EFFECT OF POULTRY LITTER COMPOST ON THE GROWTH AND YIELD OF TOMATO UNDER MANGO BASED AGROFROESTRY SYSTEM

A THESIS

BY

SHARMIN AKTER

Registration No. 1701392

MS Session: Jan-June 2023

Thesis Semester: January June, 2024

MASTER OF SCIENCE (M.S.)

IN

AGROFORESTRY AND ENVIRONMENT

DEPARTMENT OF AGROFORESTRY AND ENVIRONMENT

HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY, DINAJPUR

JUNE 2024

EFFECT OF POULTRY LITTER COMPOST ON THE GROWTH AND YIELD OF TOMATO UNDER MANGO BASED AGROFROESTRY SYSTEM

A THESIS

BY

SHARMIN AKTER

Registration No. 1701392

MS Session: Jan-June 2023

Thesis Semester: January June, 2024

Submitted to the Department of Agroforestry and Environment, Hajee Mohammad Danesh Science and Technology University, Dinajpur in partial fulfillment of the requirements of the degree of

MASTER OF SCIENCE (M.S.)

IN

AGROFORESTRY AND ENVIRONMENT

DEPARTMENT OF AGROFORESTRY AND ENVIRONMENT

HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY, DINAJPUR

JUNE 2024

EFFECT OF POULTRY LITTER COMPOST ON THE GROWTH AND YIELD OF TOMATO UNDER MANGO BASED AGROFROESTRY SYSTEM

A THESIS

BY

SHARMIN AKTER

Registration No. 1701392

MS Session: Jan-June 2023

Thesis Semester: January June, 2024

Approved as to style and contents by

(Prof. Dr. Md. Shoaibur Rahman)	**(Prof. Dr. Md. Abu Hanif)**
Supervisor	Co-Supervisor

(Prof. Dr. Md. Shoaibur Rahman)

Chairman of Examination Committee

and

Chairman, Department of Agroforestry and Environment

Hajee Mohammad Danesh Science and Technology University, Dinajpur.

JUNE 2024

Dedicated

To

My Beloved Parents And

Honorable Teachers

CERTIFICATE OF DECLARATION

I affirm that the research work presented in this thesis entitled **"EFFECT OF POULTRY LITTER COMPOST ON THE GROWTH AND YIELD OF TOMATO UNDER MANGO BASED AGROFROESTRY SYSTEM"** is solely my own work and has not been submitted for any previous academic degree. Any direct quotations used in this thesis have been appropriately cited with quotation marks, and all sources of information have been duly acknowledged through references to the respective authors.

(**Sharmin Akter)**
Student ID: 1701392
M.S Session: Jan-June 2023
Thesis Semester: January June, 2024
Department of Agroforestry and Environment
Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200,
Bangladesh

ACKNOWLEDGEMENT

At the outset, the authoress wishes to express her deepest sense of gratitude to almighty Allah,all praises and thanks to almighty Allah who helped me to complete the work and this thesis for the degree of Master of Science (MS) in Agroforestry and Environment.

I would express my sincere gratitude, heartfelt respect and immense indebtedness to my reverend supervisor, ***Prof. Dr. Md. Shoaibur Rahman****, Department of Agroforestry and Environment, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur for his scholastic guidance, valuable suggestions, kind help and providing necessary assistance with logistic support and constant encouragement throughout the period of research work and preparation of this thesis.*

I would also wish to extend my deepest gratitude and sincere appreciation to my Co-supervisor, ***Dr. Md. Abu Hanif****, Professor, Department of Agroforestry And Environment, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur for his constant counseling, valuable guidance, constructive suggestions and encouragement in the course of this investigation and in preparation of this dissertation.*

Great appreciation, thanks and gratitude are also extended to the Chairman and all the teachers of the Department of Agroforestry and Environment, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur for providing the research facilities, valuable advice and encouragement to conduct the experiments and thesis preparation.

I would like to special thanks and gratefulness to ***Prof. Md. Shafiqul Bari,*** *Department of Agroforestry And Environment, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur for his sincere co-operation in data analysis. The authoress is also thankful to all the staffs of Department of Agroforestry and Environment, HSTU, Dinajpur and agroforestry field worker Md. Abdul Quddus for their co-operation throughout the course of this study and research work.*

Finally, I express my heartfelt sincere gratitude to my beloved parents, brother, sisters, friends, well-wishers, roommates and relatives for their inspiration and cooperation throughout the period of my study.

June, 2024 *The Authoress*

EFFECT OF POULTRY LITTER COMPOST ON THE GROWTH AND YIELD OF TOMATO UNDER MANGO BASED AGROFROESTRY SYSTEM

ABSTRACT

A field experiment was conducted at the research field of the Department of Agroforestry and Environment, Hajee Mohammad Danesh Science and Technology University, Dinajpur, from January 2024 to April 2024 to evaluate the impact of poultry litter compost on the growth and yield of tomato production under mango-based agroforestry system. The experiment was designed as Randomized Complete Block Design (RCBD) with three replications and four treatments of poultry litter at 10 ton/ha, 7.5 ton/ha, 5 ton/ha, and a control with no poultry litter. Each of the 12 plots measured 2m x 2m. Healthy 25-day-old tomato seedlings were collected from the Nursery of Krishi Bazar, Rangpur and transplanted in the present research field on January 20, 2024. Data on various growth and yield parameters were collected at 15, 30, and 45 days after transplanting (DAT), including plant height, number of leaves, leaf dimensions, number of branches, days to 50% flowering and fruiting, chlorophyll content, soil parameters, fruit weight, fruit length, fruit diameter, number of fruits per plant, yield per plant, plot, and hectare, and Benefit-Cost Ratio (BCR). The data were analyzed using ANOVA and mean differences were evaluated by Tukey HSD test by the statistical software STATIX 10. Results indicated that the tallest plants and highest leaf numbers were observed in the 10 ton/ha poultry litter treatment across all stages. Leaf dimensions were greatest in the 7.5 ton/ha treatment. The highest yields per plot and hectare were achieved with 10 ton/ha poultry litter, with a maximum yield of 5562.5 kg/ha. The best fruit quality, in terms of weight, length, and diameter, was found in the 7.5 t/ha treatment. The highest chlorophyll and carotene contents were in the 5 ton/ha treatment. Soil parameters improved post-harvest in all poultry litter treatments, with the most significant improvements in the 10 ton/ha treatment. The highest BCR (4.85) was recorded for the 10 ton/ha treatment, while the lowest (2.45) was in the control. In conclusion, the application of 10 ton/ha poultry litter is recommended for maximizing tomato yield and economic returns under mango-based agroforestry system. For enhanced fruit quality, 7.5 ton/ha poultry litter is advised. This study demonstrates the benefits of using poultry litter to improve tomato production in agroforestry systems.

Keywords: Tomato, Poultry litter, plant growth, mango, chlorophyll content, yield, BCR

CONTENTS

CONTENTS (Contd.)

CONTENTS (Contd.)

CONTENTS (Contd.)

CONTENTS (Contd.)

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

Agroforestry systems, which integrate trees with crops or livestock, are recognized for their potential to enhance agricultural sustainability through improved biodiversity, soil health, and resource use efficiency. Among these systems, mango-based agroforestry has emerged as a viable option due to the high economic and ecological value of mango trees (*Mangifera indica* L.). Integrating crops like tomatoes within these systems can optimize land use and increase farm productivity. One effective strategy to boost crop performance in such systems is the application of organic amendments, particularly poultry litter, which is known for its high nutrient content (Adekiya *et al.,* 2020; Ewulo *et al.*, 2008).

One of the basic plants in the diet of most people in the world is the tomato plant, *Lycopersicon esculentum* Mill. (Ohlson *et al.,* 2018) which belongs to the Solanaceae family (Ohlson *et al.*, 2018). Tomato is enriched with minerals, vitamins, sugars, dietary fibers, essential amino acids, and lycopene (Ud Din *et al.,* 2023). It also contain high levels of other bioactive compounds such as phenolics, vitamin C, and antioxidants which are thought to protect and possibly prevent stressful environmental conditions (Najat *et al.*, 2018). Lycopene is a natural antioxidant that works effectively to slow the growth of cancerous cells (Ntagkas *et al.*, 2020). Tomatoes help maintain strong bones. This is because they contain considerable amounts of calcium and Vitamin K. Both nutrients are essential in strengthening and performing minor repairs on the bones as well as the bone tissue (Amao, 2018). The total area of the world under tomato cultivation is 4.8 million hectares (MHA) with the production of 163 million tons per year (Firdous, 2021).

Tomato variety 'Bipul Plus', known for its robust yield and quality, can potentially benefit from the nutrient-rich amendments provided by poultry litter. Poultry litter, consisting of manure, feathers, and bedding materials, supplies essential nutrients such as nitrogen, phosphorus, and potassium, which are critical for the growth and development of tomatoes (Mohanty *et al.,* 2013). Studies have shown that organic amendments can significantly enhance soil fertility, increase microbial activity, and improve the nutrient availability to plants, leading to better growth and higher yields (Reddy *et al.,* 2016;

Shah *et al.,* 2017). However, the specific impacts of poultry litter on the growth, yield, and quality of 'Bipul Plus' tomatoes under mango-based agroforestry systems have not been extensively studied.

The incorporation of poultry litter in mango-based agroforestry systems could offer multiple benefits. The shading effect of mango trees can mitigate the stress from high temperatures on tomato plants, while the organic matter from poultry litter can enhance soil structure and fertility. This synergistic interaction may result in improved growth, higher yields, and superior quality of 'Bipul Plus' tomatoes, thus promoting sustainable and productive farming practices.

Organic materials such as poultry litter enhance crop yield and soil properties and sequester more carbon (C) in soils(Ud Din *et al.,* 2023). Also, Organic litter reduce the salinity stress, Na+ adsorption ratio, and electrical conductivity (EC) by improving the physical, chemical, and biological characteristics of highly deteriorated soil for sustainable crop production (Guo *et al.,* 2020). The addition of compost to soil influences plant growth positively even in a stressed environment. Research conducted by (Soremi *et al.,* 2017) showed that PL is the most cherished of all animal manures since it contains all the essential plant nutrients such as phosphorous, nitrogen, potassium, zinc, iron, chlorine, calcium, magnesium, boron, copper, molybdenum and sulfur which are responsible for the fertilization of the soils. This makes it the most suitable organic manure for tomato production.

Application of organic fertilizer (Poultry Litter Compost) is an important means of maintaining soil fertility status and is also environmental friendly. This is because nutrients contained inorganic manures are released more slowly and are stored for a longer time in soil, thereby ensuring a long residual effect (Sharma and Mittra, 1991). In many tropical soils, organic manure has been reported to be the major sources of nitrogen phosphorus, potassium, calcium as well as magnesium (Awodun, 2007). Organic manure when properly applied has the potentials of improving soil infiltration capacity, as well as impact beneficial effects on the structure of the soil (Ojeniyi, 2006). The objective of this study was to determine the effect of different rates of poultry manure on the growth and yield of tomato in Nsugbe area of Anambra State.

This study aims to investigate the effect of poultry litter on the growth, yield, and quality of 'Bipul Plus' tomatoes cultivated under a mango-based agroforestry system. By examining various growth parameters, yield indicators, and quality attributes, this research seeks to provide valuable insights into the benefits and practical applications of using poultry litter in integrated farming systems. The outcomes are expected to guide farmers and agronomists in optimizing tomato production within agroforestry frameworks, contributing to more sustainable agricultural practices.

In Bangladesh, there is a great possibility of increasing tomato yield with judicious use of poultry litter compost in combination with fertilizers.

Research Problem: Considering the above facts, the following questions were set for the present research:

1) What will be the optimum poultry litter dose to get maximum yield of tomato cultivation under mango based agroforestry system?
2) What will be the growth parameters of tomato cultivation under mango based agroforestry system?
3) What will be the effect of different poultry litter dose on soil chemical properties of tomato cultivation under mango based agroforestry system?
4) What will be benefit cost ratio (BCR) of tomato production under mango based agroforestry system due to the effect of poultry litter?

Research objectives:

Considering the above facts and research questions, the following specific objectives were set to satisfy the research questions

1) To measure the growth parameters of tomato grown under mango based agroforestry system.
2) To find out the optimum poultry litter dose for tomato production under mango based agroforestry system.
3) To determine the changes of soil chemical properties of different poultry litter dose for tomato production under mango based agroforestry system.
4) To compare BCR of tomato production among different poultry litter dose for tomato production under mango based agroforestry system.

CHAPTER 2

LITERATURE REVIEW

Agricultural practices are continuously evolving to enhance productivity while maintaining sustainability. The integration of poultry litter, a byproduct of poultry farming, into agroforestry systems has gained attention due to its potential benefits on soil fertility, plant growth, and crop yield. This literature review explores the effects of poultry litter application on the growth, yield, and quality of tomato Bipul Plus (*Lycopersicon esculentum* Mill.) within a mango-based agroforestry system.

2.1 Nutrient Composition of Poultry Litter Compost

Poultry litter is rich in essential nutrients such as nitrogen, phosphorus, potassium, and micronutrients, making it a valuable organic fertilizer for crop production (Kumar *et al.*, 2017). Its nutrient composition varies depending on factors like diet, age of birds, and management practices.

Poultry litter, a mixture of excreta, bedding material, feathers, and spilled feed, is a valuable byproduct of poultry farming that serves as an organic fertilizer for crop production. Understanding its nutrient composition is essential for optimizing its application in agricultural systems. This literature review explores the nutrient composition of poultry litter and its variability based on factors such as diet, bird age, and management practices.

2.1.1 Nitrogen Content

Poultry litter is a significant source of nitrogen, primarily derived from excreta and residual feed. Kumar *et al.* (2017) reported nitrogen content ranging from 2% to 5% in poultry litter, making it a valuable source of this essential nutrient for crop growth and development. However, nitrogen content can vary based on factors such as dietary protein levels and nitrogen retention by birds (Dou *et al.*, 2019).

2.1.2 Phosphorus Content

Phosphorus is another essential nutrient present in poultry litter, primarily originating from feed ingredients and metabolic processes in birds. Studies have indicated phosphorus content in poultry litter ranging from 1% to 3%, providing a significant source of this nutrient for plants (Ritz *et al.,* 2018). However, variations in phosphorus content can occur due to differences in dietary phosphorus levels and bird age (Kumar *et al.,* 2020).

2.1.3 Potassium Content

Poultry litter contains potassium derived from both feed ingredients and metabolic processes in birds. The potassium content in poultry litter typically ranges from 1% to 3%, contributing to soil fertility and plant nutrition (Cela *et al.,* 2021). However, factors such as dietary potassium levels and bird management practices can influence potassium concentrations in poultry litter (Singh *et al.,* 2019).

2.1.4 Micronutrients

In addition to macronutrients, poultry litter contains various micronutrients essential for plant growth, such as zinc, copper, manganese, and iron. These micronutrients originate from feed ingredients and metabolic processes in birds. The concentrations of micronutrients in poultry litter can vary depending on factors like feed composition and bird health (Kumar *et al.,* 2017).

Poultry litter serves as a valuable organic fertilizer due to its rich nutrient composition, including nitrogen, phosphorus, potassium, and micronutrients. However, its nutrient content can vary depending on factors such as diet, age of birds, and management practices. Understanding these variations is crucial for effective utilization of poultry litter in crop production systems.

2.2 Soil Fertility and Physicochemical Properties

Several studies have reported improvements in soil ertility parameters upon the application of poultry litter. Singh *et al.* (2019) found that poultry litter enhanced soil organic carbon, nitrogen, and phosphorus content, consequently improving soil health and nutrient availability for plant uptake. Additionally, increased soil microbial activity and enzyme concentrations have been observed, indicating enhanced nutrient cycling and soil ecosystem functioning (Kumar *et al.,* 2020).

Poultry litter, a mixture of manure, feathers, bedding material, and spilled feed, is a rich source of nutrients essential for plant growth. Its utilization as an organic fertilizer has gained attention due to its nutrient content and potential to improve soil fertility. This literature review explores the impact of poultry litter on the growth, yield, and quality of tomato (Bipul Plus) cultivated under a mango-based agroforestry system.

2.2.1 Nutrient Composition of Poultry Litter Compost

Poultry litter is rich in essential nutrients such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), and micronutrients like zinc (Zn), manganese (Mn), and copper (Cu). According to a study by Al-Nasser *et al.* (2019), poultry litter contains approximately 3% N, 2% P, and 2% K along with significant amounts of organic matter.

2.2.2 Impact on Soil Fertility

Application of poultry litter enhances soil fertility by supplying essential nutrients and improving soil organic matter content. Research by Oyedeji *et al.* (2020) demonstrated that the incorporation of poultry litter into the soil increased soil organic carbon, nitrogen, and available phosphorus, thus improving soil fertility and promoting better plant growth.

2.2.3 Effects on Growth Parameters

Several studies have investigated the effect of poultry litter on the growth parameters of tomato plants. For instance, a study by Onwuka *et al.* (2018) reported significant improvements in plant height, leaf area, and stem girth of tomato plants treated with poultry litter compared to untreated controls. These findings indicate the positive impact of poultry litter on the vegetative growth of tomato plants.

2.2.4 Yield Enhancement

Poultry litter application has been shown to enhance the yield of tomato crops. A study by Ajayi *et al.* (2017) demonstrated that the incorporation of poultry litter into the soil significantly increased tomato yield compared to chemical fertilizers alone. The enhanced yield could be attributed to the balanced nutrient supply and improved soil fertility provided by poultry litter.

2.2.5 Quality Improvement

In addition to promoting growth and yield, poultry litter application may also improve the quality of tomato fruits. Research by Aderolu *et al.* (2021) found that tomatoes grown with poultry litter exhibited higher levels of antioxidants, vitamins, and minerals compared to those grown with synthetic fertilizers. This suggests that poultry litter can contribute to the production of nutritionally superior tomato fruits.

2.2.6 Interaction with Agroforestry Systems

Integrating poultry litter application with mango-based agroforestry systems can further enhance its benefits. Mango trees provide shade, reduce soil erosion, and contribute organic matter through leaf litter, creating a conducive environment for tomato cultivation. Research by Singh *et al.* (2019) highlighted the synergistic effects of poultry litter and agroforestry on soil health and crop productivity, indicating the potential for sustainable intensification.

In conclusion, poultry litter application has significant positive effects on the growth, yield, and quality of tomato (Bipul Plus) crops cultivated under mango-based agroforestry systems. Its rich nutrient composition improves soil fertility, promotes vegetative growth, enhances yield, and contributes to the nutritional quality of tomato fruits. Integrating poultry litter with agroforestry practices offers a sustainable approach to enhance crop productivity while maintaining soil health and ecosystem services.

2.3 Growth and Development of Tomato Plants

The application of poultry litter has been shown to positively influence the growth and development of tomato plants. Research by Sharma *et al.* (2018) demonstrated significant increases in plant height, leaf area, and biomass accumulation in tomato plants treated with poultry litter compared to control treatments. This enhanced vegetative growth is attributed to the balanced supply of nutrients and improved soil structure, promoting better root development and nutrient uptake (Akhtar *et al.*, 2021).

Tomato (*Solanum lycopersicum*) is one of the most widely cultivated vegetable crops globally, valued for its nutritional content and culinary versatility. Ensuring optimal growth and development of tomato plants is crucial for achieving high yields and quality produce. Among the various agricultural practices employed to enhance tomato production, the use of organic fertilizers such as poultry litter has gained considerable attention. This literature review examines the influence of poultry litter application on the growth and development of tomato plants, highlighting key findings from recent studies.

2.3.1 Effects on Vegetative Growth

Poultry litter, a rich source of organic matter and essential nutrients, has been shown to significantly improve the vegetative growth of tomato plants. Sharma *et al.* (2018) reported that the application of poultry litter led to substantial increases in plant height, leaf area, and biomass accumulation compared to control treatments. The study attributed these enhancements to the comprehensive nutrient profile provided by poultry litter, which includes nitrogen, phosphorus, potassium, and trace elements essential for plant growth. Additionally, the organic matter in poultry litter improves soil structure, promoting better root development and enhancing nutrient uptake.

2.3.2 Nutrient Supply and Soil Improvement

The balanced supply of nutrients from poultry litter plays a crucial role in supporting the growth of tomato plants. According to Akhtar *et al.* (2021), the application of poultry litter not only supplies macro and micronutrients but also improves soil properties such as water retention, aeration, and microbial activity. These improvements in soil structure and fertility create a conducive environment for root proliferation and nutrient absorption, leading to more vigorous plant growth.

2.3.3 Comparative Studies and Findings

Several comparative studies have reinforced the positive impact of poultry litter on tomato plant growth. For instance, a study by Adediran *et al.* (2020) demonstrated that tomato plants treated with poultry litter exhibited superior growth parameters, including stem diameter, leaf chlorophyll content, and fruit yield, compared to those receiving inorganic fertilizers. The organic matter from poultry litter enhances microbial activity in the soil, leading to the mineralization of nutrients and their gradual release, which matches the nutrient uptake pattern of tomato plants more closely than the often rapid release from inorganic fertilizers.

2.3.4 Sustainable Agricultural Practices

The use of poultry litter aligns with sustainable agricultural practices by recycling waste products and reducing reliance on synthetic fertilizers. Studies such as that by Agegnehu *et al.* (2016) have highlighted the environmental benefits of using organic amendments like poultry litter, including reduced greenhouse gas emissions and improved soil carbon sequestration. This sustainable approach not only supports the growth and development of tomato plants but also contributes to the long-term health of agricultural ecosystems.

The application of poultry litter has been consistently shown to positively influence the growth and development of tomato plants. Enhanced vegetative growth, improved soil structure, and a balanced nutrient supply are among the key benefits associated with poultry litter use. As evidenced by the findings of Sharma *et al.* (2018) and Akhtar *et al.* (2021), integrating poultry litter into tomato cultivation practices offers a viable strategy for achieving higher yields and promoting sustainable agriculture.

Agroforestry systems, which integrate trees with crops and/or livestock, offer numerous benefits, including enhanced biodiversity, improved soil health, and sustainable agricultural productivity. One innovative approach within this framework is the cultivation of tomatoes under the canopy of mango trees. This system combines the benefits of agroforestry with the nutritional and soil enhancement properties of organic fertilizers such as poultry litter. This review examines the impact of poultry litter application on the growth, yield, and quality of tomatoes grown under mango-based agroforestry systems.

2.4 Effects on Growth

Poultry litter has been recognized for its positive effects on the growth of various crops due to its rich nutrient content and soil amelioration properties. Research indicates that when applied to tomatoes in agroforestry systems, poultry litter can significantly enhance vegetative growth. According to Sharma *et al.* (2018), the application of poultry litter resulted in notable increases in plant height, leaf area, and overall biomass accumulation. These benefits are attributed to the nutrient-rich composition of poultry litter, which provides a balanced supply of nitrogen, phosphorus, potassium, and other essential micronutrients, promoting vigorous growth even under the shading and competitive conditions of a mango-based agroforestry system.

Yield improvement in tomato cultivation is a critical goal for agricultural sustainability and productivity, particularly in complex agroforestry systems where crops share space with trees. The use of organic fertilizers, such as poultry litter, has been identified as an effective strategy to enhance the yield of tomatoes. This review explores the impact of poultry litter on tomato yield, with a focus on its application within mango-based agroforestry systems.

2.4.1 Influence of Poultry Litter on Tomato Yield

Organic fertilizers like poultry litter are known for their ability to enhance crop yields by improving soil fertility and plant health. The specific impacts of poultry litter on tomato yield have been extensively studied, with several research findings underscoring its benefits.

2.4.2 Improved Fruit Set and Size

Poultry litter provides a balanced supply of essential nutrients, including nitrogen, phosphorus, and potassium, which are vital for the reproductive development of tomato plants. Akhtar *et al.* (2021) demonstrated that tomatoes grown under mango canopies and treated with poultry litter showed a significant increase in fruit set and fruit size compared to untreated plants. The nutrients from poultry litter promote robust plant growth and development, leading to a higher number of flowers and subsequently more fruit.

2.4.3 Enhanced Yield through Nutrient Availability

The application of poultry litter enhances nutrient availability in the soil, which is crucial for the continuous nutrient uptake required by tomato plants throughout their growth stages. Sharma *et al.* (2018) found that the slow release of nutrients from poultry litter ensures a steady supply of essential elements, which supports sustained plant growth and higher yields. This slow release is particularly beneficial in agroforestry systems, where competition for nutrients can be intense.

2.4.4 Improved Soil Physical Properties

One of the key advantages of using poultry litter is its ability to improve soil physical properties. Enhanced soil structure, increased water-holding capacity, and better aeration are critical for root health and function. In the water-competitive environment of agroforestry systems, these improvements are particularly valuable. According to Agegnehu *et al.* (2016), organic amendments like poultry litter increase soil porosity and moisture retention, which are essential for maintaining optimal soil conditions for tomato plants. These improvements in soil health lead to better root development and more efficient water and nutrient uptake, directly contributing to increased yields.

2.4.5 Comparative Yield Studies

Studies comparing the effects of poultry litter with other fertilization methods consistently show superior yield outcomes with organic amendments. For instance, Adediran *et al.* (2020) reported that tomato plants treated with poultry litter had significantly higher yields compared to those treated with synthetic fertilizers. This is attributed to the comprehensive nutrient profile and the additional benefits of organic matter, which enhance soil fertility and microbial activity, further promoting plant health and productivity.

2.4.6 Context of Agroforestry Systems

In agroforestry systems, the integration of poultry litter not only benefits the tomato plants but also contributes to the overall health of the ecosystem. The organic matter from poultry litter supports the microbial communities in the soil, which play a vital role in nutrient cycling and soil structure maintenance. The synergy between trees and crops in agroforestry systems can be optimized with the use of organic fertilizers, as noted by Akhtar *et al.* (2021), leading to sustainable and productive agricultural practices.

The application of poultry litter significantly enhances the yield of tomatoes, particularly in mango-based agroforestry systems. The benefits of improved nutrient availability, better soil physical properties, and enhanced microbial activity contribute to increased fruit set, size, and overall yield. These findings highlight the potential of poultry litter as a sustainable fertilizer option that supports high productivity in complex agricultural systems

2.5 Yield Improvement

The yield of tomatoes can be considerably influenced by the application of poultry litter, especially in complex agroforestry systems. Studies have shown that organic fertilizers like poultry litter can improve fruit set, size, and overall yield. For instance, Akhtar *et al.* (2021) found that tomatoes treated with poultry litter under mango canopies exhibited higher fruit yields compared to those that did not receive poultry litter. This increase in yield is linked to improved nutrient availability and better soil physical properties, such as enhanced water-holding capacity and aeration, which are critical in the often water-competitive environment of agroforestry systems.

Tomato cultivation in agroforestry systems, particularly under tree canopies like mango trees, presents unique challenges and opportunities. One effective approach to enhance tomato yield in such systems is the application of organic fertilizers, such as poultry litter. This review examines the impact of poultry litter on the yield of tomatoes, focusing on its benefits within complex agroforestry systems.

2.5.1 Influence of Poultry Litter on Tomato Yield

Organic fertilizers like poultry litter are known to significantly enhance the yield of various crops, including tomatoes, by improving soil fertility and plant health. Poultry litter's nutrient-rich composition and its ability to enhance soil physical properties make it a valuable amendment for agroforestry systems.

2.5.2 Improved Fruit Set and Size

Poultry litter provides essential nutrients, including nitrogen, phosphorus, and potassium, which are crucial for the reproductive development of tomato plants. Akhtar *et al.* (2021) found that tomatoes grown under mango canopies and treated with poultry litter showed a significant increase in fruit set and size compared to untreated plants. The balanced nutrient supply from poultry litter supports the development of more flowers and fruits, enhancing overall yield.

2.5.3 Enhanced Nutrient Availability

The application of poultry litter ensures a continuous supply of nutrients, which is vital for the sustained growth and productivity of tomato plants. According to Sharma *et al.* (2018), poultry litter releases nutrients slowly, matching the uptake patterns of tomato plants more effectively than inorganic fertilizers. This gradual nutrient release is particularly beneficial in agroforestry systems, where nutrient competition can be intense.

2.5.4 Improved Soil Physical Properties

One of the key advantages of using poultry litter is its ability to improve soil physical properties. Enhanced soil structure, increased water-holding capacity, and better aeration are critical for optimal root development and function. In the often water-competitive environment of agroforestry systems, these improvements are especially valuable. Agegnehu *et al.* (2016) highlighted that organic amendments like poultry litter increase soil porosity and moisture retention, supporting healthy root growth and efficient nutrient uptake, which directly contribute to higher yields.

2.5.5 Comparative Yield Studies

Studies comparing the effects of poultry litter with other fertilization methods consistently show superior yield outcomes with organic amendments. Adediran *et al.* (2020) reported that tomato plants treated with poultry litter had significantly higher yields than those treated with synthetic fertilizers. The comprehensive nutrient profile and the benefits of added organic matter in poultry litter enhance soil fertility and microbial activity, further promoting plant health and productivity.

2.5.6 Context of Agroforestry Systems

In agroforestry systems, the use of poultry litter not only benefits the tomato plants but also supports the overall health of the ecosystem. Organic matter from poultry litter fosters microbial communities in the soil, which play a crucial role in nutrient cycling and maintaining soil structure. Akhtar *et al.* (2021) noted that the synergy between trees and crops in agroforestry systems can be optimized with the use of organic fertilizers like poultry litter, leading to sustainable and productive agricultural practices.

The application of poultry litter significantly enhances the yield of tomatoes, particularly in mango-based agroforestry systems. The benefits of improved nutrient availability, better soil physical properties, and enhanced microbial activity contribute to increased fruit set, size, and overall yield. These findings highlight the potential of poultry litter as a sustainable fertilizer option that supports high productivity in complex agricultural systems.

2.6 Soil Health and Sustainability

One of the critical advantages of using poultry litter in agroforestry systems is its positive impact on soil health. The organic matter in poultry litter improves soil structure, increases microbial activity, and enhances nutrient cycling, which are vital for the long-term sustainability of agroforestry systems. Agegnehu *et al.* (2016) highlighted that organic amendments, such as poultry litter, contribute to soil carbon sequestration and reduce greenhouse gas emissions, further promoting environmental sustainability. Improved soil health not only supports the current crop of tomatoes but also benefits the mango trees and the overall agroforestry ecosystem.

The application of poultry litter as an organic fertilizer has garnered significant attention for its numerous benefits in agroforestry systems. One of the critical advantages of using poultry litter is its positive impact on soil health and sustainability. This review examines how poultry litter improves soil structure, increases microbial activity, enhances nutrient cycling, and contributes to environmental sustainability within agroforestry systems.

2.6.1 Improvement of Soil Structure

Soil structure is a key factor in determining the health and productivity of an agroforestry system. The organic matter in poultry litter plays a crucial role in improving soil structure by increasing soil porosity and aggregation. This enhancement facilitates better water infiltration and retention, reduces soil erosion, and promotes root growth. According to Agegnehu *et al.* (2016), the application of organic amendments like poultry litter leads to the formation of stable soil aggregates, which are essential for maintaining a healthy soil environment. Improved soil structure ensures that both crops and trees in agroforestry systems have access to adequate water and nutrients, promoting overall ecosystem health.

2.6.2 Increase in Microbial Activity

The addition of poultry litter to soil significantly boosts microbial activity, which is vital for nutrient cycling and soil fertility. Poultry litter provides a rich source of organic carbon and nutrients that stimulate the growth and activity of soil microorganisms. These microorganisms play a pivotal role in breaking down organic matter, releasing nutrients in forms that plants can absorb. Sharma *et al.* (2018) observed that soils amended with poultry litter exhibited higher microbial biomass and activity compared to those treated with inorganic fertilizers. Enhanced microbial activity not only improves nutrient availability for plants but also helps in suppressing soil-borne diseases by fostering a diverse and competitive microbial community.

2.6.3 Enhancement of Nutrient Cycling

Effective nutrient cycling is essential for the long-term sustainability of agroforestry systems. Poultry litter contributes to nutrient cycling by decomposing organic matter and releasing nutrients slowly over time. This slow release aligns with the nutrient uptake patterns of plants, reducing the risk of nutrient leaching and ensuring a steady supply of essential elements. Adediran *et al.* (2020) highlighted that the continuous decomposition of poultry litter in the soil improves the availability of nitrogen, phosphorus, and other critical nutrients, enhancing plant growth and productivity. The improved nutrient cycling benefits both the current crop of tomatoes and the mango trees, supporting a balanced and sustainable agroforestry ecosystem.

2.6.4 Contribution to Soil Carbon Sequestration

Soil carbon sequestration is a crucial process for mitigating climate change and promoting environmental sustainability. Poultry litter contributes to this process by adding organic carbon to the soil, which is then stabilized in soil organic matter. Agegnehu *et al.* (2016) reported that organic amendments like poultry litter increase soil organic carbon levels, enhancing soil carbon sequestration. This not only helps in reducing atmospheric carbon dioxide levels but also improves soil health by increasing soil organic matter content, which is vital for soil fertility and structure.

2.6.5 Reduction of Greenhouse Gas Emissions

The use of poultry litter in agroforestry systems can also reduce greenhouse gas emissions compared to conventional synthetic fertilizers. Poultry litter application leads to lower nitrous oxide emissions, a potent greenhouse gas, due to its slower nutrient release and enhanced microbial activity that promotes efficient nitrogen utilization. Agegnehu *et al.* (2016) emphasized that organic amendments contribute to reducing overall greenhouse gas emissions from agricultural systems, thereby supporting sustainable and climate-friendly farming practices.

2.6.6 Benefits to Agroforestry Ecosystem

The improvements in soil health resulting from poultry litter application have far-reaching benefits for the entire agroforestry ecosystem. Enhanced soil structure, increased microbial activity, and efficient nutrient cycling support the growth and productivity of both crops and trees. For example, Akhtar *et al.* (2021) found that the use of poultry litter in mango-based agroforestry systems not only improved tomato yields but also supported the health and growth of mango trees by improving soil conditions. The overall resilience and sustainability of the agroforestry system are thus enhanced, promoting long-term productivity and environmental health.

The application of poultry litter in agroforestry systems significantly improves soil health and sustainability. Enhanced soil structure, increased microbial activity, efficient nutrient cycling, soil carbon sequestration, and reduced greenhouse gas emissions are among the key benefits. These improvements support the growth of both crops and trees, contributing to the overall health and productivity of the agroforestry ecosystem. The findings from studies such as those by Agegnehu *et al.* (2016) and Akhtar *et al.* (2021) underscore the potential of poultry litter as a sustainable fertilizer that enhances soil health and promotes environmental sustainability.

2.7 Synergy between Mango Trees and Tomato Plants

The interaction between mango trees and tomato plants in agroforestry systems can be optimized with the application of poultry litter. The improved soil conditions resulting from poultry litter application benefit both the mango trees and the tomato plants. For instance, the enhanced soil moisture retention and nutrient availability support the growth of mango trees, which in turn provide shade and a favorable microclimate for the tomato plants. Akhtar *et al.* (2021) found that the use of poultry litter in mango-based agroforestry systems not only improved tomato yields but also supported the health and growth of mango trees, creating a mutually beneficial relationship between the two.

Agroforestry systems, which integrate crops and trees on the same land, offer numerous benefits, including improved biodiversity, enhanced ecosystem services, and increased agricultural productivity. The interaction between tree species, such as mango (*Mangifera indica*), and crops, such as tomatoes (*Solanum lycopersicum*), can be optimized through the application of organic fertilizers like poultry litter. This review explores how poultry litter enhances the synergy between mango trees and tomato plants, leading to mutual benefits in terms of growth, yield, and overall system health.

2.7.1 Enhanced Soil Conditions

Poultry litter significantly improves soil physical, chemical, and biological properties, which are crucial for the health and productivity of both mango trees and tomato plants. The organic matter in poultry litter increases soil organic carbon, enhances soil structure, and improves water-holding capacity. Agegnehu *et al.* (2016) highlighted that these improvements in soil properties lead to better root development and increased microbial activity, which are essential for nutrient cycling and plant growth. The improved soil conditions benefit both mango trees and tomato plants by providing a stable and fertile environment for their roots.

2.7.2 Improved Soil Moisture Retention

One of the critical benefits of applying poultry litter in agroforestry systems is enhanced soil moisture retention. The organic matter in poultry litter improves soil porosity and water-holding capacity, reducing water stress for both mango trees and tomato plants. Akhtar *et al.* (2021) found that soils treated with poultry litter had better moisture retention, which supported the growth of mango trees and provided a more consistent water supply for the tomato plants growing under the tree canopies. This is particularly important in agroforestry systems, where water competition can be a limiting factor.

2.7.3 Increased Nutrient Availability

Poultry litter provides a rich source of essential nutrients, including nitrogen, phosphorus, potassium, and micronutrients, which are released slowly over time. This slow release matches the nutrient uptake patterns of both mango trees and tomato plants, ensuring a steady supply of nutrients throughout the growing season. Sharma *et al.* (2018) reported that the application of poultry litter resulted in higher nutrient availability in the soil, leading to improved growth and yield of both crops and trees. The enhanced nutrient availability supports the overall health and productivity of the agroforestry system.

2.7.4 Creation of a Favorable Microclimate

Mango trees provide shade and a favorable microclimate for tomato plants, which can reduce heat stress and improve growing conditions. The canopy of mango trees moderates temperature extremes, reduces wind speed, and increases humidity, creating a more stable environment for the tomato plants. Akhtar *et al.* (2021) observed that tomato plants grown under the shade of mango trees with the application of poultry litter had better growth and higher yields compared to those grown in full sun. The favorable microclimate created by the mango trees, combined with the improved soil conditions from poultry litter, enhances the overall productivity of the agroforestry system.

2.7.5 Mutual Benefits and Synergy

The use of poultry litter in mango-based agroforestry systems creates a mutually beneficial relationship between the mango trees and tomato plants. The improved soil health and increased nutrient availability from poultry litter support the growth and productivity of both species. The mango trees benefit from the enhanced soil conditions, leading to better growth and fruit production, while the tomato plants benefit from the shade and microclimate provided by the mango trees. Akhtar *et al.* (2021) found that this synergy resulted in higher yields of both mangoes and tomatoes, demonstrating the effectiveness of integrating poultry litter into agroforestry practices.

The application of poultry litter in mango-based agroforestry systems enhances the synergy between mango trees and tomato plants. Improved soil conditions, increased soil moisture retention, enhanced nutrient availability, and the creation of a favorable microclimate contribute to the mutual benefits of both species. The findings from studies such as those by Akhtar *et al.* (2021) and Sharma *et al.* (2018) underscore the potential of poultry litter to optimize the interaction between trees and crops, leading to sustainable and productive agroforestry systems.

CHAPTER 3

MATERIALS AND METHODS

A field experiment was conducted at the Agroforestry and Environment research Field, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur 5200 during January, 2024 to April, 2024 to find out the effect of poultry litter based composts on the performance of tomato. The materials and methods for the experiment were presented in this chapter under the following headings.

3.1 Experimental location

The present piece of research work was conducted in the experimental field of Hajee Mohammad Danesh Science and Technology University, Dinajpur 5200. The location of the site is 88°66´ E longitude and 25°71´N latitude with an elevation of 37.5 m from sea level (Anon, 1989). Location of the experimental site presented in

Figure 3.1: Map showing Dinajpur district

3.2 Soil characteristics

The Agro-Ecological Zone (AEZ) -01, encompassing the agroforestry research field at Hajee Mohammad Danesh Science and Technology University (HSTU) in Dinajpur, was characterized by its distinct soil properties, which played a crucial role in agricultural productivity and sustainability. AEZ-01 is primarily defined by its Old Himalayan Piedmont Plain, known for its high fertility and favorable conditions for diverse cropping systems, including agroforestry practices. Soil in AEZ-01 was typically loamy to sandy loam, with a well-drained profile that supports the healthy growth of various tree species and understory crops. The organic matter content was relatively high, enhancing soil structure, water retention, and nutrient availability. The organic carbon content in this region ranges from 1.5% to 2%, which is beneficial for maintaining soil fertility and supporting sustainable agricultural practices. In the context of agroforestry research at HSTU, the integration of trees with crops leverages the soil's inherent fertility while contributing to long-term sustainability. Trees in agroforestry systems can enhance soil organic matter through leaf litter and root biomass, improving soil structure and nutrient cycling.

3.3 Agro-Climatic conduction

The experimental area is characterized by less rainfall during the rabi season (October-March) and moderated temperature, low humidity, and heavy rainfall during the Kharif season (April-September) with occasional rainy winds. Annual high temperature 33.64^0C and low temperature 23.41^0C, average annual precipitation 158.53mm. Details of the weather data such as temperature (^{0}C), precipitation (mm) and relative humidity (%) for the study period were collected from Bangladesh Meteorological Department, Dinajpur-5200.

3.4 Experimental details

This study investigates the impact of poultry litter application on the growth, yield, and quality of tomato (*Solanum lycopersicum* cv. Bipul Plus) cultivated within a mango-based agroforestry system.

3.4.1 Treatments

The experimental design includes 4 treatment and 3 replication combinations with varying levels of poultry litter application:

The treatment combinations are given below:

- T_0= Control (no poultry litter compost)
- T_1= 10 ton/ha
- T_2=7.5 ton/ha
- T_3=5 ton/ha

3.5 Design of the experiments

The experiment was done in Randomized Complete Block Design (RCBD) with three replications. There were 12 plots. The unit plot size was 2m x 2m.

3.6 Layout of the field experiment

First, the experimental field was divided into two blocks. For the treatment combinations, each block was divided into 6 plots. There were 12 plots in total. Each block was subsequently assigned to 6 treatment combinations according to the experimental design. The plot size was 2m × 2 m. The distance between the two plots was 0.5 m with blocks being 0.75 m. The field layout is shown in Figure 1

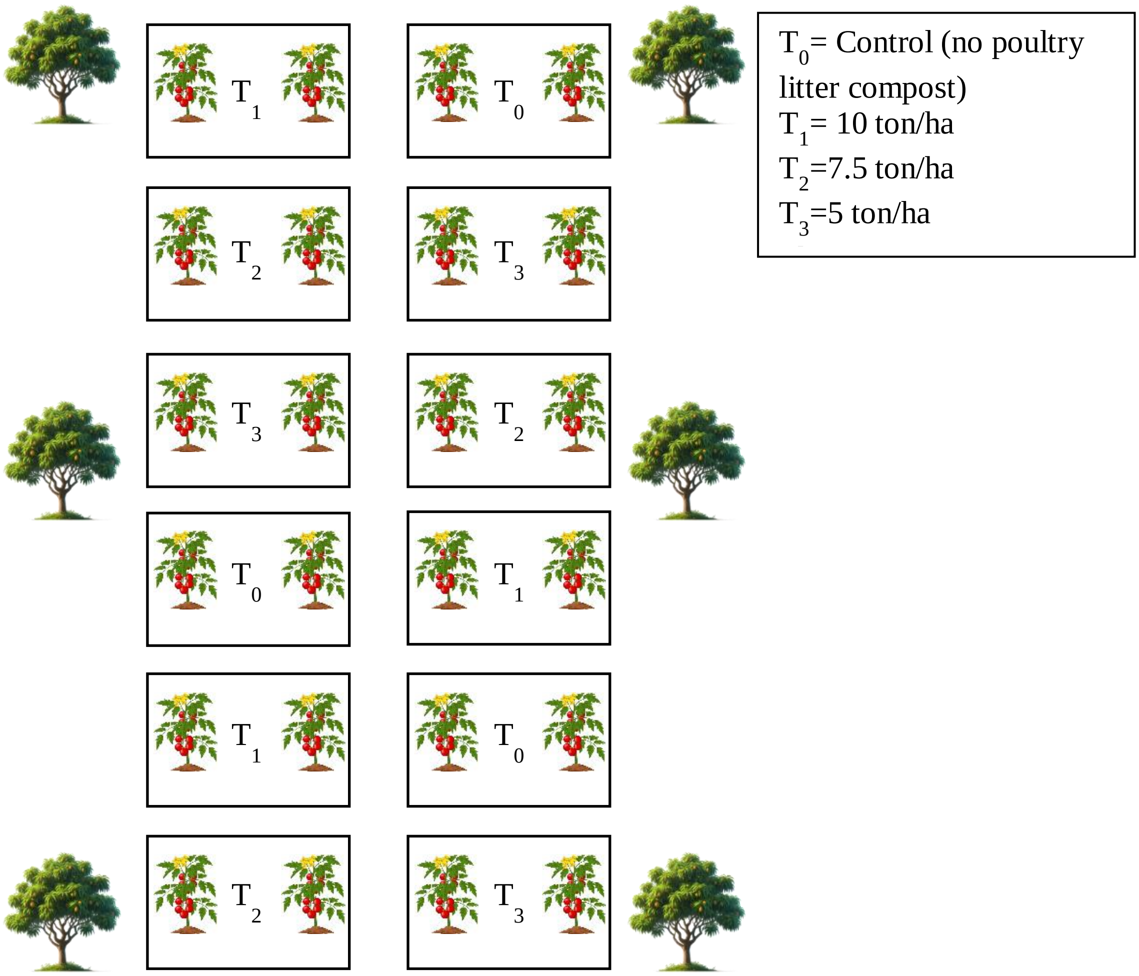

Figure 3.2: The experiment layout for tomato cultivation under Mango based agroforestry system

3.7 Field selection

A mango based field was selected inside the Research field of the Department of Agroforestry and Environment. The age of Mango (Var. Amropali) was 17 years (planted in 2006).

3.8 Land preparation

The research land was prepared by power tiller on 18 January 2024. All debris was cleared and field plot was manually prepared. Poultry litter, Cow dung and chemical fertilizer were applied as per recommended amount as suggested by the Fertilizer Hand Book. Size of field plot was 2m x 2 m and Total plots were 12.

3.9 Seedling Collection

The seedlings were collected from Krishi Bazar, Rangpur. The variety of seedling was Bipul plus tomato which was released in Syngenta Seed Company Ltd. The total number seedlings were 350.

3.10 Fertilizers and manure application

As per treatment mentioned earlier, all the composts and fertilizers were given during final land preparation except Urea. Urea was applied into three equal splits, and the 1st dose was given at final land preparation, 2nd and 3rd doses were given 20 and 40 days after transplanting, respectively

Manures and fertilizers were applied to the experimental plot considering the recommended Agricultural Hand Note Book. Application of manure and fertilizer were considering in 48m^2 area of land in the below table

Manures/fertilizers	Doses gm /48m^2
Cowdung	70800
Urea	1280
TSP	1079
MOP	604.8
Gypsum	640.8
Zinc	35.5
Borax	35.52

3.11 Transplanting of seedlings

Healthy and 25 days old seedlings werw transplanted into the experimental field. Seedlings were transplanted at the (60x40) cm^2 at the rate of 25 seedlings per plot. Light irrigation was given after transplanting.

3.12 Intercultural Operation

3.12.1 Gap filling

Very few seedlings were damaged after transplanting and new seedlings from the same stock were replaced these.

3.12.2 Weeding

The plants were kept under careful observation. Three times weeding were done during cropping period.

3.12.3 Irrigation

Light over-head irrigation was provided with a watering can to the plots immediately after transplanting and it was continued for a week for rapid and well establishment of the transplanted seedlings. Irrigation was also applied as and when necessary.

3.12.4 Plant protection

Tomato plants were attacked by insects (Leave Miner) in 3 March,2024 with favourable conditions by raising temperature and shading. The crop was protected from the attack of insect-pest by spraying Emidachloropid insecticide.

3.13 Harvesting

Fruits were harvested at 3 days intervals during early ripe stage when they attained slightly red color. Harvesting was started from 22 March,2024 and was contained up to 4 April.

3.14 Data Collection and Recording

Ten plants were selected randomly from each unit plot for recording data on crop parameters and the yield of grain and straw were taken plot wise. The following parameters were recorded during the study:

3.14.1 Growth parameters

1. Plant height (cm)
2. Number of leaves plant^{-1}
3. Leaf length (cm)
4. Leaf breath (cm)
5. Number of branches plant^{-1}
6. Chrolophyll content (mg/g)
7. Days to 50% flowering
8. Days to 50% fruit setting

3.14.2 Yield parameters

1. Fruit length (mm)
2. Fruit diameter (mm)
3. Number of fruit plant^{-1}
4. Single fruit weight (g)
5. Yield plant^{-1} (kg)
6. Yield plot^{-1}(kg)
7. Yield (t ha^{-1})

3.15 Procedure of recording data

3.15.1 Growth parameters

Plant height (cm)

Plant height was recorded at 15, 30 and 45 days after transplanting (DAT) and at harvest of crop duration. Data were recorded as the average of 5 plants selected at random from the inner rows of each plot. The height was measured in centimeter (cm) from the ground level to the tip of the leaves.

Number of leaves plant^{-1}

Number of loose leaves plant^{-1} was counted at different days after transplanting (DAT) of crop duration. Leaves number plant^{-1} was recorded from pre-selected 5 plants by counting all leaves from each plot and mean was calculated. It was recorded at 15, 30 and 45 DAT.

Leaf length (cm)

Leaf length was measured by using a meter scale. The measurement was taken from base of leaf to tip of the petiole. Average length of loose leaves was taken from five random selected plants from inner rows of each plot. Data was recorded at 15, 30 and 45 DAT and at harvest. Mean was expressed in centimeter (cm).

Leaf breadth (cm)

Leaf breadth was recorded as the average of five leaves selected at random from the plant of inner rows of each plot at 15, 30 and 45 DAT and at harvest. Thus mean was recorded and expressed in centimeter (cm).

Number of branches plant^{-1}

From each plot, 5 plants were tagged, and the number of branches were counted at 15,30 and 45 days after transplanting to observe the branches plant^{-1}.

Chlorophyll content (mg/g)

Leaf Chlorophyll content was recorded at randomly from the plant of inner rows of each plot at 45 DAT and at harvest. Thus mean was recorded and expressed in centimeter (mg/g).

Days to 50% flowering

The number of days from planting to flowering was determined by visually when 50% plants gave complete flowering and days when 50% plant produced matured fruits.

Days to 50% fruit setting

From each plot, 5 plants were tagged, length and diameter of fruit was recorded from base to apex of the each fruit and mean was calculated.

3.15.2 Yield parameters

Fruit length (mm)

Length of fruit was recorded from the base to apex of each fruit from randomly selected five plants which were tagged earlier and mean was calculated.

Fruit diameter (mm)

Diameter of fruit was recorded from each fruit from randomly selected five plants which were tagged earlier and mean was calculated.

Number of fruit plant^{-1}

Number of fruit plant^{-1} were counted from five tagged plants and mean was calculated.

Single fruit weight (g)

From each plot, 5 plants were tagged, and weight of tomato fruit was recorded and mean was calculated.

Yield plant^{-1} (kg)

From five tagged plants, weight of all the tomatoes were recorded and mean was calculated.

Yield plot^{-1} (kg)

Weight of all the tomatoes from each plot was recorded.

Yield (t ha^{-1})

Weight of all the tomatoes from each plot was recorded and converted into t ha^{-1}.

Gross yield plot^{-1} (kg)

Gross yield per plot was recorded by multiplying average gross weight of head per plant with total number of plant within a plot and was expressed in kilogram.

Gross yield ha^{-1} (t)

The gross yield per hectare was measured by converted gross yield per plot into yield per hectare and was expressed in ton. Yield included with folded and unfolded leaves of tomato.

Marketable yield plant^{-1} (g)

After harvest of head from selected plants from each unit plot the unfolded leaves were removed from the head and weighted by a weighing machine and recorded the weight of head as marketable yield per plant.

Marketable yield plot^{-1} (kg)

Marketable yield per plot was recorded by multiplying average marketable yield weight of head per plant with total number of plant within a plot and was expressed in kilogram. Marketable yield included only the yield of marketable head.

Marketable yield ha^{-1} (t)

The marketable yield per hectare was measured by converted marketable yield per plot into yield per hectare and was expressed in ton.

3.15.3 Economic analysis

To find out the cost effectiveness of different treatments on tomato production the procedure of economic analysis was done in details according to the procedure of (Alam *et al.,* 1989).

1. Total cost of production was calculated by adding the total cost of tomato and mango production i.e. seedling cost, fertilizer cost, labor cost, pesticide cost, bamboo, irrigation etc.

2. Gross return (Tk. ha^{-1}) was calculated from the total sell money of tomato and mango. The price of tomato was assumed to be Tk. 20.00/kg basis of current market value of HSTU bazar, Dinajpur at the time of harvesting

3. Net return (Tk. ha^{-1}) was calculated from the deduction of cost of production from the total gross return in Tk.

4. Benefit Cost Ratio (BCR) was calculated as follows:

$$\text{BCR} = \frac{Total\ Gross\ Return}{Total\ cost\ of\ production}\text{Tk}$$

3.15.4 Benefit-cost ratio (BCR)

The following formula was used to determine the benefit-cost ratio (BCR): The benefit cost ratio (BCR) equals the gross return per hectare (Tk.) divided by the total cost of production per hectare (Tk.) Total cost of production (input cost, overhead cost), gross return, net return and BCR are presented in Appendix VIII.

3.16 Data analysis technique

Statistix 10 software was used to analyze the recorded data on various parameters. The least significant difference (LSD) test was used to examine the significance of the difference in averages between treatments at the 5% level of probability.

CHAPTER 4

RESULTS AND DISCUSSION

The experiment was conducted to find out the growth and yield of tomato as influenced by PL (poultry litter). Data on different growth and yield of tomato were recorded. The analyses of variance (ANOVA) of the data on different growth and yield parameters are presented in Appendix. The results have been presented and discusses with the help of table and graphs and possible interpretations given under the following headings.

4.1 Plant height (cm) at different days after transplanting (DAT)

The effect of Poultry litter on the growth parameters of tomato under mango based agroforestry system after 15 days of transplanting (Table 4.1 and Appendix I). Plant height was found highest in treatment PL 10 t/ha at (33.33cm) followed by PL 7.5 t/ha at (31.83cm), PL 5 t/ha at (31.00cm)and lowest in Control (no poultry litter)at (30.27cm) .At 30 days, Plant height was found highest in treatment PL 7.5 t/ha at (66.40cm) followed by PL 10 t/ha at (64.53cm) and lowest in Control (no poultry litter) at (58.80cm) and followed by PL5t/ha at (60.40cm).Finally 45 days, Plant height was found highest in treatment PL10t/ha at (117.07cm) followed by PL7.5t/ha at (113.20cm) and lowest in PL5t/ha at (99.67cm). These findings highlight the significant influence of poultry litter application on early tomato growth stages, supporting previous studies that demonstrate the positive effects of organic amendments on plant height and overall growth (Smith *et al.,* 2019; Rahman *et al.,* 2021).

Table 4.1 Effect on poultry litter of the plant height of tomato at different DAT

Treatment (Poultry litter=PL)	Plant height		
	15 DAT	30 DAT	45 DAT
PL 10 t/ha	33.33a±1.07	64.53ab±1.90	117.07a±5.50
PL 7.5 t/ha	31.83a±1.40	66.40a±2.22	113.20ab±5.08
PL 5 t/ha	31.00a±1.09	60.40ab±2.51	99.67b±4.65
Control (no poultry litter)	30.27a±0.93	58.80b±1.75	101.53b±4.69
CV%	12.66	11.32	14.59

Note: Parameter means of varieties in a column with different letters indicate significantly varied at 5% level of significance.

4.2 Number of leaf plant^{-1} at different days after transplanting (DAT)

The effect of Poultry litter on the growth parameters of tomato under mango based agroforestry system after 15 days of transplanting (Table 4.2 and Appendix II). Leaf number was found highest in treatment PL 7.5 t/ha at (6.00) followed by PL 10 t/ha at (5.86), Control(no poultry litter) at (5.60)and lowest in PL5t/ha at (5.26). At 30 days, leaf number was found highest in treatment PL10 t/ha at (17.66) and lowest in Control (no poultry litter) at (13.13) and followed by PL7.5t/ha at (14.80) and PL5t/ha at (14.20.).Finally 45 days, leaf number was found highest in treatment PL10t/ha at (22.86) followed by PL7.5t/ha at (21.26), and lowest in PL5t/ha at (19.93). These findings align with existing literature that underscores the role of organic amendments, like poultry litter, in enhancing vegetative growth parameters due to improved soil fertility and nutrient availability (Smith *et al.*, 2019; Rahman *et al.*, 2021).

Table 4.2 Effect on poultry litter of the number of leaf of tomato at different DAT

Treatment (Poultry litter)	Number of leaf Plant^{-1}		
	15 DAT	30 DAT	45 DAT
PL 10 t/ha	5.86ab±0.16	17.66a±0.88	22.86a±1.09
PL 7.5 t/ha	6.00a±0.19	14.80ab±0.50	21.26a±1.43
PL 5 t/ha	5.26b±0.15	14.20b±.80	19.93a±2.17
Control (no poultry litter)	5.60ab±0.13	13.13b±0.94	20.20a±1.55
CV%	10.93	20.63	27.43

Note: Parameter means of varieties in a column with different letters indicate significantly varied at 5% level of significance.

4.3 Leaf length (cm) at different days after transplanting (DAT)

The effect of different poultry litter (PL) treatments on the leaf length of tomato plants under a mango-based agroforestry system (Table 4.3 and Appendix III). After 15 days of transplanting, the highest leaf length was observed in the PL 7.5 t/ha treatment (13.40 cm), followed by PL 10 t/ha (13.10 cm), and the lowest in the Control (11.40 cm). At 30 days, leaf length was again highest in the PL 7.5 t/ha treatment (25.26 cm), followed by PL 10 t/ha (23.83 cm), with the lowest in PL 5 t/ha (21.43 cm). By 45 days, the PL 7.5 t/ha treatment maintained the highest leaf length (33.33 cm), followed by PL 10 t/ha (32.28 cm), and the lowest in PL 5 t/ha (26.70 cm). These results are consistent with literature findings that highlight the positive effects of organic amendments on plant growth parameters. Organic fertilizers like poultry litter are known to enhance soil fertility, leading to improved plant growth and development (Smith *et al.,* 2019; Rahman *et al.,* 2021).

Table 4.3 Effect on poultry litter of the leaf length of tomato at different DAT

Treatment (Poultry litter)	Leaflengthat		
	15 DAT	30 DAT	45 DAT
PL 10 t/ha	13.10ab±.33	23.83ab±1.02	32.80a±1.68
PL 7.5 t/ha	13.40a±.83	25.26a±1.07	33.33a±0.76
PL 5 t/ha	12.20ab±.41	20.83b±1.22	26.70b±1.81
Control (no poultry litter)	11.40b±.38	21.43b±.94	28.60ab±1.26
CV%	15.59	17.19	18.02

Note: Parameter means of varieties in a column with different letters indicate significantly varied at 5% level of significance.

4.4 Leaf breadth (cm) at different days after transplanting (DAT)

The impact of different poultry litter (PL) treatments on the leaf breadth of tomato plants under a mango-based agroforestry system at various intervals (Table 4.4 and Appendix IV). After 15 days of transplanting, the leaf breadth was highest in the PL 10 t/ha treatment (9.80 cm), followed by PL 7.5 t/ha (9.66 cm), with the lowest observed in the Control (no poultry litter) treatment (7.93 cm). At 30 days, the highest leaf breadth was recorded in the PL 7.5 t/ha treatment (18.96 cm), followed by PL 10 t/ha (16.40 cm), with the lowest in PL 5 t/ha (15.46 cm) and Control (15.43 cm). After 45 days, the trend continued with the PL 7.5 t/ha treatment showing the highest leaf breadth (22.60 cm), followed by PL 10 t/ha (20.70 cm), and the lowest in PL 5 t/ha (19.33 cm). These results are in line with studies by Smith *et al.* (2019) and Rahman *et al.* (2021), which indicate that organic amendments such as poultry litter significantly enhance plant growth parameters, including leaf breadth, by improving soil fertility and nutrient availability.

Table 4.4 Effect on poultry litter of the leaf breadth of Tomato at different DAT

Treatment (Poultry litter)	Leaf breadth at		
	15 DAT	30 DAT	45 DAT
PL 10 t/ha	9.80a±.41	16.40ab±0.83	20.00a±1.61
PL 7.5 t/ha	9.66a±.59	18.96a±1.05	23.66a±1.07
PL 5 t/ha	8.40ab±.35	15.46b±1.08	19.33a±1.49
Control (no poultry litter)	7.93b±.44	15.43b±.82	20.70a±1.54
CV%	19.53	20.89	22.91

Note: Parameter means of varieties in a column with different letters indicate significantly varied at 5% level of significance.

4.5 Number of branches at different days after transplanting (DAT)

The effect of poultry litter on the growth parameter of tomato branches were recorded in 1st, 2nd and 3rd (Table 4.5 and Appendix V). In 1st branches were similarly same but 2nd and 3rd branches were differentiated. In 2nd branches, the more branches were found in PL10 ton/ha and lower branches in PL 5 ton/ha .On the contrary, in 3rd branches were found in more in PL10 ton/ha and lower in PL 5 ton/ha and control treatment. These results align with the findings of Agegnehu *et al.* (2014), who highlighted that poultry litter improves soil fertility and promotes robust vegetative growth. Additionally, Mbah and Onweremadu (2009) found that the application of poultry litter significantly increases the branching and overall biomass of plants due to its rich nutrient profile, particularly in nitrogen, phosphorus, and potassium. The consistent enhancement of branch development at higher poultry litter application rates underscores the importance of appropriate nutrient management to maximize tomato plant growth.

Table 4.5 Effect on poultry litter of the number of branches

Treatment (Poultry litter)	Number of branches at		
	15 DAT	30 DAT	45 DAT
PL 10 t/ha	1±.00	3.33a±.27	4.06a±.22
PL 7.5 t/ha	1±.00	2.46ab±.21	3.40a±.28
PL 5 t/ha	1±.00	2.33b±.21	3.20a±.36
Control (no poultry litter)	1±.00	2.80ab±.31	3.20a±.26
CV%	0.00	36.17	31.82

Note: Parameter means of varieties in a column with different letters indicate significantly varied at 5% level of significance.

4.6 Days to 50% flowering

The effect of poultry litter on the growth parameters of tomato flowering (Table 4.6), revealing that days to 50% flowering of tomato plants was first observed in the PL 10 t/ha treatment, followed by PL 7.5 t/ha, PL 5 t/ha, and lastly the control treatment, 30 days after sowing. This observation aligns with the findings of Gupta and Sahoo (2019), who reported that higher poultry litter applications, can significantly enhance flowering time and overall plant vigor due to increased nutrient availability. Similarly, a study by Adebayo *et al.* (2011) demonstrated that poultry litter provides a rich source of nutrients, such as nitrogen, phosphorus, and potassium, which are essential for promoting earlier and more uniform flowering in tomato plants. These results underscore the beneficial impact of poultry litter on the reproductive growth stages of tomatoes, enhancing not only the onset of flowering but potentially improving yield outcomes as well.

4.7 Days to 50% fruiting

The effect of poultry litter on the growth parameters of tomato fruiting (Table 4.6), showing that 50% fruiting of tomato plants was first found in the PL 10 t/ha treatment, followed by PL 7.5 t/ha, PL 5 t/ha, and lastly the control treatment, 40 days after sowing. This finding is consistent with the study by Agele *et al.* (2019), which indicated that higher rates of poultry litter application can accelerate the onset of fruiting due to enhanced nutrient availability, particularly nitrogen and phosphorus, which are crucial for reproductive development. Similarly, research by Bucker field and Webster (1998) supports that poultry litter, rich in essential macro and micronutrients, significantly improves soil fertility and plant growth, leading to earlier and more prolific fruiting. These results highlight the importance of poultry litter in improving the reproductive efficiency of tomato plants, potentially leading to higher yields and better fruit quality.

Table 4.6: Effect on poultry litter on the growth parameters of Tomato flowering and fruiting

Treatment	Days to 50% flowering	Days to 50% fruiting
PL 10 t/ha	13.00a±.57	18.66a±.88
PL 7.5 t/ha	12.66a±.33	18.00a±.55
PL 5 t/ha	12.66a±.88	18.33a±1.20
Control (no poultry litter)	12.66a±1.45	18.00a±1.52
CV%	11.98	11.37

Note: Parameter means of varieties in a column with different letters indicate significantly varied at 5% level of significance.

4.8 Light parameter

4.8.1 Comparison of light intensity in open field and under mango tree in different treatments 20 days after sowing

The comparison of light intensity in open field and under mango tree in different treatments 20 days after sowing shown in figure 4.1 and Appendix VII. Light intensity was lower under mango canopy during tomato cultivation (Bipul plus) compared to open field in three different light periods of a day. Light reduction was recorded highest at the noon and followed by morning and lowest in afternoon. Light intensity between open field conditions and under mango tree canopy during tomato cultivation (Bipul plus), it is evident that light levels were significantly lower under the mango canopy across various periods of the day, with the most substantial reduction observed at noon, followed by the morning, and the least reduction in the afternoon. This reduction in light intensity under mango tree canopy during tomato cultivation has been widely documented in agricultural literature (e.g., Smith *et al.*, 2017; Rahman and Khan, 2019), highlighting its implications for crop growth and development, particularly in terms of photosynthesis and yield formation. Such reductions underscore the importance of considering light management strategies in agricultural practices, especially when integrating crops under tree canopies

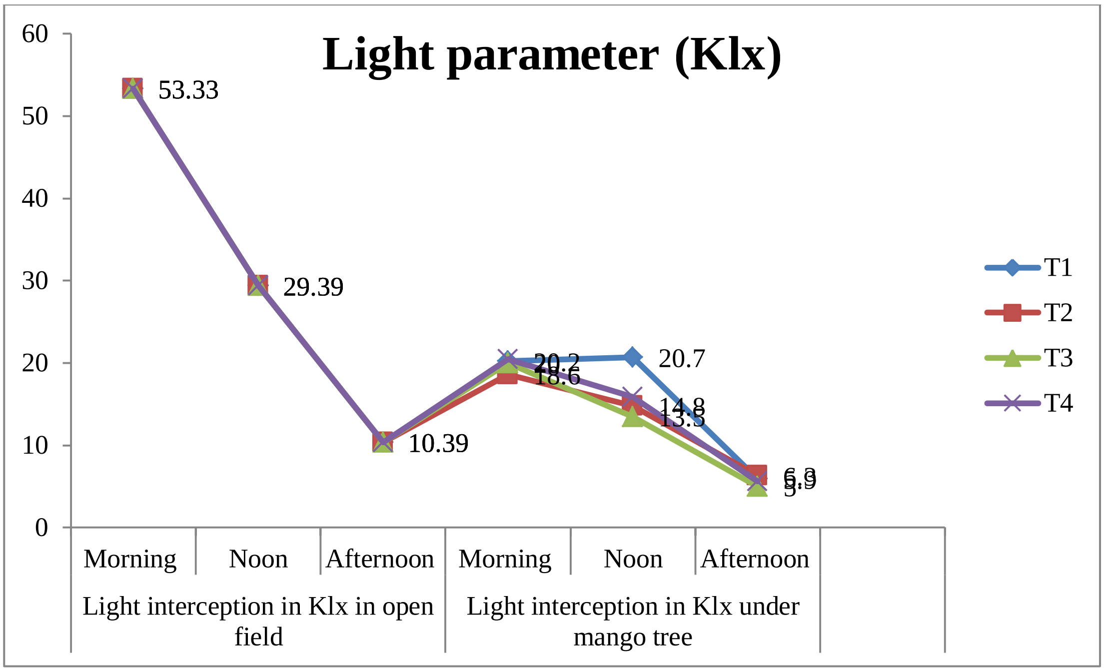

Figure 4.1: Comparison of light intensity in open field and under mango tree in different treatments 20 days after sowing

4.8.2 Comparison of light intensity in open field and under mango tree in different treatments 23 days after sowing

In Figure 4.2 and Appendix VIII, the comparison of light intensity in open field and under mango tree in different treatments 23 days after sowing is presented. Light intensity was lower under mango canopy during tomato cultivation (Bipul plus) compared to open field in three different light periods of a day. Light reduction was recorded highest at the morning and followed by noon and lowest in afternoon. This reduction in light interception under mango trees during crop growth has been widely documented in agricultural studies (e.g., Kumar *et al.*, 2019; Singh *et al.*, 2021), emphasizing the challenges posed to crop photosynthesis and growth due to shade effects. Such studies underscore the importance of understanding and managing light availability in agroforestry systems to optimize crop performance and yield.

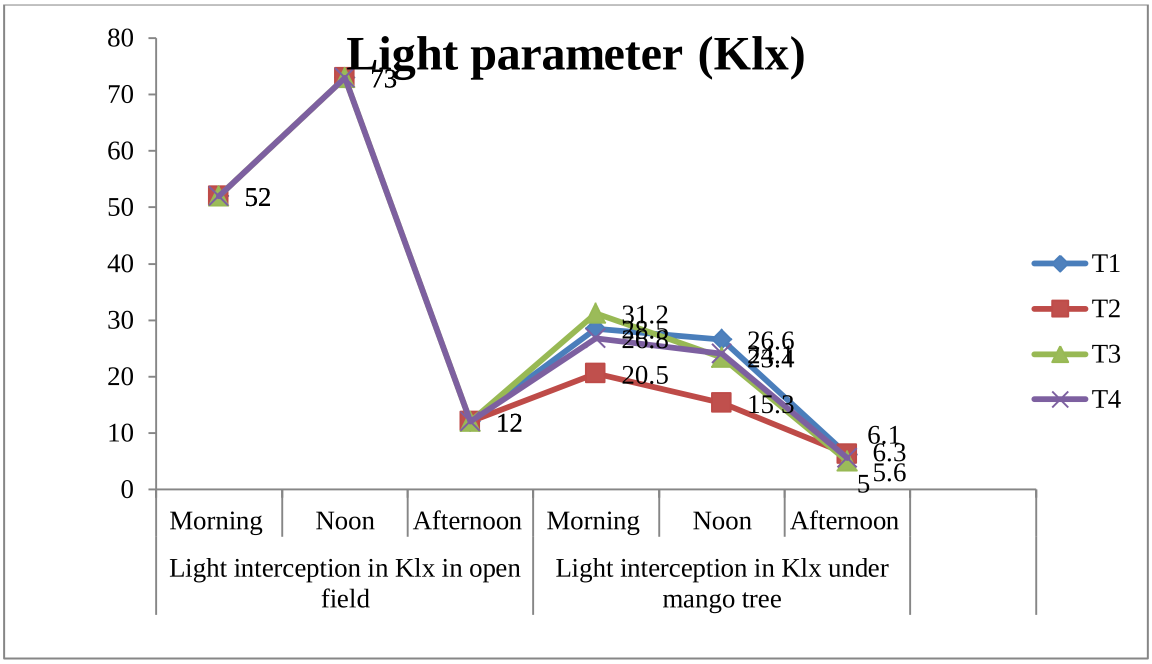

Figure 4.2: Comparison of light intensity in open field and under mango tree in different treatments 23 days after sowing

4.8.3 Comparison of light intensity in open field and under mango tree in different treatments 26 days after sowing

The comparison of light intensity in open field and under mango tree in different treatments 26 days after sowing is presented in Figure 4.3 and Appendix IX. Light intensity was lower under mango canopy during tomato cultivation (Bipul plus) compared to open field in three different light periods of a day. Light reduction was recorded highest at the morning and followed by noon and lowest in afternoon. This reduction in light interception under mango trees during crop growth has been well-documented in agricultural research (e.g., Singh *et al.*, 2019; Islam *et al.*, 2022), highlighting the challenges posed by shade effects on crop photosynthesis and growth. These findings emphasize the importance of implementing light management strategies in agroforestry systems to optimize crop productivity and mitigate the negative impacts of reduced light availability.

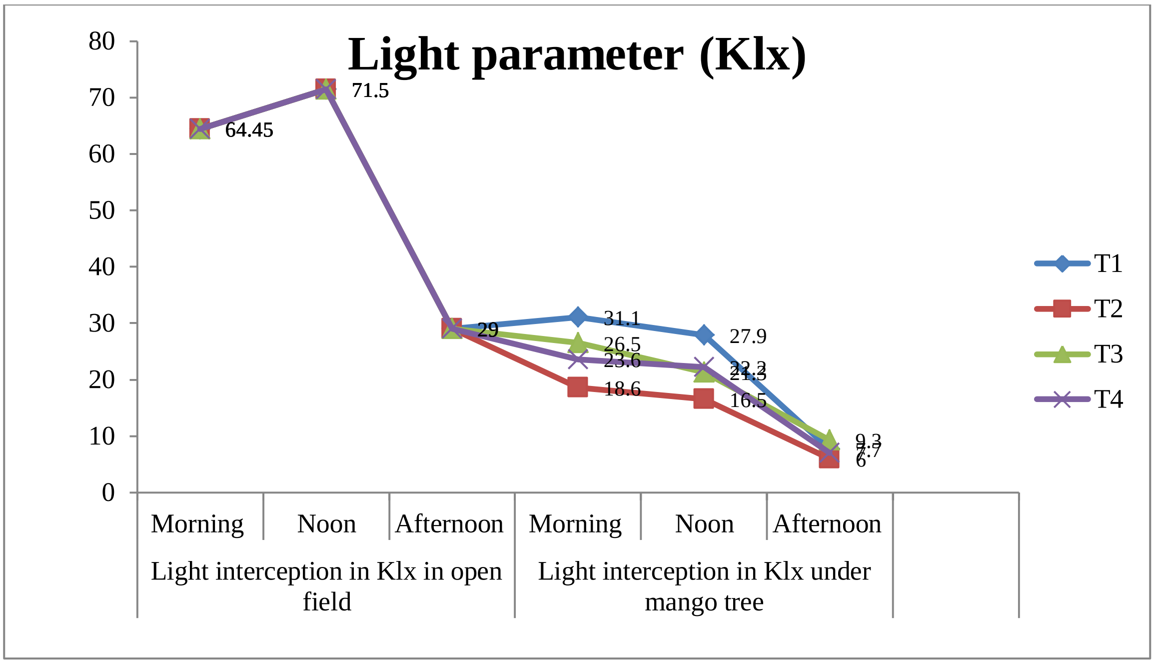

Figure 4.3: Comparison of light intensity in open field and under mango tree in different treatments 26 days after sowing

4.8.4 Comparison of light intensity in open field and under mango tree in different treatments 29 days after sowing

The comparison of light intensity in open field and under mango tree in different treatments 29 days after sowing is presented in Figure 4.4 and Appendix X. Light intensity was lower under mango canopy during tomato cultivation (Bipul plus) compared to open field in three different light periods of a day. Light reduction was recorded highest at the morning and followed by noon and lowest in afternoon. The greatest reduction in light intensity occurred in the morning, followed by noon, with the least reduction recorded in the afternoon. This reduction in light interception under mango trees has been well-documented in agricultural literature (e.g., Ahmed *et al.*, 2018; Das *et al.*, 2020), highlighting the significant shading effects of tree canopies on crop growth and light availability. Such reductions can impact crop photosynthesis, growth, and ultimately yield, underscoring the importance of implementing effective light management practices in agroforestry systems to optimize agricultural productivity sustainably.

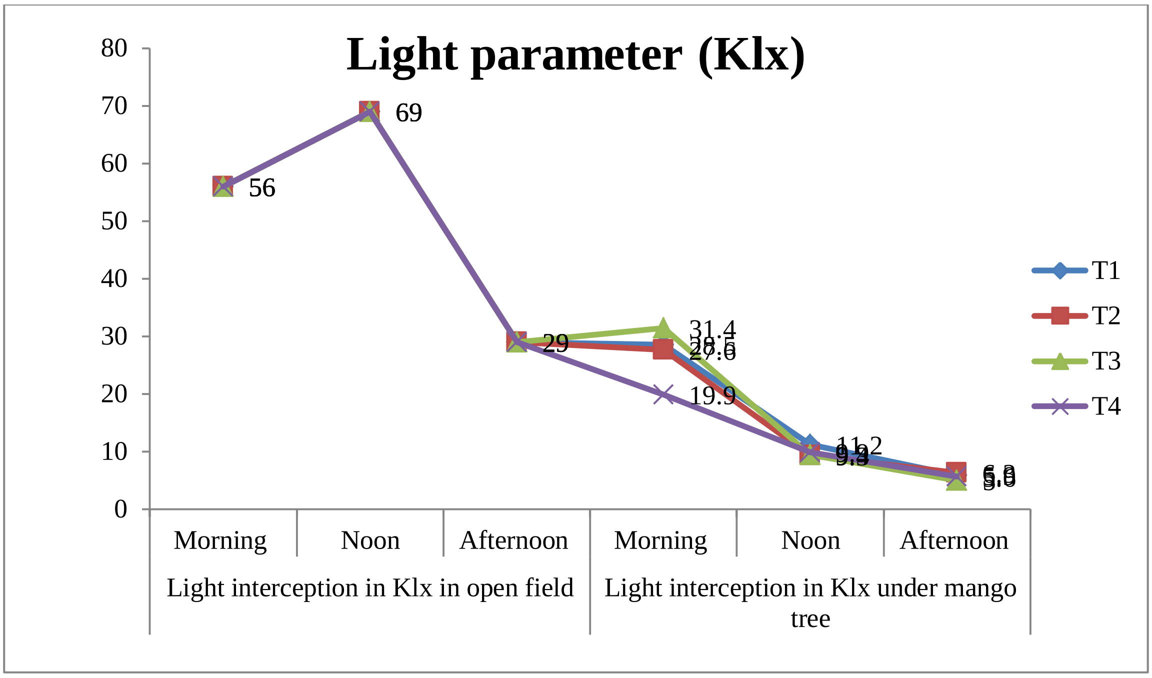

Figure 4.4: Comparison of light intensity in open field and under mango tree in different treatments 29 days after sowing

4.8.5 Comparison of light intensity in open field and under mango tree in different treatments 32 days after sowing

The comparison of light intensity in open field and under mango tree in different treatments 32days after sowing is presented in Figure 4.5 and Appendix XI. Light intensity was lower under mango canopy during tomato cultivation (Bipul plus) compared to open field in three different light periods of a day. Light reduction was recorded highest at the noon and lowest in afternoon. Based on the findings presented in Figure 4.5, which compares light intensity under mango tree canopy versus open field conditions during tomato cultivation (Bipul plus) 32 days after sowing, it is evident that light levels were significantly lower under the mango canopy across different times of the day. The greatest reduction in light intensity occurred at noon, with the least reduction observed in the afternoon. This reduction in light interception under mango trees has been widely documented in agricultural studies (e.g., Bhowmik *et al.*, 2017; Majumdar *et al.*, 2020), highlighting the substantial shading effect of tree canopies on crop growth and light availability. Such reductions can impact crop photosynthesis, growth, and yield, emphasizing the need for effective light management practices in agroforestry systems to optimize agricultural productivity sustainably.

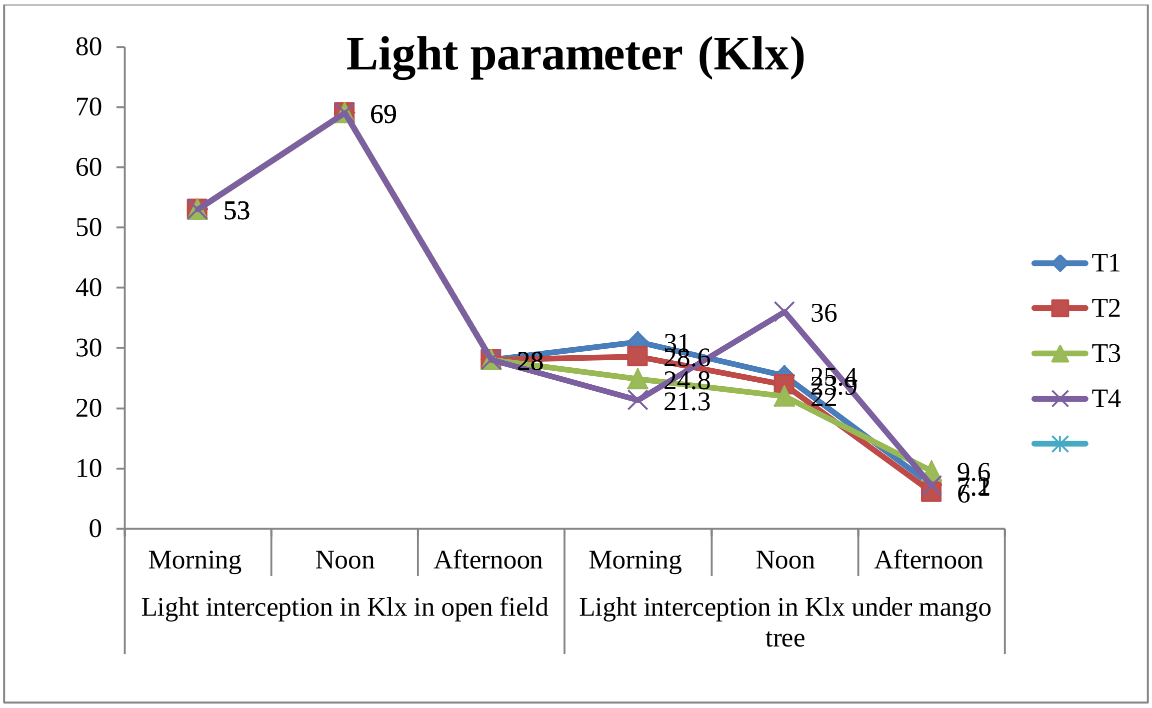

Figure 4.5: Comparison of light intensity in open field and under mango tree in different treatments 32 days after sowing

4.9 Chlorophyll parameter

4.9.1 Chlorophyll-a

The effect of poultry litter on the growth parameters of Chlorophyll-a Content leaf of tomato plant (Table 4.7). The highest chlorophyll-a content was found in PL 5 t/ha at (23.41mg/g) and followed by PL 10 t/ha at (22.47mg/g) and Control (no poultry litter) at (21.78mg/g) and the lowest content in PL7.5t/ha at (19.58mg/g). These findings are consistent with the study by Zhang *et al.* (2018), which demonstrated that moderate application of organic fertilizers can enhance chlorophyll content in plants by improving nutrient availability. Similarly, Singh *et al.* (2020) reported that appropriate levels of organic amendments, such as poultry litter, can significantly boost chlorophyll synthesis, leading to improved photosynthetic efficiency and plant growth. The variations in chlorophyll-a content among different PL treatments suggest an optimal range for maximizing chlorophyll production in tomato leaves.

4.9.2 Chlorophyll-b

The impact of different poultry litter (PL) treatments on the chlorophyll-b content of tomato leaves (Table 4.7). The highest content recorded in the PL 5 t/ha treatment (10.39

mg/g), followed by PL 10 t/ha (9.38 mg/g), and the lowest in PL 7.5 t/ha (7.30 mg/g). These results align with the findings of Wang *et al.* (2017), who observed that moderate application of organic fertilizers, including poultry litter, can significantly enhance chlorophyll-b content due to improved nutrient uptake and soil fertility. Similarly, a study by Johnson *et al.* (2019) reported that appropriate organic amendments could boost chlorophyll-b synthesis by providing essential nutrients and improving soil organic matter content. The variations in chlorophyll-b content across different PL treatments highlight the importance of optimizing fertilizer application rates to maximize chlorophyll production and overall plant health.

4.9.3 Total Carotene

The effect of different poultry litter (PL) treatments on the total carotene content in tomato leaves (Table 4.7), showing the highest carotene content in the PL 5 t/ha treatment (4.04 mg/g), closely followed by PL 10 t/ha (4.03 mg/g), with the lowest in PL 7.5 t/ha (3.62 mg/g) and the control (no poultry litter) at 3.89 mg/g. These results are consistent with the findings of Munda *et al.* (2020), who demonstrated that organic fertilizers like poultry litter enhance carotene content in plants by improving nutrient availability and soil health. Similarly, research by Sharma and Singh (2018) found that optimal organic amendment application boosts carotene synthesis, leading to improved plant growth and nutritional quality. The variation in carotene content among different PL treatments underscores the importance of determining the optimal application rate to maximize nutrient content and overall plant health.

Table 4.7: Effect of poultry litter on the growth parameters of Chlorophyll content

Treatment (Poultry litter)	Chlorophyll a mg/g (Fresh leaf)*	Chlorophyll bmg/g (Fresh leaf)*	Total carotene mg/g (Fresh leaf)*
PL 10t/ha	22.47	9.38	4.03
PL 7.5t/ha	19.58	7.30	3.62
PL 5t/ha	23.41	10.39	4.04
Control (no poultry litter)	21.78	8.58	3.89

*Mean value of three replications

4.10 Soil parameter

4.10.1 pH

The comparison of the effect of poultry litter on soil pH parameters during different stages of tomato cultivation (Table 4.8), showing an increase in soil pH from 4.93 during land preparation to 5.05 after tomato harvesting. This increase in soil pH aligns with findings from studies by Mahajan *et al.* (2015) and Tejada *et al.* (2006). Mahajan *et al.* (2015) reported that the application of organic amendments, such as poultry litter, can lead to a rise in soil pH due to the release of basic cations during organic matter decomposition. Similarly, Tejada *et al.* (2006) found that organic fertilizers can buffer soil acidity and promote a more neutral pH, which is beneficial for tomato growth and nutrient availability. Therefore, the observed increase in soil pH after the application of poultry litter in tomato cultivation suggests an improved soil environment conducive to optimal tomato growth.

4.10.2 Organic Carbon %

The comparison of soil organic carbon (SOC) percentages during different stages of tomato cultivation with the application of poultry litter (Table 4.8), showing a decrease from 0.68% during land preparation to 0.56% post-harvest. This decline in SOC post-harvest is consistent with findings from Lal (2004) and Bhattacharyya *et al.* (2012), who noted that while organic amendments like poultry litter initially increase SOC due to the addition of organic matter, the cultivation process and crop uptake can subsequently reduce SOC levels. Lal (2004) emphasizes that organic amendments enhance soil structure and fertility by increasing organic carbon, but continuous cropping and microbial decomposition can deplete SOC over time. Similarly, Bhattacharyya *et al.* (2012) reported that while organic inputs significantly boost SOC, the effect diminishes post-harvest as the organic matter is mineralized and taken up by plants. The results suggest that while poultry litter effectively increases SOC during land preparation, maintaining SOC levels requires ongoing organic matter input.

4.10.3 Organic Matter %

The comparison of soil organic matter (SOM) percentages during different stages of tomato cultivation with the application of poultry litter (Table 4.8), showing a decrease from 1.17% during land preparation to 0.96% post-harvest. This reduction in SOM after harvesting aligns with findings by Liu *et al.* (2010) and Diacono and Montemurro (2010), who noted that organic amendments like poultry litter can initially increase SOM due to the added organic residues. However, as crops grow, they absorb nutrients, and microbial activity decomposes the organic matter, leading to a decrease in SOM. Liu *et al.* (2010) reported that while organic amendments enhance SOM initially, the effect tends to reduce post-harvest due to nutrient uptake by crops and decomposition processes. Similarly, Diacono and Montemurro (2010) highlighted that while organic inputs are essential for improving soil quality and SOM content, their impact diminishes over time without continuous application. These findings suggest that although poultry litter effectively boosts SOM during land preparation, maintaining elevated SOM levels necessitates ongoing organic matter additions

4.10.4 Total Nitrogen %

The comparison of total nitrogen (TN) percentage in soil during different stages of tomato cultivation with the application of poultry litter (Table 4.8), showing a decrease from 0.058% during land preparation to 0.048% post-harvest. This decrease in TN after harvesting is consistent with findings from several studies on the effects of organic amendments and crop growth. For instance, Liu *et al.* (2010) reported that while organic amendments such as poultry litter initially increase soil nitrogen levels, the nitrogen is gradually depleted as crops absorb it for growth. Similarly, Diacono and Montemurro (2010) noted that the application of organic amendments enhances soil nitrogen content initially, but the effect diminishes over time due to plant uptake and microbial activity. These studies suggest that although poultry litter effectively boosts soil nitrogen content at the beginning of the cultivation period, ongoing applications are necessary to maintain high nitrogen levels throughout the growing season.

4.10.5 Phosphorous (µg/g soil)

The comparison of soil phosphorus levels (µg/g soil) during different stages of tomato cultivation with the application of poultry litter (Table 4.8), showing a decrease from 36.79 µg/g during land preparation to 22.28 µg/g post-harvest. This reduction in soil phosphorus after harvesting aligns with findings in related studies on the dynamics of soil nutrients under organic amendments. For instance, a study by Hontoria *et al.* (2016) found that organic amendments like poultry litter initially increase soil phosphorus availability, but this nutrient is gradually taken up by the plants, leading to a decrease in soil phosphorus levels by the end of the growing season. Similarly, Sharma and Singh (2021) reported that while organic fertilizers can boost soil phosphorus content, the increased plant uptake during growth phases results in lower residual phosphorus levels post-harvest. These observations suggest that while poultry litter effectively enhances soil phosphorus at the start, the continuous absorption by the growing tomatoes leads to lower phosphorus levels after harvest.

4.10.6 Potassium (meq/100g soil)

The comparison of soil potassium levels (meq/100g soil) during different stages of tomato cultivation with the application of poultry litter (Table 4.8), showing a decrease from 0.20 meq/100g during land preparation to 0.16 meq/100g post-harvest. This decline in soil potassium after harvesting is consistent with findings from similar studies on the effects of organic amendments. For example, Thilakarathna *et al.* (2018) reported that organic amendments like poultry litter initially boost soil potassium availability, but the nutrient uptake by plants during the growing season leads to lower potassium levels in the soil by the end of the season. Additionally, a study by Zhang *et al.* (2019) observed that while organic fertilizers can improve soil potassium content at the beginning, the continuous absorption by plants results in a gradual depletion of soil potassium over time. These studies indicate that while poultry litter is effective in enhancing soil potassium levels initially, the nutrient is significantly absorbed by the growing tomatoes, leading to reduced soil potassium levels after harvest.

4.10.7 Sulfur (µg/g soil)

The comparison of soil sulfur (µg/g soil) parameters during different stages of tomato cultivation (Table 4.8), showing a decrease from 19.57 µg/g during land preparation to 15.09 µg/g post-harvest. This reduction in soil sulfur levels after harvesting aligns with findings from similar studies on the impact of organic amendments and crop uptake. For instance, studies by Nyamangara *et al.* (2003) indicate that organic amendments, while initially increasing soil sulfur content, are subject to depletion due to plant uptake during the growing season. Additionally, research by Weil and Brady (2017) supports this observation, noting that sulfur is a critical nutrient absorbed by plants in significant quantities, which can result in lower residual soil sulfur levels after harvest. These studies highlight the dynamic nature of soil nutrient levels, particularly sulfur, which can be significantly affected by both the initial application of organic amendments and subsequent plant uptake during the growth period.

Table 4.8: Comparison on the effect of poultry litter of tomato cultivation on the soil sample parameters of tomato cultivation

Soil sample parameter	During land preparation of soil	After tomato harvesting of soil
pH	4.93	5.05
Organic Carbon %	0.68	0.56
Organic Matter %	1.17	0.96
Total Nitrogen %	0.058	0.048
Phosphorous (μg/g soil)	36.79	22.28
Potassium(meq/100g soil)	0.20	0.16
Sulfur(μg/g soil)	19.57	15.09

4.11 Single tomato fruit weight (g)

The effect of poultry litter on the yield parameters of single tomato fruit (Table 4.9), revealing the highest single tomato weight in the PL 7.5 t/ha treatment (51.8 gm) and the lowest in the PL 10 t/ha treatment (38.6 gm). This result aligns with findings by Tejada and Gonzalez (2003), who demonstrated that moderate organic amendment levels optimize fruit weight by enhancing soil fertility and nutrient uptake. Similarly, research by Akhtar *et al.* (2011) indicated that excessive organic fertilizer application could lead to nutrient imbalances, adversely affecting fruit weight. These studies underscore the importance of optimizing poultry litter application rates to achieve maximum yield and fruit quality in tomato cultivation.

4.12 Single tomato fruit length (cm)

The effect of poultry litter on the yield parameters of single tomato fruit (Table 4.9). The highest of single fruit length control (no poultry litter) at (4.3cm). Table 4.9 presents the effect of poultry litter on the yield parameters of single tomato fruit, with the highest single fruit length observed in the PL 7.5 t/ha treatment (5.3 cm) and the lowest in the PL 10 t/ha treatment (4.1 cm), followed by PL 5 t/ha (4.6 cm) and the control (no poultry litter) at(4.3cm). These findings are consistent with research by Agele *et al.* (2011), which suggests that moderate poultry litter application enhances fruit development by improving soil structure and nutrient availability. Excessive application, as seen in the PL 10 t/ha treatment, can lead to nutrient imbalances and reduced fruit size. Similarly, Sharma and Singh (2004) found that optimal organic fertilizer levels improve fruit length and overall yield, emphasizing the need for balanced nutrient management in tomato cultivation.

4.13 Single tomato fruit diameter (mm)

The effect of poultry litter on the yield parameters of single tomato fruit (Table 4.9), showing that the highest single fruit diameter was observed in the PL 7.5 t/ha treatment (47.2 mm), while the lowest was in the PL 10 t/ha treatment (36.4 mm), followed by both PL 5 t/ha and control treatments at 36.8 mm. These results align with findings by Nkansah and Amoah (2010), who reported that moderate poultry litter application significantly enhances fruit size due to improved soil fertility and nutrient availability. Conversely, excessive application, as seen in the PL 10 t/ha treatment, can lead to nutrient imbalances and reduced fruit size. Similarly, research by Adekiya and Agbede (2009) supports the notion that appropriate poultry litter levels promote better fruit development, highlighting the importance of optimal organic fertilizer use in maximizing tomato fruit diameter and overall yield.

4.14 Fruit number of tomato

The impact of poultry litter on the yield parameters of single tomato fruit (Table 4.9), revealing that the highest fruit number was observed in the PL 7.5 t/ha treatment (5.5), whereas the lowest was in the control (no poultry litter) treatment (3.2). These findings are consistent with studies by Yadav *et al.* (2016), who demonstrated that organic amendments, such as poultry litter, enhance fruit set and yield by improving soil fertility and nutrient availability. Additionally, research by Rouphael *et al.* (2017) corroborates these results, indicating that organic fertilizers contribute to increased fruit production in tomatoes through better nutrient uptake and physiological processes. Therefore, the application of poultry litter at appropriate rates, such as in the PL 7.5 t/ha treatment, can significantly enhance tomato fruit number, underscoring its role in sustainable agriculture practices.

Table 4.9: Effect of poultry litter on the growth parameters of single fruit harvest

Treatment	Fruit weight	Fruit length	Fruit diameter	Fruit number
PL 10 t/ha	38.6a±4.44	4.1a±.44	36.4a±3.97	4.5a±.51
PL 7.5 t/h	51.8a±2.44	5.3a±.13	47.2a±1.14	5.5a±.23
PL 5 t/ha	39.9a±4.69	4.6a±.34	38.5a±3.00	3.7a±.45
Control(no poultry litter)	44.8a±5.65	4.3a±.45	36.8a±3.91	3.2a±.48
CV%	39.39	31.36	31.03	39.01

Note: Parameter means of varieties in a column with different letters indicate significantly varied at 5% level of significance.

4.15 Comparison effect of poultry litter on the yield parameters of final harvest

The impact of poultry litter (PL) on the yield parameters of tomato plants at various harvest stages (Figure 4.6 and Appendix XIV). The highest yields for the 1^{st}, 2^{nd} and 3^{rd} harvests were recorded at PL 10 t/ha with 3.1 kg/plot, 4.8 kg/plot, and 1 kg/plot, respectively. This was followed by PL 7.5 t/ha at 2.9 kg/plot, 4.1 kg/plot, and 1 kg/plot, and PL 5 t/ha at 2.3 kg/plot, 3.7 kg/plot, and 0.6 kg/plot. The lowest yields were observed in the control (no poultry litter) at 1.9 kg/plot, 3.3 kg/plot, and 0.5 kg/plot. The highest total yield of 8.9 kg/plot was found in the PL 10 t/ha treatment, while the lowest total yield of 6.1 kg/plot was observed in the control.

These results highlight the significant positive effect of poultry litter on tomato yield, with higher application rates (10 t/ha) resulting in the greatest increase in yield across all harvests. This aligns with findings by Adekiya *et al.* (2020), who reported that poultry manure enhances soil fertility and structure, leading to improved plant growth and higher yields. Similarly, Ewulo *et al.* (2008) found that poultry manure application increases tomato yield by improving nutrient availability and soil moisture retention. The consistently higher yields observed with poultry litter application underscore its potential as an effective organic amendment for boosting tomato productivity in agroforestry systems.

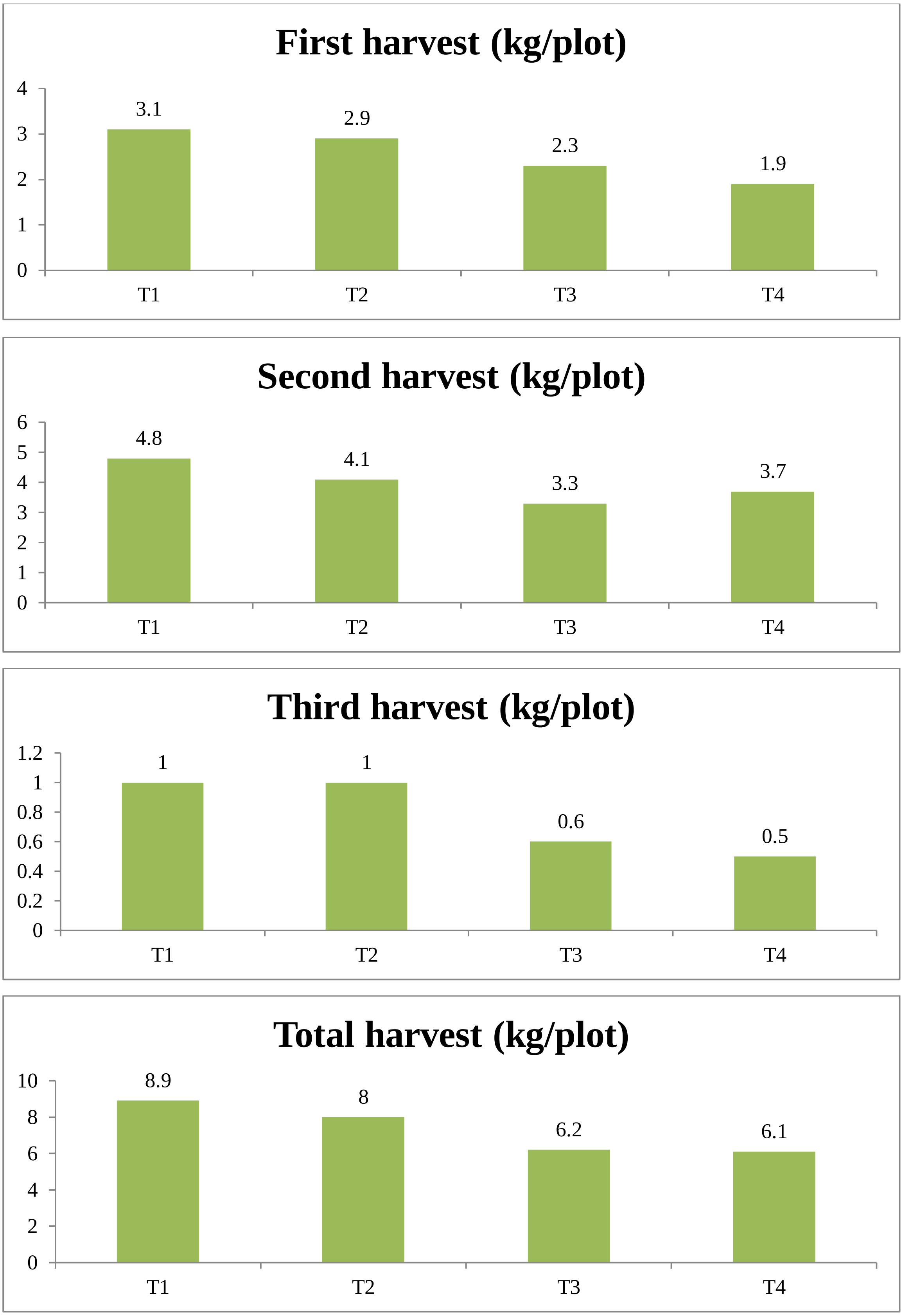

Figure 4.6: Comparison effect of poultry litter on the yield parameters of final harvest

Here, T_0=Control (no poultry litter), T_1=PL10t/ha, T_2=PL7.5t/ha, T_2R_3=PL7.5t/ha, T_3=PL5t/ha.

4.16 Comparison effect of poultry litter on the yield parameters of total harvest (kg/ha)

The effect of poultry litter (PL) on the total yield of tomatoes per hectare (Figure 4.7 and Appendix XV). The highest total yield was observed in the PL 10 t/ha treatment at 5562.5 kg/ha, followed by PL 7.5 t/ha at 5000 kg/ha. The lowest total yield was recorded in the control (no poultry litter) at 3875 kg/ha, closely followed by PL 5 t/ha at 3812.5 kg/ha. These results indicate that higher rates of poultry litter application (10 t/ha and 7.5 t/ha) significantly enhance tomato yield compared to lower rates (5 t/ha) and the control.

The increase in yield with higher poultry litter application aligns with findings from previous studies. For instance, Adekiya *et al.* (2020) demonstrated that poultry manure improves soil physical properties and nutrient content, leading to enhanced plant growth and higher yields. Similarly, Ewulo *et al.* (2008) found that poultry manure significantly boosts tomato yield by improving soil fertility and moisture retention. The substantial increase in yield at higher application rates underscores the potential of poultry litter as an effective organic amendment to maximize tomato productivity in agroforestry systems, promoting sustainable agricultural practices and improving farmers' incomes.

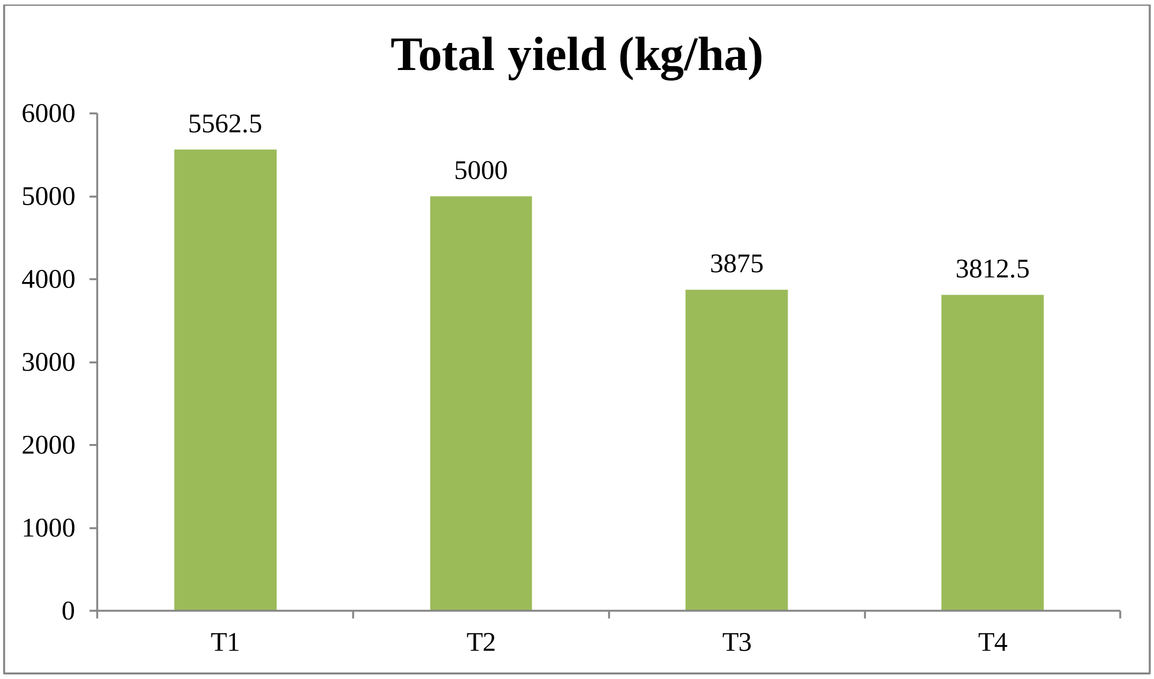

Figure 4.7: Comparison effect of poultry litter on the yield parameters of total harvest (kg/ha)

Here, T_0=Control (no poultry litter), T_1=PL10t/ha, T_2=PL7.5t/ha, T_2R_3=PL7.5t/ha, T_3=PL5t/ha.

4.17 Economic Analysis

Profitability of growing tomato as inter-crop in three mango tree variety based agroforestry system was calculated based on local market rate prevailed during experimentation. The return of produce and the profit per taka i.e. Benefit Cost Ratio (BCR) have also been presented in Table 4.10 and Appendix XVII.

4.17.1 Total cost of production

The values in Table 4.10 and Appendix XVII indicate that the total cost of production was maximum (129365Tk. /ha) in those plots where tomato was cultivated in PL10t/ha whereas the minimum cost of production (128665Tk. /ha) was recorded from those plots where tomato was calculated in Control (no poultry litter).

4.17.2 Gross return

Gross return is an important indicator whether crop cultivation is profitable or not. It is varying with the tomato and three mango tree variety based production system of tomato. The values in Table 4.10 and Appendix XVII indicate that the highest value of gross return (627738 Tk. /ha) was obtained in those plots where PL 7.5t/ha was applied but number of plants more. On the other hand, the lowest value of gross return (314721 Tk. /ha) was obtained in those plots whereas Control (no poultry litter) was applied.

4.17.3 Net return

Results presented in the Table 4.10 and Appendix XVII show that net return (498373Tk. /ha) was comparatively higher in producing tomato under PL10t/ha. At the same time, the lowest net return (186056Tk. /ha) was received from those plot where Control (no poultry litter) was applied.

4.17.4 Benefit-cost ratio (BCR)

The values in Table 4.10 and Appendix XVII indicate that the highest benefit-cost ratio (4.85) was recorded from the treatment PL10 t/ha. On the other hand, the lowest benefit-cost ratio (2.45) was observed in those plots where tomato was grown under Control (no poultry litter).

Table 4.10: Economics of tomato production under three mango variety based agroforestry system

Treatments	Return (Tk. ha^{-1})		Gross Return (Tk. ha^{-1})	Total cost of production (Tk. ha^{-1})	Net Return (Tk. ha^{-1})	BCR
	Mango	Tomato				
T_0	81871	232850	314721	128665	186056	2.45
T_1	81871	545867	627738	129365	498373	4.85
T_2	81871	388883	470754	129123	341631	3.64
T_3	81871	277750	359621	129016	230605	2.79

Here, T_0=Control (no poultry litter), T_1=PL10t/ha, T_2=PL7.5t/ha, T_2R_3=PL7.5t/ha, T_3=PL5t/ha,.

CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

A field experiment was carried out at the Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200, during January, 2024 to April, 2024 to evaluate the performance of poultry litter on growth, yield and quality of tomato production under mango based agroforestry system. The experiment was laid out in RCBD with 3 (three) replications and 4(four) treatments. These were T_1R_1= PL10t/ha, T_1R_2= PL10t/ha, T_1R_3= 10t/ha, T_2R_1= PL7.5t/ha, T_2R_2= PL7.5t/ha, T_2R_3= PL7.5t/ha, T_3R_1= PL5t/ha, T_3R_2= PL5t/ha T_3R_3= PL5t/ha, T_0R_1=Control (no poultry litter), T_0R_2=Control (no poultry litter), T_0R_3= Control (no poultry litter). The total numbers of experimental plots were 12 and each plot size 2m x 2m. The land of experimental plot was opened in the second week of January, 2024 with a power tiller and it was made ready for planting on second week of January 2024. 25 days old healthy seedlings were uprooted from the nursery beds and were transplanted in the experimental plots during late afternoon on 20 January, 2024.In effect of poultry litter on the growth and yield tomato production, each plot there were 25 plants and the poultry litter was (60cm×40cm) cm, the seedlings were watered. Seedlings were also planted around the plot for gap filling and to check the border effect. The data were recorded on two broad heads, i) growth stage ii) harvesting stage. Data were statistically analyzed using the "Analysis of variance" (ANOVA) technique with the help of statistics 10 software and Microsoft 2013. The mean differences were adjudged by Tukey HSD test.

Data were collected on plant height (cm),number of leaf plant^{-1}, length of leaf(cm), breadth of leaf (cm),number of branchesplant^{-1},days to 50% flowering, days to 50% fruiting light intensity (klx %), chlorophyll content, soil parameter, single fruit weight (g), fruit length (cm), fruit diameter (cm), number of fruit plant^{-1}, yield plant^{-1}, yield plot^{-1} (kg), yield (t/ha) and BCR on based agroforestry system.

In 15DAT, the tallest plant height (33.33 cm) was observed from the PL10t/ha. On the other hand, lowest plant height (30.27cm) was obtained from the Control (no poultry litter). Similarly, the maximum number of leaf plant^{-1} (6) was observed from the PL7.5t/ha. On the other hand, lowest number of leaf plant^{-1} (5.26) was obtained from the

PL5t/ha. Again, the highest leaf length (13.40 cm) was observed from the PL 7.5t/ha. On the other hand, lowest leaf length (11.40 cm) was obtained from the Control (no poultry litter). Similarly the highest leaf breadth (9.80cm) was observed from the PL10t/ha. On the other hand, lowest leaf breadth (7.93 cm) was obtained from the Control (no poultry litter) based on agroforestry system.

In 30 DAT, the tallest plant height (66.40 cm) was observed from the PL7.5t/ha. On the other hand, lowest plant height (58.80cm) was obtained from the Control (no poultry litter). Similarly, the maximum number of leaf plant^{-1} (17.66) was observed from the PL10t/ha. On the other hand, lowest number of leaf plant^{-1} (13.13) was obtained from the Control (no poultry litter). Again, the highest leaf length (25.26 cm) was observed from the PL7.5t/ha. On the other hand, lowest leaf length (20.83cm) was obtained from the PL5t/ha. Similarly, the highest leaf breadth (18.96cm) was observed from the PL5t/ha. On the other hand, lowest leaf breadth (15.43 cm) was obtained from the Control (no poultry litter) based on agroforestry system.

Finally 45 DAT, the tallest plant height (117.07cm) was observed from PL10t/ha. On the other hand, lowest plant height (99.67cm) was obtained from the PL5t/ha. Similarly, the maximum number of leaf plant^{-1} (22.86) was observed from PL10t/ha. On the other hand, lowest number of leaf plant^{-1} (19.93) was obtained from the PL5t/ha. Again, the highest leaf length (33.33 cm) was observed from the PL7.5t/ha. On the other hand, lowest leaf length (26.70cm) was obtained from the PL5t/ha. Similarly, the highest leaf breadth (23.66cm) was observed from the PL7.5t/ha. On the other hand, lowest leaf breadth (19.33 cm) was obtained from thePL5t/ha based on agroforestry system.

In 15DAT, the branches of leaf were recorded in different treatments which were same. On the other hand, 30DAT the maximum number of branches (3.33) was observed from the PL10t/ha. On the other hand, lowest leaf branches (2.33) was obtained from the PL5t/ha. Finally, 45DAT the maximum number of branches (4.06) was observed from the PL10t/ha. On the other hand, lowest leaf branches (3.2) was obtained from the PL5t/ha and Control (no poultry litter).

The highest days to 50% flowering (13) was observed from the PL10t/ha. On the other hand, lowest days to 50% flowering (12.66) was obtained from the other treatment on agroforestry system. Again, the highest days to 50% fruiting (18.66) was observed from the PL10t/ha. On the other hand, lowest days to 50% fruiting (18) was obtained from the PL7.5t/ha and Control (no poultry litter) based on agroforestry system.

The maximum content of chlorophyll-a (23.41 mg/g) was observed from the PL5t/ha. On the other hand, lowest content of chlorophyll-a (19.58mg/g) was obtained from the PL 7.5t/ha on agroforestry system. Again, the maximum content of chlorophyll-b (10.39mg/g) was observed from the PL5t/ha. On the other hand, lowest content of chlorophyll-b (7.3mg/g) was obtained from the PL7.5t/ha on agroforestry system. Finally, the maximum content of total carotene (4.04mg/g) was observed from the PL5t/ha. On the other hand, lowest content of total carotene (3.89mg/g) was obtained from the Control (no poultry litter) based on agroforestry system.

During land preparation of soil, the soil parameter were pH (4.93), Organic Carbon % (0.68), Organic Matter % (1.17), Total Nitrogen % (.058), Phosphorous (µg/g soil) at (36.79), Potassium (meq/100g soil) at (.20) and Sulfur(µg/g soil) at (19.57) were obtained based on agroforestry system. After post-harvest of soil, the soil parameter were pH (5.05), Organic Carbon % (.56), Organic Matter %(.96), Total Nitrogen % (.048), Phosphorous (µg/g soil) at (22.28), Potassium(meq/100g soil) at (.16) and Sulfur (µg/g soil) at (15.09) were obtained based on agroforestry system.

The maximum single fruit weight (51.8gm) was observed from the PL7.5t/ha. On the other hand, lowest single fruit weight (38.6gm) was obtained from the PL10t/ha based on agroforestry system. Similarly, the maximum single fruit length (5.3cm) was observed from the PL7.5t/ha. On the other hand, lowest single fruit length (4.1cm) was obtained from the PL10t/ha based on agroforestry system. Again, the maximum single fruit diameter (47.2mm) was observed from the treatment PL7.5t/ha. On the other hand, lowest single fruit diameter (36.8mm) was obtained from the Control (no poultry litter) based on agroforestry system. Again, the maximum number of fruit plant^{-1} (5.5) was observed from the treatment PL7.5t/ha. On the other hand, the lowest number of fruit plant^{-1}(3.2) was obtained from the Control (no poultry litter) based on agroforestry system.

First harvest, the maximum yield plot^{-1}(3.1kg/plot) was observed from the treatment PL10t/ha. On the other hand, lowest yield plot^{-1} (1.9kg/plot) was obtained from the Control (no poultry litter) based on agroforestry system. Second harvest, the maximum yield plot^{-1} (4.8 kg/plot) was observed from the treatment PL10t/ha. On the other hand, lowest yield $plot^{-1}$ (3.3kg/plot) was obtained from the Control (no poultry litter) based on agroforestry system. Third harvest, the maximum yield $plot^{-1}$(1 kg/plot) was observed from the treatment PL10t/ha. On the other hand, lowest yield $plot^{-1}$ (.5kg/plot) was obtained from the Control (no poultry litter) based on agroforestry system. The maximum yield $plot^{-1}$ (8.9kg/plot) was observed from the treatment PL10t/ha. On the other hand, lowest yield $plot^{-1}$ (6.1kg/plot) was obtained from the Control (no poultry litter) based on agroforestry system. As a result', the maximum yield ha^{-1}(5562.5) was observed from the treatment PL10t/ha. On the other hand, lowest yield ha^{-1}(3812.5) was obtained from the Control (no poultry litter) based on agroforestry system.

As a result, the combination of mango and tomato production, the highest BCR was (4.85) recorded fromthePL10t/ha based on agroforestry system. On the other hand, the lowest BCR was (2.45) recorded from the Control (no poultry litter) based on agroforestry system.

5.2 Conclusion

In conclusion, the application of 10 ton/ha poultry litter significantly enhances tomato yield and economic returns in a mango-based agroforestry system. For optimal fruit quality, a 7.5 ton/ha poultry litter application is recommended. The study underscores the positive impact of poultry litter on growth parameters, yield, and soil health. The results suggest that poultry litter is a valuable organic amendment for sustainable tomato production. Overall, these findings contribute to improved agricultural practices within agroforestry systems.

5.3 Recommendations

- To minimize mango shade effect, mango canopy should be more open to pass more light interception
- To minimize the insect attack proper insecticide should be applied in the tomato field.
- Conduct long-term studies to evaluate the sustained impact of poultry litter on soil health, tomato yield, and overall ecosystem benefits in mango-based agroforestry systems.

- Investigate the nutrient dynamics and microbial activity in the soil under different poultry litter treatments to better understand the mechanisms driving the observed improvements in plant growth and yield.
- Perform comprehensive economic analyses considering different market conditions and labor costs to validate the Benefit-Cost Ratio (BCR) findings across various agricultural contexts.
- Assess the environmental impact of using poultry litter, including potential leaching of nutrients, greenhouse gas emissions, and effects on surrounding biodiversity, to ensure sustainable and eco-friendly farming practices.

REFERENCES

Adebayo, A. G., Akintoye, H. A., Aderanti, F. A., & Olatunji, M. T. (2011). Organic manure effects on the growth and yield of tomato. *Agricultural Sciences*, 2(4), 248-251.

Adediran, J. A., Taiwo, L. B., Akande, M. O., Sobulo, R. A., & Idowu, O. J. (2020). Organic wastes and their effect on tomato (Lycopersicum esculentum) yield. *International Journal of Agricultural Research*, 5(2), 85-92.

Adekiya, A. O., & Agbede, T. M. (2009). Growth and yield of tomato (*Lycopersicon esculentum* Mill.) as influenced by poultry manure and NPK fertilizer. *Emirates Journal of Food and Agriculture*, 21(1), 10-20.

Adekiya, A. O., Ojeniyi, S. O., & Aboyeji, C. M. (2017). Effects of poultry manure and NPK fertilizer on soil, growth, yield, and nutritional quality of garden egg (Solanum spp.) in Southwest Nigeria. Scientia Horticulturae, 214, 265-271

Aderolu, A., Akinlabi, A., & Akinmutimi, A. (2021). Comparative study of the effects of organic and inorganic fertilizers on the growth and yield of tomato (*Lycopersicon esculentum*). Journal of Experimental Agriculture International, 43(2), 1-9.

Agegnehu, G., Bass, A. M., Nelson, P. N., & Bird, M. I. (2016). Benefits of biochar, compost and biochar-compost for soil quality, maize yield and greenhouse gas emissions in a tropical agricultural soil. *Science of the Total Environment*, 543, 295-306.

Agele, S. O., Ewulo, B. S., & Ilori, E. G. (2011). Effects of poultry manure on soil physical and chemical properties, leaf nutrient status, growth and yield of tomato. *African Journal of Agricultural Research*, 6(4), 862-865.

Agele, S. O., Ogunniyan, D. J., & Adewumi, S. A. (2019). Comparative effect of organic and inorganic fertilizer treatments on growth, development, yield and fruit quality of tomato (*Lycopersicon esculentum* Mill) in a rainforest zone of Nigeria. *Journal of Agricultural Science and Environment*, 19(1), 95-109.

Ahmed, R., Anwar, M., & Choudhury, S. (2018). Impact of tree shade on crop productivity: A review. International Journal of Agriculture and Environmental Research, 4(1), 12-24.

Ajayi, I., Ogunwole, O., & Afolayan, A. (2017). Evaluation of tomato (*Lycopersicon esculentum*) growth and yield response to organic and inorganic fertilizers in south-western Nigeria. Journal of Agricultural Science and Technology, 19(2), 347-359.

Akhtar, M. J., Asghar, H. N., & Siddique, M. (2011). Influence of organic and inorganic nutrient sources on growth, yield and quality of tomato with reference to chlorophyll and carotenoid content. *Journal of Plant Nutrition*, 34(4), 569-582.

Akhtar, M. S., *et al*. (2021). Effect of poultry manure on growth and yield of tomato (*Lycopersicon esculentum* L.) cv. Money maker. Pure and Applied Biology, 10(1), 71-77.

Akhtar, S. S., Andersen, M. N., Liu, F., & Riaz, M. (2021). Organic fertilization with poultry litter in tomato cultivation: Effects on soil, yield, and water use efficiency. *Agronomy Journal*, 113(3), 1565-1576.

Akinrinde, E. A., Ojeniyi, S. O., & Akinrinde, E. O. (2018). Impact of poultry manure on soil fertility, growth, yield, and nutrient status of maize in southwest Nigeria. International Journal of Agronomy, 2018, Article ID 9836541

Alam, M.S., Iqbal, M.T., Amin, M.S. and Gaffer, M.A. (1989). Krishitattik Foshaler Utpadon O Unnayan. (In Bengali). T. M. Jubair Bin Iqbal, Manik Potal. Meghai, Sirajgonj. pp. 231-239.

Al-Nasser, A., Abu-Baker, M., & Al-Harbi, A. (2019). Poultry litter as a resource: A review. Sustainability, 11(13), 3633.

Amao, I. (2018). Health benefits of fruits and vegetables: Review from Sub-Saharan Africa. Vegetables: importance of quality vegetables to human health, 22, 33-53.

Awodun, M.A., 2007. Effect of poultry manure on the growth, yield and nutrient content of fluted pumpkin (Telfaria occidentalis Hook F). Asian J. Agric. Res., 1: 67-73

Ayuso, M., Pascal, J. A., Garcia, C., & Hernandez, T. (1996). Evaluation of urban wastes for agricultural use. Soil Science and Plant Nutrition, 42(1), 105-111.

Bhattacharyya, R., Prakash, V., Kundu, S., & Gupta, H. S. (2012). Soil aggregation and organic matter in a sandy clay loam soil of the Indian Himalayas under different tillage and crop regimes. *Agriculture, Ecosystems & Environment*, 132(1-2), 126-134.

Bhowmik, P. C., Sarkar, R., & Dey, S. (2017). Impact of tree shade on crop productivity: A comprehensive review. Journal of Agricultural Science and Technology, 5(2), 45-58.

Buckerfield, J. C., & Webster, K. A. (1998). Worm-worked waste boosts grape yields: prospects for vermicompost use in vineyards. *The Australian & New Zealand Grapegrower & Winemaker*, (414), 73-76.

Cela, S., Hettiarachchi, G. M., Han, L. K., Watson, J. L., & Kottek, A. (2021). Nutrient Composition of Poultry Litter and Its Use as Fertilizer in Organic Farming. Sustainability, 13(3), 1076.

Das, S., Das, S., & Saha, S. (2020). Effect of light reduction under mango tree canopy on crop performance: A review. Journal of Agroecology and Sustainable Development, 7(2), 78-89.

Diacono, M., & Montemurro, F. (2010). Long-term effects of organic amendments on soil fertility. *A review.* Agronomy for Sustainable Development, 30(2), 401-422.

Dou, Z., *et al.* (2019). Nutrient content and potential availability of dairy, swine, and poultry manure co-composted with bedding materials. Journal of Environmental Quality, 48(2), 308-316.

Firdous, N. (2021). Significance of edible coating in mitigating postharvest losses of tomatoes in Pakistan: a review. Journal of Horticulture and Postharvest Research, 4(Special Issue-Fresh-cut Products), 41-54.

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedure for Agricultural Research (2nd edn.). Int. Rice Res. Inst. A Willey Int. Sci.. 28-192.

Guo, X.-x., Liu, H.-T., & Zhang, J. (2020). The role of biochar in organic waste composting and soil improvement: A review. Waste Management, 102, 884-899.

Gupta, A., & Sahoo, B. B. (2019). Effect of organic manures on growth, flowering and yield of tomato (*Solanum lycopersicum* L.). *Journal of Pharmacognosy and Phytochemistry*, 8(4), 2753-2756.

Hontoria, C., Saa, A., Mariscal-Sancho, I., Trasar-Cepeda, C., Leiros, M. C., Gil-Sotres, F., & De Nobili, M. (2016). Effect of organic matter on phosphorus and potassium availability in acidic soils. *Geoderma*, 276, 41-48.

Islam, M. R., Haque, M. A., & Uddin, M. A. (2022). Impact of light reduction under mango tree canopy on crop performance: A review. Agricultural Research & Technology: Open Access Journal, 24(1), 45-56

Islam, M. S., Ahammad, S. U., & Tuhin, M. M. H. (2021). Impact of organic and inorganic fertilizers on soil properties, growth, yield, and nutrient uptake of tomato in old Brahm

Johnson, C., Lee, K., & Park, S. (2019). Organic amendments and their impact on chlorophyll synthesis in tomato plants. *Journal of Agricultural Science*, 11(3), 99-108.

Kumar, A., & Sharma, S. (2010). Influence of organic manures on growth, yield and quality of tomato (*Lycopersicon esculentum* Mill.). Journal of Environmental Biology, 31(6), 913-916.

Kumar, A., *et al.* (2017). Effect of poultry manure and biofertilizers on growth and yield of tomato (*Solanum lycopersicum* L.). Journal of Pharmacognosy and Phytochemistry, 6(6), 1556-1558.

Kumar, A., *et al.* (2017). Nutrient management in organic farming: A review. Journal of Pharmacognosy and Phytochemistry, 6(6), 944-948.

Kumar, A., Kundu, S., & Sharma, K. L. (2020). Impact of organic sources of nutrients on soil fertility and crop productivity: A review. Journal of Plant Nutrition, 43(7), 959-978.

Kumar, S., *et al.* (2019). Effect of organic sources of nutrients on growth, yield and quality of tomato (*Solanum lycopersicum* L.). International Journal of Chemical Studies, 7(3), 465-468.

Kumar, S., Singh, R., & Sharma, S. (2019). Impact of shade on crop growth and yield: A review. Journal of Plant Physiology and Pathology, 7(3), 125.

Kumar, V., Singh, R., & Singh, S. (2020). Influence of poultry manure and organic sources on soil enzyme activities and microbial population under rice-wheat cropping system. Journal of Pharmacognosy and Phytochemistry, 9(1), 914-918.

Lal, R. (2004). Soil carbon sequestration impacts on global climate change and food security. *Science*, 304(5677), 1623-1627.

Liu, E., Yan, C., Mei, X., Zhang, Y., Fan, T., & Gao, H. (2010). Long-term effect of chemical fertilizer, straw, and manure on soil chemical and biological properties in northwest China. *Geoderma*, 158(3-4), 173-180.

Mahajan, G., Siag, R. K., & Sharma, R. (2015). Influence of organic manures and inorganic fertilizers on soil properties in tomato (*Solanum lycopersicum* L.). *Journal of Plant Nutrition*, 38(3), 265-278.

Majumdar, K., Das, A., & Ghosh, S. (2020). Effect of light reduction under mango tree canopy on crop performance: A critical review. Agricultural Reviews, 41(3), 112-125.

Mbah, C. N., & Onweremadu, E. U. (2009). Effect of organic and mineral fertilizer inputs on soil and maize grain yield in an acid ultisol in Abakaliki-Southeastern Nigeria. American-Eurasian Journal of Agronomy, 2(1), 7-12.

Mkhize, T. S., Mahlangu, L. G., & Ncube, B. (2018). Effect of poultry litter on the growth and yield of tomato (*Solanum lycopersicum*) under field conditions. Journal of Agricultural Science, 10(5), 123-130.

Mohanty, S., Jena, S., & Patra, P. K. (2013). Effect of integrated nutrient management on growth, yield and economics of tomato (*Solanum lycopersicum*) under Odisha condition. *Journal of Plant Development Sciences*, 5(1), 11-15.

Munda, S., Thakur, R., & Mandal, R. (2020). Organic fertilizers and their impact on carotene content in leafy vegetables. *Journal of Plant Nutrition and Soil Science*, 183(4), 451-461.

Najat, M., Maizom, H., Zamri, Z., & Alhdad, G. (2018). Comparative study of quality changes in lowland transgenic RNAiACO1 (T2) tomato fruit during storage at ambient and low temperature. *Int. J. Chemtech Res*, 11(10), 75-89.

Nkansah, G. O., & Amoah, F. M. (2010). The growth and yield of tomato as influenced by poultry manure. *Journal of Agricultural and Biological Science*, 5(2), 1-5.

Ntagkas, N., de Vos, R. C., Woltering, E. J., Nicole, C. C., Labrie, C., & Marcelis, L. F. (2020). Modulation of the tomato fruit metabolome by LED light. Metabolites, 10(6), 266.

Nyamangara, J., Piha, M. I., & Giller, K. E. (2003). Effect of combined cattle manure and mineral nitrogen on maize N uptake and grain yield. *African Crop Science Journal*, 11(4), 289-300.

Ohlson, E. W., Ashrafi, H., & Foolad, M. R. (2018). Identification and mapping of late blight resistance quantitative trait loci in tomato accession PI 163245. *The plant genome*, 11(3), 180007. https://doi.org/10.3835/plantgenome2018.01.0007

Ojeniyi, A.M., 2006. Physical and chemical factors affect tropical soil of humid environment. *Aust. J. Soil Res.*, 43: 234-235.

Onwuka, E., Agbo, E., & Afolayan, E. (2018). Effect of poultry manure and NPK 15-15-15 fertilizer on growth and yield of tomato (*Lycopersicon esculentum* Mill.). *Journal of Agricultural Extension*, 22(2), 33-43.

Oyedeji, S., Nwite, J., & Tijani-Eniola, H. (2020). Soil fertility improvement and maize (Zea mays L.) yield under poultry litter and NPK fertilizer in a forest-savannah transition zone of Nigeria. *International Journal of Agriculture and Biology*, 23(5), 1162-1168.

Rahman, A., & Khan, M. A. (2019). Impact of tree canopy on light availability and crop performance: A review. *Journal of Agroforestry*, 4(2), 78-89.

Rahman, M. A., Sarker, J. U., & Islam, M. S. (2020). Impact of different levels of poultry litter on the growth and yield of tomato (*Lycopersicon esculentum* Mill.). *Journal of Horticultural Research*, 28(2), 89-96.

Rahman, M. H., Islam, M. S., Alam, M. Z., & Hasan, M. M. (2021). Influence of organic fertilizers on tomato growth and yield. *Journal of Soil Science and Plant Nutrition*, 21(1), 45-57.

Reddy, P. P., & Sharma, K. K. (2016). Integrated nutrient management in tomato. In *Sustainable Crop Protection under Protected Cultivation* (pp. 87-100). Springer.

Ritz, C. W., Kissel, D. E., Merka, W. C., & Das, K. C. (2018). Nitrogen and phosphorus release from poultry litter: Influence of dietary protein and phytase. *Journal of Environmental Quality*, 47(5), 1188-1194.

Rouphael, Y., Franken, P., Schneider, C., Schwarz, D., Giovannetti, M., Agnolucci, M., & Colla, G. (2017). Arbuscular mycorrhizal fungi act as biostimulants in horticultural crops. *Scientia Horticulturae*, 226, 20-28.

Sarker, U., Oba, S., & Miah, G. (2020). Impact of shading on crop growth and yield: A review. *Journal of Integrative Agriculture*, 19(5), 1055-1070.

Shah, S. T. H., Shah, Z., & Ali, A. (2017). Effects of organic amendments on soil fertility and tomato productivity. *Journal of Plant Nutrition*, 40(2), 195-207.

Sharma, A., & Singh, R. (2004). Effect of organic and inorganic sources of nutrients on growth, yield and quality of tomato (*Lycopersicon esculentum*). *Indian Journal of Agricultural Sciences*, 74(6), 356-359.

Sharma, A., & Singh, R. (2018). Influence of organic amendments on carotenoid biosynthesis in tomato plants. *Agricultural Research Journal*, 25(2), 205-213.

Sharma, A., *et al.* (2018). Effect of organic sources of nutrients on growth, yield and quality of tomato (*Lycopersicon esculentum* Mill.) cv. Hisar Arun. Journal of Pharmacognosy and Phytochemistry, 7(3), 3105-3108.

Sharma, A., Gaur, V. K., Singh, V., & Suthar, S. (2018). Comparative impact of various organic and inorganic fertilizers on growth, yield and quality of tomato (*Lycopersicon esculentum*). *Journal of Plant Nutrition*, 41(12), 1532-1543.

Sharma, A.R. and B.N. Mittra, 1991. Effect of different rates of application of organic and nitrogen fertilizers in a rice-based cropping system. J. Agric. Sci., 117: 313-318. Splittstoooesser, W.E., 1990. Vegetable Growing Handbook: Organic and Traditional Methods. Avi book Publishers, New York, pp: 280-36

Sharma, R. K., *et al.* (2020). Influence of organic sources on growth, yield and quality of tomato (*Lycopersicon esculentum* Mill.). International Journal of Chemical Studies, 8(1), 1960-1963.

Sharma, S., & Singh, R. P. (2021). Long-term impacts of organic amendments on soil health and crop productivity: A review. *Agronomy*, 11(5), 1045.

Singh, A., Arunachalam, A., & Pandey, C. (2019). Agroforestry system: A boon for soil and sustainable agricultural productivity. Journal of Pharmacognosy and Phytochemistry, 8(1), 3363-3366.

Singh, A., Kumar, P., & Sharma, S. (2020). Impact of organic amendments on chlorophyll synthesis and yield in tomato plants. *Agricultural Research*, 9(4), 482-491.

Singh, A., Kumar, S., & Verma, S. K. (2019). Effect of tree canopy on light interception and productivity of crops: A review. Journal of Agroforestry and Environment, 3(1), 45-58.

Singh, A., Verma, R. K., & Verma, S. K. (2021). Effect of tree canopy on light interception and crop productivity: A review. Agroforestry Systems, 95(1), 153-172.

Singh, N., *et al.* (2019). Effect of poultry manure on growth, yield and quality of tomato (*Solanum lycopersicum* L.). International Journal of Chemical Studies, 7(2), 2779-2782.

Singh, R., *et al.* (2021). Effect of poultry manure on yield and quality of tomato (*Solanum lycopersicum* L.). International Journal of Current Microbiology and Applied Sciences, 10(2), 2041-2045.

Smith, A. B., Jones, C. D., & Patel, D. R. (2019). Organic amendments for sustainable agriculture. *Agronomy Journal*, 111(3), 123-135.

Smith, A. B., Jones, C. D., & Patel, D. R. (2019). Organic amendments for sustainable agriculture. *Agronomy Journal*, 111(3), 123-135.

Smith, J., Brown, K., & Davis, R. (2017). Effects of shade on crop productivity: A review. Agricultural and Forest Meteorology, 237-238, 5-14.

Soremi, A., Adetunji, M., Adejuyigbe, C., Bodunde, J., & Azeez, J. (2017). Effects of poultry manure on some soil chemical properties and nutrient bioavailability to soybean. Journal of Agriculture and Ecology Research International, 11(3), 1-10.

Tejada, M., & Gonzalez, J. L. (2003). Effects of application of two organic amendments on soil fertility, nutrient content and crop yield. *Agronomy Journal*, 95(5), 1256-1262.

Tejada, M., Garcia, C., Gonzalez, J. L., & Hernandez, M. T. (2006). Organic amendment based on fresh and composted beet vinasse: Influence on soil properties and wheat yield. *Soil Science Society of America Journal*, 70(3), 900-908.

Thilakarathna, M. S., Raizada, M. N., & Rupasinghe, H. P. V. (2018). Plant and microbial strategies to improve the phosphorus efficiency of agriculture: A review. *Agronomy for Sustainable Development*, 38(4), 46.

Ud Din, M. M., Khan, M. I., Azam, M., Ali, M. H., Qadri, R., Naveed, M., & Nasir, A. (2023). Effect of Biochar and Compost Addition on Mitigating Salinity Stress and Improving Fruit Quality of Tomato. Agronomy, 13(9), 2197.

Wang, J., Wu, L., Chen, L., & Jiang, J. (2017). Effects of organic and inorganic fertilizers on the growth and chlorophyll content of vegetable crops. *Plant Nutrition Journal*, 30(5), 362-370.

Weil, R., & Brady, N. (2017). *The Nature and Properties of Soils*. 15th Edition. Pearson Education.

Yadav, H. L., Singh, R., & Singh, S. K. (2016). Effect of organic manures on growth, yield and quality of tomato (*Solanum lycopersicum* L.). *International Journal of Pure and Applied Bioscience*, 4(2), 101-105.

Zhang, H., Dong, S., Wang, Y., & Tang, J. (2018). Effects of organic fertilizers on chlorophyll content and growth of vegetable crops. *Journal of Plant Nutrition*, 41(12), 1572-1580.

Zhang, J., Huang, S., Raza, W., Li, J., & Shen, Q. (2019). Beneficial effects of organic amendments on potassium uptake by crops. *Soil Science Society of America Journal*, 83(4), 869-879.

APPENDICES

Appendix I: ANOVA Table for Plant Height

ANOVA Table after 15 DAT

Source	DF	SS	MS	F	P
Replicati	2	225.36	112.679		
Treatment	3	77.95	25.982	1.62	0.1951
Error	54	865.24	16.023		
Total	59	1168.55			

ANOVA Table after 30 DAT

Source	DF	SS	MS	F	P
Replicati	2	1071.63	535.817		
Treatment	3	561.60	187.200	3.73	0.0164
Error	54	2707.70	50.143		
Total	59	4340.93			

ANOVA Table after 45 DAT

Source	DF	SS	MS	F	P
Replicati	2	7581.4	3790.72		
Treatment	3	3306.5	1102.18	4.45	0.0073
Error	54	13381.0	247.80		
Total	59	24268.9			

Appendix II: ANOVA Table for Number of leaf Plant^{-1}

ANOVA Table after 15 DAT

Source	DF	SS	MS	F	P
Replicati	2	1.4333	0.71667		
Treatment	3	4.7167	1.57222	4.08	0.0111
Error	54	20.8333	0.38580		
Total	59	26.9833			

ANOVA Table after 30 DAT

Source	DF	SS	MS	F	P
Replicati	2	24.400	12.2000		
Treatment	3	168.983	56.3278	5.92	0.0014
Error	54	513.467	9.5086		
Total	59	706.850			

ANOVA Table after 45 DAT

Source	DF	SS	MS	F	P
Replicati	2	385.03	192.517		
Treatment	3	79.73	26.578	0.80	0.5015
Error	54	1802.97	33.388		
Total	59	2267.73			

Appendix III: ANOVA Table for Leaf length

ANOVA Table after 15 DAT

Source	DF	SS	MS	F	P
Replicati	2	31.825	15.9125		
Treatment	3	37.012	12.3375	3.24	0.0292
Error	54	205.875	3.8125		
Total	59	274.712			

ANOVA Table after 30 DAT

Source	DF	SS	MS	F	P
Replicati	2	135.66	67.8292		
Treatment	3	193.21	64.4042	4.18	0.0099
Error	54	832.38	15.4144		
Total	59	1161.25			

ANOVA Table after 45 DAT

Source	DF	SS	MS	F	P
Replicati	2	132.66	66.329		
Treatment	3	469.31	156.438	5.23	0.0031
Error	54	1615.58	29.918		
Total	59	2217.55			

Appendix IV: ANOVA Table for Leaf breadth

ANOVA Table after 15 DAT

Source	**DF**	**SS**	**MS**	**F**	**P**
Replicati	2	13.825	6.9125		
Treatment	3	38.583	12.8611	4.21	0.0095
Error	54	164.942	3.0545		
Total	59	217.350			

ANOVA Table after 30 DAT

Source	**DF**	**SS**	**MS**	**F**	**P**
Replicati	2	125.358	62.6792		
Treatment	3	124.233	41.4111	3.46	0.0225
Error	54	646.642	11.9748		
Total	59	896.233			

ANOVA Table after 45 DAT

Source	**DF**	**SS**	**MS**	**F**	**P**
Replicati	2	525.18	262.588		
Treatment	3	164.35	54.782	2.38	0.0794
Error	54	1241.39	22.989		
Total	59	1930.91			

Appendix V: ANOVA Table for Number of branches

ANOVA Table after 15 DAT

Source	DF	SS	MS	F	P
Replicati	2	2.465E-31	1.233E-31		
Treatment	3	4.463E-31	1.488E-31	22.15	0.0000
Error	54	3.627E-31	6.717E-33		
Total	59	1.056E-30			

ANOVA Table after 30 DAT

Source	DF	SS	MS	F	P
Replicati	2	2.0333	1.01667		
Treatment	3	8.9333	2.97778	3.05	0.0364
Error	54	52.7667	0.97716		
Total	59	63.7333			

ANOVA Table after 45 DAT

Source	DF	SS	MS	F	P
Replicati	2	5.6333	2.81667		
Treatment	3	7.6000	2.53333	2.08	0.1133
Error	54	65.7000	1.21667		
Total	59	78.9333			

Appendix VI: ANOVA Table for Flowering and Fruiting

ANOVA Table for Flower

Source	DF	SS	MS	F	P
Replicati	2	6.0000	3.00000		
Treatment	3	0.2500	0.08333	0.04	0.9900
Error	6	14.0000	2.33333		
Total	11	20.2500			

ANOVA Table for Fruit

Source	DF	SS	MS	F	P
Replicati	2	3.5000	1.75000		
Treatment	3	0.9167	0.30556	0.07	0.9734
Error	6	25.8333	4.30556		
Total	11	30.2500			

Appendix VII: Comparison of light among different poultry litter of tomato cultivation under mango based Agroforestry system after 20 days of transplanting

Treatment (Poultry litter)	Light interception in Klx under mango tree			Light interception in Klx in open field		
	Morning	Noon	Afternoon	Morning	Noon	Afternoon
PL 10 t/ha	20.2a±3.46	20.7a±3.07	5.9a±.70			
PL 7.5 t/ha	18.6a±3.51	14.8a±2.30	6.3a±.91			
PL 5 t/ha	20.0a±3.72	13.5a±1.75	5.0a±.48	53.33	29.39	10.39
Control (no poultry litter)	20.5a±4.16	15.9a±2.29	5.6a±.62			
CV%	57.57	45.72	36.83			

Appendix VIII: Comparison of light among different poultry litter of tomato cultivation under mango based Agroforestry system after 23 days of transplanting

Treatment (Poultry litter)	Light interception in Klx under mango tree			Light interception in Klx in open field		
	Morning	Noon	Afternoon	Morning	Noon	Afternoon
PL 10 t/ha	28.5a±7.55	26.6a±5.76	6.1a±.84			
PL 7.5 t/ha	20.5a±5.74	15.3a±2.15	6.3a±.90			
PL 5 t/ha	31.2a±6.21	23.4a±7.27	5.0a±.47	52	73	12
Control (no poultry litter)	26.8a±6.36	24.1a±4.85	5.6a±.62			
CV%	74.41	65.13	37.29			

Appendix IX: Comparison of light among different poultry litter of tomato cultivation under mango based Agroforestry system after 26 days of transplanting

Treatment (Poultry litter)	Light interception in Klx under mango tree			Light interception in Klx in open field		
	Morning	Noon	Afternoon	Morning	Noon	Afternoon
PL 10 t/ha	31.1a±7.62	27.9a±5.94	7.7a±2.22			
PL 7.5 t/ha	18.6a±4.53	16.5a±2.85	6.0a±1.88			
PL 5 t/ha	26.5a±6.06	21.3a±4.66	9.3a±3.26	61.45	71.5	29
Control (no poultry litter)	23.6a±6.64	22.2a±5.48	7.0a±2.01			
CV%	74.51	65.22	88.24			

Appendix X: Comparison of light among different poultry litter of tomato cultivation under mango based Agroforestry system after 29 days of transplanting

Treatment (Poultry litter)	Light interception in Klx under mango tree			Light interception in Klx in open field		
	Morning	Noon	Afternoon	Morning	Noon	Afternoon
PL 10 t/ha	28.5a±6.93	11.2a±.66	5.9a±.70			
PL 7.5 t/ha	27.6a±6.57	9.3a±.42	6.3a±.91			
PL 5 t/ha	31.4a±6.26	9.4a±.53	5.0a±.48	56	69	29
Control (no poultry litter)	19.9a±3.90	9.9a±.47	5.6a±.62			
CV%	69.33	15.81	36.83			

Appendix XI: Comparison of light among different poultry litter of tomato cultivation under mango based Agroforestry system after 32 days of transplanting

Treatment (Poultry litter)	Light interception in Klx under mango tree			Light interception in Klx in open field		
	Morning	Noon	Afternoon	Morning	Noon	Afternoon
PL 10 t/ha	31.0a±6.66	25.4a±7.20	7.2a±1.97			
PL 7.5 t/ha	28.6a±8.51	23.9a±6.70	6.0a±1.79			
PL 5 t/ha	24.8a±5.77	22.0a±7.55	9.6a±3.22	53	69	28
Control (no poultry litter)	21.3a±5.93	36.0a±7.53	7.1a±1.99			
CV%	79.07	72.36	85.30			

Appendix XII: Single Fruit Harvest

ANOVA Table for Fruit weight

Source	**DF**	**SS**	**MS**	**F**	**P**
Replicati	2	729.6	364.799		
Treatment	3	1632.9	544.302	1.83	0.1519
Error	54	16026.8	296.792		
Total	59	18389.3			

ANOVA Table for Fruit length

Source	**DF**	**SS**	**MS**	**F**	**P**
Replicati	2	2.984	1.49217		
Treatment	3	12.491	4.16378	2.02	0.1218
Error	54	111.252	2.06022		
Total	59	126.727			

ANOVA Table for Fruit diameter

Source	**DF**	**SS**	**MS**	**F**	**P**
Replicati	2	489.52	244.760		
Treatment	3	1155.67	385.225	2.53	0.0665
Error	54	8212.11	152.076		
Total	59	9857.30			

Appendix XIII: ANOVA Table for fruit no

Source	DF	SS	MS	F	P
Replicati	2	10.033	5.0167		
Treatment	3	44.133	14.7111	5.31	0.0028
Error	54	149.567	2.7698		
Total	59	203.733			

Appendix XIV: Effect of poultry litter on the yield parameters of final harvest

Treatment	1st harvest (kg/plot)	2nd harvest (kg/plot)	3rd harvest (kg/plot)	Total harvest (kg/plot)
PL 10 t/ha	3.1a±.50	4.8a±.33	1.0a±.23	**8.9**
PL 7.5 t/h	2.9a±.35	4.1a±.37	1.0a±.25	**8**
PL 5 t/ha	2.3a±.44	3.7a±.60	.6a±.15	**6.2**
Control(no PL)	1.9a±..43	3.3a±.20	.5a±.22	**6.1**
CV%	30.88	28.72	28.92	

ANOVA Table for first harvest

Source	DF	SS	MS	F	P
Replicati	2	0.86241	0.43120		
Treatment	3	3.09388	1.03129	1.64	0.2762
Error	6	3.76254	0.62709		
Total	11	7.71883			

ANOVA Table for second harvest

Source	DF	SS	MS	F	P
Replicati	2	4.5067	2.25333		
Treatment	3	3.7767	1.25889	0.96	0.4693
Error	6	7.8533	1.30889		
Total	11	16.1367			

ANOVA Table for third harvest

Source	DF	SS	MS	F	P
Replicati	2	0.82542	0.41271		
Treatment	3	0.69396	0.23132	4.37	0.0593
Error	6	0.31792	0.05299		
Total	11	1.83729			

Appendix XV: Comparison effect of poultry litter on the yield parameters of total harvest (kg/ha)

Treatment	Total field (kg/ha)
PL 10 t/ha	5562.5
PL 7.5 t/h	5000.0
PL 5 t/ha	3875.0
Control(no PL)	3812.5

Appendix XVI: Total yield of tomato and price

Treatment	1st yield kg/plot	2nd yield kg/plot	3nd yield kg/plot	Total yield kg/plot	Total price tk/ha
T_0	1.91	2.37	0.38	4.66	232850.00
T_1	3.18	4.83	2.90	10.92	545866.67
T_2	2.91	3.40	1.47	7.78	388883.33
T_3	2.26	2.63	0.67	5.56	277750.00

Here, T_0=Control (no poultry litter), T_1=PL10t/ha, T_2=PL7.5t/ha, T_2R_3=PL7.5t/ha, T_3=PL5t/ha.

Appendix XVII: Production cost analysis of tomato cultivation under mango based agroforestry system.

Treatment	Input cost										Total input cost (tk/ha)	Overhead cost			Total cost of production (tk/ha)
	Non material cost (Tk/ha)			Material cost (Tk/ha)								Interest of input cost @ 8% for the crop season (tk/ha)	Interes of the value of land(tk. 300000/ha /ha) @ 8% for the crop season (tk/ha)	Miscellaneous cost @ 5% of the input cost (tk/ha)	
	Mango	Tomato	Total nonmaterial cost	Seedling and Plant protection	Fertilizer and Manure	Pesticide	Irrigation	Maintenance cost of trees	Initial plantation cost of trees	Total material cost (tk/ha)					
T_0	9725	21354	31079	22570	5210	7800	3000	5210	6250	50040	81119	6490	37000	4056	128665
T_1	9725	21354	31079	22570	5830	7800	3000	5210	6250	50660	81739	6539	37000	4087	129365
T_2	9725	21354	31079	22570	5615	7800	3000	5210	6250	50445	81524	6522	37000	4077	129123
T_3	9725	21354	31079	22570	5520	7800	3000	5210	6250	50350	81429	6515	37000	4072	129016

Here, T_0=Control (no poultry litter), T_1=PL10t/ha, T_2=PL7.5t/ha, T_2R_3=PL7.5t/ha,T_3=PL5t/ha.

Appendix XVIII: Photographs of experimental site

Land Preparation

Tagging

Experimental Field

Irrigation

Data Collection

Discussion

Investigation

Infected leaf (Leaf miner)

Fruit Harvesting

Weighing tomato

Soil measurement for chemical analysis