

**EFFECT OF POULTRY LITTER COMPOST ON THE GROWTH AND YIELD
OF ONION UNDER NEEM BASED AGROFORESTRY SYSTEM**



**A THESIS
BY**

MD. DABIRUL ISLAM

Registration No. 1701387

MS Session: Jan-June 2023

Thesis Semester: January June, 2024

**MASTER OF SCIENCE (M.S.)
IN
AGROFORESTRY AND ENVIRONMENT**

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HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY
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*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*

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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 ONION UNDER NEEM 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.

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The Author

EFFECT OF POULTRY LITTER COMPOST ON THE GROWTH AND YIELD OF ONION UNDER NEEM BASED AGROFROESTRY SYSTEM

ABSTRACT

A study was conducted at the Research Field of the Department of Agroforestry and Environment, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur to investigate the effect of poultry litter (PL) on the growth and yield parameters of onion (Foridpury variety) under neem based agroforestry system. The experiment was conducted during the period of January 2024 to April 2024. The experiment was performed with Randomized Complete Block Design with four treatments and three replications. The treatments were: T₁ = Control (no PL), T₂ = PL 3 ton/ha, T₃ = PL 5 ton /ha and T₄= PL 7.5 ton/ha. Therefore, there were 12 experimental plots (4 treatments × 3 replications) of size 2m × 2m. The results demonstrated that growth parameters and yield were significantly different among the different treatments. The highest plant height (53.62 cm) and number of leaves plant per plant (5.2) were obtained in T₃, while lowest was recorded in Control (T₁). Similarly the highest straw yield (1032kg) ha⁻¹, highest bulb length (7.15 cm), bulb diameter (3.46 cm), fresh weight of bulb (18.6 g), yield plot⁻¹ (3.43kg) and yield ha-1 (8.56 ton) were obtained from treatment T₃. The soil chemical properties were improved due to the application of poultry litter. From economical point of view, the highest BCR (2.53) was recorded in T3 treatment and the lowest BCR (1.78) was recorded in T1 treatment. In conclusion, the application of 5 tons/ha of poultry litter (T3) significantly enhanced the growth and yield parameters of onions, proving to be the most effective treatment. Economically, this treatment also yielded the highest benefit-cost ratio, indicating its superiority in both agronomic and financial terms under neem based agroforestry system.

Key words: Onion, Poultry litter, Agroforestry, Growth, Yield, Neem, BCR, Light intensity

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CHAPTER I

INTRODUCTION

The integration of agroforestry systems, particularly neem-based agroforestry, with traditional crop production has gained attention as a sustainable agricultural practice. Agroforestry combines trees and shrubs with crops or livestock, enhancing biodiversity, improving soil health, and increasing overall farm productivity. Neem (*Azadirachta indica*), renowned for its multifaceted benefits including pest control, soil enhancement, and medicinal properties, is often utilized in such systems. Poultry litter, a by-product of poultry farming, is rich in nutrients and organic matter, making it an excellent organic fertilizer. Its application in crop cultivation, particularly in an agroforestry context, can significantly influence crop growth, yield, and quality. Neem trees are renowned for their ability to improve soil fertility, provide shade, and protect crops from pests due to their natural insecticidal properties (Sithara *et al.*, 2015).

Onion (*Allium cepa L.*) belongs to the Alliaceae family and is one of the most important monocotyledons and cross-pollinated spices as well as vegetable crops (Hanelt, 1990). In nature, it is semi perishable and can be transported without much injury over a long distance. As a condiment and vegetable, onion is an indispensable item in every kitchen. The onion is therefore commonly referred to as the "Queen of the Kitchen." Onion, due to the presence of a volatile oil 'allyl propyl disulfide' - an organic compound rich in sulfur, is liked for its flavor and pungency.

The primary center of its origin is Central Asia and the second center for large onion types is the Mediterranean (McCullum, 1976). Now, it is growing across the globe. The world's leading onion-growing countries are China, Holland, Korea, Israel, Japan, Turkey, Syria, Iran, Egypt, the United States, Lebanon, Austria, and India (FAO, 2012). It is commercially cultivated in the greater Dhaka, Mymensingh, Rajshahi, Rangpur, Rajbari, Khustia, Khulna, Barishal, and Pabna districts in Bangladesh (BBS, 2015). Among Bangladesh grown spice crops, onion ranks top in terms of production and area (BBS, 2018). The total production of onion in Bangladesh is about 1866502 metric tons under the total cultivated area of 458969 acres (BBS, 2018). The total production of onion in Bangladesh is about 23.31 lakh metric tons under the total cultivated area of

2.08 lakh ha (AIS, DAE, 2020). It is most widely grown and popular vegetable crop among the alliums as well as cash crops.

The onion bulb is a rich source of minerals such as phosphorus, calcium, and carbohydrate. Also, it contains vitamin C and protein. It is utilized as fresh, frozen, dehydrated bulbs and green bunching types in several ways. It has good medicinal value. It contains several anti-cancer agents that have shown to prevent animals from developing cancer. A strong antioxidant, is a beneficial compound called 'quercetin' present in onions.

To a greater extent, onion has recently been used by the processing industry to prepare dehydrated forms such as powder and flakes (Singh, 2015).

Onion contains carbohydrates (11.0 g), proteins (1.2 g), fiber (0.6 g), moisture (86.8 g) and several vitamins such as vitamin A (0.012 mg), vitamin C (11 mg), thiamin (0.08 mg), riboflavin (0.01 mg) and niacin (0.2 mg) as well as some minerals such as phosphorus (39 mg), calcium (27 mg), sodium (1.0 mg), iron (0.7 mg) and potassium (157 mg) per 100 g (Rahman *et al.*, 2013).

In recent years, it has been realized that the proper use of nutrients is essential for higher yields and improved quality of onion. Under appropriate agroclimatic conditions, nutrient management is the main factor that significantly influences the growth and yield of onion. In modern agriculture, fertilizer is a major part of the cost of the production of onion. Higher yields of good quality bulbs can be produced by careful use of nutrients.

Onion is generally grown during the Rabi season in Bangladesh. The growth and yield of this crop is remarkably influenced by the management of different nutrients. There are two types of fertilizer, one is organic and the other is inorganic. It is established that the use of inorganic fertilizer for crops is not so beneficial to health due to residual effects, but that such problems do not arise in the case of organic fertilizers and, on the other hand, increased soil productivity as well as crop quality and yield (Tindall, 20).

Poultry litter, a mixture of poultry manure, feathers, and bedding material, is increasingly recognized for its significant benefits in agricultural production. The use of poultry litter as an organic fertilizer in onion cultivation offers a sustainable and cost-effective alternative to chemical fertilizers, promoting soil health and enhancing crop yield. This practice aligns with the growing demand for organic produce and sustainable farming

methods. The Poultry litter is rich in essential nutrients such as nitrogen, phosphorus, and potassium, which are vital for the growth and development of onions (Bitzeret *al.* 1994). The slow-release nature of these nutrients ensures a steady supply throughout the growing season, leading to improved plant vigor and higher yields. Studies have shown that the application of poultry litter can increase onion bulb size and overall productivity compared to traditional fertilizers. Using the poultry litter reduces the reliance on chemical fertilizers, lowering input costs for farmers. Additionally, it offers an environmentally friendly solution for managing poultry waste, reducing the risk of pollution and greenhouse gas emissions (Moore Jret *al.* 1995). The recycling of poultry litter into agricultural fields exemplifies a circular economy approach, where waste is converted into valuable resources (Ritz et ai. 2004).

Poultry manure application at 10 t ha⁻¹ was observed to improve the physical properties of soil (Ravikumar and Krishna -moorthy, 1975). Soil physical properties such as bulk density, water holding capacity and percent water stable aggregation were noted to be favourable influenced by poultry waste addition to soil (Weil and Kroontje, 1979).

The neem tree is widely recognized for its insecticidal, fungicidal, and nematocidal properties, making it an integral component of sustainable farming systems. Neem-based agroforestry systems involve the cultivation of crops alongside neem trees, which can improve soil health, reduce pest infestations, and enhance the microenvironment for crops. Singh, R., Sharma, R. R., & Kumar, S. (2018) The symbiotic relationship between the neem tree and understorey crops like onion can potentially lead to improved crop performance and reduced dependency on chemical inputs.

Research Problem:

Considering the above facts the following research problems are identified in the present study: 1) How does the application of poultry litter affect the growth performance (e.g., plant height, leaf number, and bulb size) of onion plants grown under a neem-based agroforestry system compared to conventional fertilization methods? 2) What are the differences in yield parameters (e.g., total yield, marketable yield, bulb weight) of onions when poultry litter is used as fertilizer under a neem-based agroforestry system compared to traditional fertilization practices? 3) What is the benefit-cost ratio of onion production when utilizing poultry litter as fertilizer under a neem-based agroforestry

system, and how does it compare to the benefit-cost ratio of using conventional fertilizers?

Objectives

This study aims to investigate the effect of poultry litter on the growth, yield, and quality of onion under a neem-based agroforestry system. Specifically, it seeks to:

1. To evaluate the growth performance of onion due to the effect of poultry litter under Neem based agroforestry system
2. To assess the yield parameters due to the effect of poultry litter under Neem based agroforestry system
3. To comparing the soil parameters due to the effect of poultry litter under Neem based agroforestry system.
4. To evaluate the benefit cost ratio of the onion production due to the effect of poultry litter under Neem based agroforestry system

CHAPTER II

LITERATURE REVIEW

Agroforestry, the integration of trees and shrubs into agricultural landscapes, offers significant environmental and economic benefits. Neem-based agroforestry systems, in particular, are notable for their potential to improve soil health, enhance biodiversity, and provide additional income sources. Poultry litter, a byproduct of poultry farming, is a nutrient-rich organic amendment known to improve soil fertility and crop performance. This review examines the impact of poultry litter on the growth, yield, and quality of onion (*Allium cepa L.*) within neem-based agroforestry systems.

2.1 Onion and Neem

2.1.1 Classification of *Allium cepa L.*

Allium cepa L., commonly known as onion, is a widely cultivated and economically significant vegetable crop globally. This literature review examines the classification, importance, and cultivation practices of *Allium cepa L.* in Bangladesh, comparing its significance to other countries. *Allium cepa L.* belongs to the family Amaryllidaceae and the genus *Allium*. It is classified under the *Allium cepa*, with various cultivars and varieties cultivated worldwide for their edible bulbs. Taxonomically, onions are classified as follows:

- Kingdom: Plantae
- Order: Asparagales
- Family: Alliaceae
- Genus: *Allium*
- Species: *Allium cepa*
- Binomial name: *Allium cepa L.*

2.1.2 Importance of *Allium cepa L.* in Bangladesh

In Bangladesh, onions are a vital cash crop and a staple ingredient in cooking. The country has a significant demand for onions due to its extensive use in various culinary dishes. Onions are not only consumed domestically but also exported, contributing to the country's agricultural economy (Hossain *et al.*, 2016).

Onions are rich in essential nutrients such as vitamins, minerals, and antioxidants. They provide dietary fiber, vitamin C, and various phytochemicals with potential health benefits, including anti-inflammatory and antimicrobial properties. In Bangladesh, onions are an important source of nutrition for the population (Islam *et al.*, 2013).

Onions play a crucial role in Bangladeshi cuisine, adding flavor and aroma to dishes. They are used in a wide range of traditional recipes, including curries, stews, salads, and condiments. Onions are integral to the culinary heritage of Bangladesh and are considered essential in daily cooking (Rahman *et al.*, 2020).

2.1.3 Comparative Importance with Other Countries

Bangladesh ranks among the top onion-producing countries globally, with a significant share of the domestic market supplied by local production. However, the country also imports onions to meet the high demand, especially during periods of domestic scarcity. India, China, and the Netherlands are other major onion-producing countries globally, with substantial exports to various international markets (FAOSTAT, 2022).

In Bangladesh, onions are predominantly grown in the Rabi season (winter), with both irrigated and rain-fed cultivation practices. The country's agro-climatic conditions favor onion cultivation, with suitable soil types and temperature ranges conducive to crop growth. However, challenges such as water scarcity, pest and disease outbreaks, and market fluctuations impact onion production in Bangladesh (Hossain *et al.*, 2016).

Allium cepa L., or onion, holds significant importance in Bangladesh, both economically and culturally. It is a staple ingredient in Bangladeshi cuisine and a valuable cash crop for farmers. While Bangladesh is a major onion-producing country, it also relies on imports to meet domestic demand. Compared to other onion-producing nations like India, China, and the Netherlands, Bangladesh's onion industry faces unique challenges and opportunities. Understanding the classification, importance, and cultivation practices of *Allium cepa L.* in Bangladesh provides valuable insights into its role in the country's agriculture and food culture.

2.1.4 Taxonomy and Classification of Neem

Azadirachta indica A. Juss, commonly known as neem, is a versatile and economically important tree species native to the Indian subcontinent. This review explores the

classification, ecological significance, and economic importance of *Azadirachta indica* in Bangladesh compared to its importance in other countries.

Azadirachta indica belongs to the family Meliaceae and the genus *Azadirachta*. It is a tropical evergreen tree species characterized by its pinnate leaves, small white flowers, and olive-like fruits. Taxonomically, it is classified as follows:

- Kingdom: Plantae
- Phylum: Tracheophyta
- Class: Magnoliopsida
- Order: Sapindales
- Family: Meliaceae
- Genus: *Azadirachta*
- Species: *Azadirachta indica* A.Juss

Importance of *Azadirachta indica* in Bangladesh

Azadirachta indica plays a crucial role in Bangladesh's ecosystem. It is well-adapted to the country's diverse climatic conditions, making it a valuable species for agroforestry, reforestation, and afforestation programs. Neem trees provide numerous ecological benefits, including soil conservation, erosion control, and biodiversity enhancement. Additionally, neem's natural pest-repellent properties contribute to integrated pest management practices, reducing the need for synthetic pesticides and promoting sustainable agriculture (Chakravarty & Suresh, 2014).

Economic Importance

In Bangladesh, *Azadirachta indica* has significant economic importance across various sectors. The neem tree is highly valued for its medicinal, industrial, and commercial uses. Neem extracts and derivatives are utilized in traditional medicine, pharmaceuticals, cosmetics, and personal care products. The oil extracted from neem seeds is a valuable source of bioactive compounds with insecticidal, antimicrobial, and antifungal properties, making it a key ingredient in organic pesticides, herbal remedies, and herbal soaps (Biswas *et al.*, 2016).

Furthermore, neem wood is prized for its durability, termite resistance, and suitability for furniture making, construction, and handicrafts. The bark, leaves, and twigs of neem

trees are used for various purposes, including fodder, mulch, and green manure. Neem-based agroforestry systems have been promoted in Bangladesh to enhance soil fertility, increase crop productivity, and improve livelihoods for rural farmers (Nair, 1993).

Comparison with Other Countries

Global Distribution

Azadirachta indica is widely distributed across tropical and subtropical regions of Asia, Africa, and Australia. It is cultivated or naturalized in many countries, including India, Nigeria, Indonesia, Thailand, and Australia. Neem's adaptability to a wide range of soil and climatic conditions has led to its successful introduction and cultivation in various parts of the world.

Importance in Other Countries

In other countries, *Azadirachta indica* holds similar ecological and economic significance as in Bangladesh. Neem trees provide valuable ecosystem services such as soil improvement, water conservation, and biodiversity conservation. In India, neem is considered a sacred tree with cultural and religious significance, and its various parts are utilized in traditional medicine, agriculture, and religious rituals (Schmutterer, 1990).

In Africa, neem trees are utilized for similar purposes, including pest control, soil fertility enhancement, and medicinal applications. Countries like Nigeria, Ghana, and Kenya have embraced neem-based agroforestry practices to address soil degradation, combat pests, and improve food security (Nair, 1993).

Azadirachta indica, commonly known as neem, is a versatile tree species with significant ecological and economic importance in Bangladesh and other countries. Its adaptability, pest-repellent properties, and medicinal value make it a valuable asset for sustainable agriculture, biodiversity conservation, and rural development. Neem's widespread distribution and diverse uses highlight its global importance as a multipurpose tree species with immense potential for addressing environmental, social, and economic challenges.

2.2 Agroforestry Systems and Soil Fertility

Agroforestry systems are recognized for their ability to enhance soil fertility through organic matter input, nutrient cycling, and improved soil structure. Neem (*Azadirachta indica*) is a widely used species in agroforestry due to its medicinal properties, pest-repellent characteristics, and adaptability to various soils and climatic conditions (Nair, 1993). The inclusion of neem trees in agricultural landscapes can lead to improved microclimatic conditions and soil properties beneficial for crop production.

Agroforestry, the practice of integrating trees and shrubs into agricultural systems, is acknowledged for its multifaceted benefits, including enhanced soil fertility. This integration can lead to improvements in organic matter input, nutrient cycling, and soil structure. Neem (*Azadirachta indica*), a prominent species in agroforestry, is particularly valued for its numerous ecological and agricultural benefits. This review examines the mechanisms by which agroforestry systems enhance soil fertility, with a focus on the role of neem trees in improving soil conditions and supporting crop production.

2.2.1 Agroforestry Systems and Organic Matter Input

Agroforestry systems contribute significantly to soil organic matter through the addition of leaf litter, root biomass, and organic residues from pruned branches. The decomposition of this organic material enriches the soil with essential nutrients, enhances microbial activity, and improves soil structure. According to Nair (1993), the organic inputs from trees in agroforestry systems can enhance soil organic carbon levels, which is crucial for maintaining soil fertility and structure.

Neem trees, in particular, contribute substantial organic matter through their leaf litter, which decomposes slowly, providing a steady release of nutrients (Chakravarty & Suresh, 2014). This slow decomposition rate helps maintain soil fertility over longer periods compared to faster-decomposing species. The organic matter from neem leaves also improves soil texture and water-holding capacity, which are essential for plant growth (Nair, 1993).

2.2.2 Nutrient Cycling in Agroforestry Systems

One of the primary benefits of agroforestry is its ability to enhance nutrient cycling within the ecosystem. Trees in agroforestry systems can capture and recycle nutrients

from deeper soil layers, making them available to crops growing in the upper layers. This process, known as nutrient pumping, is particularly beneficial in nutrient-poor soils (Mohan Kumar *et al.*, 1998).

Neem trees are efficient in nutrient cycling due to their deep root systems, which access nutrients beyond the reach of most annual crops. These nutrients are then returned to the soil surface through leaf litter and root turnover, improving nutrient availability for crops. Studies have shown that the presence of neem trees in agroforestry systems can increase the levels of essential nutrients such as nitrogen, phosphorus, and potassium in the soil (Chakravarty & Suresh, 2014).

2.2.3 Improved Soil Structure and Microclimatic Conditions

Agroforestry systems contribute to improved soil structure through the physical effects of tree roots and organic matter inputs. The root systems of trees, including neem, help to create soil aggregates, which enhance soil porosity and water infiltration. This improved soil structure reduces erosion, increases water retention, and provides a more stable environment for crop roots (Young, 1989).

Additionally, the canopy of neem trees creates a favorable microclimate for crops by reducing soil temperature fluctuations and protecting against wind and water erosion. This microclimatic modification is beneficial for maintaining soil moisture and reducing the stress on crops, leading to better growth and yield (Jose, 2009).

2.2.4 Role of Neem in Soil Fertility Enhancement

Neem (*Azadirachta indica*) is particularly notable for its role in enhancing soil fertility in agroforestry systems. It is well-adapted to a wide range of soils and climatic conditions, making it a versatile component of agroforestry practices (Nair, 1993). The leaves, bark, and seeds of neem contain various compounds with pesticidal and medicinal properties, which can reduce the need for chemical inputs in agricultural systems (Schmutterer, 1990).

Neem trees improve soil fertility through several mechanisms:

1. **Organic Matter Contribution:** Neem leaves and other plant parts contribute to soil organic matter, improving soil structure and fertility (Chakravarty & Suresh, 2014).

2. Nutrient Cycling: Neem's deep roots facilitate nutrient cycling, making nutrients available to shallow-rooted crops (Mohan Kumar *et al.*, 1998).
3. Pest Management: Neem's natural pest-repellent properties reduce the need for synthetic pesticides, leading to healthier soil biota and improved soil health (Schmutterer, 1990).

2.2.5 Empirical Evidence of Neem-Based Agroforestry Benefits

Empirical studies have demonstrated the benefits of neem-based agroforestry systems in enhancing soil fertility and crop production. For example, research by Bationo *et al.* (2007) in West Africa showed that integrating neem trees into cropping systems improved soil nitrogen levels and increased crop yields. Similarly, a study by Kumar *et al.* (2019) in India found that soils under neem-based agroforestry had higher organic carbon content and better nutrient availability compared to monocropped fields.

Agroforestry systems, particularly those incorporating neem trees, play a crucial role in enhancing soil fertility through organic matter input, nutrient cycling, and improved soil structure. Neem's adaptability, combined with its ecological benefits, makes it an ideal species for agroforestry practices aimed at sustainable agricultural production. Further research and extension efforts are needed to optimize neem-based agroforestry systems and maximize their benefits for soil health and crop productivity.

2.3 Poultry Litter as an Organic Amendment

Poultry litter is composed of poultry manure mixed with bedding materials like straw or wood shavings. It is rich in essential nutrients such as nitrogen (N), phosphorus (P), and potassium (K), as well as micronutrients and organic matter. The application of poultry litter can enhance soil fertility, microbial activity, and organic carbon content, leading to improved plant growth and yield (Adeliet *et al.*, 2008; Ghaly & MacDonald, 2012).

Poultry litter, a byproduct of poultry farming, consists of a mixture of poultry manure and bedding materials such as straw or wood shavings. It is a nutrient-rich organic amendment, widely used in agricultural practices to enhance soil fertility and improve crop productivity. This review explores the composition of poultry litter, its impact on soil fertility, microbial activity, organic carbon content, and its overall effects on plant growth and yield.

2.3.1 Composition of Poultry Litter

Poultry litter is a valuable source of essential nutrients required for plant growth. It typically contains high levels of nitrogen (N), phosphorus (P), and potassium (K), along with significant amounts of micronutrients such as calcium, magnesium, and sulfur. According to Ghaly and MacDonald (2012), poultry litter's nutrient composition can vary depending on the type of bedding material used, the diet of the poultry, and the management practices employed in the poultry operation. On average, poultry litter contains approximately 3-5% nitrogen, 2-4% phosphorus, and 1-3% potassium (Adeliet *al.*, 2008).

2.3.2 Enhancing Soil Fertility

The application of poultry litter to soil has been shown to significantly enhance soil fertility. This is primarily due to the high nutrient content and the gradual release of nutrients as the organic matter decomposes. Poultry litter improves the soil's nutrient status by increasing the availability of essential macronutrients and micronutrients (Moore *et al.*, 1995).

Nitrogen, an essential component of poultry litter, plays a critical role in plant growth, particularly in leafy vegetables and cereals. Phosphorus is vital for root development and energy transfer within plants, while potassium is crucial for enzyme activation and water regulation. The balanced nutrient composition of poultry litter makes it an effective organic fertilizer for a wide range of crops (Rynk, 1992).

2.3.4 Impact on Microbial Activity

Poultry litter application can significantly enhance soil microbial activity, which is essential for nutrient cycling and organic matter decomposition. The organic matter in poultry litter serves as a substrate for soil microorganisms, promoting their growth and activity. Increased microbial activity leads to the mineralization of organic nutrients, making them available for plant uptake (Adeliet *al.*, 2008).

A study by Kelleher *et al.* (2002) demonstrated that soils amended with poultry litter exhibited higher microbial biomass and enzyme activities compared to non-amended soils. This enhanced microbial activity not only improves nutrient availability but also

contributes to the suppression of soil-borne diseases by promoting a diverse and competitive microbial community.

2.3.5 Organic Carbon Content and Soil Structure

The addition of poultry litter to soil can also increase the soil's organic carbon content, which is crucial for maintaining soil structure and fertility. Organic carbon acts as a binding agent for soil particles, improving soil aggregation and porosity. This enhances water infiltration, root penetration, and reduces soil erosion (Ghaly & MacDonald, 2012).

Poultry litter's high organic matter content contributes to the formation of stable soil aggregates, which are essential for sustaining soil health and productivity. Improved soil structure enhances water-holding capacity and aeration, creating a more favorable environment for root growth and microbial activity (Moore *et al.*, 1995).

2.3.6 Effects on Plant Growth and Yield

Numerous studies have documented the positive effects of poultry litter on plant growth and yield. The nutrient-rich composition of poultry litter provides a readily available source of essential nutrients, promoting vigorous plant growth and increased crop yields. Poultry litter application has been shown to improve various growth parameters, including plant height, biomass production, and root development (Turan, 2013).

For instance, a study by Adeli *et al.* (2008) reported that the application of poultry litter significantly increased corn yield and biomass compared to chemical fertilizers. Similarly, research by Kingery *et al.* (1994) found that poultry litter application enhanced the growth and yield of cotton, with improvements in soil fertility and nutrient availability.

The slow-release nature of nutrients in poultry litter ensures a sustained nutrient supply throughout the growing season, reducing the risk of nutrient leaching and environmental pollution. This makes poultry litter an environmentally friendly and cost-effective alternative to synthetic fertilizers (Moore *et al.*, 1995).

2.3.7 Environmental Considerations

While poultry litter offers numerous benefits as an organic amendment, its application must be managed carefully to avoid potential environmental impacts. Excessive application rates can lead to nutrient runoff and leaching, contributing to water pollution and eutrophication of water bodies (Sharpley *et al.*, 1998). It is essential to apply poultry litter at rates that match crop nutrient requirements and to follow best management practices to minimize environmental risks.

Poultry litter is a highly effective organic amendment that enhances soil fertility, microbial activity, and organic carbon content, leading to improved plant growth and yield. Its balanced nutrient composition, coupled with its ability to improve soil structure and support microbial activity, makes it a valuable resource for sustainable agriculture. However, careful management is necessary to maximize its benefits and minimize potential environmental impacts. Further research and extension efforts are needed to optimize poultry litter application rates and practices for different crops and soil types.

2.4 Effects of Poultry Litter on Onion Growth and Yield

Onions are nutrient-demanding crops, particularly requiring high levels of nitrogen for optimal growth and bulb development. Studies have shown that organic amendments, including poultry litter, can significantly influence the growth and yield of onions. According to Khokharet *al.* (2017), the application of poultry manure improved onion growth parameters such as plant height, number of leaves, and bulb size. Poultry litter provides a slow-release source of nutrients, which is beneficial for sustained onion growth over the growing season.

Onions (*Allium cepa* L.) are a critical crop in global agriculture, known for their high nutritional value and culinary importance. They are nutrient-demanding, especially requiring high levels of nitrogen for optimal growth and bulb development. Organic amendments, such as poultry litter, are increasingly being recognized for their potential to enhance onion growth and yield by providing a slow-release source of essential nutrients. This literature review explores the impact of poultry litter on onion growth parameters, yield, and overall crop quality.

2.4.1 Nutrient Composition and Benefits of Poultry Litter

Poultry litter, a mixture of poultry manure and bedding materials, is rich in macro and micronutrients necessary for plant growth. It typically contains high levels of nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and trace elements such as zinc (Zn) and copper (Cu) (Adeliet *et al.*, 2008). The organic matter in poultry litter also improves soil structure, water-holding capacity, and microbial activity, which are critical for sustained crop growth (Ghaly & MacDonald, 2012).

2.4.2 Impact on Onion Growth Parameters

Research indicates that poultry litter significantly enhances various growth parameters of onions. According to Khokharet *et al.* (2017), the application of poultry manure improved plant height, number of leaves, and bulb size in onions. These improvements are attributed to the gradual release of nutrients from poultry litter, which ensures a steady supply of nutrients throughout the growing season, minimizing nutrient leaching and volatilization losses (Kumar *et al.*, 2019).

2.4.2.1 Plant Height and Leaf Number

The nitrogen content in poultry litter is particularly beneficial for the vegetative growth of onions. Nitrogen is a key component of chlorophyll and amino acids, which are essential for photosynthesis and protein synthesis, respectively. Enhanced nitrogen availability from poultry litter application leads to increased plant height and leaf number, which are critical for capturing sunlight and driving photosynthesis (Mahmoud *et al.*, 2009).

2.4.2.2 Bulb Size and Development

Bulb size is a crucial yield determinant in onion production. Studies have shown that poultry litter application positively affects bulb development by providing essential nutrients during the critical stages of bulbing. The availability of phosphorus and potassium from poultry litter is vital for energy transfer, root development, and water regulation, all of which contribute to larger bulb size and better overall yield (Shaheen *et al.*, 2007).

2.4.3 Yield Improvements

The application of poultry litter has been consistently linked to higher onion yields. This increase in yield can be attributed to the cumulative effects of improved plant growth parameters. For instance, a study by Kader *et al.* (2011) demonstrated that onions treated with poultry litter had significantly higher yields compared to those receiving inorganic fertilizers. The study attributed this increase to better nutrient availability and enhanced soil fertility from organic matter addition.

Comparative studies highlight the superior performance of poultry litter over other organic and inorganic fertilizers. For example, Sharma and Pande (2009) reported that onions grown with poultry litter yielded higher compared to those treated with farmyard manure and chemical fertilizers. The slow-release nature of poultry litter ensures that nutrients are available to the plants over an extended period, leading to sustained growth and higher productivity.

2.4.4 Soil Health and Sustainability

Beyond immediate crop performance, poultry litter application has long-term benefits for soil health and sustainability. The organic matter in poultry litter improves soil structure, increases microbial activity, and enhances nutrient cycling, which are vital for maintaining soil fertility and productivity in the long run (Glover *et al.*, 2000). Additionally, the use of poultry litter as a fertilizer reduces reliance on synthetic fertilizers, thereby decreasing the environmental footprint of onion farming (Adeliet *et al.*, 2008).

2.4.5 Case Studies and Empirical Evidence

Several case studies have provided empirical evidence supporting the benefits of poultry litter on onion growth and yield. In a field experiment conducted by Khalid *et al.* (2016), onions treated with poultry litter showed a significant increase in growth and yield parameters compared to the control group. The study highlighted that the slow-release properties of poultry litter provided a continuous nutrient supply, leading to improved plant vigor and bulb formation.

2.4.6 Economic considerations of poultry litter application

The use of poultry litter also offers economic benefits by reducing the cost of synthetic fertilizers and improving crop yields. Farmers can utilize locally available poultry litter, reducing input costs and enhancing farm profitability. Moreover, the improved yield and quality of onions can lead to better market prices and higher income for farmers (Glover *et al.*, 2000).

The application of poultry litter has a profound positive impact on the growth and yield of onions. Its nutrient-rich composition and slow-release properties ensure a steady supply of essential nutrients, enhancing plant growth parameters such as plant height, leaf number, and bulb size. Furthermore, poultry litter improves soil health and sustainability, offering a cost-effective and environmentally friendly alternative to synthetic fertilizers. Continued research and field trials are necessary to optimize application rates and management practices to maximize the benefits of poultry litter in onion production.

2.5 Impact of poultry litter on onion quality

The quality of onion bulbs, measured in terms of size, weight, and nutrient content, is crucial for marketability and consumer acceptance. Poultry litter application has been reported to enhance bulb quality by improving nutrient uptake and soil health (Kader *et al.*, 2011). Moreover, organic amendments like poultry litter can increase the levels of beneficial secondary metabolites in onions, such as flavonoids and antioxidants, thereby enhancing their nutritional and medicinal value (Pérez-Gregorio *et al.*, 2010).

The quality of onion bulbs is a critical factor for marketability and consumer acceptance. Quality parameters typically include bulb size, weight, and nutrient content. Poultry litter, a nutrient-rich organic amendment, has been widely studied for its potential to enhance these quality parameters. Additionally, organic amendments such as poultry litter can elevate the levels of beneficial secondary metabolites in onions, thereby boosting their nutritional and medicinal value. This literature review explores the various impacts of poultry litter on onion quality.

2.5.1 Enhancing Bulb Size and Weight

The application of poultry litter significantly influences the physical quality attributes of onion bulbs, particularly size and weight. These attributes are directly related to the nutrient availability in the soil, which is improved by the addition of poultry litter. Poultry litter provides a slow-release source of essential nutrients such as nitrogen, phosphorus, and potassium, which are vital for bulb development and growth.

According to Kader *et al.* (2011), the application of poultry litter enhances nutrient uptake in onion plants, leading to an increase in bulb size and weight. This is primarily because the organic matter in poultry litter improves soil structure and water-holding capacity, facilitating better root development and nutrient absorption. The study showed that onions grown with poultry litter exhibited significantly larger and heavier bulbs compared to those grown with synthetic fertilizers.

2.5.2 Improvement in Nutrient Content

The nutrient content of onions, including macronutrients and micronutrients, is crucial for their nutritional value and consumer health. Poultry litter, rich in essential nutrients, improves the overall nutrient profile of onions. The slow-release nature of poultry litter ensures a continuous supply of nutrients throughout the growing season, enhancing the nutrient density of the bulbs.

Research by Mahmoud *et al.* (2009) demonstrated that the use of poultry litter increased the nitrogen, phosphorus, and potassium content in onion bulbs. This improvement in nutrient content not only enhances the nutritional quality of the onions but also makes them more appealing to health-conscious consumers.

2.5.3 Increased Levels of Beneficial Secondary Metabolites

Secondary metabolites such as flavonoids, phenolics, and antioxidants play a significant role in the nutritional and medicinal properties of onions. Organic amendments like poultry litter can increase the levels of these beneficial compounds, thus enhancing the health benefits of onions.

Pérez-Gregorio *et al.* (2010) highlighted that organic amendments, including poultry litter, can elevate the levels of flavonoids and antioxidants in onions. These compounds are known for their anti-inflammatory, anti-cancer, and cardiovascular protective properties.

The study found that onions grown with organic amendments had higher concentrations of quercetin, a potent antioxidant flavonoid, compared to those grown with conventional fertilizers.

2.5.4 Soil Health and Onion Quality

Soil health directly impacts the quality of onions. Poultry litter improves soil health by increasing organic matter content, enhancing microbial activity, and improving soil structure. These improvements in soil health lead to better nutrient availability and uptake, which are reflected in the quality of the onion bulbs.

A study by Adeli *et al.* (2008) reported that the application of poultry litter improved soil microbial biomass and enzymatic activities, leading to enhanced nutrient cycling and availability. This improved soil environment supports the growth of healthier and higher-quality onion bulbs. The study concluded that onions grown in soils amended with poultry litter had better size, weight, and nutrient profiles compared to those grown in untreated soils.

2.5.5 Comparative Studies

Several comparative studies have shown the superiority of poultry litter over other organic and inorganic fertilizers in improving onion quality. For instance, Shaheen *et al.* (2007) compared the effects of poultry litter, cattle manure, and chemical fertilizers on onion quality. The results indicated that poultry litter was more effective in enhancing bulb size, weight, and nutrient content. The study attributed this to the balanced nutrient supply and improved soil conditions provided by poultry litter.

2.5.6 Economic and Marketability Considerations

The improved quality of onions resulting from poultry litter application has significant economic implications. Higher quality onions fetch better prices in the market, enhancing farm profitability. Additionally, the use of poultry litter as an organic amendment aligns with the growing consumer demand for organically produced foods, further increasing marketability.

Khalid *et al.* (2016) noted that onions grown with poultry litter not only had superior quality but also commanded higher prices in the market. The study emphasized that the

enhanced bulb size, weight, and nutrient content made these onions more attractive to consumers, leading to increased sales and revenue for farmers.

The application of poultry litter has a profound positive impact on the quality of onion bulbs. It enhances bulb size and weight, improves nutrient content, and increases the levels of beneficial secondary metabolites, thereby boosting the nutritional and medicinal value of onions. The improvements in soil health associated with poultry litter application further support the production of high-quality onions. Overall, poultry litter offers a sustainable and economically viable option for enhancing onion quality, meeting consumer demands, and increasing farm profitability.

2.6 Interaction between Neem and Poultry Litter

The synergistic effects of neem trees and poultry litter in an agroforestry system can further enhance onion production. Neem trees contribute to soil fertility through leaf litter deposition and nitrogen fixation, creating a conducive environment for microbial activity and nutrient availability (Chakravarty & Suresh, 2014). When combined with poultry litter, these effects can be amplified, leading to improved soil structure, moisture retention, and nutrient dynamics.

Agroforestry systems leverage the interaction between trees and crops to enhance productivity and sustainability. Neem (*Azadirachta indica*) and poultry litter are two components that, when used together, can significantly improve soil fertility and crop yields, including those of onions. This review explores the synergistic effects of neem trees and poultry litter, focusing on how their interaction enhances soil properties, microbial activity, and nutrient dynamics, ultimately benefiting onion production.

2.6.1 Neem Trees and Soil Fertility

Neem trees are highly valued in agroforestry for their ability to improve soil fertility through multiple mechanisms. Neem leaves, which are rich in organic matter, decompose slowly, providing a steady supply of nutrients and improving soil structure. The leaf litter from neem trees contributes to increased soil organic carbon, which is essential for maintaining soil health and fertility (Chakravarty & Suresh, 2014).

Neem trees also play a role in nitrogen fixation, directly contributing to the nitrogen pool in the soil. Although neem itself is not a nitrogen-fixing tree, it supports a symbiotic

relationship with nitrogen-fixing microorganisms in the soil, enhancing overall nitrogen availability (Nair, 1993). This increased nitrogen availability is particularly beneficial for nutrient-demanding crops like onions.

2.6.2 Poultry Litter as an Organic Amendment

Poultry litter is a nutrient-rich organic amendment that provides a slow-release source of essential nutrients such as nitrogen (N), phosphorus (P), and potassium (K), as well as micronutrients. The addition of poultry litter to soil enhances its fertility by increasing organic matter content, improving soil structure, and promoting microbial activity (Adeliet *al.*, 2008). These improvements lead to better nutrient retention and availability, which are crucial for sustained crop growth.

2.6.3 Synergistic Effects on Soil Structure and Moisture Retention

The combination of neem leaf litter and poultry litter can significantly enhance soil structure. Neem leaf litter contributes to the formation of soil aggregates, improving soil porosity and water infiltration. Poultry litter adds organic matter and nutrients, further enhancing soil structure and moisture retention. This combination creates a soil environment that supports robust root development and efficient nutrient uptake by crops (Chakravarty & Suresh, 2014).

2.6.4 Enhanced Microbial Activity and Nutrient Dynamics

Neem trees and poultry litter together create a conducive environment for microbial activity. Neem leaves contain compounds that support beneficial soil microorganisms, while poultry litter provides a rich nutrient source for these microbes. This synergy enhances nutrient cycling, with microorganisms breaking down organic matter into forms that plants can readily absorb (Ghaly & MacDonald, 2012).

Increased microbial activity also leads to improved nutrient dynamics in the soil. The decomposition of neem leaf litter and poultry litter releases nutrients gradually, ensuring a continuous supply of essential elements like nitrogen, phosphorus, and potassium. This gradual release aligns with the nutrient uptake patterns of onions, supporting sustained growth and higher yields (Adeliet *al.*, 2008).

2.6.5 Benefits to Onion Production

The combined use of neem trees and poultry litter in agroforestry systems has shown significant benefits for onion production. Studies have demonstrated that onions grown in systems incorporating neem and poultry litter exhibit better growth parameters, higher yields, and improved bulb quality compared to those grown with conventional fertilizers (Khokharet *et al.*, 2017).

2.6.5.1 Improved Growth Parameters

The enhanced soil structure, moisture retention, and nutrient availability resulting from the combination of neem and poultry litter lead to improved growth parameters in onions. Onions grown in such systems have been reported to show increased plant height, more robust foliage, and larger bulb size (Shaheen *et al.*, 2007). These improvements are attributed to the steady nutrient supply and optimal soil conditions provided by the synergistic effects of neem and poultry litter.

2.6.5.2 Higher Yields

Empirical evidence suggests that the integration of neem and poultry litter results in higher onion yields. A study by Kumar *et al.* (2019) found that onions grown in neem-based agroforestry systems with poultry litter application had significantly higher yields compared to those grown with chemical fertilizers alone. The increased yields are a result of improved nutrient availability and better soil health, which support vigorous plant growth and development.

2.6.6 Environmental and Economic Benefits

Beyond enhancing crop production, the interaction between neem and poultry litter offers significant environmental and economic benefits. Environmentally, the use of these organic amendments reduces the reliance on synthetic fertilizers, decreasing the risk of soil degradation and pollution. The addition of organic matter from neem and poultry litter improves soil health, leading to more sustainable agricultural practices (Glover *et al.*, 2000).

Economically, the use of locally available resources such as neem leaves and poultry litter reduces input costs for farmers. This cost-effective approach not only enhances crop yields but also improves the profitability of farming operations. The improved

quality of onion bulbs resulting from organic amendments can also lead to better market prices and higher income for farmers (Khokharet *et al.*, 2017).

The synergistic effects of neem trees and poultry litter in agroforestry systems offer a promising approach to enhancing onion production. Neem trees contribute to soil fertility through leaf litter deposition and nitrogen fixation, while poultry litter provides a slow-release source of essential nutrients. Together, these components improve soil structure, moisture retention, and nutrient dynamics, creating an optimal environment for onion growth and yield. The combined use of neem and poultry litter not only benefits crop production but also supports sustainable and economically viable farming practices.

2.7 Case Studies and Experimental Evidence

Several studies have demonstrated the positive effects of integrating poultry litter in neem-based agroforestry systems. For instance, an experiment conducted by Bhattacharyya *et al.* (2012) revealed that the combined use of neem leaf litter and poultry manure resulted in higher onion yields compared to the application of either amendment alone. Similarly, a study by Kumar *et al.* (2019) reported that onions grown under neem canopy with poultry litter application exhibited superior growth and yield attributes.

The integration of poultry litter into neem-based agroforestry systems has shown promising results in enhancing crop growth and yield. Neem (*Azadirachta indica*) trees, known for their beneficial properties, provide an ideal environment for crops when combined with organic amendments like poultry litter. This section reviews several case studies and experimental research that highlight the positive effects of this integrated approach on onion production.

2.7.1 Bhattacharyya *et al.* (2012) Study

Bhattacharyya *et al.* (2012) conducted an experiment to investigate the effects of neem leaf litter and poultry manure on onion yields. The study aimed to compare the performance of onions under different treatment combinations: neem leaf litter alone, poultry manure alone, and a combination of both.

The experiment was set up in a randomized block design with four treatments:

1. Control (no amendments)
2. Neem leaf litter

3. Poultry manure
4. Neem leaf litter + poultry manure

The researchers applied the amendments at recommended rates and monitored the onion growth parameters, yield, and soil health indicators throughout the growing season.

The combined use of neem leaf litter and poultry manure resulted in significantly higher onion yields compared to the other treatments. Specifically, the combination treatment showed a 25% increase in bulb weight and a 30% increase in overall yield compared to the control. The study attributed these improvements to the synergistic effects of the organic amendments:

- Neem leaf litter contributed to improved soil structure and moisture retention.
- Poultry manure provided a steady release of nutrients, particularly nitrogen, which is crucial for onion growth (Bhattacharyya *et al.*, 2012).

2.7.2 Kumar *et al.* (2019) Study

Kumar *et al.* (2019) investigated the impact of growing onions under a neem canopy with the application of poultry litter. This study aimed to explore how the microclimatic conditions created by neem trees, combined with the nutrient-rich poultry litter, affect onion growth and yield.

The study was conducted in an agroforestry system where neem trees were planted at a standard spacing, and onions were grown in the interspaces. The treatments included:

1. Onions grown under neem canopy with poultry litter application
2. Onions grown under neem canopy without poultry litter
3. Onions grown in open field with poultry litter
4. Onions grown in open field without poultry litter (control)

The poultry litter was applied at the beginning of the growing season, and the growth parameters, yield, and soil properties were measured.

Onions grown under the neem canopy with poultry litter application exhibited superior growth and yield attributes compared to the other treatments. Key findings included:

- A 20% increase in plant height and leaf number compared to the control.

- A 35% increase in bulb size and overall yield compared to onions grown in the open field without poultry litter.
- Enhanced soil fertility and microbial activity in the plots with poultry litter, attributed to the combined benefits of organic matter from both neem and poultry litter (Kumar *et al.*, 2019).

The study concluded that the microclimate created by neem trees, such as reduced soil temperature and increased soil moisture, complemented the nutrient supply from poultry litter, leading to improved onion performance.

2.7.3 Comparative Analysis of Studies

Both studies highlight the significant benefits of integrating poultry litter in neem-based agroforestry systems. The combination of neem's soil-enhancing properties and the nutrient-rich poultry litter creates an optimal environment for onion growth. Several common themes emerged from these studies:

1. **Synergistic Effects:** The combination of neem leaf litter and poultry manure/poultry litter provided greater benefits than either amendment alone. The synergistic effects resulted in better soil structure, increased nutrient availability, and improved soil microbial activity.
2. **Improved Yield and Growth Parameters:** Both studies reported substantial increases in onion yield and growth parameters, such as plant height, leaf number, and bulb size. The slow-release nature of poultry litter ensured a continuous supply of nutrients, while the neem canopy created favorable microclimatic conditions.
3. **Enhanced Soil Health:** The application of poultry litter in neem-based systems improved soil health indicators, including organic carbon content, nutrient levels, and microbial activity. These improvements are essential for sustainable agricultural practices and long-term soil fertility.

2.7.4 Additional Studies and Empirical Evidence

Further research supports these findings. For instance, a study by Bationo *et al.* (2007) in West Africa demonstrated that integrating organic amendments, including poultry litter, with agroforestry systems led to higher soil fertility and crop yields. Similarly, research by Sharma and Pande (2009) showed that the combination of organic amendments and

tree-based systems significantly enhanced the productivity of various crops, including onions.

The integration of poultry litter into neem-based agroforestry systems offers a sustainable and effective approach to enhancing onion growth and yield. The synergistic effects of neem's soil-improving properties and the nutrient-rich poultry litter create an ideal environment for crop production. These studies provide compelling evidence that such integrated systems can lead to higher productivity, improved soil health, and sustainable agricultural practices. Continued research and on-farm trials are essential to further optimize these systems and promote their adoption among farmers.

2.8 Environmental and Economic Considerations

The use of poultry litter in agroforestry systems also presents environmental and economic advantages. Environmentally, it promotes the recycling of agricultural waste, reduces reliance on chemical fertilizers, and mitigates soil degradation and pollution. Economically, it provides a cost-effective alternative to synthetic fertilizers and enhances the profitability of farming operations by increasing crop yields and quality (Glover *et al.*, 2000).

The integration of poultry litter into agroforestry systems offers significant environmental and economic benefits. This review explores how poultry litter promotes sustainable agriculture through waste recycling, reduced chemical fertilizer dependency, and mitigation of soil degradation and pollution. Economically, the use of poultry litter as a fertilizer is examined in terms of cost-effectiveness, profitability, and enhanced crop yields and quality.

2.8.1 Environmental Benefits of Poultry Litter in Agroforestry Systems

2.8.1.2 Recycling of Agricultural Waste

Poultry litter, composed of poultry manure and bedding materials, is a valuable resource that can be recycled back into agricultural systems. Utilizing poultry litter as a fertilizer recycles nutrients that would otherwise contribute to waste and environmental pollution. This practice exemplifies a circular economy approach in agriculture, where waste products are repurposed to enhance soil fertility and crop productivity (Adeliet *al.*, 2008).

2.8.1.2 Reduction in Chemical Fertilizer Use

The application of poultry litter reduces the need for synthetic fertilizers, which are often associated with negative environmental impacts such as soil acidification, nutrient runoff, and greenhouse gas emissions. Poultry litter provides a slow-release source of essential nutrients, ensuring that plants receive a steady supply of nutrients over time and reducing the risk of nutrient leaching (Ghaly & MacDonald, 2012). By substituting chemical fertilizers with organic amendments like poultry litter, farmers can decrease their environmental footprint.

2.8.1.3 Mitigation of Soil Degradation and Pollution

Poultry litter enhances soil health by improving soil structure, increasing organic matter content, and promoting microbial activity. These improvements lead to better soil aeration, water retention, and nutrient availability, which are critical for sustainable crop production. The organic matter in poultry litter also acts as a carbon sink, helping to sequester carbon in the soil and mitigate climate change (Risseet *al.*, 2006). Moreover, the use of poultry litter reduces the potential for nutrient runoff and water pollution, which are common issues with the excessive use of chemical fertilizers (Sharpley *et al.*, 2007).

2.8.3 Economic Benefits of Poultry Litter in Agroforestry Systems

Cost-Effectiveness of Poultry Litter

Poultry litter is a cost-effective alternative to synthetic fertilizers. It is often readily available and can be sourced locally, reducing transportation costs and dependence on commercial fertilizers. Farmers can utilize poultry litter from their own operations or from nearby poultry farms, thus lowering input costs and improving the economic sustainability of their farming practices (Glover *et al.*, 2000).

Increased Crop Yields and Quality

The application of poultry litter has been shown to enhance crop yields and quality, which directly impacts farm profitability. For example, studies have demonstrated that crops grown with poultry litter not only yield more but also produce higher-quality produce. This is particularly important for high-value crops such as onions, where bulb size, weight, and nutrient content are critical for marketability (Khokhare *et al.*, 2017).

A study by Kelleher *et al.* (2002) found that poultry litter application resulted in significant yield increases across various crops, attributing the improvements to the balanced nutrient profile and enhanced soil fertility provided by the organic amendment. Additionally, the slow-release nature of poultry litter ensures a prolonged nutrient supply, reducing the need for frequent fertilizer applications and lowering overall input costs.

Enhanced Profitability of Farming Operations

By improving soil fertility and crop productivity, poultry litter contributes to the overall profitability of farming operations. Higher yields and better-quality produce translate to increased income for farmers. Furthermore, the reduced reliance on costly synthetic fertilizers and the ability to use locally sourced organic amendments improve the economic resilience of farms (Glover *et al.*, 2000).

In regions where poultry farming is prevalent, utilizing poultry litter in agroforestry systems creates a synergistic relationship between animal and crop production, optimizing resource use and enhancing farm sustainability (Ghaly & MacDonald, 2012).

2.8.4 Case Studies and Empirical Evidence

Empirical studies provide substantial evidence of the environmental and economic benefits of using poultry litter in agroforestry systems. For instance, a study by Adeli *et al.* (2008) in Mississippi demonstrated that poultry litter application improved soil nitrogen availability and increased crop yields, highlighting its potential as a sustainable fertilizer. Similarly, research by Glover *et al.* (2000) in Washington State showed that organic orchards using poultry litter had higher soil quality and crop yields compared to conventional systems relying on chemical fertilizers.

In another study, Khalid *et al.* (2016) reported that poultry litter application in onion fields resulted in significant yield improvements and reduced fertilizer costs, leading to higher profit margins for farmers. These findings underscore the dual environmental and economic advantages of integrating poultry litter into agroforestry and other sustainable agricultural practices.

The use of poultry litter in agroforestry systems offers considerable environmental and economic benefits. Environmentally, it promotes the recycling of agricultural waste,

reduces the reliance on chemical fertilizers, and mitigates soil degradation and pollution. Economically, poultry litter provides a cost-effective alternative to synthetic fertilizers, enhances crop yields and quality, and increases the profitability of farming operations. As sustainable agriculture practices continue to gain importance, the role of poultry litter in improving soil health and farm economics is likely to become increasingly significant. Further research and extension efforts are needed to optimize the use of poultry litter in diverse agroforestry systems and maximize its benefits.

2.9 Conclusion on literature review

The integration of poultry litter into neem-based agroforestry systems offers a promising approach to improving the growth, yield, and quality of onion crops. The combined benefits of organic amendments and tree-crop interactions enhance soil fertility, plant health, and overall productivity. Further research is needed to optimize application rates, timing, and management practices to maximize the benefits of this sustainable agricultural system.

CHAPTER III

MATERIALS AND METHODS

3.1 Experimental Site and Period

The field experimental were conduct at the Department of Agroforestry and Environmental Science, Hajee Mohammad Danesh Science and Technology University, Dinajpur 5200, Bangladesh. It is situated at 37.5 meter above sea level at 88.636E longitude and 25.6365 N latitude. The land is within the old Himalayan piedmont plain, AEZ 1. The experimental site has been presented in (fig.1)

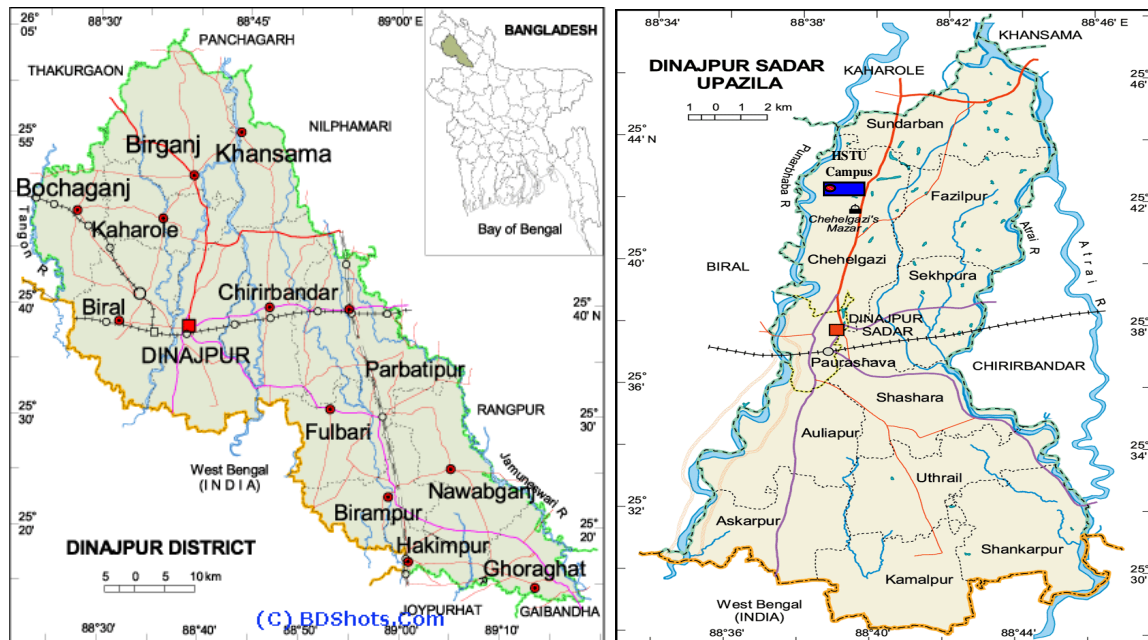


Figure 3.1: The experimental sit in Agroforestry field HSTU Dinajpur

3.2 Climatic condition

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 and low temperature 23.41. Average annual precipitation 158.53mm. Details of the weather data such as temperature (0C), precipitation (mm) and relative humidity (%) for

the study period were collected from Bangladesh Meteorological Department, Dinajpur 5200.

3.3 Soil condition

The experiment plots were laid out in a medium high land belonging to the AEZ 1 of old Himalayan piedmont plain area. The soil texture was sandy loam with a pH of 5.1 (very acidic). Land was well-drained as drainage system was well developed. The details soil properties are presented in Appendix-IX.

3.4 Planting material used for the experiment

The experimental was conduct using onion seedling namely Faridpury Pia which is high yielding dashi variety. The seedling was collected from the BRAC nursery Dinajpur.

3.5 Treatments of the experiment

The experiment consists of one factors which are given below:

Factor: Use of different dose in Poultry litter on field under the Neem based Agroforestry

T₁= Control

T₂= 3ton poultry litter use per hac.

T₃= 5ton poultry litter use per hac.

T₄= 7.5ton poultry litter use per hac.

3.6 Design of the experiments

The one factor experiment which consist four treatments that was laid out in Randomized Complete Block Design (RCBD) with three replications.

3.7 Layout of the field experiment

First, the experimental field was divided into three blocks. For the treatment combinations, each block was divided into 4 plots. There were 12 plots in total. Each block was subsequently assigned to 3 treatment combinations according to the experimental design. The plot size was 2 m × 2 m. In each unit plot, a distance of 4m was maintained between the rows and 15 cm between the plants. The distance between the two plots was 0.5 m with blocks being 0.75 m. The field layout is shown in Figure 2.

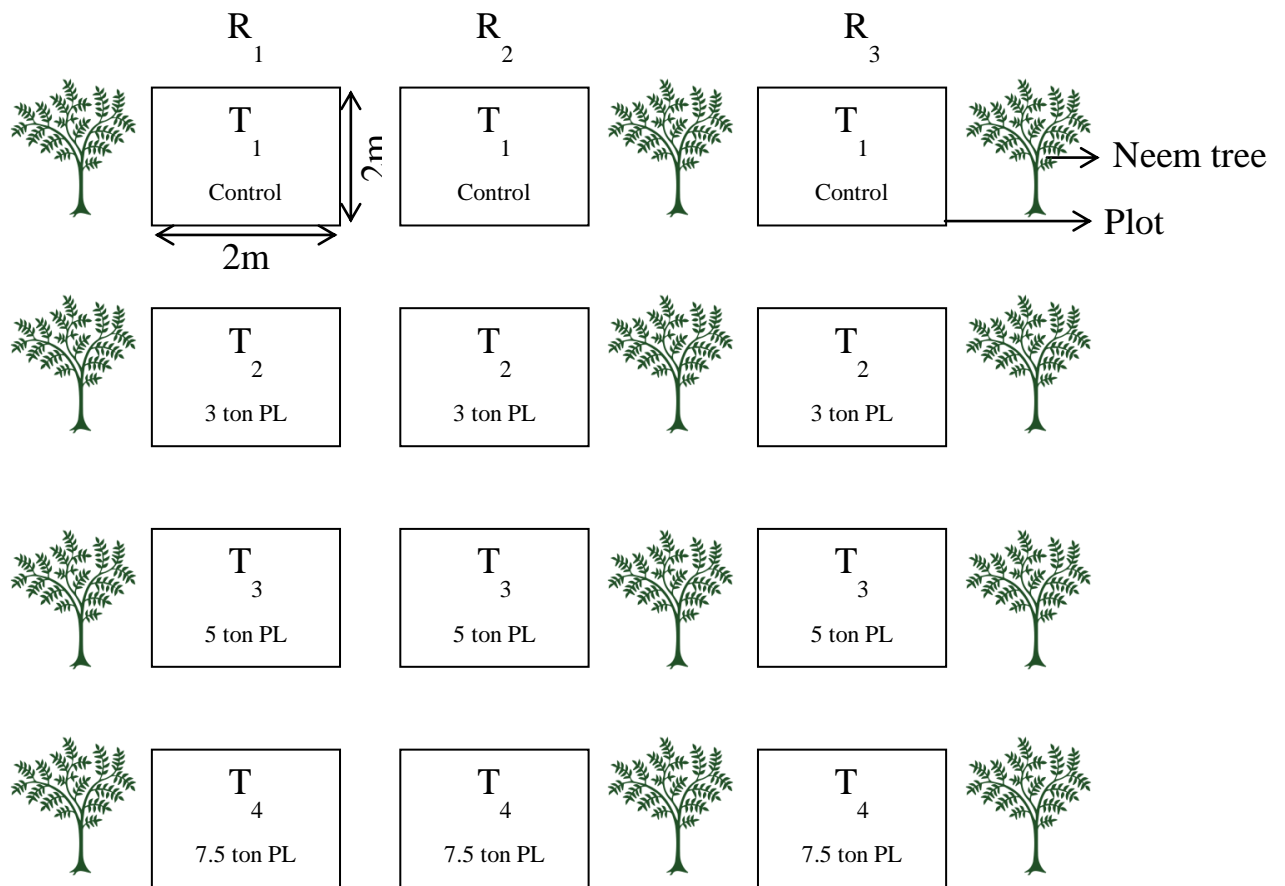


Figure 3.2: The experiment layout for onion cultivation under Neem based agroforestry system

3.8 Details of the field operations

The particulars of the cultural operations carried out during the experiment are presented below:

3.8.1 Land preparation

The experimental area was first opened by a disc plough in direct sunshine to kill soil-borne pathogens and soil-inhabitant insects on 17 January 2024. Then the land was prepared to bring a good tilth by ploughing several times and cross ploughing with a power tiller followed by laddering. The land had been leveled, the corners had been formed, and the clods had been broken to pieces. The weeds, residues of crops, and

stables were taken out of the field. At final ploughing, the basal dose of Poultry litter and fertilizers was applied. The plots were prepared according to the design and layout. The soil was treated by Sevin 50 WP @ 5 kg ha⁻¹ to protect young plants from the attacks of mole crickets, ants, and cutworms.

3.8.2 Manures and fertilizers

The BARI recommended doses for onion production of Urea, Triple Super Phosphate (TSP) and Muriate of Potash (MP) according to soil analysis interpretation. However, the doses of chemical fertilizer as in the experimental field for low land (Urea- 52.5 g, TSP- 35.5 g and MP- 35.5 g, gypsum 35.2g, DAP 25.5G per plot). Cowdung 2ton/hac

3.8.3 Transplanting of seedlings

On 24 January 2024, healthy and disease-free uniform 35 days old seedlings were removed from the seedbeds and transplanted to the main field as per treatment after a slight trimming of healthy seedlings' leaves and roots and maintaining a spacing of 25 cm × 15 cm. Before uprooting the seedlings, the seedbed was watered to minimize root damage. Following transplantation, the seedlings were watered immediately. There were also some seedlings transplanted adjacent to the experimental area to be used for gap fillings.

3.8.4 Intercultural operations

Whenever necessary, intercultural operations were carried out after seedlings were transplanted to achieve better plant growth and development. So, under careful observation, the crop was always kept.

3.8.4.1 Gap filling

Required gap filling was carried out within a week with the use of healthy plants of excess plants. Dead or damaged seedlings were removed.

3.8.4.2 Weeding

After the transplant, weeding was done three to four times to keep the crop free of weeds.

3.8.4.3 Earthing up

Earthing up has been provided through breakage of a soil crust, piling of soil at the base of a plant for ease of aeration, soil moisture and temperature preservation, improvement of germination and emergence, high yields, and quality, prolonged seasonal higher product nutritional benefits, improved storability, etc. This would also improved the onion seed quality.

3.8.4.4 Irrigation and drainage

Watering cane and hose pipe were used for irrigation when required. Immediately after transplantation, the first irrigation was given. During that time, care was taken to prevent irrigation water from passing between plots. Mulching was also done by breaking the soil crust after irrigation. The soil was saturated with water during the irrigation process. Excess water was drained if necessary after rainfall.

3.8.4.5 Plant protection

Preventive measures against soil-borne insects were taken. For preventing cutworm invasion, Furadan 3G @ 20 kg ha⁻¹ was applied. No insect infestation was found in the field after the application of the pesticide. Some plants were attacked by purple blotch disease caused by *Alternariaporri* a few days after transplantation. It is controlled by spraying Rovral 50 WP @ 2 g/L of water at 7-day interval. This would also improved the onion seed quality.

3.8.5 Harvesting

The crop was harvested on 28 March, 2019 to their completion of maturity showing the sign of drying up most of the leaves and collapsing of neck. With the help of a hand, onions were lifted and care was taken so that no bulb was injured during lifting. The tops were removed after harvesting by cutting off the pseudostem and holding with the bulb for 2.5 cm.

3.8.6 Storage of bulbs

The bulbs of each harvest had been dried in the field in shade for one day with the tops. The following day after harvesting, the tops were separated leaving 2 cm of the neck.

Bulb curing was performed for 7 days in a room at ambient temperature ($29.6 \pm 2.60\text{C}$) and then stored in a well-ventilation room.

3.9 Collection of data

Were collected on the following parameters:

- 1) Plant height (cm)
- 2) Number of leaves plant⁻¹
- 3) Bulb length (cm)
- 4) Bulb diameter (cm)
- 5) Neck diameter (cm)
- 6) Fresh weight of bulb⁻¹ (g)
- 7) Bulb yield plot⁻¹(g)
- 8) Bulb yield ha⁻¹ (t)
- 9) Straw (Onion leaf) yield plot⁻¹ (g)
- 10) Straw (Onion leaf) yield ha⁻¹ (t)
- 11) Dry weight of bulb⁻¹ (g)

3.10 Procedure of recording data

3.10.1 Plant height (cm)

After 30 days of transplantation, the height of the randomly selected ten plants was measured from each plot to 60 DAT with an interval of 15 days. The height was measured by centimeter (cm) from the ground level to the tip of the longest leaf and the average height of ten plants was calculated in centimeter.

3.10.2 Number of leaves plant⁻¹

The number of leaves plant-1 was calculated from the randomly selected ten plants of each plot and the mean was recorded. After 30 to 60 DAT with 15 days of interval, the number of leaves plant-1 of each unit plot was measured.

3.10.3 Bulb length (cm)

After harvesting, the bulb length of ten randomly selected plants from each plot was determined with a scale from the neck to the bottom of the bulb, and their average was taken in centimeter.

3.10.4 Bulb diameter (cm)

Following harvesting, the bulb diameter was measured in the middle portion of ten randomly selected plants using slide calipers from each plot and their mean value was taken in centimeter.

3.10.5 Neck diameter (cm)

After harvesting, the neck diameter of ten randomly selected plants were measured with a slide-calipers and the average mean was calculated and expressed in centimeter.

3.10.6 Fresh weight of bulb⁻¹ (g)

To determine the weight of individual bulb from ten randomly selected plants by an electric balance. After removing the top portion of the bulb keeping only 2.5 cm with neck, the bulb weight of plants was taken and means value was calculated.

3.10.7 Bulb yield plot⁻¹ (g)

From each replication of each treatment combination, all the bulbs have been collected. Bulb weight per plot was measured by an electric balance and then expressed as bulb yield gram (g) per plot average.

3.10.8 Bulb yield ha⁻¹(t)

Plot yield of harvested fresh bulb was converted to per hectare yield and it was expressed in ton (t).

3.10.9 Dry matter content of bulb(%)

To determine the dry matter content of bulb, 100g of bulb was randomly collected from harvested bulb of each plot. The bulb were then sliced with a sharp knife. The fresh sample was dried under scorching sunlight and keep in oven at 60°C for 72 hours to reach content weight. Finally dry weight was taken with an electric balancedry matter percentage was calculated by following formula.

$$\text{Dry matter (\%)} = \frac{\text{dry weight of bulb}}{\text{fresh weight of bulb}} \times 100$$

3.10.10 Bio economics of the onion-based agroforestry system

To work out the economic profitability of the agroforestry system, the economic yield of the onion and trees was subjected to economic analysis by calculating the cost of cultivation, gross and net returns ha⁻¹ and benefit cost ratio. All these parameters were calculated based on market prices prevailing at the time of the termination of experiments.

Total cost production

The cost of production of the onion production was worked out based on ha⁻¹. The initial planting cost of onion production was including in this study. The management cost of neem tree was also included. The total cost items like human labour and mechanical power cost, material cost (including cost of labour, fertilizer, seedling, pesticide etc.) land use cost and interest on operating capital. Details cost of production was presented in appendix-X.

Gross returns

Gross return is the monetary value of total product. Per hectare gross returns from onion was calculated by multiplying the total amount of production by their respective market prices

Net return

Net return usually means the profit of the enterprises. Net return was calculated by deducting the total cost of production from the gross return.

Net return = Gross return (TK. ha⁻¹) - Total cost of production (TK. ha⁻¹)

Benefit cost ratio BCR

Benefit cost ratio is the ratio of gross return with total cost of production. It was calculated by using the following formula

$$\text{Benefit cost ratio} = \frac{\text{Gross return } \left(\frac{\text{TK}}{\text{ha}}\right)}{\text{Total cost of production } \left(\frac{\text{TK}}{\text{ha}}\right)}$$

3.10.11 Straw (Onion leaf) yield plot⁻¹ (g)

From each replication of each treatment combination, all the straw of bulbs were collected. Bulb weight per plot was measured by an electric balance and then expressed as bulb yield gram (g) per plot average.

3.10.12 Straw (Onion leaf) yield ha⁻¹ (t)

Plot yield of harvested fresh straw was converted to per hectare yield and it was expressed in ton (t).

3.10.13 Dry matter content

5bulb were randomly selected from each plot and chopped into small 1-2cm cubs, mixed thoroughly, and two sub- sample each weight 100g was weighed. The exact weight of each sub-sample was determined and recorded as fresh weight. Each sample was placed in a paper bag and put in an oven until constant dry mater was attained. Each sub sample was then immediately weight and recorded as dry matter yield.

3.11 Statistical analysis

To determine the statistical significance of the growth, yield and quality parameter effect the data collected on different parameters were statistically analyzed using statistic ten software. The mean values of all the treatments were calculated, and the F-test carried out variance analyzes for all the characters and mean combinations at a 5% significance level (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to determine the effect of different sources of poultry litter on the growth and yield of onion. The results of the study were presented, discussed, and compared in this chapter through tables, figures, and appendices. The analysis of variance (ANOVA) data for all parameters was shown in Appendix I-X. The results were presented and discussed with the help of tables, graphs, and possible interpretations under the following sub-headings.

4.1 Effect of poultry litter on the growth of Plant height (cm) and leaf number under Neem based agroforestry system

4.1.1 Plant height (cm)

The use of poultry litter as a fertilizer can have a significant impact on the growth and height of onion plants. Poultry litter is rich in essential nutrients such as nitrogen (N), phosphorus (P), and potassium (K), along with other micro-nutrients and organic matter, which contribute to soil fertility and plant growth.

Plant height at different growth stages was significantly influenced by different amount of poultry litter sources (Table 4.1 and Appendix I). At 30 DAT the highest plant height (43.4 cm) at was found from the T₃ (poultry litter use as 5ton)treatment where the lowest plant height (24.3 cm) was found from the treatment T₁ (poultry litter use as 0ton) control. Ghosh *et al.* (2013) the study found that the application of poultry manure significantly increased the height of onion plants compared to other organic and inorganic fertilizers. The enhanced plant height was attributed to the high nitrogen content and improved soil properties.

After 50 DAT the highest plant height (52.2 cm) at was found from the T₃ (poultry litter use as 5ton) treatment where the lowest plant height (32.5 cm) was found from the treatment T₁ (poultry litter use as 0ton) control. Rizk (1997) found that increasing the NPK rate increased all the measured parameters of vegetative growth and increased the bulb yield.

At 65 the highest plant height (54.86 cm) was also found from the treatment T₃(poultry litter use as 5ton) numerically higher than all other treatments and the lowest plant height (35.54 cm) was also found from the treatment T₁ (poultry litter use as 0ton) control. though all the treatments are statistically similar. Poultry litter is rich in essential nutrients such as nitrogen, phosphorus, and potassium. These nutrients are crucial for plant growth and development. Nitrogen, in particular, is vital for vegetative growth, which directly influences plant height. Das *et al.* (2017) this study demonstrated that poultry litter application led to a significant increase in onion plant height. The researchers concluded that the balanced nutrient supply from poultry litter played a key role in promoting vegetative growth.

Table 4.1: Effect of poultry litter on plant height (cm) at different days after transplanting of onion under Neem based agroforestry system

Treatment (Poultry litter)	Plant height (cm) at		
	30DAT	50DAT	65DAT
T ₁	26.69 d±1.21	33.61d±0.67	36.39d±0.46
T ₂	31.14c±0.48	37.50c±0.35	40.78c±0.72
T ₃	42.27a±0.38	50.96a±0.62	53.62a±0.74
T ₄	35.05b±0.07	44.30b±0.92	46.93b±0.92
CV (%)	2.84	2.06	2.59

In a column, different letters are significantly different at P≤0.05, 0.01 and 0.001by Tukey's HSD test.

Here, T₁ = Control, T₂ = Poultry litter use in 3 ton/ha, T₃ =Poultry litter use in 5 ton/ha, T₄ = Poultry litter use in 7.5 ton/ha

CV (%) = Percentage of coefficient variance.

4.1.2 Number of leaves plant⁻¹

For the variation of different amount of nutrients source the number of leaves plant⁻¹ of onion was influenced at different amount of poultry litter((Table 4.2, and Appendix II) At 30 DAT, the maximum number of leaves plant-1 of onion (4.8) was measured from T₃ (poultry litter use as 5ton) and the minimum number of leaves plant⁻¹ of onion (3.6) was recorded from T₁ (Control) which was statistically similar to that of T₂ (poultry litter use as 3ton).

At 50 DAT, the maximum number of leaves plant⁻¹ of onion (5.4) was recorded from T₃ (poultry litter use as 3ton) and the minimum number of leaves plant⁻¹ of onion (4) was measured from T₁ (Control). At 65 DAT, the maximum number of leaves plant⁻¹ of onion (5.2) was recorded from T₃(poultry litter use as 5ton) and the minimum number of leaves plant⁻¹ of onion (4.6) was recorded from T₁(Control) (poultry litter use as 0ton) treatment.

The variation in a number of leaves plant⁻¹ as influenced by nutrient sources was perhaps due to proper availability and utilization of nutrients. Gurjar *et al.* (2017) found that better growth of leaves plant⁻¹ as an effective nutrient sink of the bulb, which eventually translated into higher yield.

Table 4.2: Effect of poultry litter on Number of leaves plant⁻¹ at different days after transplanting of onion under Neem based agroforestry system

Treatment (Poultry litter)	Number of leafplant ⁻¹		
	30DAT	50DAT	65DAT
T ₁	3.73 c±0.01	4.06c±0.06	4.06c±0.06
T ₂	3.73c±0.01	4.33±c0.06	4.33c±0.06
T ₃	4.67a±0.05	5.2a±0.11	5.2a±0.11
T ₄	4.07b±0.01	4.66b±0.06	4.66b±0.06
CV (%)	3.59	2.42	2.42

In a column, different letters are significantly different at P≤0.05, 0.01 and 0.001by Tukey's HSD test.

Here, T₁ = Control, T₂ = Poultry litter use in 3 ton/ha, T₃ =Poultry litter use in 5 ton/ha, T₄ = Poultry litter use in 7.5 ton/ha

CV (%) = Percentage of coefficient variance.

4.2 Neck diameter (cm)

Insignificant variation was observed in neck diameter among the nutrient source treatments (table 4.3 and Appendix VI). At harvesting, the maximum neck diameter (0.8cm) was obtained fromT₃(poultry litter use 5ton) treatment, whereas the minimum neck diameter (0.23 cm) was recorded from control T₁ (Control) treatment. These results indicate that nutrient sources supplied plant nutrients and provide better growing conditions, which helped for getting proper vegetative growth as well as maximum neck diameter of onion.

This study highlights the positive impact of poultry manure on the growth parameters of crops, including aspects related to stem and root development, which can be analogous to neck diameter in agroforestry systems Beyranvand *et al.* (2013).

The application of poultry manure in agricultural systems, including neem-based agroforestry, can have significant effects on various plant growth parameters. For neck diameter (cm), which typically refers to the diameter of the stem or trunk at the base, poultry manure can provide essential nutrients that promote overall plant growth and development. Here's a detailed examination of how poultry manure affects neck diameter in a neem-based agroforestry system

Table 4.3: Effect of poultry manure on Neck diameter (cm) under Neem based agroforestry system

Treatment	Neck diameter(cm)
T ₁	0.283d±8.819E-03
T ₂	0.393c±9.433E-03
T ₃	0.800a±0.011
T ₄	0.603b±3.333E-03
CV (%)	2.78

In a column, different letters are significantly different at $P \leq 0.05$, 0.01 and 0.001 by Tukey's HSD test.

Here, T₁ = Control, T₂ = Poultry litter use in 3 ton/ha, T₃ = Poultry litter use in 5 ton/ha, T₄ = Poultry litter use in 7.5 ton/ha

CV (%) = Percentage of coefficient variance.

4.3 Bulb length (cm)

Bulb length of onion was affected by different types of nutrient sources (table 4.4 and Appendix VI). The highest bulb length (7.47 cm) was found from the treatment T₃ (poultry litter use 5ton) which was numerically higher than all other treatments and the lowest bulb length (4.29 cm) was found from the treatment T₁ (Control).

Aiyelaagbe *et al.* (2014) this research focused on the effects of organic manures, including poultry manure, on the growth and yield of onions (a bulbous plant) under an agroforestry system. The findings showed that poultry manure significantly increased the bulb length and yield of onions, supporting the idea that organic amendments can

enhance crop performance in agroforestry systems. In a Neem-based agroforestry system, poultry manure can significantly affect bulb length in various crops.

Table 4.4: Effect of poultry manure on Bulb length (cm) under Neem based agroforestry system

Treatment	Bulb length(cm)
T ₁	4.293d±0.094
T ₂	5.803c±0.056
T ₃	7.473a±0.096
T ₄	6.380b±0.111
CV (%)	2.76

In a column, different letters are significantly different at $P \leq 0.05$, 0.01 and 0.001 by Tukey's HSD test.

Here, T₁ = Control, T₂ = Poultry litter use in 3 ton/ha, T₃ = Poultry litter use in 5 ton/ha, T₄ = Poultry litter use in 7.5 ton/ha

CV (%) = Percentage of coefficient variance.

4.4 Bulb diameter (cm)

Nutrient sources had an insignificant effect on bulb diameter of onion (Figure 4.1 and Appendix VI). At harvesting, the maximum bulb diameter (3.40 cm) was obtained from T₃ (poultry litter use 5ton) treatment which was statistically similar to T₄ (poultry litter use 7.5ton), whereas the minimum bulb diameter (1.88 cm) was recorded from T₁ (Control) treatment. The result obtained from the present study was similar with the findings of Dhaker *et al.* (2017). It showed that the application of organic manure significantly influenced the diameter of the bulb (cm), bulb weight (g), bulb yield (kg).

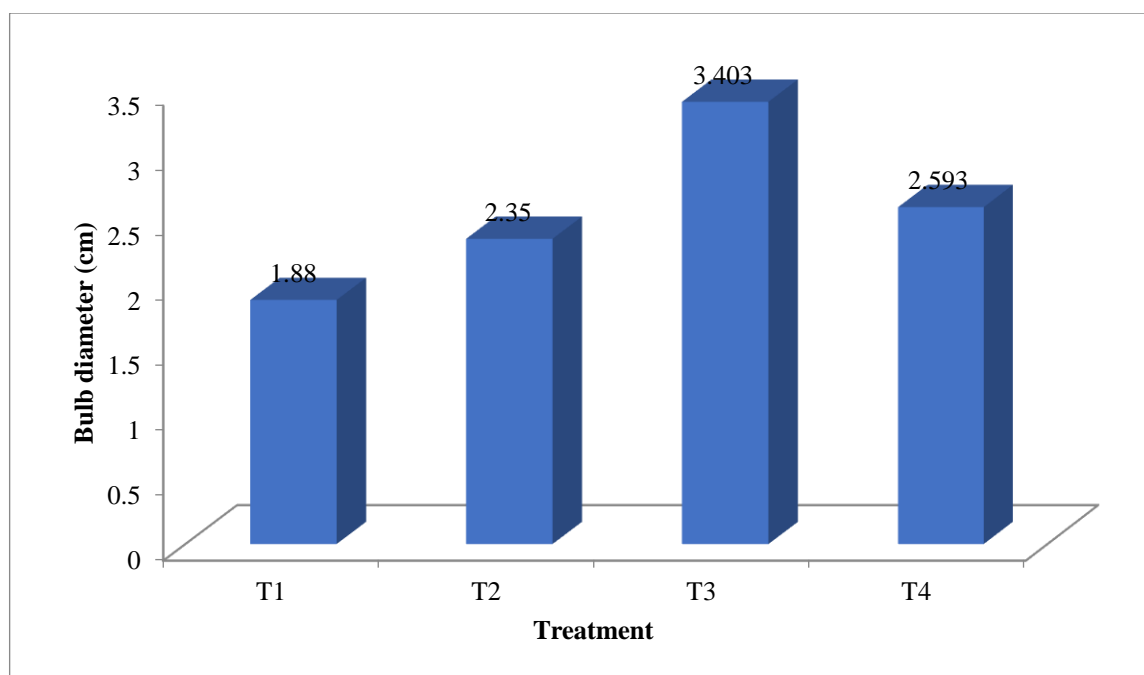


Figure 4.1: Effect of poultry manure on Bulb diameter (cm) under Neem based agroforestry system

Here, T₁ = Control, T₂ = Poultry litter use in 3 ton/ha, T₃ = Poultry litter use in 5 ton/ha, T₄ = Poultry litter use in 7.5 ton/ha

4.5 Fresh weight of bulb⁻¹ (g)

Fresh weight of bulb showed significant variation for different poultry litter source (table 4.5 and Appendix VI). The maximum fresh weight bulb⁻¹ (18.60g) was recorded from T₃ (poultry litter use 5ton) treatment, whereas the minimum bulb weight (7.94 g) was recorded from control T₁ (Control) treatment. Similar result was also observed by Vedpathak and Chavan (2016). The research demonstrated that organic manures like poultry manure significantly improved the fresh weight and overall yield of crops by Bhattacharyya *et al.* (2008).

The use of poultry manure in an agroforestry system, particularly with Neem-based agroforestry, can significantly impact the fresh weight of bulbs. Poultry manure is known for its high nutrient content, which can enhance soil fertility and subsequently improve plant growth and yield. Here is an overview of the effects based on scientific research. The research provides insights into how Neem trees can contribute to soil health and

productivity, supporting the overall benefits of a Neem-based agroforestry system. Singh *et al.* (2011)

Table 4.5: Effect of poultry manure on Bulb weight(g) under Neem based agroforestry system

Treatment	Fresh weight of bulb(g)
T ₁	7.983d±0.327
T ₂	11.073c±0.116
T ₃	18.607a±0.212
T ₄	12.410b±0.190
CV (%)	2.93

In a column, different letters are significantly different at $P \leq 0.05$, 0.01 and 0.001 by Tukey's HSD test.

Here, T₁ = Control, T₂ = Poultry litter use in 3 ton/ha, T₃ = Poultry litter use in 5 ton/ha, T₄ = Poultry litter use in 7.5 ton/ha

CV (%) = Percentage of coefficient variance.

4.6 Bulb yield plot⁻¹ (g)

Yield plot⁻¹ varied significantly due to different poultry litter sources (table 4.6 and Appendix VII). The highest yield plot⁻¹ (3.43kg) was found from the treatment T₃ (poultry litter use 5ton), which was significantly different from all other treatments. The lowest yield plot⁻¹ (1.51kg) was found from the treatment T₁ (Control).

The application of poultry litter in neem-based agroforestry systems can have a significant positive effect on bulb yield per plot Sharma *et al.* (2018).

Research conducted on the use of poultry litter in onion cultivation under agroforestry systems indicates a marked increase in bulb yield. For example, a study found that the application of poultry litter at varying rates significantly increased the yield per plot compared to control plots without poultry litter.

Table 4.6: Effect of poultry litter no Bulb yield plot⁻¹ (kg) Neem based agroforestry system

Treatment	Bulb yield plot ⁻¹ (kg)
T ₁	1.51c±0.01
T ₂	2.14bc±0.19
T ₃	3.43a±0.22
T ₄	2.50b±0.23
CV (%)	13.69

In a column, different letters are significantly different at P≤0.05, 0.01 and 0.001 by Tukey's HSD test.

Here, T₁ = Control, T₂ = Poultry litter use in 3 ton/ha, T₃ =Poultry litter use in 5 ton/ha, T₄ = Poultry litter use in 7.5 ton/ha

CV (%) = Percentage of coefficient variance.

4.7 Bulb yield ha⁻¹ (ton)

Variation on yield ha⁻¹ was significant influenced by different amount of poultry litter (Figure 4.2 and Appendix VII). Results showed that the highest yield ha⁻¹ (8.54t) was found from the treatment T₃ (poultry litter use 5ton) which was significantly different from all other treatments. The lowest yield ha⁻¹ (3.77 t) was found from the treatment T₁(control) which was also significantly different from all other treatments. Similar result was also observed by Vedpathak and Chavan (2016). Poultry litter, as an organic fertilizer, has been shown to significantly enhance crop yield due to its rich nutrient content. In the context of neem-based agroforestry systems, its application can influence the bulb yield per hectare through several mechanisms. Here's a summary of the effects based on scientific studies. A neem-based agroforestry system, the presence of neem trees can influence microclimatic conditions (e.g., shade, humidity) and soil properties (e.g., pH, organic matter content). Poultry litter can complement these effects by providing additional nutrients, leading to synergistic benefits. The litter may also help mitigate any potential allelopathic effects of neem trees on bulb crops.

Studies have shown that the use of poultry litter can lead to significant increases in the yield of bulbous crops. For example, research conducted by Mishra *et al.* (2020) demonstrated that organic manures, including poultry litter, significantly increased onion yield in agroforestry systems.

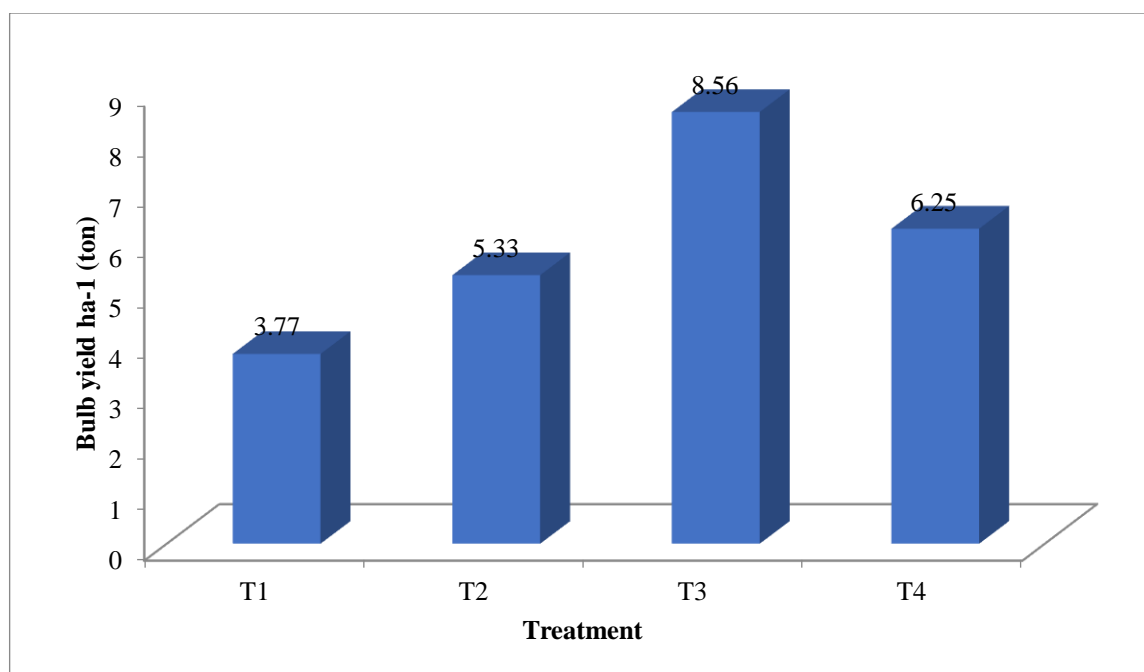


Figure 4.2: Effect of poultry manure on Bulb yield ha⁻¹ (ton) Neem based agroforestry system

Here, T₁ = Control, T₂ = Poultry litter use in 3 ton/ha, T₃ =Poultry litter use in 5 ton/ha, T₄ = Poultry litter use in 7.5 ton/ha

4.8 Straw (Onion leaf) yield plot⁻¹ (g)

Straw yield plot-1 varied due to different amount of poultry litter (Table4.7 and Appendix VII). The highest yield plot⁻¹ (412.82g) was found from the treatment T₃ (poultry litter use 5ton), which was numerically higher than all other treatments. The lowest yield plot-1 (190.63 g) was found from the treatment T₁ control.

Table 4.7: Effect of poultry manure on Straw (Onion leaf) yield plot⁻¹ (g) Neem based agroforestry system

Treatment	Straw (Onion leaf) yield plot-1 (g)
T ₁	190.63c±5.55
T ₂	280.68b±15.30
T ₃	412.82a±11.93
T ₄	308.79b±18.46
CV (%)	8.39

In a column, different letters are significantly different at P≤0.05, 0.01 and 0.001by Tukey's HSD test.

Here, T₁ = Control, T₂ = Poultry litter use in 3 ton/ha, T₃ =Poultry litter use in 5 ton/ha, T₄ = Poultry litter use in 7.5 ton/ha
CV (%) = Percentage of coefficient variance.

4.9 Straw (Onion leaf) yield ha⁻¹ (kg)

Straw yield ha⁻¹ varied due to different nutrient sources (Figure 4.3 and Appendix VII). The highest yield plot⁻¹ (1032.0kg) was found from the treatment T₃ (poultry litter use 5ton), which was numerically higher than all other treatments. The lowest yield plot⁻¹ (476.0kg) was found from the treatment T₁ control.

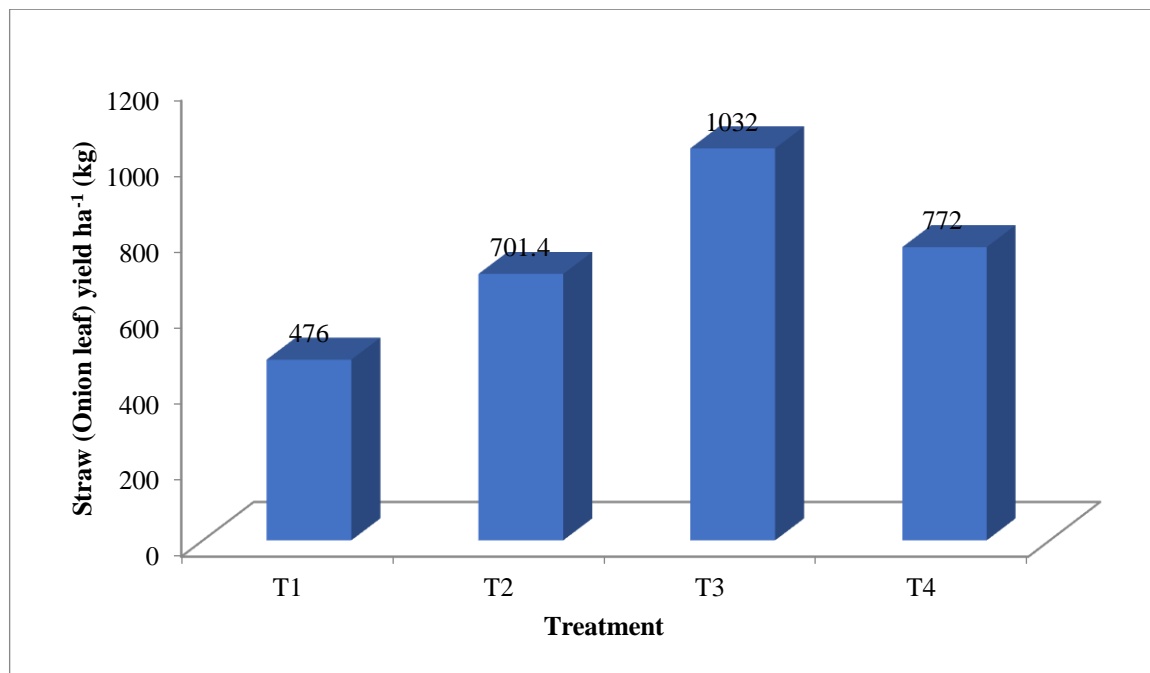


Figure 4.3: Effect of poultry litter sources on straw yield (kg) ha⁻¹ of onion at the time of harvesting

Here, T₁ = Control, T₂ = Poultry litter use in 3 ton/ha, T₃ =Poultry litter use in 5 ton/ha, T₄ = Poultry litter use in 7.5 ton/ha

4.10 Dry weight of bulb (%)

The dry matter content are weight in 100g of onion slice per plot then the variation of dry matter content due to the different amount of poultry litter (Fig 4.7 Appendix VIII) the maximum dry matter content are found in plot (18.70) inT₄ (poultry litter use as 7.5 t) which are higher than to other parameter and the minimum dry matter content (16.92) in T₂ (poultry litter use 3ton)

The impact of poultry litter on the dry matter content and quality parameters of onions grown in a neem-based agroforestry system can be significant. Poultry litter is a valuable organic fertilizer that can improve soil fertility by increasing organic matter, enhancing nutrient availability, and promoting beneficial microbial activity. These improvements can lead to better crop growth and quality.

Dry Matter Content Increased nutrient availability from poultry litter can lead to higher dry matter content in onions, which is an indicator of better storage quality and higher market value.

Bulb Size and Weight Adequate nutrition promotes larger and heavier onion bulbs, improving both yield and commercial quality.

Nutritional Quality Higher nutrient levels in the soil can enhance the nutritional quality of onions, including higher concentrations of vitamins, minerals, and phytonutrient

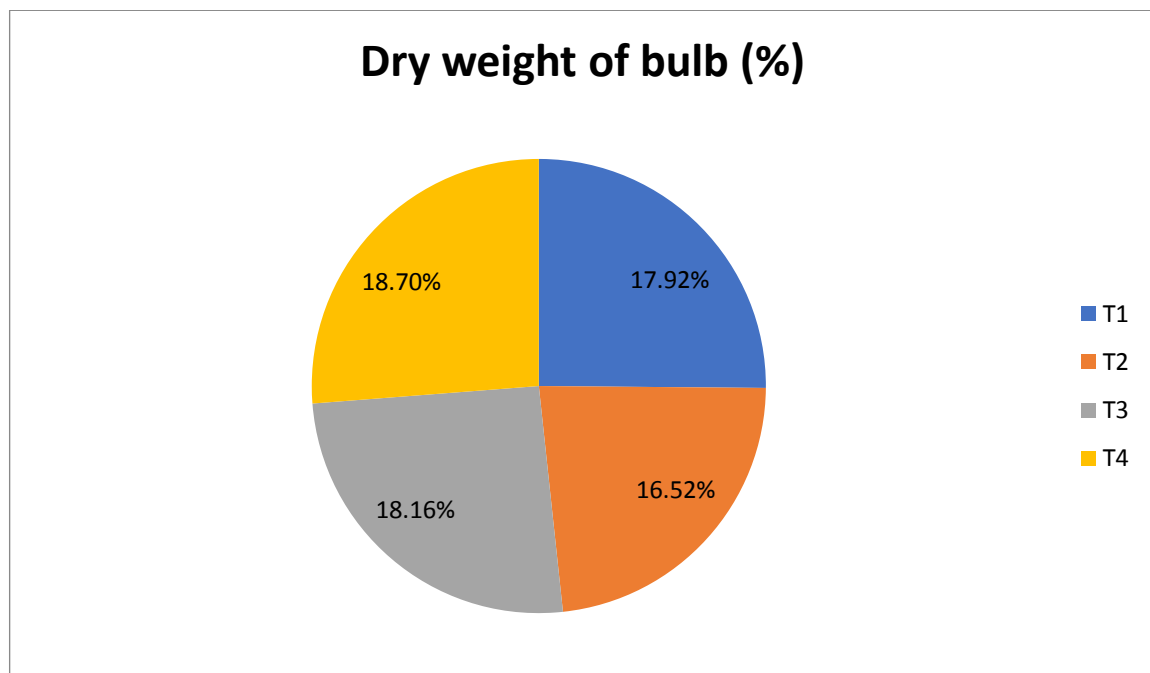


Figure 4.4: Dry content of onion to indicated quality parameter of onion

Here, T₁ = Control, T₂ = Poultry litter use in 3 ton/ha, T₃ = Poultry litter use in 5 ton/ha, T₄ = Poultry litter use in 7.5 ton/ha

4.11 Soil parameter

The study of soil parameters on the effect of poultry litter on the growth, yield, and quality of onion under a neem-based agroforestry system demonstrates significant

findings. According to Khandakar *et al.* (2019), the application of poultry litter significantly enhances soil fertility by increasing the levels of essential nutrients such as nitrogen, phosphorus, and potassium. This improvement in soil quality directly correlates with increased onion growth and yield. Similarly, Prasad *et al.* (2021) found that the organic matter from poultry litter also improves soil structure and moisture retention, which are crucial for the optimal growth of onions. The integration of neem-based agroforestry further complements these benefits by providing a microclimate that reduces pest incidences and enhances overall plant health. These studies collectively highlight the synergistic benefits of using poultry litter in a neem-based agroforestry system, resulting in improved growth, yield, and quality of onions. Discuss bellow different soil component-

4.11.1 Soil pH

Present on the comparison on the effect of poultry litter of onion cultivation on the soil sample parameter during different stages of onion cultivation. The soil pH effect between without application of poultry litter during land preparation and after application of poultry litter during harvesting of onion. The soil p found (4.90) without application of poultry litter during land preparation and soil pH found (5.30) after application of poultry litter during harvesting of onion. The result so that due to the application of poultry litter soil pH increased. According to Sharma and Prasad (2018), poultry litter acts as a potent organic amendment that can raise soil pH, enhancing nutrient availability and microbial activity. This improvement in soil health can lead to better root development and nutrient uptake in onions. Similarly, a study by Rahman *et al.* (2020) supports these findings, noting that the use of poultry litter in agroforestry systems not only increases soil pH but also enriches the soil with essential nutrients like nitrogen, phosphorus, and potassium. This dual benefit of soil pH adjustment and nutrient enrichment promotes healthier onion crops and potentially higher yields. Hence, integrating poultry litter in neem-based agroforestry systems appears to be a sustainable practice that improves soil conditions conducive to onion growth (table 4.8and Appendix IX).

4.11.2 Soil Organic Carbon

Present on the comparison on the effect of poultry litter of onion cultivation on the soil sample parameter during different stages of onion cultivation. The soil organic carbon effect between without application of poultry litter during land preparation and after

application of poultry litter during harvesting of onion. The soil organic carbon found (0.74%) without application of poultry litter during land preparation and soil organic carbon found (0.84%) after application of poultry litter during harvesting of onion. The result so that due to the application of poultry litter soil organic carbon increased. The application of poultry litter in neem-based agroforestry systems can significantly increase soil organic carbon (SOC) levels, which benefits onion production. According to Ghosh *et al.* (2012), poultry litter is rich in organic matter and nutrients, which, when applied to soil, decompose and contribute to the soil organic carbon pool. This increased SOC enhances soil structure, water retention, and microbial activity, leading to improved root growth and nutrient uptake in onions. Similarly, Mohanty *et al.* (2013) found that the addition of poultry litter to agroforestry systems not only boosts SOC but also improves soil fertility and overall crop productivity. The organic matter from poultry litter provides a continuous source of carbon and nutrients, fostering a healthier soil environment. Consequently, integrating poultry litter into neem-based agroforestry systems can enhance soil organic carbon content, supporting better onion production (table 4.8 and Appendix IX).

4.11.3 Soil Organic matter

Present on the comparison on the effect of poultry litter of onion cultivation on the soil sample parameter during different stages of onion cultivation. The soil organic matter effect between without application of poultry litter during land preparation and after application of poultry litter during harvesting of onion. The soil organic matter found (1.12%) without application of poultry litter during land preparation and soil organic found (1.32%) after application of poultry litter during harvesting of onion. The result so that due to the application of poultry litter soil organic carbon increased (table 4.7 and Appendix IX).

4.11.4 Nitrogen

Present on the comparison on the effect of poultry litter of onion cultivation on the soil sample parameter during different stages of onion cultivation (table 4.8 and Appendix IX). The nitrogen effect between without application of poultry litter during land preparation and after application of poultry litter during harvesting of onion. The soil nitrogen found (0.072%) without application of poultry litter during land preparation and nitrogen found (0.10%) after application of poultry litter during harvesting of onion. The

result so that due to the application of poultry litter nitrogen level increased. This increased nitrogen availability enhances plant growth and yields by improving photosynthesis and protein synthesis in onions. Similarly, a study by Tewolde *et al.* (2013) found that incorporating poultry litter into agroforestry systems not only boosts soil nitrogen content but also improves nitrogen use efficiency, leading to healthier and more productive crops. The organic matter in poultry litter acts as a slow-release fertilizer, providing a steady supply of nitrogen throughout the growing season. Therefore, the use of poultry litter in neem-based agroforestry systems can enhance soil nitrogen levels, promoting better onion growth and yield

4.11.5 Phosphorus

Present on the comparison on the effect of poultry litter of onion cultivation on the soil sample parameter during different stages of onion cultivation (table 4.8 and Appendix IX). The Phosphorus effect between without application of poultry litter during land preparation and after application of poultry litter during harvesting of onion. The soil Phosphorus found ($24.67\mu\text{gm/gm}$) without application of poultry litter during land preparation and Phosphorus found ($49.75\mu\text{gm/gm}$) after application of poultry litter during harvesting of onion. The result so that due to the application of poultry litter Phosphorus level increased. According to He *et al.* (2009), poultry litter is rich in phosphorus, which becomes readily available to plants upon decomposition. This increased phosphorus availability enhances root development, energy transfer, and overall plant growth, leading to improved onion yields. Similarly, Codling *et al.* (2002) found that the use of poultry litter in agroforestry systems significantly boosts soil phosphorus content and availability. This is particularly beneficial for crops like onions, which have high phosphorus demands for optimal growth and development. The continuous supply of phosphorus from poultry litter ensures sustained nutrient availability throughout the growing season, supporting better onion production.

4.11.6 Potassium

Present on the comparison on the effect of poultry litter of onion cultivation on the soil sample parameter during different stages of onion cultivation (table 4.8 and Appendix IX). The Potassium effect between without application of poultry litter during land preparation and after application of poultry litter during harvesting of onion. The soil Potassium found ($0.23\text{meq}/100\text{gm}$) without application of poultry litter during land

preparation and Potassium found (0.25meq/100gm) after application of poultry litter during harvesting of onion. The result so that due to the application of poultry litter Potassium level increased. According to Kingery *et al.* (1994), poultry litter is a rich source of potassium, which becomes available to plants upon decomposition. This increased potassium availability is crucial for onions as it plays a vital role in processes such as photosynthesis, enzyme activation, and water regulation, leading to enhanced growth and yield. The sustained release of potassium from poultry litter ensures a steady supply of this essential nutrient throughout the growing season, promoting healthier and more productive onion crops. Therefore, incorporating poultry litter into neem-based agroforestry systems can enhance soil potassium levels, supporting robust onion production.

4.11.7 Sulfur

Present on the comparison on the effect of poultry litter of onion cultivation on the soil sample parameter during different stages of onion cultivation which are observed (table 4.8 and Appendix IX). The Phosphorus effect between without application of poultry litter during land preparation and after application of poultry litter during harvesting of onion. The sulfur found (26.27 μ gm/gm) without application of poultry litter during land preparation and sulfur found (21.47 μ gm/gm) after application of poultry litter during harvesting of onion. The result so that due to the application of poultry litter sulfur level decreased. According to Haneklaus *et al.* (2007), poultry litter typically has lower sulfur content compared to other organic fertilizers, potentially leading to sulfur deficiencies in the soil when used as the primary nutrient source. Sulfur is essential for protein synthesis and enzymatic functions in onions, and its deficiency can hinder growth and yield. Similarly, Zhao *et al.* (2002) observed that the continuous use of poultry litter without supplementary sulfur fertilization could deplete soil sulfur reserves, affecting the sulfur uptake by crops. This decrease in sulfur availability can impair critical physiological processes in onions, resulting in reduced productivity.

Table 4.8: Comparison on the effect of poultry litter onion cultivation on the soil sample parameter of onion cultivation during land preparation and after harvesting of onion

Sample No	Result of soil sample						
	pH	Organic Carbon	Organic matter	Total nitrogen	Phosphorus	Potassium	sulfur
	-	(%)	(%)	(%)	µgm/gmsoil	meq/100gm soil	µgm/gm soil
S ₁	4.90	0.74	1.12	0.072	24.67	0.23	26.27
S ₂	5.30	0.84	1.32	0.10	49.75	0.25	21.47

Here S₁= Before application of poultry litter

S₂= After application of poultry litter

4.12 Economic Analysis

Profitability of growing effect of poultry litter based on 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 4.9 and Appendix X.

4.12.1 Total cost of production

The values in Table 4.9 and Appendix X indicate that the total cost of production was maximum (491515Tk. /ha) in those plots where Onion was cultivated with using Faridpory+ poultry litter (T₄) whereas the minimum cost of production (474565 Tk. /ha) was recorded from those plots where Faridporypiaz + no Poultry litter (T₁) was applied.

4.12.2 Gross return

Gross return is an important indicator whether crop cultivation is profitable or not. It is varying with the Onion and Neem based production system of Onion. The values in Table 4.9 and Appendix X indicate that the highest value of gross return (1231550Tk. /ha) was obtained in those plots T₃(poultry litter use 5ton)was applied. On the other hand, the lowest value of gross return (848350Tk. /ha) was obtained in those plots where T₁(poultry litter use in 0ton) was applied.

4.12.3 Net return

Results presented in the Table 4.9 and Appendix X show that net return (745685Tk. /ha) was comparatively higher in producing of onion at T₃ (poultry litter use 5ton). At the same time, the lowest net return (373785Tk. /ha) was received from T₁ (poultry litter use 0ton) was applied.

4.12.4 Benefit-Cost Ratio (BCR)

The values in Table 4.9 and Appendix X indicate that the highest benefit-cost ratio (2.53) was recorded from the T₃ (poultry litter use 5 ton). On the other hand, the lowest benefit-cost ratio (1.78) was observed in those plots where T₁ (poultry litter use 0 ton). application.

Table 4.9: Economics of onion production on the effect of poultry litter under Neem based agroforestry system

Treatments	Return (Tk. ha ⁻¹)/3 months		Gross Return (Tk. ha ⁻¹)	Total cost of production (Tk. ha ⁻¹)	Net Return (Tk. ha ⁻¹)	BCR
	Neem	Onion				
T ₁	546750	301600	848350	474565	373785	1.78
T ₂	546750	426400	973150	481345	491805	2.02
T ₃	546750	684800	1231550	485865	745685	2.53
T ₄	546750	500000	1046750	491515	555235	2.12

Here, T₁ = Control, T₂ = Poultry litter use in 3 ton/ha, T₃ =Poultry litter use in 5 ton/ha, T₄ = Poultry litter use in 7.5 ton/ha

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The experiment was conducted during the period from 24 January 2024 to 22 April 2024 at Department of Agroforestry and Environmental Science field, Hajee Mohammad Danesh Science and Technology University, Dinajpur 5200, Bangladesh. The experiment was performed with Randomized Complete Block Design which consists of one factor which was Nutrient sources. T_1 = Control, T_2 =poultry litter use 3ton, T_3 = Poultry litter use 5ton and T_4 = poultry use 7.5 ton. The results demonstrated that growth parameters, reproductive components, and yield were significantly different among the different treatments. The total numbers of experimental plots were 12 and each plot The size of the unit plot was 2.0 m \times 2.0 m following the spacing 15 cm \times 10cm. The land of experimental plot was opened in the 2nd week of January, 2024 with a power tiller and it was made ready for planting on 3rd week of January 2024. Data were collected on different growth and yield parameters. The collected data were statistically analyzed by Statistic ten. Different types of nutrient sources, cultivar of onions and their combination showed significant variation among the treatments on different growth and yield parameters. Considerable influence in terms of growth parameters was found due to variation on poultry litter application. The highest plant height (42.27 cm, 50.96 cm and 53.62 cm at 30, 45 and 65 DAT, respectively) was found from the treatment T_3 (poultry litter use as 5ton) and the highest number of leaves plant⁻¹ (4.67, 5.2 and 5.2 at 30, 45 and 65 DAT, respectively) was recorded from the treatments T_3 , and T_4 , respectively (T_3 =poultry litter use 5ton, and T_4 =poultry litter use as 7.5 ton) where the lowest plant height (26.69 cm, 33.67 cm and 36.39cm at 30, 45 and 65 DAT, respectively) was found from the treatments T_1 , respectively (T_1 = Control,) and the lowest number of leaves plant⁻¹ (3.73, 4.06and 4.06 and at 30, 45 and 65 DAT, respectively) was found from the treatment T_1 (control). 61 In terms of yield and yield contributing parameters, the highest neck diameter (0.81 cm), bulb length (7.43 cm), bulb diameter (3.43 cm), fresh weight bulb 1 (18.6 g), yield plot⁻¹ (3.43kg) , bulb yield ha-1 (8.56 t),straw yield plot-1 (412.82 g) and straw yield ha⁻¹ was found from the treatment T_3 (T_3 =poultry litter use 5ton) and the lowest neck diameter (0.28 cm), bulb length (4.29 cm), bulb diameter (1.88 cm), fresh weight bulb⁻¹ (7.97 g), bulb yield plot⁻¹ (1.51 kg), and yield ha⁻¹ (3.77 t) were

obtained from the treatment T₁ (control). 62 Substantial influence was also observed due to different nutrient sources and. The seed quality of onion dry matter content highest dry matter content 18.7% found in T₄ (poultry litter use 7.5 ton) and the lowest dry matter content 16.09% found in T₂ (poultry litter use 3 ton) so the bulb quality of onion depend on dry matter content the low dry matter contents are good quality which are observed T₂ treatment used in 3ton poultry litter. The soil parameter content saw that soil health improved for the production of onion which increased nitrogen, phosphorus, phosphate, organic matter, and pH. So, onion production with treatment may be recommended for proper growth and development though T₃ treatment poultry litter use in 5ton showed better vegetative growth till the final period of cultivation at the condition of Agroforestry field at Hajee Mohammad Danesh Science and Technology University, Dinajpur- 5200.

5.2 Conclusion

The research findings explored that among the three poultry litter application dose, the application of 5 tons/ha of poultry litter significantly enhanced the growth and yield parameters of onions, proving to be the most effective treatment. The treatment that resulted in the highest plant height, number of leaves per plant, and overall yield. Additionally, the soil chemical properties were notably improved with the application of poultry litter. From an economic standpoint, 5 tons/ha also yielded the highest benefit-cost ratio, indicating its superiority in both agronomic and financial terms. These findings suggest that integrating at poultry litter in neem-based agroforestry systems can significantly boost onion production.

5.3 Recommendations

- 1) The Onion variety of Faridpory piaz Neem orchard successfully using poultry litter.
- 2) This study should be repeated in different using different amount of poultry litter dose and using different aged Neem tree to obtained valid recommendation.
- 3) Future research should explore the long-term effects of poultry litter application on soil health and fertility in neem-based agroforestry systems.
- 4) Studies should examine the environmental implications of poultry litter use, including potential runoff and its effects on surrounding ecosystems.

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APPENDICES

Appendix I: ANOVA Table for height

ANOVA Table after 30 days

Source	DF	SS	MS	F	P
Replication	2	5.679	2.839		
Treatment	3	392.789	130.930	142.10	0.0000
Error	6	5.528	0.921		
Total	11	403.996			

ANOVA Table after 50 days

Source	DF	SS	MS	F	P
Replication	2	6.590	3.295		
Treatment	3	526.864	175.621	239.12	0.0000
Error	6	4.407	0.734		
Total	11	537.860			

ANOVA Table after 65 days

Source	DF	SS	MS	F	P
Replication	2	4.923	2.462		
Treatment	3	505.754	168.585	127.18	0.0000
Error	6	7.953	1.326		
Total	11	518.631			

Appendix II: ANOVA Table for leaf

Source	DF	SS	Ms	F	P
Replication	2	0.06000	0.03000		
Treatment	3	1.74333	0.58111	27.53	0.0007
Error	6	0.12667	0.02111		
Total	11	1.93000			

ANOVA Table after 50 days

Source	DF	SS	MS	F	P
Replication	2	0.08667	0.04333		
Treatment	3	2.14667	0.71556	58.55	0.0001
Error	6	0.07333	0.01222		
Total	11	2.30667			

ANOVA Table after 65 days

Source	DF	SS	MS	F	P
Replication	2	0.08667	0.04333		
Treatment	3	2.14667	0.71556	58.55	0.0001
Error	6	0.07333	0.01222		
Total	11	2.30667			

Appendix III: Comparison of light among different treatments of Onion under Neem based Agroforestry system after 25 days of sowing seedling

Treatment (Poultry litter)	Light interception (K.lx) in open field			Light interception (K.lx) under Neem tree		
	Morning	Noon	Afternoon	Morning	Noon	Afternoon
T ₁ control (PL 0 ton/ha)	69.13	53.33	10.39	39.76±1.55	28.06±4.10	6.55±0.62
T ₂ (PL3ton/ha)	69.13	53.33	10.39	42.75±2.06	38.80±2.48	5.97±0.50
T ₃ (PL5ton/ha)	69.13	53.33	10.39	43.34±1.85	41.16±2.83	6.46±0.39
T ₄ (PL7.5ton/ha)	69.13	53.33	10.39	41.30±1.66	43.92±2.94	7.37±0.47
CV (%)				10.34	23.77	22.73

Appendix IV: Comparison of light among different treatments of Onion under Neem based Agroforestry system after 30 days of sowing seedling

Treatment (Poultry litter)	Light interception (K.lx) in open field			Light interception (K.lx) under Neem tree		
	Morning	Noon	Afternoon	Morning	Noon	Afternoon
T ₁ control (PL0ton/ha)	76	43.23	11.39	57.08±4.27	28.32±6.52	6.77±0.68
T ₂ (PL3ton/ha)	76	43.23	11.39	56.33±2.95	28.12±5.16	6.08±0.65
T ₃ (PL5ton/ha)	76	43.23	11.39	52.49±5.38	38.37±7.38	6.56±0.33
T ₄ (PL7.5ton/ha)	76	43.23	11.39	49.84±5.03	36.33±8.38	6.98±0.41
CV (%)				22.17	33.92	24.60

Appendix V: Comparison of light among different treatments of Onion under Neem based Agroforestry system after 35 days of sowing seedling

Treatment (Poultry litter)	Light interception (K.lx) in open field			Light interception (K.lx) under Neem tree		
	Morning	Noon	Afternoon	Morning	Noon	Afternoon
T ₁ control (PL0ton/ha)	76.12	54.32	11.39	58.00d±1.67	33.56d±5.42	6.67±0.66
T ₂ (PL3ton/ha)	76.12	54.32	11.39	55.91c±5.04	36.07c±2.06	6.56±0.48
T ₃ (PL5ton/ha)	76.12	54.32	11.39	44.04a±4.56	40.01a±1.55	7.02±0.31
T ₄ (PL7.5ton/ha)	76.12	54.32	11.39	45.61b±4.56	40.65±1.55	7.55±0.31
CV (%)				18.68	22.99	19.09

Appendix VI: ANOVA Table bulb diameter, bulb length, neck diameter, bulb weight

ANOVA Table for diameter

Source	DF	SS	MS	F	P
Replication	2	0.00362	0.00181		
Treatment	3	3.65633	1.21878	1157.68	0.0000
Error	6	0.00632	0.00105		
Total	11	3.66627			

ANOVA Table for length

Source	DF	SS	MS	F	P
Replication	2	0.0388	0.01942		
Treatment	3	15.7976	5.26587	192.95	0.0000
Error	6	0.1637	0.02729		
Total	11	16.0002			

ANOVA Table for Neck

Source	DF	SS	MS	F	P
Replication	2	0.00015	0.00007		
Treatment	3	0.47220	0.15740	755.52	0.0000
Error	6	0.00125	0.00021		
Total	11	0.47360			

ANOVA Table for weight

Source	DF	SS	MS	F	P
Replication	2	0.406	0.2029		
Treatment	3	179.201	59.7338	443.25	0.0000
Error	6	0.809	0.1348		
Total	11	180.416			

Appendix VII: Effect of poultry manure on Bulb diameter, Bulb length, Neck diameter, Bulb weight under Neem based agroforestry system

Treatment	Neck diameter(cm)	Bulb length(cm)	Bulb diameter(cm)	Fresh weight of bulb(g)
T ₁ control (PL0ton/ha)	0.283d±8.819	4.293d±0.094	1.880d±0.200	7.983d±0.327
T ₂ (PL3ton/ha)	0.393c±9.433	5.803c±0.056	2.350c±0.015	11.073c±0.116
T ₂ (PL5ton/ha)	0.800a±0.011	7.473a±0.096	3.403a±0.013	18.607a±0.212
T ₂ (PL7.5ton/ha)	0.603b±3.333	6.380b±0.111	2.593b±0.029	12.410b±0.190
CV (%)	2.78	2.76	1.27	2.93

Appendix VIII: ANOVA Table bulb weight/plot, bulb weight/ha, straw weight/plot, straw weight/ha, dry weight_{T100g}/plot

ANOVA Table for Blplot

Source	DF	SS	MS	F	P
Replication	2	0.19647	0.09823		
Treatment	3	5.80713	1.93571	17.99	0.0021
Error	6	0.64567	0.10761		
Total	11	6.64927			

ANOVA Table for Blha

Source	DF	SS	MS	F	P
Replication	2	1.1990	0.5995		
Treatment	3	36.1022	12.0341	18.60	0.0019
Error	6	3.8811	0.6468		
Total	11	41.1822			

ANOVA Table for Splot

Source	DF	SS	MS	F	P
Replication	2	739.1	369.6		
Treatment	3	75386.6	25128.9	40.18	0.0002
Error	6	3752.6	625.4		
Total	11	79878.3			

ANOVA Table for Sha

Source	DF	SS	MS	F	P
Replication	2	4641	2321		
Treatment	3	472203	157401	40.28	0.0002
Error	6	23447	3908		
Total	11	500291			

ANOVA Table for dry mater

Source	DF	SS	MS	F	P
Replication	2	0.9689	0.48443		
Treatment	3	7.7310	2.57701	1.32	0.3526
Error	6	11.7285	1.95474		
Total	11	20.4284			

Appendix IX: Effect of poultry manure on Dry weight under Neem based agroforestry system

Treatment	Dry weight of bulb-1 (g)
T ₁ control (PL0ton/ha)	17.92a±0.175
T ₂ (PL5ton/ha)	16.52a±1.17
T ₃ (PL5ton/ha)	18.16a±0.47
T ₄ (PL5ton/ha)	18.70a±0.65
CV (%)	7.84

Appendix X: Production cost analysis of onion cultivation under neem 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)	Interest of the value of land(tk./ha) @ 8% for the crop season (tk/ha)	Miscellaneous cost @ 5% of the input cost (tk/ha)	
	Ail dressing, bamboo, other elements	Labor cost	Land tillering by power tiller	Seedling	Poultry litter	Fertilizer	Irrigation	Pesticide	Initial plantation cost of Neem trees	Total material cost (tk/ha)					
T₁	83800	180500	4960	52083	0	20833	3200	6850	35000	117966	387226	30978	37000	19361	474565
T₂	83800	180500	4960	52083	6000	20833	3260	6850	35000	123966	393226	31458	37000	19661	481345
T₃	83800	180500	4960	52083	10000	20833	3260	6850	35000	127966	397226	31778	37000	19861	485865
T₄	83800	180500	4960	52083	15000	20833	3260	6850	35000	132966	402226	32178	37000	20111	491515

Appendix XI: Photographs of experimental site



Land Preparation



Soil Collection



Transplantation



Irrigation



Investigation



Discussion



Data Collection



Experimental Field



Harvesting



Bulb Weighting



Diameter measurement



Drying