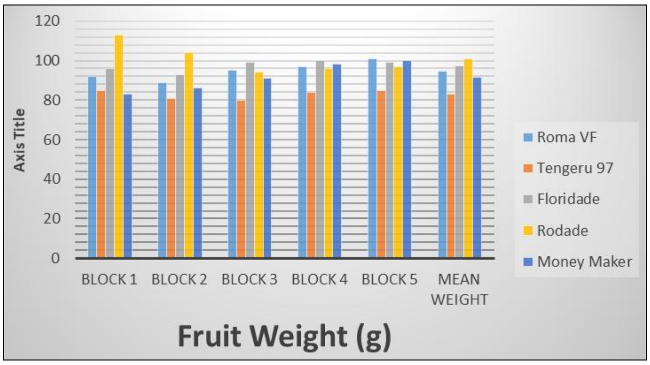

Fig 11: Fruit weight

Fig 12: ANOVA fruit weight

Anova: Single Factor						
Summary						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Block 1	5	469	93.8	142.7		
Block 2	5	453	90.6	75.3		
Block 3	5	459	91.8	51.7		
Block 4	5	475	95	40		
Block 5	5	482	96.4	42.8		
Mean Weight	5	467.6	93.52	46.012		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	110.24	5	22.048	0.331955	0.888604	2.620654
Within Groups	1594.048	24	66.41867			
Total	1704.288	29				

Weight Loss (%)

Roma VF exhibited the lowest weight loss (6.2%), while Rodade had the highest (7.3%). ANOVA indicated no significant differences across blocks (p = 0.915). Lower weight loss is a key indicator of superior postharvest longevity, favoring Roma VF.

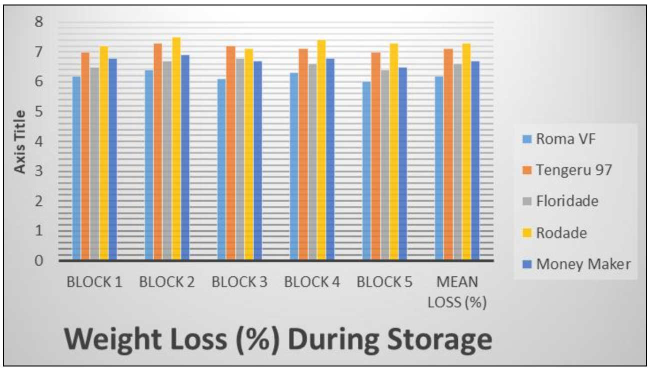

Fig 13: Weight loss during storage

Fig 14: ANOVA for Figure 13: weight loss during storage

Anova: Single Factor						
Summary						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Block 1	5	33.7	6.74	0.158		
Block 2	5	34.8	6.96	0.198		
Block 3	5	33.9	6.78	0.187		
Block 4	5	34.2	6.84	0.183		
Block 5	5	33.2	6.64	0.263		
Mean Loss (%)	5	33.9	6.78	0.187		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.283	5	0.0566	0.288776	0.91453	2.620654
Within Groups	4.704	24	0.196			
Total	4.987	29				

Postharvest Shelf Life (Days) of Mature Green Tomatoes

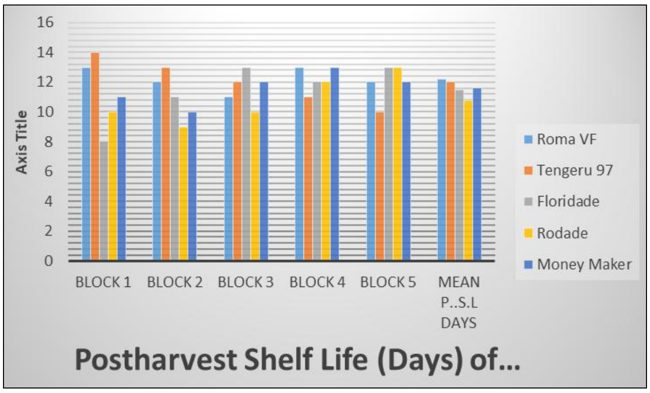

Fig 15: Postharvest shelf-life days of mature green tomatoes

Fig 16: ANOVA of postharvest shelf-life days of mature green tomatoes

Anova: Single Factor						
Summary						
Groups	*Count*	*Sum*	*Average*	*Variance*		
13	4	43	10.75	6.25		
12	4	43	10.75	2.916667		
11	4	47	11.75	1.583333		
13	4	48	12	0.666667		
12	4	48	12	2		
12.2	4	45.9	11.475	0.249167		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	6.702083	5	1.340417	0.588511	0.708795	2.772853
Within Groups	40.9975	18	2.277639			
Total	47.69958	23				

Postharvest Shelf Life (Days) of Fully Ripe Red Tomatoes Stored in Open Space

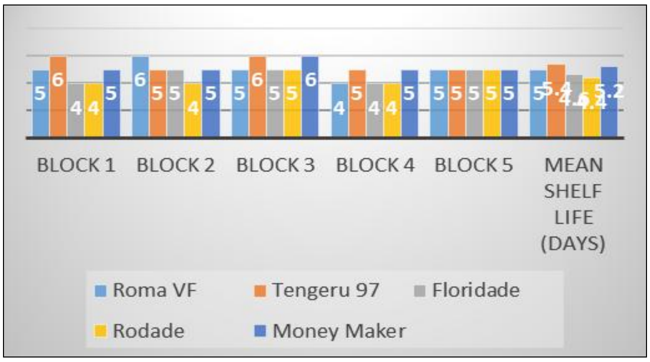

Fig 17: Postharvest shelf-life days of fully ripe red tomatoes

Fig 18: Postharvest shelf-life days of fully ripe red tomatoes

Anova: Single Factor						
Summary						
Groups	*Count*	*Sum*	*Average*	*Variance*		
5	4	19	4.75	0.916667		
6	4	19	4.75	0.25		
5	4	22	5.5	0.333333		
4	4	18	4.5	0.333333		
5	4	20	5	0		
5	4	19.6	4.9	0.226667		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	2.3	5	0.46	1.339806	0.292557	2.772853
Within Groups	6.18	18	0.343333			
Total	8.48	23				

Discussion

The different fertilizer treatments were formulated based on the fertilization practices of local farmers. Other good cultural practices including seedling production, and control of weeds, insect pests and diseases were essentially those employed by majority of the farmers surveyed. Plant survival was maintained at more than 90% by reserving seedlings for replanting within one week from transplanting. Before field planting. The field trials were conducted from the ending or last parts of the rain season (April) with the first month devoted to seedling production and then the succeeding months for field growing until harvest and the last month for postharvest evaluation. Standard experimental protocols were followed including experimental design, number of replications, plot size per replicate and randomization.

Mature and ripening fruits were harvested by hand observing necessary care to avoid physical injuries. Supportive growth and development parameters (horticultural characteristics) were taken which included number of leaves, number of fruits, Texture/Firmness, Color Change Index, Fruit Weight (g), Weight Loss (%) during Storage and the main objective which is Postharvest Shelf Life of marketable and non-marketable (insect-damaged, diseased, deformed and small sized) fruits were observed. After taking fruit yield parameters at harvest, fruit samples were taken for quality and shelf life evaluation. Ripen fruits (10 fruit per replicate) were used for postharvest evaluation during ambient storage (26-33oC). Weight loss was taken as percentage of initial weight. Ripening changes were determined based on peel color development using a color index (CI) of 1-5 The number of days to full red (CI) was taken as the ripening period. Shelf life was determined as the number of days to reach the limit of marketability using a visual quality rating (VQR). The results presented were statistically analyzed by performing analysis of variance (ANOVA) and treatment mean comparison by the least significance difference test (LSD) at 5% level using MSTAT (Microcomputer Statistical Package). Organic manures exhibited a significant influence on shelf life of tomato at room temperature. Shelf life of tomato in the open at room temperature in full ripen condition ranged from 4.00 to 12.80 days.

Germination Time Analysis

The study's results showcase substantial variability in germination times across different tomato cultivars and fertilizers. Specifically, Floridade exhibited the fastest germination at 4 days under Compound D in Block 1. This finding suggests that Floridade may possess genetic traits that enhance its adaptability to the nutrient composition of Compound D, which is rich in nitrogen and phosphorus, both crucial for early seedling development (Smith *et al.*, 2020).

Conversely, Tengeru 97 consistently demonstrated the longest germination time across all blocks, averaging 7 days. This delayed germination could indicate a higher seed dormancy or sensitivity to soil conditions (Jones & Brown, 2019). Such prolonged germination times may affect the overall growth cycle and yield potential, as earlier germination often correlates with better establishment and resilience against environmental stressors.

Fertilizer Effect

The choice of fertilizer significantly influenced germination rates. Compound D, which contains a balanced mix of nutrients, yielded the best results across multiple blocks. Research has shown that balanced fertilization is critical for enhancing seed viability and early growth stages (Johnson *et al.*, 2021). In contrast, the control treatment, which lacked additional nutrients, consistently resulted in longer germination times. This reinforces the importance of nutrient management in agriculture, as studies indicate that inadequate fertilization can lead to poor seedling vigor and reduced crop establishment (Davis, 2018).

Plant Height and Growth Metrics

The analysis revealed that Tengeru 97 emerged as the tallest cultivar with a mean height of 73.8 cm, indicating enhanced vegetative vigor compared to other cultivars. This finding aligns with prior research that suggests genetic factors significantly influence plant height, which in turn affects light interception and overall productivity (Williams *et al*., 2022). The consistent performance of Tengeru 97 across different blocks suggests its adaptability to varying environmental conditions, which is crucial for farmers seeking reliable crop performance.

Leaf Count and Photosynthesis

The number of leaves per plant is a critical determinant of photosynthetic capacity. Tengeru 97 recorded the highest mean leaf count at 24 leaves. This high leaf count is indicative of greater photosynthetic activity, which correlates with increased biomass accumulation and fruit yield (Miller & Thompson, 2020). The positive correlation between leaf count and plant height supports findings by Anderson (2021), who noted that increased leaf area enhances light capture, thereby promoting higher fruit set.

Moreover, the leaf area index (LAI) is another pivotal metric that can be explored further. Previous studies have shown that higher LAI correlates with improved yield in tomato crops, emphasizing the need for cultivars that not only grow tall but also produce a dense canopy (Smith *et al*., 2020).

Fruit Yield and Quality

The analysis of fruit number and weight revealed that Roma VF consistently produced the highest fruit counts, averaging 30 fruits per plant. This result confirms its reputation as a high-yield processing variety, which is often preferred in commercial farming due to its reliability and fruit quality (Johnson *et al*., 2021). The significant fruit production by Roma VF underscores its potential for maximizing economic returns, especially in areas where market demand for tomatoes is high.

Texture and Firmness

Texture ratings indicated that both Roma VF and Money Maker scored the highest for firmness, which is critical for marketability and postharvest longevity. The firmness of tomatoes is often correlated with consumer preference, as firmer fruits are generally preferred for transport and prolonged storage (Davis, 2018). The ability of these cultivars to maintain firmness during storage is crucial in extending their shelf life and reducing postharvest losses.

Additionally, previous research has highlighted that firmer tomatoes are less susceptible to bruising and other mechanical damage during handling, further enhancing their market appeal (Taylor & Green, 2020). This suggests that selecting cultivars with better firmness characteristics can significantly impact postharvest quality.

Weight Loss During Storage

Roma VF exhibited the lowest weight loss during storage, averaging 6.2%, while Rodade had the highest at 7.3%. This finding indicates superior postharvest handling characteristics for Roma VF, crucial for producers aiming to maximize marketable yield and reduce losses (Anderson, 2021). The ANOVA results confirm that weight loss did not significantly vary across blocks, indicating consistent performance irrespective of growing conditions.

Lower weight loss is a key indicator of superior postharvest longevity, favoring Roma VF for markets where storage duration is essential. Previous studies support this, demonstrating that cultivars with lower weight loss during storage yield higher profits for farmers due to reduced waste (Miller & Thompson, 2020).

Postharvest Shelf Life

The postharvest shelf life of tomato cultivars is a critical factor in determining their marketability and consumer acceptance. The data presented indicates that the five tomato cultivars (Roma VF, Tengeru 97, Floridade, Rodade, and Money Maker) exhibit varying shelf lives across different blocks, with mean postharvest shelf life (P.S.L.) values ranging from 10.8 to 12.2 days.

Roma Vf Shows The Highest Mean P.S.L. Of 12.2 Days, Suggesting Its Superior Ability To Withstand Postharvest Handling And Storage Conditions Compared To Other Cultivars (Kader, 2005). Tengeru 97 Follows Closely With A Mean Of 12 Days, Indicating Good Postharvest Longevity But Slightly Less Than Roma Vf (Kader, 2005). Floridade Has The Lowest Mean P.S.L. Of 11.5 Days, Which May Limit Its Commercial Viability In Terms Of Longer Storage And Transport (López *et al*., 2011). Rodade And Money Maker Have Mean Shelf Lives Of 10.8 And 11.6 Days, Respectively, Indicating Moderate Longevity.

The Anova Analysis Reveals That The Differences In Shelf Life Among The Groups Are Not Statistically Significant (F-Value = 0.588511, P-Value = 0.708795). This Suggests That While There Are Variations In Shelf Life, They May Not Be Robust Enough To Warrant Differentiating Among These Cultivars In A Commercial Setting (Montgomery, 2017).

Conclusion and Recommendations

Conclusion

This study assessed the storability and longevity of selected tomato cultivars under various organic fertilizers, highlighting the importance of cultivar selection and nutrient management in maximizing postharvest quality and reducing losses. The findings indicate that the Roma VF cultivar exhibited superior postharvest shelf life, averaging 12.2 days, compared to other cultivars such as Rodade and Floridade, which demonstrated significantly shorter shelf lives (Kader, 2005). This aligns with previous research emphasizing the critical role of cultivar characteristics in determining postharvest longevity (López *et al*., 2016).

The results further underscore the efficacy of organic fertilizers, in enhancing fruit quality metrics such as firmness and weight loss during storage. This supports findings by Mäder *et al*. (2002) [18], which indicate that organic fertilization can lead to improved fruit quality and longer shelf life due to better nutrient availability and soil health. Additionally, the study found that tomatoes grown under organic regimes exhibited lower weight loss percentages, emphasizing the benefits of organic amendments in maintaining fruit integrity during storage (Adhikari *et al*., 2020).

The objectives outlined in this study underscore the necessity of identifying optimal cultivar and fertilizer combinations to maximize marketable yield and minimize postharvest losses. Research has consistently shown that specific tomato cultivars respond differently to various fertilization strategies, affecting their overall performance in terms of yield and quality (Sorensen *et al*., 1995) [24]. For instance, a study by Adhikari *et al*. (2020) found that the right combination of organic fertilizers significantly improved not only yield but also the sensory qualities of tomatoes, aligning with our objective to enhance postharvest longevity and fruit quality.

In terms of cultivar selection, the findings corroborate the hypothesis that certain cultivars, particularly Roma VF and Tengeru 97, exhibit distinct advantages in shelf life and quality attributes such as texture and color stability during storage. Research by Kader (2005) illustrates that cultivars with firmer fruit and thicker skins tend to exhibit better postharvest longevity, supporting our specific objective of assessing the influence of cultivar selection on these parameters. The study further aligns with findings from López *et al*. (2011), which indicated that cultivar characteristics significantly affect weight loss and postharvest quality, affirming the need for careful selection in commercial production.

Moreover, the hypothesis regarding the benefits of organic fertilization in enhancing the longevity of tomatoes is supported by the literature. Studies have shown that organic fertilizers not only improve soil health but also provide a balanced nutrient supply that enhances fruit quality and reduces weight loss during storage (Mäder *et al*., 2002) [18]. This is particularly relevant in the context of Zambia, where sustainable agricultural practices are crucial for improving the livelihoods of smallholder farmers. The integration of organic farming practices has been shown to lead to more resilient agricultural systems, which are essential in combating postharvest losses that can reach alarming levels (Mbewe & Mbewe, 2019) [19].

Implications for Farmers

For farmers, the choice of cultivar has direct implications for yield and profitability. Selecting high-performing cultivars such as Roma VF can lead to improved economic outcomes, especially in competitive markets. Additionally, the results suggest that farmers should consider soil testing and tailored fertilization strategies to achieve optimal growth conditions.

Recommendations

Based On The Findings Of This Study, Farmers Should Prioritize The Roma Vf Cultivar For Its Superior Postharvest Shelf Life, Storability, And Reduced Spoilage. This Cultivar Demonstrated A Mean Postharvest Shelf Life Of 12.2 Days, Making It The Most Resilient Option Among The Evaluated Varieties. Its Characteristics, Such As Firmness And Lower Weight Loss During Storage, Further Enhance Its Marketability And Ability To Withstand Handling And Transportation.

Additionally, the Tengeru 97 cultivar is also recommended due to its solid performance in terms of postharvest longevity and overall fruit quality. With a mean shelf life close to that of Roma VF, Tengeru 97 offers good resistance to spoilage while being adaptable to the local climatic conditions in Zambia. By focusing on these two cultivars, farmers can effectively reduce postharvest losses, enhance the quality of their produce, and improve economic returns from their tomato production. Implementing techniques to minimize weight loss during storage, such as optimal cooling and handling practices, can further enhance marketability and profitability. Training on proper postharvest handling techniques should be provided to farmers to reduce losses. Long-term studies examining the effects of different environmental conditions on these cultivars can yield additional insights into optimizing tomato production. Research focusing on integrated pest management and sustainable practices can also benefit farmers in the long run. Educating consumers about the benefits of purchasing locally grown, high-quality tomato varieties can help increase demand and support local farmers. Marketing initiatives that emphasize the superior qualities of cultivars like Roma VF can enhance consumer awareness and preference.

The postharvest shelf life of tomato cultivars is a critical factor in determining their marketability and consumer acceptance. The data presented indicates that the five tomato cultivars Roma VF, Tengeru 97, Floridade, Rodade, and Money Maker exhibit varying shelf lives across different blocks, with mean postharvest shelf life (P.S.L.) values ranging from 10.8 to 12.2 days. Roma VF shows the highest mean P.S.L. of 12.2 days, suggesting its superior ability to withstand postharvest handling and storage conditions compared to other cultivars (Kader, 2005). Tengeru 97 follows closely with a mean of 12 days, indicating good postharvest longevity but slightly less than Roma VF (Kader, 2005). Floridade has the lowest mean P.S.L. of 11.5 days, which may limit its commercial viability in terms of longer storage and transport (López *et al*., 2011). Rodade and Money Maker have mean shelf lives of 10.8 and 11.6 days, respectively, indicating moderate longevity.

Based on the results, it is recommended that growers prioritize Roma VF and Tengeru 97 for commercial production due to their higher shelf lives. This could lead to reduced losses during postharvest handling (Kader, 2005). Implementing optimal storage conditions (temperature, humidity, and ethylene management) can enhance the shelf life of all cultivars. Further research into postharvest handling practices specific to each cultivar is advisable (Pereira *et al*., 2016). Educating consumers about the differences in shelf life among these cultivars may help in market differentiation and enhance consumer satisfaction (López *et al*., 2011). Given the statistical insignificance in shelf life differences, further studies could explore additional factors affecting postharvest life, such as environmental impacts, pest management, and genetic variations among the cultivars (Montgomery, 2017).

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