AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING AND
ENTREPRENEURIAL DEVELOPMENT (AAMUSTED),
MAMPONG-ASHANTI

INFLUENCE OF LEGUME TREE PRUNINGS AND POULTRY MANURE ON GROWTH AND YIELD OF CUCUMBER IN A CHROMIC LUVISOL SOIL

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MASTER OF PHILOSOPHY CROP SCIENCE (AGRONOMY)

2025

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A THESIS IN THE DEPARTMENT OF CROP AND SOIL SCIENCES EDUCATION, FACULTY OF AGRICULTURE EDUCATION, SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE OF MASTER OF PHILOSOPHY CROP SCIENCE

JUNE 2025

DECLARATION

STUDENT'S DECLARATION

I declare that except for references to the works of other researchers which have been duly cited and acknowledged, this research is the result of my own effort and that no part or whole has been presented for another degree elsewhere.

CANDIDATE’S NAME: OKYERE EMMANUEL BOATENG

Signature…………………………………….

Date…………………………..……………

SUPERVISORS' DECLARATION

We hereby declare that this thesis has been supervised according to the guidelines for the Supervision of the postgraduate thesis as laid down by the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED).

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ACKNOWLEDGMENT

I would like to express my heartfelt gratitude to the many individuals who have contributed to the completion of this postgraduate programme. First and foremost, I am deeply thankful to my thesis supervisors, Prof. Kofi Agyarko and Prof. (Mrs) Margaret Esi Essifie.

A very big thanks to my father Mr. Okyere Peter and the entire family for their support together with my children’s prayer.

My gratitude goes to my wife Mrs. Phyllis Aniwaa, Mr Okyere Michael and Mr. Ntumi Richard for their advice and words of encouragement.

The greatest of all goes to the Almighty Jehovah who saw me through this entire Journey.

DEDICATION

This thesis is dedicated to my late mother Madam Margaret Okyere

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LIST OF ABBREVIATIONS

CSIR-CRI	Council for Scientific and Industrial Research of Crops Research Institute
HSD	Honestly Significant Difference
CV	Coefficient of variation
DAP	Days after planting
PM	Poultry manure
GS	*Gliricidia sepium*
LL	*Leucaena leucocephala*
SRI	Soil Research Institute
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
EDTA	Ethylenediaminetetraacetic acid

ABSTRACT

Two field experiments were conducted at the Multipurpose Crop Nursery of AAMUSTED, Asante Mampong and Adanwomase Senior High School farm during the major rainy season (from March to July 2022), to determine the effects of legume tree prunings and poultry manure on growth and yield of cucumber in a chromic luvisol. The experimental design used was a Randomized Complete Block Design (RCBD) replicated four times. The treatments were; (i) 10 t/ha *Gliricidia sepium*, (ii) 10 t/ha *Leucaena leucocephala*, (iii)10 t/ha Poultry manure, (iv) 5t/ha *Gliricidia sepium* +5 t/ha Poultry manure, (v) 5 t/ha *Leucaena leucocephala* + 5 t/ha Poultry manure, (vi) 5 t/ha *Gliricidia sepium* + 5 t/ha *Leucaena leucocephala* and (vii) Control (no fertilizer/amendment). The results show that the 5 t/ha *Leucaena leucocephala* + 5 t/ha Poultry manure improved soil pH, N, and organic carbon, while 10 t/ha *Leucaena leucocephala* increased K, Ca, and Mg. However, the highest exchangeable acidity was from the 10 t/ha Poultry manure. The application of poultry manure at 10 t/ha was the most effective treatment across both locations since it led to earliest flowering, longest vine, greatest number of leaves per plant, and superior chlorophyll content of leaf, and the highest fresh and dry shoot weights. The control plot recorded the least results in most of the vegetative growth and in fruit diameter parameters measured. The 10t/ha *Gliricidia sepium* exhibited the least performance in total fruit yield at both locations. The 10t/ha poultry manure produced the highest yield (36.04t/ha) at Asante Mampong and (36.88t/ha) at Adanwomase. The combination of 5t/ha *Leucaena leucocephala* + 5t/ha poultry manure produced the longest fruits and the widest fruit diameter in both locations, and therefore 10 t/ha poultry manure only is recommended to farmers aiming at improving cucumber yield and the combination of 5 t/ha *Leucaena leucocephala* + 5 t/ha poultry manure to farmers aiming to improve cucumber fruit length and widest fruit size.

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Cucumber (*Cucumis sativus* L.) is a widely grown fruit vegetable found across tropical and temperate zones of the world. As a member of the *Cucurbitaceae* family, it is a warm-season crop that performs best under consistent high temperatures. Thought to be among the earliest domesticated plants; cultivated for over 5,000 years, it traces its origin to India before spreading to many parts of the world (Ajibola & Amujoyegbe, 2019). The crop is extensively produced throughout Asia and Europe, with China accounting for the highest global output of about 54.3 million tonnes annually, followed by Turkey with approximately 1.7 million tonnes (FAOSTAT, 2017). Within Africa, Egypt leads production with around 613,000 tonnes per year, placing it ninth worldwide, while Cameroon ranks twenty-first with roughly 224,000 tonnes (FAOSTAT, 2017).

Cucumbers are primarily produced for three uses: fresh whole, fresh sliced, and pickled (Jakob & Geyer, 2021). Fresh whole cucumbers such as English, garden, Persian, mini, and lemon varieties are sold for direct consumption, while sliced types serve the food service industry, requiring uniform sizes for salads. Pickling cucumbers, including the well-known gherkin, are smaller and thicker (Ugwu & Suru, 2021)1).

Cucumber ranks among the most valuable fruit vegetables due to its nutritional and medicinal benefits. It contains vitamins A, B6, C, and K, as well as dietary fiber, magnesium, phosphorus, and manganese (Ikenganyia *et al*., 2015). Its ascorbic and caffeic acids reduce skin irritation, while the skin’s chlorophyll and silica improve complexion. Cucumber juice is often recommended as a source of silicon for healthy skin. However, pickling reduces nutrient content, especially vitamin C (Swamy, 2017). Increasing popularity in developing countries is linked to its health and medicinal value, as well as its use in pharmaceuticals, salads, beverages, and fruit drinks. Its low sugar content aids fat metabolism, making it beneficial for diabetic patients (Kumar *et al*., 2010).

Leguminous plants play a vital role in sustaining soil fertility (Swarup et al., 2019). Prunings from perennial species such as *Leucaena leucocephala*, *Gliricidia sepium,* and *Acacia auriculiformis* are commonly utilized as mulch and in the preparation of organic fertilizers. Among these organic materials, residues from *Gliricidia sepium* and *Leucaena leucocephala* are particularly valued for enhancing soil productivity. These tree legumes can easily be found as living hedges and shelters and intercrop with cocoa and other plants in the rural areas in Ghana and are commonly used by villagers as fuel wood and animal feed. Pruning of legume trees have the potential for supplying nitrogen and phosphorus.

Poultry manure on the other hand contain large amount of nitrogen, phosphorus and potassium and secondary and trace elements, has a low C:N ratio and serves as a soil amendment by adding organic matter, thereby improving soil structure, porosity (bulk density) and water holding capacity (Adekiya, 2019). Poultry manure is an excellent organic fertilizer as it contains about 3.5% N, 1.5-3.5%P, 1.5-3.0% K and many micro nutrients.

1.2 Problem Statement and Justification

The predominant use of chemical fertilizers in modern agriculture raises significant concerns. These concerns include the high cost of chemical fertilizers, limited access in certain regions, adverse ecological impacts such as water pollution, and increase acidity of the soil. These issues not only strain agricultural budgets but also pose health risks to consumers and have detrimental effects on the environment. In light of these challenges, there is a growing demand for sustainable, cost-effective, and environmentally friendly alternatives to chemical fertilizers that can enhance agricultural production while mitigating the ecological and health problems associated with chemical inputs.

Sustainable agricultural practices are crucial for ensuring long-term food security while preserving the environment. The study addresses the need to explore sustainable and environmentally friendly farming techniques that can enhance crop yield without degrading the soil or harming ecosystems. Chromic Luvisol soil is characterized by its rich nutrient content. However, continuous farming and the use of chemical fertilizers can lead to soil degradation over time. Investigating the influence of legume tree pruning and poultry manure on this soil type can provide insights into how to maintain or improve soil health while promoting crop growth. Moreover, the study examines the use of poultry manure, which is an organic and nutrient-rich source of fertilization. This can offer a sustainable alternative to chemical fertilizers, reducing costs for farmers. Understanding the impact of legume tree pruning on cucumber growth and yield introduces the concept of crop diversification. Legume trees can provide additional benefits such as nitrogen fixation, which can enhance soil fertility and contribute to the growth of subsequent crops. By exploring sustainable agricultural practices, this research aligns with the global effort to reduce the environmental footprint of farming. Organic practices like the use of poultry manure and legume tree prunings can help reduce the negative ecological impacts of conventional agriculture, such as water pollution and soil degradation.

1.3 Main Objective

The main objective of the study was to examine the growth and yield of cucumber as affected by legume tree prunings and poultry manure in a chromic luvisol soil.

1.3.1 Specific Objectives

The specific objectives of the study were to**:**

1. Determine the effect of legume tree prunings and poultry manure on soil physico-chemical properties.
2. Evaluate the effects of legume tree prunings and poultry manure on the phenology and vegetative growth of cucumber.
3. Assess the effects of legume tree prunings and poultry manure on yield and yield components of cucumber.

CHAPTER TWO: LITERATURE REVIEW

2.1 Origin and distribution of Cucumber

The cultivation of cucumber dates back to ancient civilizations, originating in India over 3,000 years ago (Chomicki *et al*., 2020). From India, it spread to China and later gained popularity among the ancient Greeks and Romans (Mayor, 2019). Historical accounts from these societies reference its growth and consumption, while archaeological discoveries of cucumber seeds across regions further confirm its ancient presence (Peña- Chocarro & Pérez- Jordà, 2019). The Romans developed artificial growing methods to supply Emperor Tiberius with cucumbers year-round. Columbus later introduced the crop to the New World in 1494, cultivating it in Haiti and nearby islands. Most cucumber varieties known today existed over four centuries ago, ranging from short, stubby fruits to the elongated English greenhouse types reaching nearly two feet (Ishieze, 2017).

Cucumber's genetic diversity has been a subject of significant research. Modern cucumber cultivars exhibit considerable genetic variability, which has been attributed to historical trade routes and the cucumber's adaptable nature. These genetic studies have revealed the cucumber's close relationship with other cucurbit species, shedding light on its evolutionary history and the domestication process (Grumet *et al*., 2021). The process of cucumber domestication is a fascinating chapter in its history. Wild cucumber relatives, such as *Cucumis sativus var. hardwickii,* are believed to be the ancestors of the cultivated cucumber. This domestication process resulted in the development of the modern cucumber varieties we know today (Piperno, 2017). Genetic studies have further pinpointed regions in Asia, including India, as key centers for cucumber domestication (Chomicki *et al*., 2020). Cucumbers have played a significant role in various cultures and cuisines. From the Indian subcontinent to ancient Greece and Rome, cucumbers have been featured in culinary and medicinal applications (Wehner *et al*., 2020). Their refreshing taste and high-water content have made them a popular choice in hot climate. The Bible provides evidence for the cultivation and consumption of cucumbers in ancient Egypt. We remember the fish we ate freely in Egypt, and the cucumbers, melons, leeks, onions, and garlic, according to Numbers 11:5. Cucumbers were also grown by the Greeks and (later) the Romans. The Cucurbitaceae family also includes the essential fruits watermelon, muskmelon, pumpkin, and squash. According to cave excavations, cucumber has been farmed as a food source for over 3000 years. Cucurbitacin, a chemical found in early cucumbers, is presumably what made them so bitter. These organic defense substances function to keep out pests and insects. Despite significant progress by plant breeders to get rid of the bitter chemicals, bitterness is still an issue with some cucumber species today.

2.2 Botany and morphology of cucumber

Cucumber is a creeping, climbing annual herbaceous plant belonging to the family Cucurbitaceae. It produces long, trailing vines with alternate, simple, triangular-ovate leaves that are 3–7 lobed and deeply cordate at the base. The leaf canopy shades the developing fruits, while thin, spiraling tendrils enable the plant to climb when support is available (Henderson et al., 2019; Wehner et al., 2020).

Cucumber plants are monoecious, bearing separate male and female flowers on the same plant. Both flower types are bright yellow, but the female flower is distinguishable by a swollen ovary at its base and a shorter peduncle compared to the male flower. Depending on the cultivar, cucumber plants may also be gynoecious (producing only female flowers) or parthenocarpic (producing fruit without pollination or fertilization). Bees play a critical role in pollination, especially for monoecious and gynoecious types (Singh et al., 2024).

The fruit of cucumber is typically elongated, cylindrical, and green, with tapered ends. Internally, it contains numerous small seeds. Fruit morphology varies widely among cultivars in terms of length (10–76 cm), shape, skin texture (smooth to spiny), color (yellow to dark green), and bitterness (Swamy, 2017; El-Ramady et al., 2015). If left to mature, the fruit becomes bulbous, turns yellow, and loses its edibility.

Cucumber varieties are broadly categorized into slicing, pickling, and specialty types such as Armenian and lemon cucumbers. Popular cultivars include English (long, thin-skinned, often wrapped), garden (dark waxy skin, typically peeled), Persian (small, sweet, seedless, “burpless”), Kirby (miniature, diverse skin colors), and lemon cucumbers (round, yellow, sweet) (Tahir et al., 2019; Ugwu & Suru, 2021).

Agronomically, cucumbers thrive in warm, sunny environments with well-drained soils and consistent moisture. They are grown from seeds or seedlings and progress through distinct growth stages: seedling, vegetative, flowering, and fruiting. Proper care and nutrient management are essential for optimal yield and fruit quality.

Beyond their culinary versatility—commonly consumed fresh in salads, sandwiches, or pickled—cucumbers are valued for their nutritional benefits, including high water content, low calories, and contributions of vitamin K, vitamin C, and potassium (Cheng & Shan, 2020). They also have applications in the cosmetic industry due to their hydrating and skin-soothing properties (O'Connor, 2017).

2.3 Pollination

Pollination plays a vital role in cucumber production. Each seed requires at least one pollen grain, and inadequate pollination can cause fruit abortion, deformities, or poor fruit set. For proper fruit shape and size, 10–20 bee visits are needed per flower during its single day of receptivity (Pilling *et al*., 2013). Beehives should be introduced when about 25% of plants start flowering; introducing them earlier may divert bees to other crops or wildflowers, while later introduction risks missing the first female flowers. Bee activity peaks from morning to early afternoon but declines in cool or wet conditions, which can lead to poor fruit set (Dohzono & Yokoyama, 2010). Although cucumber varieties can cross-pollinate among themselves, they do not cross with squash, pumpkins, muskmelons, or watermelons. In gynoecious (all-female) cultivars, pollination is maintained by mixing seeds of a monoecious (pollen-producing) variety with those of the gynoecious hybrid (McDonald, 2020).

2.4 Climatic Requirement of Cucumber

Cucumber thrives under warm temperatures, low humidity, moderate light intensity, and well-structured soil with a consistent supply of water and nutrients (Singh *et al*., 2017). The optimal temperature range for growth is 20–25°C, while growth declines below 16°C and above 30°C. Development is severely hindered below 5°C and drastically reduced beyond 40°C (Kaur *et al.,* 2015). Humidity levels depend largely on rainfall, being higher in wet seasons and lower in dry periods (Spracklen *et al*., 2012). High relative humidity increases the risk of diseases like Downy and Powdery mildew, and low transpiration can limit calcium uptake to leaves and fruits. Conversely, at low humidity, irrigation becomes essential to maintain adequate soil moisture without waterlogging. Low humidity also favours powdery mildew and spider mites. Additionally, extreme heat before or during flowering can cause sterility in cucumber plants (Yan *et al*., 2020).

2.5 Soil Requirement of Cucumber

Cucumbers thrive in light-textured, well-drained soils rich in organic matter, with an ideal pH range of 6.0–6.8. Although they adapt to various soil types, sandy soils promote earlier production. The crop tolerates moderately acidic soils, with growth possible down to pH 5.5 (Kader *et al*., 2016). When soil acidity is high, applying ground calcitic limestone or dolomitic limestone if magnesium levels are low helps adjust the pH to optimal levels for healthy growth.

2.6 Nutrient level of cucumber

Around half a cup of cucumber can provide about 8 calories. They are primarily composed of water, with trace amounts of vitamins K and A. They also include several plant chemicals called lignins. An unpeeled medium cucumber contains: Energy: 30 grams, Fat total: 0 grams, Grain: 6 grams, 3 grams of protein, 2 grams of fiber, 10% of the daily recommended intake of vitamin C (DV), 57 percent of the DV for vitamin K, Magnesium: 9% of the daily value, Twelve percent of the DV for potassium and Manganese makes up 9% of the DV.

2.7 Importance of cucumber

Cucumber fruit consists of approximately 95% water, making it an effective natural diuretic that supports hydration and bodybuilding. Although it contains low levels of vitamin C and potassium, its skin is a source of vitamin A. Regular consumption of cucumber has been shown to lower high blood pressure and support kidney function (Asif, 2014). Beyond its nutritional importance, cucumber also serves as a valuable raw material in the cosmetic industry. Interestingly, studies have reported that cucumber peel, when eaten by cockroaches, can kill them after several nights (Usman *et al.*, 2015).

2.8 Uses of cucumber

Cucumber leaves are occasionally dried and ground into powder for later use, while the seeds are processed for edible oil in parts of Asia. In some regions, cucumber seeds serve as a substitute for dried peas or beans in rice dishes and soups (Chinatu *et al.*, 2017). In Nigeria, the seeds are consumed as food, and cooked immature fruits are traditionally used to treat dysentery in children. In South India, yellow curry cucumber (Dosakaya) is a popular ingredient in curries and stews, often combined with buttermilk or yogurt.

The ascorbic acid in cucumber helps soothe skin irritation and swelling (Garg *et al*., 2016), while the peel provides dietary fiber, promoting bowel health and reducing the risk of colon cancer by clearing toxins from the gut. Additionally, cucumber leaves and seed-cake are used as livestock feed, and the leafy tops are grazed by animals and game (Chinatu *et al.*, 2017).

2.9 Description of Leucaena leucocephala

Leucaena leucocephala is a fast-growing, evergreen, and thornless shrub that can reach heights between 5 and 20 meters, particularly in the Hawaiian giant variety. Native to Mexico and Guatemala, the species spread to Southeast Asia and the Philippines in the sixteenth century and was later introduced to Australia in the late nineteenth century. It is a long-lived perennial legume with an estimated half-life of about 23 years, even under harsh environmental conditions in Australia. The plant bears bipinnate leaves made up of numerous small leaflets, each measuring approximately 8–16 mm in length. Its cream-colored, globular flower heads give rise to flat, brown pods containing 15–30 seeds, with flowering and fruiting occurring seasonally.

Currently, *L. leucocephala* is cultivated across Central and South America, Africa, Australia, Southeast Asia, and many tropical islands for diverse uses, including soil enrichment, reforestation, firebreak establishment, timber production, and as a source of animal feed (Nair *et al*., 2021). The species is also valuable in agroforestry systems such as alley cropping and as an overstory shade plant for crops like cocoa, coffee, and vanilla. Its leaves can be incorporated into the soil as green manure or mulch (Klompe, 2017). One hectare of *L. leucocephala* foliage can contribute roughly 500 kg of nitrogen, equivalent to about 2,500 kg of ammonium sulfate. The leaves are rich in nutrients, containing 20–30% protein with approximately 70% digestibility (National Research Council). Compared with *Acacia* and *Medicago sativa* (alfalfa), *L. leucocephala* contains nearly double the nitrogen, potassium, and calcium, as well as higher levels of riboflavin, vitamin K, and beta-carotene. Furthermore, this nitrogen-fixing legume is known to tolerate saline soils, and studies indicate that *L. leucocephala* can maintain growth and photosynthetic activity under moderate salt stress (Ndabankulu *et al*., 2022).

2.9.1 Classification of *Leucaena leucocephala*

Kingdom: Plantae

(unranked): Angiosperms

Order: Fabales

Family: Fabaceae

Subfamily: Caesalpinioideae

Genus: *Leucaena*

Species: *leucocephala*

2.9.2 Nutritional content of *Leucaena leucocephala*

One of the leguminous trees with the fastest growth rate is *Leucaena leucocephala*. In Thailand, Indonesia, and Central America, its leaves and seeds are consumed as food by humans, while its foliage is utilized as animal feed (Sethi & Kulkarni, 1995). Leucaena leaf's median chemical make-up was calculated to be 4.15 nitrogen (N), and 29.2 crude protein (CP). 4.3 mimosine, 19.2 crude fiber, 10.5 ash, 1.00 tannin, 1.9 calcium, 0.23 phosphorus, 0.34 magnesium, 1.7 potassium, and 237.5 parts per million of carotene.

2.10 Environmental impact

1. It fixes a significant amount of nitrogen (150 to 300 kg/ha), which encourages the growth of grass or maize.
2. Land reclamation and erosion control. Its deep taproot aids in separating compacted subsoil layers, enhancing water penetration and lowering runoff from the surface. It keeps salty subsurface water from rising to the surface. Leucaena, a plant grown on contour lines, aids in preventing erosion on challenging terrain.
3. It protects climbing crops and other plants like cocoa, coffee, and tea from wind damage by acting as a shelterbelt and providing shade (vanilla, pepper, passion fruit).
4. Due to the speed at which its leaves degrade, it serves as green manure in alley cropping systems (Sileshi et al., 2014).

2.11 Description of *Gliricidia sepium*

The arid and sub-humid lowlands along the pacific coasts of Mexico and Central America, as well as nearby dry interior valleys, are *Gliricidia sepium's* actual native range. Other regions of Central America were colonized by native Americans who domesticated the species. The Spanish brought it to the Philippines and the Caribbean. As a result, Gliricidia has spread widely throughout the tropics in the last century. Farmers choose the adaptable, quickly growing *Gliricidia sepium* tree. It is a little to medium-sized tree that develops between two and fifteen meters in height. It can have a single stem or several stems, and its trunk can grow up to 30 cm in diameter. The bark ranges from grayish-brown to whitish and becomes deeply furrowed as the tree matures and increases in diameter. Its leaves are alternately arranged and pinnately compound, with oblong, pointed leaflets that increase in size toward the tip. Each leaf bears about 7 to 25 leaflets, typically measuring 40–80 mm in length and 20–40 mm in width.

The emergence of flowers coincides with the start of the dry season when all trees have dropped their leaves. Flowering takes place throughout its natural range from November to March. There may be year-round flowering in regions without a marked dry season, but there are usually few pods.

Lowland dry woodlands between sea level and 1200 m are the natural habitat of *Gliricidia sepium*. Due to its susceptibility to cold, it is uncommon above the elevation. The range of temperatures is 20 to 30 Celsius. Although it operates badly below the content, it can withstand temperatures of up to 42°. It is said to be able to resist mild alkaline and minor salinity in soils. It is tolerant of acidic soils but not highly acidic soils (pH 4.5) or soils with significant aluminum saturation (greater than 60 percent). Gliricidia is a brazen pioneer that quickly takes over barren grounds and reclaims Imperata grassland (Handayanto *et al*., 1997).

2.12 Nutrient content of *Gliricidia sepium*

The Latin name Gliricidia translates to 'mouse killer,' derived from glīrēs (dormice) and -cida (killer), reflecting the plant's traditional use as a natural rodenticide. As a rodenticide, the leaves are used with cooked corn in Central America. According to Meena *et al*. (2018), leaves are also harmful to horses, and many animals cannot handle significant consuming amounts of Gliricidia. Under a typical diet, ruminants don't appear to be harmed. The harmful effects of Gliricidia may result from bacteria converting coumarin to dicoumarol during fermentation. In addition, there may include tannins, cyanogens, HCN (up to 4 mg/kg), and unidentified alkaloids.

Gliricidia has been identified as a potential nitrate accumulator (Bennison & Paterson, 1993). N Up to 15% of the food could contain *Gliricidia sepium* without harming the hens' health or the quality of their eggs (Meena *et al*., 2018). Furthermore, *Gliricidia sepium* can be added to growing chick meals at a rate of 10% without impairing animal performance or survival. A meal consisting of 25% *Gliricidia sepium*, 25% *Leucaena leucocephala*, and 50% cassava peels resulted in growth equivalent to the control diet (Sethi & Kulkarni, 1995). It has been demonstrated that maintaining rabbit meat quality at the same dietary level of 25 percent is ideal. However, giving 20 percent Gliricidia to male rabbits may decrease semen quality and output (Sethi & Kulkarni, 1995). Comparing Gliricidia and Leucaena, it was discovered that Leucaena was more palatable yet produced better live-weight gains and feed conversion rates. Gliricidia is fed to sheep with varying degrees of success. A similar low growth response was seen in sheep fed a mixture of 50% *Gliricidia sepium* and 50% *Pennisetum purpureum* (Ouachinou *et al.,* 2018). However, when supplemented with poor diets in Mexico, *Gliricidia sepium* supplementation had favorable impacts on dry matter intake and digestibility (Alayon & Ku-Vera, 1998). Gliricidia can replace soybean meal in developing sheep-fed intensive diets without affecting animal growth (Marie-Magdeleine *et al*., 2009).

In Malawi, Gliricidia sepium has been intercropped with maize systems to enhance productivity and soil fertility (Beedy et al., 2010). As the potassium content of the soils may vary depending on the rates of crop removal and leaching, the local environmental circumstances, exceptionally high rainfall, maybe the cause of the higher soil exchangeable potassium on the dry side (Zörb et al., 2014).

According to (Chesney, 2012), in Niger, *G. sepium* can generate up to 130 kg of nitrogen per hectare per year and 10 to 20 tons of dry matter with the correct pruning practices. Rosecrance *et al*., (1992) discovered that soil carbon and nitrogen levels were more significant in an alley cropping system with *G. sepium* than in plots lacking this species. Similar results were found by (Ngosong *et al.,* 2019), who noted a 15, 35 to 50% increase in maize production in Cameroon and attributed this to the addition of both organic matter and nitrogen to the soil. The provision of mineral N fertilizers could avoid soil N shortage, which results in stunted cocoa growth, fruit abortion, and poor pod yields (Kaba *et al.,* 2019). Still, these are frequently out of reach for smallholder farmers, who make up the bulk of cocoa growers in Ghana. Additionally, just 20% of Ghana's 1.6 million hectares of cocoa farms are estimated to use mineral fertilizers, and many of the country's remote locations are difficult to access. Common in tropical agro forestry systems is N_2-fixing legume trees that, with correct management, may offer an alternative to N fertilizers to increase soil N availability for the benefit of non-legume plants. *Gliricidia sepium* contains nitrogen, 19.0 % dry matter, 22.6% crude protein, 44.3 % NDF, 6.80 % ADF, 5.67 % ADL, 1.74% calcium and 0.17% phosphorus. 2.7.03 Environmental impact.

2.13 Environmental impact

The legume *Gliricidia sepium* may fix nitrogen. The half-life of Gliricidia leaves is approximately 20 days, generating a large amount of litter. As a result, the plant is regarded as an effective soil enhancer. It serves as a windbreak due to its fast growth and deep roots. It can be utilized to restore depleted land because it grows on steep slopes. Because it creates light shade and lowers soil temperatures, Gliricidia is frequently employed as nurse trees or as shade for perennial plants, including coffee, tea, and cocoa (Orwa *et al*., 2009).

1. Living fence: The most prevalent species of a living fence in the tropics may be *Gliricidia sepium*. Large stakes are used to create fence posts. Fences can be used to harvest green manure, forage, fuelwood, and stakes. Fuelwood: The wood is dense and robust, with a specific gravity ranging from 0.5 to 0.8. It has a calorific value of 4,900 kcal/kg and is a good fuel, burning cleanly and without sparks. Gliricidia woodlots, secondary forests, and natural stands have all been managed

to produce commercial energy. Additionally, the wood is used to make poles, furniture, agricultural implements, and lumber.

2. Farming Systems: When applied as mulch or green manure, the nitrogen-rich leaf increases crop productivity by adding nutrients, controlling weeds, retaining moisture, and lowering soil temperature. Typically, the cropping area's hedgerows or fences provide leaf biomass. Paddy and upland rice, corn, cassava, and coconuts are examples of companion crops. On sloping farmland, hedgerows are utilized to prevent erosion and create passive terraces. The management of hedgerows should reduce crop competition. However, hedgerow systems can be labor-intensive, which might discourage more people from using them. Gliricidia is used to support cassava, yams, vanilla, pepper, and passion fruit, and a shade for tea, coffee, and cacao. These crops profit from Gliricidia ability to enhance the soil. Fields with Gliricidia lessen the frequency of several fungal and insect assaults.
3. Pests: Gliricidia is relatively free from insect and disease problems.
4. Symbiosis: *Gliricidia sepium* uses soil bacteria called Rhizobium to fix atmospheric nitrogen. Before planting, seeds or plants should be inoculated with the appropriate Rhizobium bacteria if Gliricidia is brought to a new region or a degraded site.

2.14 Description of poultry manure

Because it contains the significant nutrients nitrogen (N), phosphorus (P), and potassium (K), as well as the minor elements that all crops need, poultry dung is a complete fertilizer. Garden organic matter and nutrients can be obtained from poultry manure and litter (bedding and manure), whether from a domestic or commercial flock of birds. Compared to inorganic or synthetic fertilizers, manure and litter's organic nature offers many benefits, including improved soil structure due to increased water-holding capacity, pore space, and aeration for healthy plant growth. Thick clay soil is lightened and kept from sticking together by the organic matter in poultry manure. Additionally, they can improve a soil's cation exchange capacity or ability to store nutrients. It is less likely for the nutrients in organic fertilizers to leak out of the garden and contaminate surface or ground waters since they release their nutrients to plants more gradually and over a more extended period.

2.15 Empirical Review of *Gliricidia sepium*, *Leucaena leucocephala* and poultry manure

Soil degradation remains one of the major challenges to sustainable agriculture. To enhance soil quality under continuous cultivation, the leguminous species *Gliricidia sepium* acts as a natural fertilizer source (Meena *et al*., 2018). In a pot experiment, both green leaf manure and intercropping with *G. sepium* significantly improved the growth of sweet corn. The amended soils recorded higher pH, organic matter, and increased nitrogen, potassium, phosphorus, and calcium levels. Green leaf manure at 5–10% resulted in maximum growth at four weeks after transplanting, while 10–20% promoted optimum development after eight weeks. Thus, using *G. sepium* as green manure or in intercropping systems improved soil fertility and nutrient balance.

Leucaena leucocephala (Lam.) de Wit, native to southern Mexico and Central America, is now naturalized in over 130 countries due to its multiple uses in fodder, timber, paper pulp, shade, and soil improvement (Kato-Noguchi *et al*., 2022). Despite its benefits, it is among the world's 100 worst invasive alien species, forming dense stands that threaten native ecosystems, especially on islands. Studies spanning three decades indicate that *L. leucocephala* exhibits allelopathy; a biological mechanism through which its extracts, leachates, and residues release allelochemicals that suppress the germination and growth of nearby plants (Kato-Noguchi *et al*., 2022).

These allelochemicals, including phenolic acids, flavonoids, and mimosine, are released through decomposition and root exudation (Latif *et al*., 2017). *Leucaena* accumulates mimosine (0.11–6.4% of dry weight) in nearly all plant parts, inhibiting cell division and disrupting enzyme activities such as peroxidase, catalase, and IAA oxidase (Kato-Noguchi & Kurniadie, 2022). These compounds likely contribute to its invasiveness and ability to dominate ecosystems. However, concentrations of such chemicals in its rhizosphere remain largely unreported.

Lima et al. (2018) examined the long-term influence of *L. leucocephala* on soil properties and oil palm yields. The species significantly ($P < 0.01$) improved mean weight diameter, water retention, available nitrogen, phosphorus, and exchangeable cations, leading to greater fresh fruit bunch (FFB) production. Over three years, FFB yields reached 10.93 t/ha in *Leucaena*-planted plots, compared with 6.8 t/ha in control plots (Imogie *et al*, 2008).

Similarly, Iddrisu et al. (2021) conducted field experiments at AAMUSTED, Mampong-Ashanti, during the 2018 major and minor seasons to evaluate the combined effect of organic and inorganic fertilizers on carrot yield. Treatments included cattle dung (CD), poultry manure (PM), *Gliricidia sepium* prunings (GP), and *Leucaena leucocephala* prunings (LP) at 10 t/ha, alongside NPK (15-15-15) at 300 kg/ha and their combinations. Results revealed that integrating organic and inorganic fertilizers enhanced growth and yield more than sole or no amendments (Amartey *et al*., 2022). Root yields (24.3–54.2 t/ha) were up to 95% higher than the control (19.4–27.8 t/ha), with the best outcomes from 5 t/ha CD + 5 t/ha GP and 5 t/ha CD + 5 t/ha PM treatments.

Hardarson and Broughton (2003) found that *L. leucocephala*, interplanted with *Cassia siamea* and *C. spectabilis*, exhibited variable nitrogen fixation levels, with a notable increase after thinning at 14 months. Although the non-fixing reference species produced more above-ground biomass, *Leucaena* prunings contributed useful nitrogen when applied as green manure.

Further research by Akinnifesi et al. (2011) demonstrated that green manure from *Leucaena* significantly enhanced maize and millet yields, regardless of whether prunings were incorporated or surface-applied. The proportion of cereal nitrogen derived from prunings ranged from 8–33%, indicating that multipurpose tree residues are valuable nutrient sources, even at moderate application rates, reducing dependence on synthetic fertilizers.

2.16 Effect of *Gliricidia sepium* and *Leucaena leucocephala* on growth and yield of cucumber

The integration of leguminous trees such as *Gliricidia sepium* and *Leucaena leucocephala* into agroecosystems has long been advocated for their ability to enhance soil fertility and crop productivity through biological nitrogen fixation. Emerging empirical evidence underscores their beneficial roles not only through conventional green manure strategies but also via more intricate belowground biological interactions.

Jalonen (2012) provided compelling insights into the mechanisms of nitrogen (N) transfer in agroforestry systems, shifting the focus from traditional reliance on pruning and mulching to the significance of root exudates and common mycelial networks (CMNs). In a model system involving *Gliricidia sepium* and *Dichanthium aristatum,* it was demonstrated that up to 14% of the grass's nitrogen was derived from *G. sepium* through belowground pathways; primarily root exudation, with CMNs contributing an additional 2.5%. These results highlight the potential for leguminous trees to support associated crops through subtle and underappreciated biological routes, especially when arbuscular mycorrhizal fungi (AMF) colonization is favourable (Jalonen, 2012).

Complementing this view, Bisht *et al.* (2024) examined how AMF mediate plant resilience under abiotic stress conditions such as salinity, drought, and heavy metal toxicity. Although their focus is broader and not specific to *G. sepium* or *L. leucocephala*, their findings reinforce the idea that AMF foster improved nutrient and water acquisition. This symbiosis increases photosynthetic efficiency and crop performance—critical aspects under environmental stress, and a compelling argument for integrating AMF into legume-based cropping systems (Bisht *et al*., 2024).

In contrast to Jalonen's mechanistic approach, Afolayan (2020) adopts a field-oriented lens by comparing the impact of AMF, *G. sepium*, *L. leucocephala*, poultry manure, and NPK fertilizers on *Dioscorea rotundata* (white yam). The findings support the notion that organic amendments and microbial inoculants significantly enhance growth and tuber yield more effectively than chemical fertilizers. Particularly notable is the observed synergy between AMF and leguminous tree green manures, which improved physiological traits such as relative water content and chlorophyll concentration—indicating enhanced overall plant health and productivity (Afolayan, 2020).

Taken together, these studies reveal several critical patterns. First, there is strong empirical agreement that leguminous trees, particularly when paired with AMF, significantly enhance plant growth and productivity through both nutrient provisioning and stress mitigation. Second, while traditional agronomic practices emphasize aboveground biomass contribution, Jalonen's work highlights a research gap in our understanding of belowground nutrient dynamics, especially in field conditions and for crops beyond grasses. However, a crucial limitation across the reviewed literature is the absence of direct studies on *Cucumis sativus* (cucumber), creating a critical gap in crop-specific applications of these findings. Moreover, few studies rigorously differentiate the effects of *G. sepium* and *L. leucocephala* under comparable conditions, leaving unanswered questions about species-specific efficacy.

In conclusion, while the ecological and physiological benefits of *G. sepium* and *L. leucocephala* are well supported in current literature, their potential to enhance cucumber yield and resilience remains an open field for targeted investigation. Future research should emphasize controlled, comparative trials in cucumber production, ideally integrating both above- and belowground analyses, to unlock the full potential of these leguminous species in sustainable horticultural systems.

2.17 Effect of poultry manure on soil physical and chemical properties

The application of poultry manure (PM) as an organic soil amendment has consistently demonstrated significant agronomic and environmental benefits across diverse cropping systems. Empirical studies show that PM enhances both the physico-chemical properties of soil and plant nutritional uptake, contributing to increased crop productivity.

Adeleye *et al* (2010) conducted a factorial field experiment in south western Nigeria and found that applying 10 t/ha of poultry manure significantly improved soil structure by reducing bulk density and temperature, while increasing total porosity and moisture retention capacity. The manure also enriched soils with organic matter, nitrogen, phosphorus, potassium, calcium, and magnesium, and reduced exchangeable acidity. This nutrient enrichment led to improved leaf nutrient content, growth, and yield of *Dioscorea rotundata* (yam), highlighting the role of PM in enhancing both soil health and crop output.

Similarly, Mandal, *et al*, (2013) reported in a simulated turfgrass system that composted poultry litter significantly improved soil physical and chemical properties. Incorporation of the compost led to a 38% increase in total water content, a 42% reduction in soil bulk density, and a significant increase in organic matter (up to 6.4%), soil pH (from 6.0 to 7.4), and cation exchan]ge capacity (up to 186%). These transformations, absent in control and NPK-fertilized plots, underscore the superiority of organic amendments like PM over inorganic fertilizers in ameliorating degraded soils.

Further validating these outcomes, Kobierski *et al.* (2017) conducted a decade-long study that demonstrated a sustained rise in organic carbon, pH, exchangeable bases, and available zinc, phosphorus, and potassium in PM-treated soils. However, the study also revealed a suppressive effect on phosphomonoesterase activity, likely due to phosphorus saturation, suggesting the need for balanced applications to preserve enzymatic function.

Soremi *et al.* (2017) provided additional evidence from a multi-site pot experiment on soybeans in southwestern Nigeria. Poultry manure, applied at varying rates up to 10 t/ha, increased organic carbon, exchangeable cations (Ca, Mg, K, Na), and the effective cation exchange capacity. This translated into higher concentrations of N, P, and K in plant tissues and enhanced dry matter yield. Importantly, these improvements were more pronounced than those achieved with NPK fertilizer, underscoring PM's superior nutrient provisioning and uptake facilitation.

Taken together, these findings form a consistent pattern: poultry manure serves as a potent enhancer of soil quality, nutrient bioavailability, and crop productivity across multiple plant species and environmental contexts. While the specific mechanisms may vary ranging from improved water retention and cation exchange to increased enzymatic activity, the agronomic benefits are widely reported and reproducible. Nevertheless, caution is warranted in long-term application, as over-enrichment with elements such as phosphorus may disrupt soil enzymatic balance (Kobierski *et al*., 2017).

2.18 Effect of poultry manure on growth and yield of cucumber

Empirical investigations across Nigeria have consistently demonstrated that poultry manure (PM) is a highly effective organic input for improving cucumber (*Cucumis* *sativus* Linn.) growth and yield. These studies highlight the importance of optimizing application rates to maximize plant performance in varying agro-ecological zones.

A study by Oke *et al*. (2020) conducted in Ibadan, Nigeria, showed that cucumber plants treated with PM at 15 t/ha significantly outperformed the control in virtually all agronomic parameters. Vine length, number of leaves, branches, vine diameter, and fruit yield components were markedly higher at this rate. The average fruit yield reached 31.9 t/ha, with significant increases in fruit weight, number, and size, suggesting that 15 t/ha is effective for commercial cultivation in south-western Nigeria.

Similarly, Enujeke (2013), working in the Asaba region, found a positive correlation between increasing PM rates and plant performance. The highest application rate of 20 t/ha resulted in superior vine length (up to 167.3 cm at 8 weeks), leaf number (56.4), and fruit yield (49.3 t/ha). These findings confirm that higher PM rates support vigorous vegetative growth and higher fruit output in humid tropical conditions, possibly due to enhanced nutrient supply and soil conditioning effects.

In Southeastern Nigeria, Okoli and Nweke (2015) extended the analysis by testing PM rates up to 40 t/ha. Their study showed a continued positive response, with maximum vine length (68.9 cm at 60 days after planting), leaf count (254), and fruit yield (5.2 t/ha) observed at the highest rate. Interestingly, days to 50% flowering were reduced with increasing PM levels, indicating accelerated reproductive development. Although seedling emergence was not significantly affected, nutrient uptake and overall productivity improved markedly with PM enrichment, reinforcing its role as a superior alternative to mineral fertilizers.

Taken together, these findings establish a strong pattern: poultry manure significantly improves cucumber growth and yield across multiple regions. While the optimum rate varies slightly—15 t/ha in Ibadan (Oke *et al*., 2020), 20 t/ha in Asaba (Enujeke, 2013), and 40 t/ha in Enugu (Okoli & Nweke, 2015)—each study affirms that PM enhances both vegetative and reproductive growth. However, the lack of diminishing returns even at high rates, such as 40 t/ha, signals the need for further investigation into threshold levels for nutrient toxicity, soil microbiological changes, and long-term sustainability.

CHAPTER THREE: MATERIALS AND METHODS

3.1 Experimental Locations

Two field experiments were carried out at Asante Mampong in the Mampong Municipality and Adanwomase in the Kwabre East District of the Ashanti Region of Ghana during the major rainy season of 2020 (March to July 2022).

3.1.1 Asante-Mampong (Site I)

The field experiment was carried out at the Multipurpose Crop Nursery of the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED), Asante Mampong Campus, during the major rainy season. Asante Mampong lies within Ghana’s Forest-Savannah Transitional Zone, at an elevation of approximately 135 m above sea level (Geodatos, 2020). The area records an average annual rainfall of about 1,270 mm, characterized by a bimodal pattern—major rains from April to July and minor rains from September to November. A brief dry spell occurs in August, followed by the harmattan season from December to March.

The mean annual temperature is around 27°C, typically fluctuating between 22°C and 30°C (GSS, 2014). The experimental soil belongs to the Bediese Series of the Chromic Luvisol class. It is a deep red sandy loam, free from stones and concretions, well-drained, friable, and has excellent water-holding capacity, with an average pH of 6.5. The soil originates from Voltaian sandstone, as classified under the FAO-UNESCO system (Avornyo *et al.*, 2020a). The district map of Asante Mampong is presented in *Plate 3.1* below.

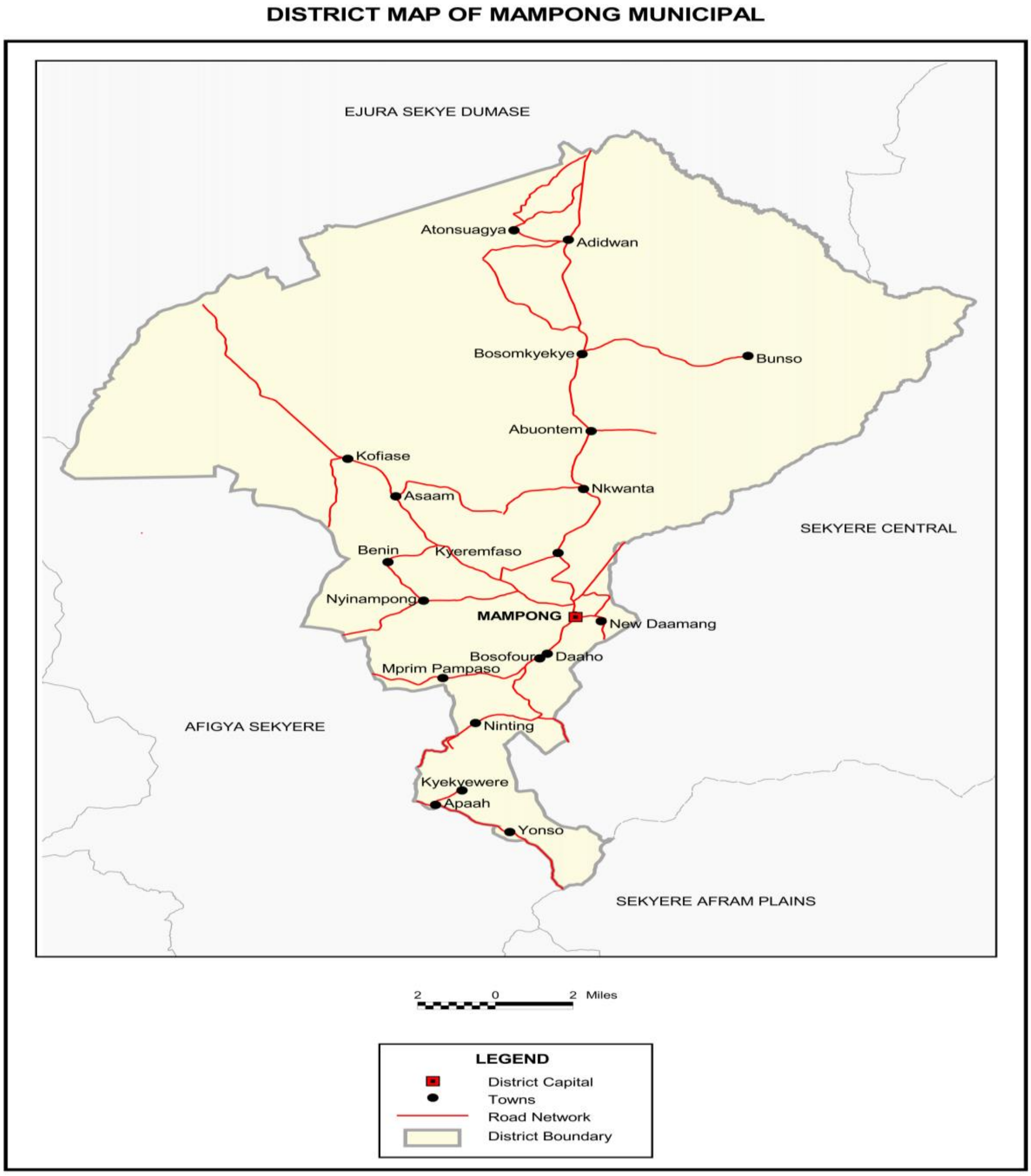


Plate 3.1. District Map of Mampong Municipal

3.1.2 Adanwomase-Kwabre (Site II)

The second field experiment was carried out at the Adanwomase Senior High School farm in Adanwomase, located within the Kwabre East District of Ghana’s Ashanti Region. Formerly part of the Kwabre District, this district was established in 1988 following its separation from the Kwabre-Sekyere District. Geographically, it lies near the center of the Ashanti Region, between latitudes 6°45′–6°50′ N and longitudes 1°30′–

1°35′ W. It is bordered by the Sekyere South District to the north, Kumasi Metropolis to the south, Ejisu-Juaben District to the east, and Afigya Kwabre District to the west.

The area lies within the semi-deciduous forest zone, characterized by a blend of forest and savanna vegetation. Its fine-textured granitic soils support the cultivation of both forest and savanna crops. Covering approximately 148 km²—about 0.06% of the Ashanti Region’s total land area (24,389 km²)—the district experiences a wet semi-equatorial climate with two distinct rainy seasons. The major rains occur from April to June, peaking in June, while the minor rains fall between September and October. The dry season lasts from November to February. Annual rainfall averages 125–175 mm, with relative humidity levels of 75–80% during the wet season and 70–72% in the dry months. The location of the Kwabre East District (Adanwomase) is illustrated in Plate 3.2 below.

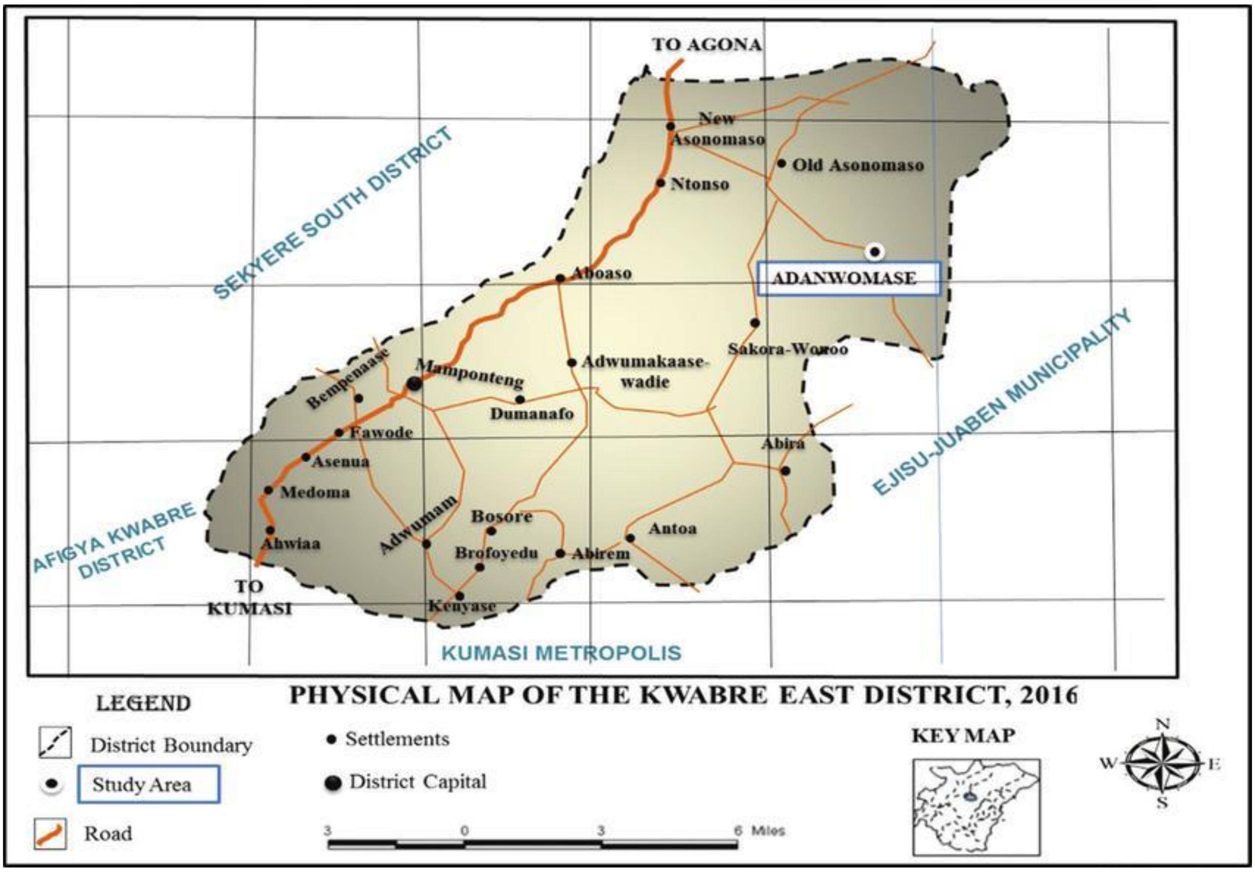


Plate 3.2. District Map of Kwabre -East

3.2 Experimental Design and Treatments

The experiment followed a Randomized Complete Block Design (RCBD) comprising seven (7) treatments, each replicated four (4) times to ensure statistical reliability and minimize experimental error. The treatments included:

T1- 10 t/ha *Gliricidia sepium* prunnigs (GS)

T2 -10 t/ha *Leucaena leucocephala* prunnigs (LL)

T3- 10 t/ha Poultry manure (PM)

T4- 5t/ha *Gliricidia sepium* +5 t/ha Poultry manure (5t/ha GS + 5t/ha PM)

T5- 5t/ha *Leucaena leucocephala* + 5t/ha Poultry manure (5t/ha LL+5t/ha PM)

T6- 5t/ha *Gliricidia sepium*+ 5t/ha *Leucaena leucocephala* (5t/ha GS +5t/ha LL)

T7- control (no fertilizer/amendment)

3.3 Cultural and Management Practice

3.3.1 Land preparation

The experimental areas were ploughed and harrowed to a fine tilt. The debris was raked off the field to obtain levelled field followed by Lining and pegging. The plots were marked and pegged 2.0 m long and 2.5 m in width, each giving an area of 5.0 m^2. The land was demarcated into replications. One meter was left in between the replications. Seven plots were measured in each replicate, giving a total of twenty-eight (28) plots in all for the four (4) replicates

3.3.2 Legume tree pruning and poultry manure preparation

Fresh tender stems and leaves of legume tree pruning of *Gliricidia sepium* and *Leucaena leucocephala* were collected from AAMUSTED, Mampong campus and shade dried for two weeks. The legume tree prunings were later milled to reduce size into powdered form. The poultry manure used for the experiment was collected from the AAMUSTED, Mampong campus poultry farm. Poultry manure collected was heaped under shade and covered with a black polythene sheet for two (2) weeks for further decomposition until the temperature was stabilized before incorporated into the soil.

3.3.3 Poultry manure and legume pruning application and planting

Soil treatments were administered on 23rd April 2022 at Asante Mampong and 30th April 2022 at Adanwomase. The amendments were thoroughly mixed into the soil using a hand fork and rake, after which the plots were watered and left for two weeks to allow partial decomposition before planting.

The *Tokyo F1* cucumber variety, developed by the Crops Research Institute (CSIR-CRI), was selected for its vigorous growth, resistance to diseases, uniform fruit shape, and high yield potential.

Planting took place on 7th May 2022 at Asante Mampong and 14th May 2022 at Adanwomase. Two seeds were sown per hill at a depth of 3–5 cm and later thinned to one healthy plant per stand two weeks after emergence. A spacing of 0.4 m × 0.5 m was adopted, giving five rows per plot with five plants per row, totalling 25 plants per plot.

3.3.4 Weed Control

Weed control was manually done using a hoe, cutlass as well as handpicking. Weeding was carried out three times at two weeks, four weeks and 6 weeks after planting during the experiments. The common weed found on the field was *Cyperus rotundus* at Asante Mampong site.

3.3.5 Irrigation

Due to erratic rainfall, supplementary irrigation was carried out as and when the need arose. Subsequent watering was done every other day in the morning and evening using watering cans. Each plant was given 1.5 liters of water per plant per day.Pest and Disease Control.

3.3.6 Pest and Disease Control

Routine inspections of the experimental plots were conducted twice weekly to monitor pest and disease incidence throughout the growing season. Notable pests observed included cucumber beetles (*Diabrotica* spp.) and whiteflies (*Bemisia tabaci*), which appeared during the vegetative and flowering stages. To control these pests, Cypermethrin 10% EC was applied at a dilution of 1 ml per litre of water, using a15 litre knapsack sprayer.

3.3.7 Staking

The staking of cucumber plants, using the string method, was carried out during the fourth week after sowing to support vertical growth and optimize canopy exposure.

3.4 Data collected

Five plants on each plot were sampled and tagged from which the growth and yield parameters were recorded.

3.4.1 Poultry manure and legume pruning sampling and analysis

Samples of poultry manure and legume tree prunings were also taken and analyzed. The routine analysis of poultry manure and legume tree prunings took place at the Soil Research Institute of CSIR, Kwadaso in Kumasi. This was done for each experimental site before incorporation into the soil.

3.4.2 Initial soil sampling and analysis

Soil sampling was carried out prior to land preparation. Composite samples from each replication were collected at a 0–15 cm depth before applying manure and legume prunings, using the zigzag sampling method. The samples were thoroughly mixed, and quartering was performed by discarding two opposite quarters and remixing the remainder until about 1 kg of soil was obtained.

The samples were then pulverized, shade-dried, and sieved through a 2 mm mesh before being analyzed for physical and chemical properties at the Soil Research Institute, Kwadaso (Kumasi). This procedure was conducted for each experimental site, both before planting and after harvesting.

3.4.3 Soil organic carbon

Soil organic carbon was determined using the modified Walkley-Black method (Nelson & Sommers, 1982). The process involved wet combustion of soil organic matter with a mixture of potassium dichromate ($K_2Cr_2O_7$) and sulphuric acid (H_2SO_4), followed by titration of the excess dichromate with ferrous sulphate ($FeSO_4$).

Approximately 1.0 g of air-dried soil was weighed into a 250 ml Erlenmeyer flask, with a reference and blank included. Then, 10 ml of 0.1667 M $K_2Cr_2O_7$ solution was added, and the sample was gently swirled to wet the soil. Using an automatic pipette, 20 ml of concentrated H_2SO_4 was dispensed rapidly and mixed vigorously for one minute, then allowed to stand for 30 minutes. After cooling, 100 ml of distilled water, 10 ml of ortho-phosphoric acid, and 1 ml of diphenylamine indicator were added.

Titration was performed with 1.0 M $FeSO_4$ until the colour changed from purple to dark green, indicating the end point. To confirm the endpoint, 0.5 ml of 0.1667 M $K_2Cr_2O_7$ was added, followed by dropwise $FeSO_4$ until a stable colour was reached. The volume of $FeSO_4$ used was recorded, and percent carbon (%C) was calculated accordingly.

Calculation:

The organic carbon content of soil was calculated as:

$$\% \text{ O.C } = \frac{\text{M } \times 0.39 \ \times \text{mcf } \times (\text{V}_1 - \text{ V}_2)}{\text{s}}$$

where

M = molarity of ferrous sulphate solution.

V_1 = ml of ferrous sulphate solution required for blank.

V_2 = ml of ferrous sulphate solution required for sample.

s = weight of air – dry sample in grams.

mcf = moisture correcting factor $\frac{(100 + \% \text{ moisture})}{100}$.

$0.39 = 3 \ \times 0.001 \ \times 100 \ \% \ \times 1.3$ (3 = equivalent weight of carbon).

1.3 = a compensation factor for the incomplete combustion of the organic carbon.

3.4.4 Total nitrogen

Total nitrogen was analyzed using the Kjeldahl digestion and distillation method described by Bremner and Mulvaney (1982). Approximately 0.2 g of soil was weighed into a Kjeldahl digestion flask, followed by the addition of 5 ml of distilled water. After 30 minutes, a selenium tablet and 5 ml of concentrated H_2SO_4 were added. The flask was placed on a digestion unit and heated gently at first, then vigorously for about 3 hours until a clear solution formed.

After cooling, 40 ml of distilled water was added, and the digest transferred into a 100 ml distillation tube. Then, 20 ml of 40% NaOH was introduced, and the sample distilled for 4 minutes using a Tecator Kjeltec distiller. The distillate (about 75 ml) was collected into a flask containing 20 ml of 4% boric acid (H_3BO_3) with bromocresol green (PT5) indicator, which changed colour from pink to green during distillation.

The distillate was titrated with 0.02 M HCl until the solution shifted from green to pink, indicating the endpoint. The volume of HCl used was recorded, and percent nitrogen (%N) calculated. A blank titration was also performed to correct for any trace nitrogen in reagents or water.

Calculation:

The percentage nitrogen in the sample was expressed as:

$$\%\ N = \frac{(M \times (a - b) \times 1.4 \times mcf)}{s}$$

where

M = concentration of hydrochloric acid used in titration.

a = volume of hydrochloric acid used in sample titration.

b = volume of hydrochloric acid used in the blank titration.

s = weight of air − dry sample in grams.

$$mcf = \text{moisture correcting factor } \frac{(100 + \%\ \text{moisture})}{100}$$

3.4.5 Bray's No. 1 Phosphorus (available phosphorus)

Available phosphorus was determined using the Bray No. 1 extraction method (Bray & Kurtz, 1945), which utilizes a hydrochloric acid–ammonium fluoride ($HCl–NH_4F$) solution to release easily soluble phosphorus. The extracted phosphorus was then quantified spectrophotometrically using the blue ammonium molybdate–ascorbic acid method.

Approximately 5 g of soil was placed in a 100 ml extraction bottle, followed by the addition of 35 ml of Bray No. 1 solution (0.03 M NH_4 F in 0.025 M HCl). The mixture was shaken for 10 minutes on a reciprocal shaker and then filtered through Whatman No. 42 filter paper into a 100 ml volumetric flask. A 5 ml aliquot of the filtrate was pipetted into a 25 ml test tube, to which 10 ml of ammonium paramolybdate reagent and a small amount of ascorbic acid were added. The mixture was allowed to stand for 15 minutes to develop a blue colour, after which absorbance was measured at 660 nm using a Spectronic 21D spectrophotometer.

Phosphorus concentration was determined from a calibration curve prepared using a standard series (0–6 mg P/L), obtained by serial dilution of a 12 mg P/L stock solution in 100 ml volumetric flasks with distilled water.

Calculation:

$$\mathrm{P\ (mgkg^{-1})} = \frac{(a - b) \times 35 \times 15 \times \mathrm{mcf}}{s}$$

where

$a = \mathrm{mg/l\ P\ in\ sample\ extract.}$

$b = \mathrm{mg/l\ P\ in\ blank.}$

$s = \mathrm{weight\ of\ air - dry\ sample\ in\ gram.}$

$$\mathrm{mcf = moisture\ correcting\ factor}\ \frac{(100 + \%\ \mathrm{moisture})}{100}$$

$35 = \mathrm{volume\ of\ extracting\ solution.}$

$15 = \mathrm{final\ volume\ of\ sample\ solution.}$

3.4.6 Exchangeable cations

Exchangeable base cations: calcium (Ca^{2+}), magnesium (Mg^{2+}), potassium (K^{+}), and sodium (Na^{+}) were extracted from the soil using 1.0 N ammonium acetate (NH_4 OAc) solution at pH 7.0, following the method described by Thomas (1982). The extracted solution was subsequently analyzed to quantify the concentrations of the individual cations.

3.4.6.1 Extraction of the exchangeable bases

A 5 g soil sample was transferred into a leaching tube and leached with 100 ml of buffered 1.0N ammonium acetate (NH_4OAc) solution at pH 7.

3.4.6.2 Determination of Potassium

A 25 ml portion of the extract was transferred into an Erlenmeyer flask, to which 1.0 ml of hydroxylamine hydrochloride, 1.0 ml of 2% potassium cyanide, and 1.0 ml of 2% potassium ferrocyanide were added. After allowing the mixture to react for several minutes, 4 ml of 8 M potassium hydroxide and a small amount of murexide indicator were introduced. The solution was then titrated with 0.01 N EDTA until a clear blue endpoint appeared, and the titration value was recorded.

3.4.6.3 Determination of calcium and magnesium

A 25 ml portion of the extract was measured into an Erlenmeyer flask, followed by the addition of 1.0 ml hydroxylamine hydrochloride, 1.0 ml of 2% potassium cyanide, 1.0 ml of 2% potassium ferrocyanide, 10.0 ml of ethanolamine buffer, and 0.2 ml of Eriochrome Black T indicator. The solution was titrated with 0.01 N EDTA (ethylenediaminetetraacetic acid) until a distinct turquoise-blue endpoint was reached, and the titration value was recorded. Magnesium concentration was then determined by subtracting the calcium titre from the combined calcium–magnesium titre value.

Calculation:

Exchangeable Calcium (cmol of Ca (+) kg^{-1}soil) =

$$\left[\frac{V_1 - V_2}{V_3} \times V_4 \times N \times \frac{100}{w}\right] \times \mathrm{mfc}$$

where

V_1 = volume of EDTA required for sample aliquot titration, ml

V_2 = volume of EDTA required for blank titration, ml

V_3 = volume of aliquot taken, ml

V_4 = total volume of original NH_4OAc extracts, ml

N = normality of EDTA

w = weight of sample taken in g

mcf = moisture correcting factor $\frac{(100 + \%\ \mathrm{moisture})}{100}$

Exchangeable Calcium plus Magnesium (cmol of Ca + Mg kg^{-1} soil)

$$= \left[\frac{V_5 - V_6}{V_7} \times V_4 \times N \times \frac{100}{w}\right] \times \mathrm{mfc}$$

where

V_4 = total volume of original NH_4OAc extracts, ml

V_5 = volume of EDTA required for sample aliquot titration, ml

V_6 = volume of EDTA required for blank aliquot titration, ml

V_7 = volume of aliquot taken, ml

N = normality of EDTA

w = weight of sample taken in g

$$\text{mcf} = \text{moisture correcting factor}\ \frac{(100 + \%\ \text{moisture})}{100}$$

$1\text{ml}\ 0.01\ \text{N EDTA} = 0.2004\ \text{mg}\ Ca^{2+} = 0.1216\ Mg^{2+}$

3.4.6.4 Exchangeable potassium and sodium determination

Potassium and sodium concentrations in the percolate were determined using a flame photometer. Standard series for both elements were prepared by diluting 1000 mg/L stock solutions to 100 mg/L. A 25 ml portion of each was transferred into a 250 ml volumetric flask and filled to volume with distilled water. Then, 0, 5, 10, 15, and 20 ml aliquots of the 100 mg/L standard were pipetted into 200 ml volumetric flasks, followed by 100 ml of 1.0N NH_4 OAc, and topped up with distilled water. This produced standard concentrations of 0, 2.5, 5.0, 7.5, and 10.0 mg/L. Potassium and sodium levels in the percolate were measured directly using flame photometry at 766.5 nm and 589.0 nm wavelengths, respectively.

Calculations:

$$\text{Exchangeable K}\ (\text{cmolkg}^{-1}\text{soil}) = \frac{(a - b) \times 250 \times \text{mcf}}{10 \times 39.1 \times s}$$

$$\text{Exchangeable Na}\ (\text{cmolkg}^{-1}\text{soil}) = \frac{(a - b) \times 250 \times \text{mcf}}{10 \times 23 \times s}$$

where

a = mg/l K or Na in the diluted sample percolate.

b = mg/l K or Na in the diluted blank percolate.

s = weight of air – dry sample in gram.

$$\text{mcf} = \text{moisture correcting factor}\ \frac{(100 + \%\ \text{moisture})}{100}$$

3.4.7 Exchangeable acidity

Exchangeable acidity, defined as the total of Al^{3+} and H^{+} ions, was determined using a 1.0M KCl extract. Ten grams of soil were placed in a 100 ml bottle, mixed with 50 ml of 1.0M KCl, capped, and shaken for one hour. The mixture was then filtered, and a 25 ml aliquot of the filtrate was pipetted into a 250 ml Erlenmeyer flask. After adding 2–3 drops of phenolphthalein indicator, the solution was titrated with 0.1M NaOH until a permanent pink colour appeared. A blank titration was also carried out for reference.

Calculation:

$$\text{Exchangeable acidity } (\text{cmolkg}^{-1}\text{soil}) = \frac{(a-b) \times M \times 2 \times 100 \times \text{mcf}}{s}$$

where

a = ml NaOH used to titrate sample.

b = ml NaOH used to titrate blank.

M = molarity of NaOH solution.

s = weight of air − dry sample in gram.

2 = 50/25 (filtrate/pipetted volume)

$$\text{mcf} = \text{moisture correcting factor } \frac{(100 \times \%\text{ moisture})}{100}$$

3.4.7.1 Effective cation exchange capacity (ECEC)

The effective cation exchange capacity (ECEC) was obtained by summing the exchangeable bases: calcium (Ca^{2+}), magnesium (Mg^{2+}), potassium (K^{+}), and sodium (Na^{+}) with the exchangeable acidity ($Al^{3+} + H^{+}$).

3.4.7.2 Exchangeable cations

Exchangeable bases; calcium (Ca^{2+}), magnesium (Mg^{2+}), potassium (K^+), and sodium (Na^+) were analyzed using 1.0N ammonium acetate (NH_4OAc) extract, following the procedure described by Thomas (1982).

3.4.7.3 Extraction of the exchangeable bases

A 5 g soil sample was transferred into a leaching tube and leached with 100 ml of buffered 1.0N ammonium acetate (NH_4OAc) solution at pH 7.

3.4.8 Characterization of soil (Particle size analysis)

In determining the percentages of primary soil separates, the Bouyoucous hydrometer method was employed (Day, 1965). Each sample was analyzed for particle size distribution (clay, silt, and sand). The beaker's weight was first measured using a balance, and 50 g of 2 mm-sieved soil was added. Twenty milliliters (20 ml) of H_2O_2 were introduced to oxidize organic matter, followed by 100 ml of Calgon solution (sodium hexametaphosphate and sodium hydrogen carbonate). The mixture was stirred and heated to the first sign of boiling, then transferred into a settling cylinder and topped to the 1000 ml mark with distilled water. After agitation with a plunger, timing began immediately. A hydrometer (ASTM 152H) was inserted, and readings were taken at 40 seconds and 5 hours, along with corresponding temperatures. A blank sample reading was also recorded. Equations (1–4) were used to determine the particle size distribution of each soil sample

(1) 40sec (corr) = 2(40sec reading – 40sec blank + T)

(2) 5 hr (corr) = 2(5hr reading – 5hr blank +T)

Where T = Temperature correction.: For every degree above 20 °C(d), T= 0.3 X d

% Sand = (100 – 40 sec (corr)

% Silt = 40 Sec(corr) -5hr (corr)

% Clay = 5 hr (corr)

The textural classification according to USDA is used.

3.4.8.1 Soil pH

Soil pH was determined in a 1:2.5 soil-to-water ratio using a glass electrode pH meter (H19017 Microprocessor). About 10 g of soil was weighed into a 50 ml polythene beaker, and 25 ml of distilled water was added. The mixture was thoroughly stirred and left to stand for 30 minutes. After calibrating the pH meter with pH 4.01 and 7.00 buffer solutions, the electrode was immersed in the upper layer of the soil suspension, and the pH reading was recorded.

3.5 Phenological data

- **Days to 50% emergence**

This was determined when 50% of the planted seeds had emerged, counting from the three central rows selected, after which the mean value was calculated.

- **Day to 50% flowering**

Days to 50% flowering were determined by recording the number of days from planting until half of the plants in the three central rows had flowered, after which the mean value was calculated.

3.6 Vegetative growth parameters

- **Vine length**

Vine length was measured from the plant base to the tip of the main stem using a meter rule. Measurements were taken from five randomly selected and tagged plants within the three central rows, starting two weeks after planting and at two-week intervals thereafter, and the mean values were calculated.

- **Number of leaves per plant**

The number of leaves per plant was recorded from five randomly selected and tagged plants within the three central harvestable rows. Leaves were counted for each tagged plant beginning two weeks after planting and at two-week intervals throughout the growing period, after which the mean values were calculated.

- **Chlorophyll content of leaf**

Leaf chlorophyll content was measured using a chlorophyll meter on five randomly selected and tagged plants within the three central harvestable rows. Measurements were taken two weeks after planting and at two-week intervals throughout the growing period, and the mean values were calculated.

- **Dry Matter Accumulation**

Dry matter was assessed two weeks after planting and at one-week intervals thereafter. Two plants were uprooted from the border of each plot, chopped into smaller pieces, and weighed for fresh shoot weight using a Westinghouse electronic scale. A 200 g subsample of the fresh shoots was oven-dried at 85 °C until a constant weight was reached, after which the mean dry shoot weight was calculated and recorded.

3.7 Yield and yield components

- **Fruit length**

A tape measure was used to measure the fruits harvested from the three central rows of each plot, after which the mean fruit length was calculated.

- **Fruit diameter**

A manual vernier caliper was used to measure the widest portion of fruits harvested from five plants selected within the three central rows of each plot, and the mean fruit diameter was calculated.

- **Fruit weight**

The fruits from the harvested area of the three central rows of each plot was harvested and weighed by using a weighing scale and their means recorded.

- **Total fruit yield**

Total fruit yield from the harvested area within the three central rows of each plot was recorded and used to compute yield per hectare. The cucumber yield (t/ha) was calculated using the formula described by (Muhammad *et al*., 2019).

Cucumber yield (kg/ha) = (cucumber yield) / (Harvested area (m^2) x 10000 m^2

3.8 Data analysis

The data was analyzed using the analysis of variance (ANOVA) with GenStat Release 18.1 statistical package. Tukey's Honestly Significant Difference (HSD) was used to separate treatment means at 5% level of probability.

CHAPTER FOUR: RESULTS

4.1 Physico-chemical properties of soil at the experimental sites

4.1.1 Initial Physico-chemical properties of the soil at the experimental sites.

Table 4.1 shows physico-chemical properties of the soil at the experimental site before planting and after harvesting in Asante Mampong and Adanwomase. The initial and final soil analysis were interpreted using a guide to interpretation of soil analytical data in Ghana. (SRI, 2007). At Asante Mampong, the pH was 5.67 which was lower compared to the higher 6.18 pH at Adanwomase. Soil at Asante Mampong recorded the highest Phosphorus (P) value of 8.04 mg/kg compared to the least value of 6.18 mg/kg at Adanwomase (Table 4.1). The results also showed Nitrogen (N), Potassium (K), Magnesium (Mg), and organic matter content to be higher at Adanwomase than Asante Mampong, whereas Calcium (Ca) and Magnesium (Mg) were higher at Mampong than Adanwomase. Percentage organic carbon was the same at both locations. Similarly, with exchangeable acidity, Asante Mampong recorded the highest compared to the lowest at Adanwomase.

For initial particle size analysis, % sand was higher at Adanwomase than Asante Mampong whereas at Asante Mampong, % silt was higher than that of Adanwomase. Both locations had the same % clay content. For final particle size analysis, Asante Mampong had the highest % sand whereas % silt was higher at Adanwomase than Asante Mampong. Both Asante Mampong and Adanwomase recorded the same % clay. The soils at the two locations were found to be sandy in nature (Table 4.1).

4.1.2 Physico-chemical properties of the soil after harvest

Table 4. 2 presents result of chemical and physical properties of treatments after harvesting cucumber. The application of 5 t/ha *Leucaena leucocephala* + 5 t/ha Poultry manure at both Asante Mampong and Adanwomase had the highest pH whereas the

lowest was recorded from 10 t/ha poultry manure at both locations. Phosphorus was higher with the application of 5 t/ha *Gliricidia sepium* + 5 t/ha Poultry manure at both locations with 10 t/ha *Gliricidia sepium* recording the lowest at both locations. Nitrogen was higher in 5 t/ha *Leucaena leucocephala* + 5 t/ha Poultry manure at both locations. The application of 10 t/ha *Leucaena leucocephala* had the highest Potassium (K), Calcium (Ca), and Magnesium (Mg) at both Asante Mampong and Adanwomase. Exchangeable acidity was higher with the application of 10 t/ha poultry manure at both locations with the lowest recorded from the combination of 5 t/ha *Leucaena leucocephala* + 5 t/ha Poultry manure. Generally, organic carbon content was higher in 5 t/ha *Leucaena leucocephala* + 5 t/ha Poultry manure at both locations. The application of 10 t/ha *Leucaena leucocephala* in general had the highest organic matter at both Asante Mampong and Adanwomase.

Table 4.1: Initial soil chemical analysis, and initial and final soil physical properties of soils at Asante Mampong and Adanwomase.

Soil Samples				Exch. Bases (cmol/kg)				Exch. Acidity		% Org. C.	% Org. M.
	pH	P	N (%)	K	Ca	Mg	Na	Al	E.C.E.C		
	(H_2O)	mg/kg						(cmol/kg)			
Asante Mampong	5.67	8.04	0.13	0.22	4.22	0.73	0.13	0.08	7.56	1.12	1.40
Adanwomase	6.18	6.18	0.14	0.36	3.62	0.43	0.10	0.05	4.56	1.12	1.93

	Initial particle size analysis		Final particle size analysis	
	Asante Mampong	Adanwomase	Asante Mampong	Adanwomase
% Sand	88.00	92.00	91.71	91.36
% Clay	4.00	4.00	2.00	2.00
% Silt	6.00	4.00	6.29	6.64
Textural class	Sand	Sand	Sand	Sand

Table 4.2 Chemical and physical properties of soils after harvest at Asante Mampong and Adanwomase

Treatments	pH (H_2O)	Avail. P mg/kg	N (%)	Exch. Bases (cmol/kg)				Exch. Acidity(cmol/kg)		% OC.	% OM.	% Sand	% Silt	% Clay	Texture
				K	Ca	Mg	Na	Al	E.C.E.C						
							Asante Mampong								
10 t/ha GS	5.34	27.83	0.12	0.32	2.34	1.07	0.08	0.75	4.55	0.92	1.58	92.00	6.00	2.00	*Sand*
10 t/ha LL	5.78	1538.47	0.15	0.42	3.41	1.70	0.09	0.60	6.22	1.20	2.06	91.00	7.00	2.00	*Sand*
10 t/ha PM	4.68	25.51	0.14	0.30	2.13	1.28	0.35	1.30	5.36	0.88	1.51	90.00	8.00	2.00	*Sand*
5 t/ha GS + 5 t/ha LL	5.13	46.39	0.11	0.25	2.13	0.43	0.08	0.85	3.73	0.80	1.38	92.00	6.00	2.00	*Sand*
5 t/ha GS + 5 t/ha PM	5.29	2288.38	0.13	0.22	1.70	1.49	0.05	0.80	4.27	1.00	1.72	91.00	7.00	2.00	*Sand*
5 t/ha LL + 5 t/ha PM	5.84	1012.76	0.16	0.34	3.83	1.28	0.05	0.55	5.73	1.20	2.06	93.00	5.00	2.00	*Sand*
Control	5.62	102.05	0.13	0.36	3.41	2.13	0.05	0.60	6.55	1.08	1.86	93.00	5.00	2.00	*Sand*
							Adanwomase								
10 t/ha GS	5.21	26.83	0.11	0.22	2.34	1.04	0.07	0.65	4.45	0.91	1.55	91.50	6.50	2.00	*Sand*
10 t/ha LL	5.55	1534.47	0.14	0.32	3.21	1.60	0.08	0.50	6.12	1.19	2.03	90.50	7.50	2.00	*Sand*
10 t/ha PM	4.47	24.51	0.12	0.24	2.03	1.18	0.33	1.20	5.16	0.87	1.47	90.00	8.00	2.00	*Sand*
5 t/ha GS + 5 t/ha LL	5	45.39	0.09	0.23	2.03	0.33	0.07	0.75	3.53	0.79	1.31	91.50	6.50	2.00	*Sand*
5 t/ha GS + 5 t/ha PM	4.9	2285.38	0.12	0.21	1.50	1.39	0.04	0.70	4.17	0.97	1.64	91.00	7.00	2.00	*Sand*
5 t/ha LL + 5 t/ha PM	5.63	1010.76	0.15	0.24	3.66	1.18	0.04	0.45	5.63	1.18	2.01	92.50	5.50	2.00	*Sand*
Control	5.51	101.05	0.10	0.35	3.21	2.03	0.04	0.50	6.45	1.07	1.79	92.50	5.50	2.00	*Sand*

LL= Leucaena leucocephala; GS = Gliricidia sepium; PM = Poultry manure; GS + LL = Gliricidia sepium + Leucaena leucocephala; GS + PM = Gliricidia sepium + Poultry manure; LL + PM = Leucaena leucocephala + Poultry manure

4.2. Climatic Conditions at the Experimental sites

At Asante Mampong, total rainfall amounted to 644.15 mm. The highest relative humidity, 92.67%, was observed in July, with the lowest (76.63) recorded in March (Table 4.3).

At Adanwomase, a total of 653.284 mm of rainfall was recorded. Relative humidity peaked at 94.06% in July, while the lowest value, 77.55%, occurred in March. The average maximum and minimum temperatures for the season were 38.15 °C and 24.58°C, respectively (Table 4.4).

Month	Total Rainfall (mm)	Relative Humidity (%)	Mean Temperature (℃)	
			Max	**Min**
March	107.63	76.41	37.59	24.22
April	129.63	80.94	36.94	24.04
May	132.06	86.95	34.92	23.46
June	141.56	92.63	31.83	22.71
July	133.27	92.67	30.28	21.93
Total	**644.15**			

Table 4.3: Climatic data for Experiment I (Asante Mampong)

(Ghana Meteorological Agency – Mampong Ashanti, 2022)

Table 4.4: Climatic data for Experiment site II (Adanwomase)

Month	Total Rainfall (mm)	Relative Humidity (%)	Mean Temperature (℃)	
			Max	**Min**
March	109.25	77.55	38.15	24.58
April	131.58	82.15	37.49	24.40
May	134.05	88.26	35.44	23.82
June	143.69	94.03	32.31	23.05

July	135.27	94.06	30.73	22.26
Total	**653.84**			

(Ghana Meteorological Agency – Mampong Ashanti, 2022).

4.3 Phenology

4.3.1 Days to 50% emergence and Days to 50% flowering

Table 4.5 shows the days to 50% emergence of cucumber as influenced by legume tree pruning and poultry manure application at Asante Mampong and Adanwomase. The emergence period ranged between 6 and 7 days at both sites. There were no significant (P≥0.05) differences observed among the treatment means for location, treatment, or their interaction (location × treatment) (Table 4.5).

Table 4.5 presents the days to 50% flowering of cucumber as influenced by legume tree pruning and poultry manure application at Asante Mampong and Adanwomase. The time to reach 50% flowering ranged from 35 to 38 days at both locations. There were no significant (P≥0.05 differences among the treatment means for location, treatment, or their interaction (location × treatment) (Table 4.5).

Table 4.5: Days to 50% emergence and Days to 50% flowering of cucumber as affected by legume tree prunings and poultry manure application at Asante Mampong and Adanwomase

Treatment	**Days to 50% emergence**			**Days to 50% flowering**		
	Asante Mampong	**Adanwomase**	**Mean**	**Asante Mampong**	**Adanwomase**	**Mean**
10 t/ha GS	7	7	7	37	37	37
10 t/ha LL	6	6	6	36	37	37
10 t/ha PM	6	6	6	35	36	36
5 t/ha GS + 5 t/ha LL	7	7	7	37	37	37
5 t/ha GS + 5 t/ha PM	7	6	7	37	37	37
5 t/ha LL + 5 t/ha PM	6	6	6	36	36	36
Control	7	6	7	37	38	38
Mean	**6.67**	**6.38**	**6.53**	**36.57**	**36.67**	**36.62**
HSD ($P \leq 0.05$)	**NS**	**NS**		**NS**	**NS**	
CV (%)	**10**	**8.94**		**3.29**	**3.14**	
Location =	HSD= NS	P= 0.1888	HSD=NS	P= 0.7911		
Treatment =	HSD=NS	p= 0.4495	HSD=NS	P= 0.0968		
Location*Treatment =	HSD=NS	P=0.9380	HSD=NS	P= 0.9410		

Means followed by or sharing the same letters within a column are not significantly different at 5% level of significance; CV = coefficient of variation; HSD = Honestly significant difference, DAP = Days after planting; NS = Non-significance; LL= Leucaena leucocephala; GS = Gliricidia sepium; PM = Poultry manure; GS + LL = Gliricidia sepium + Leucaena leucocephala; GS + PM = Gliricidia sepium + Poultry manure; LL + PM = Leucaena leucocephala + Poultry manure.

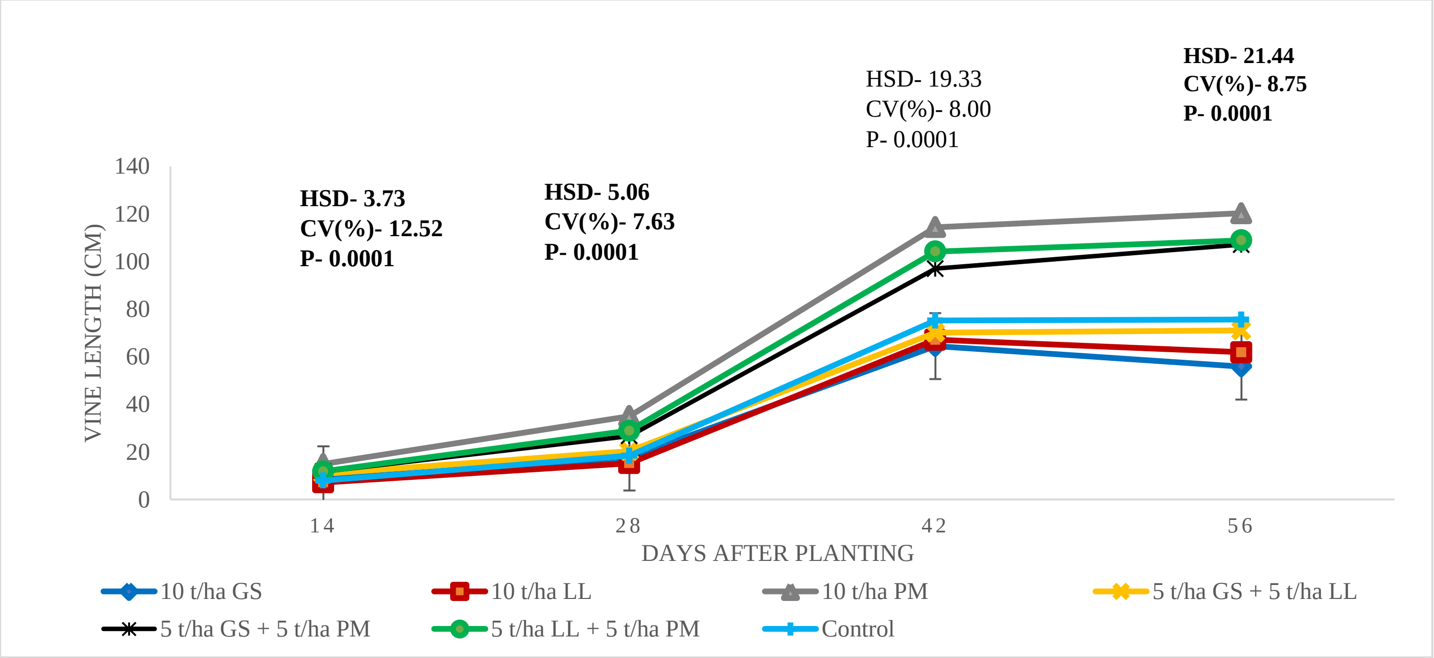
4.4 Vegetative growth parameters

4.4.1 Vine length

Figures 4.1 shows result of vine length of cucumber as affected by legume tree prunings and poultry manure application at Asante Mampong and Adanwomase. At Asante Mampong, the treatment means differed significantly (P≤0.05) from each other from 14 DAP to 56 DAP. The vine length increased throughout the entire period from 14 DAP to 56 DAP. The highest increase in vine length throughout the growing period was recorded from plots treated with 10 t/ha poultry manure followed by the application of 5 t/ha *Leucaena leucocephala* + 5 t/ha poultry manure (Figure 4.1A). The least vine length was recorded from plots treated with 10 t/ha *Gliricidia sepium.*

At Adanwomase, the vine length increased throughout the entire period of its growth from 14 DAP to 56 DAP (Figure 4.1B). There were significant (P≤0.05) differences recorded between the treatment means from 14 DAP to 56 DAP. The longest vine length from 14 DAP to 42 DAP was recorded from 10 t/ha poultry manure treated plot. However, at 56 DAP, the greatest vine length was recorded from the combination of 5 t/ha *Gliricidia sepium* + 5 t/ha poultry manure treated plot whereas the control treated plots had the least plant growth (Figure 4.1B).

A. Asante Mampong



B. Adanwomase

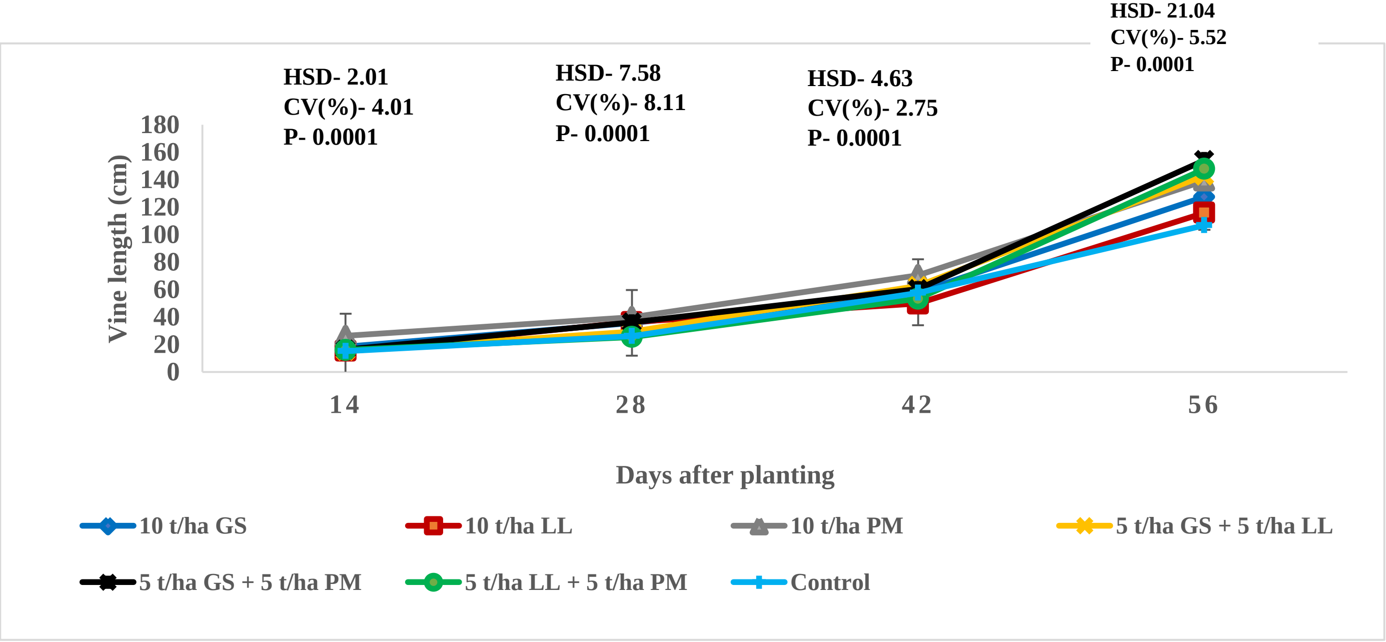


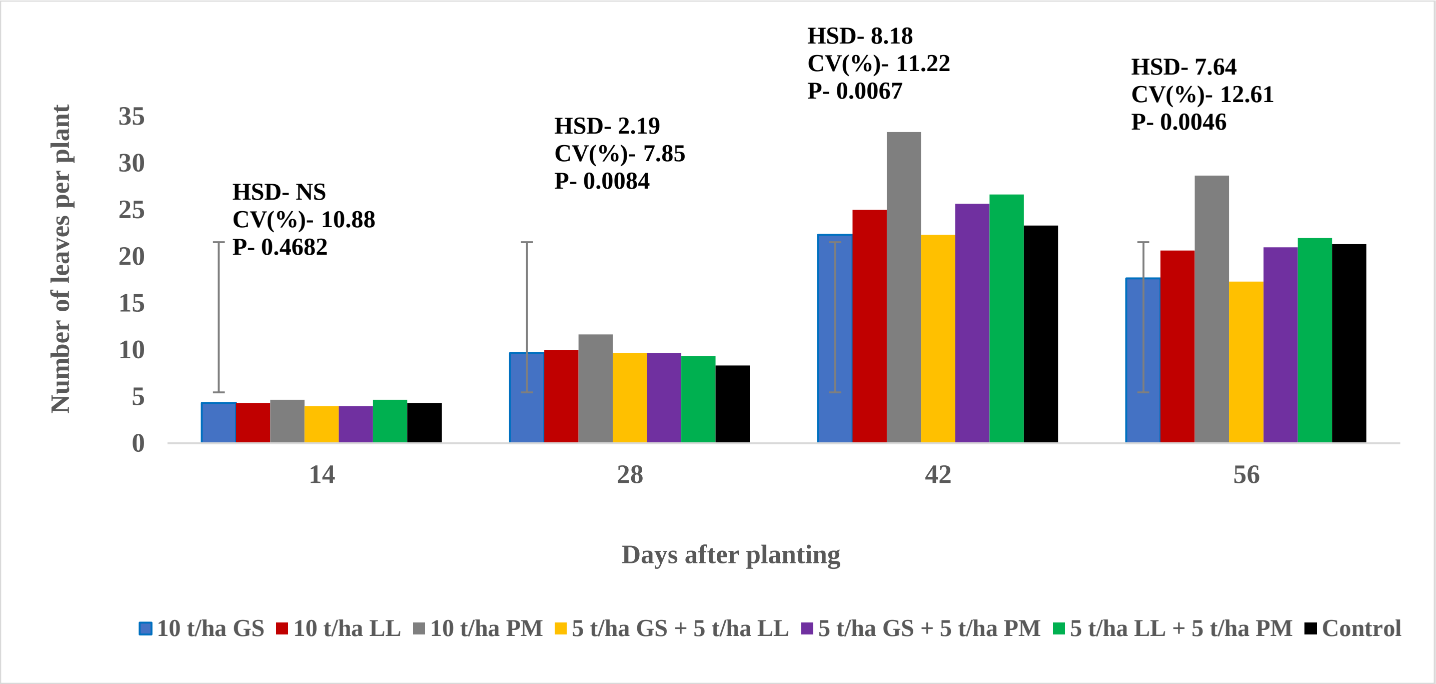
Figure 4.1: Vine length of cucumber as affected by legume tree prunings and poultry manure application at Asante Mampong Adanwomase.

4.4.2 Number of leaves per plant

Figures 4.2 depict the number of leaves per cucumber plant as influenced by legume tree prunings and poultry manure application at Asante Mampong and Adanwomase. At Asante Mampong, leaf count increased steadily from 14 to 42 DAP but declined slightly at 56 DAP. No significant ($P \geq 0.05$) differences were observed among treatments at 14 DAP (Figure 4.2A). However, from 28 to 56 DAP, the treatment means differed significantly ($P \leq 0.05$). Plots treated with 10 t/ha poultry manure recorded the greatest number of leaves per plant throughout the growing period, whereas those receiving 5 t/ha *Gliricidia sepium* + 5 t/ha poultry manure generally had the lowest leaf count.

At Adanwomase, the number of leaves per plant increased from 14 DAP to 42 DAP. However, at 56 DAP, the number of leaves per plant decreased. Significantly ($P \leq 0.05$), differences were recorded between the treatment means from 14 DAP to 56 DAP (Figure 4.2B). The application of 10 t/ha poultry manure treated plot had the highest number of leaves per plant followed by plots that received 10 t/ha *Leucaena leucocephala* whereas the control treated plots had the lowest number of leaves per plant.

(A) Asante Mampong



(A) Adanwomase

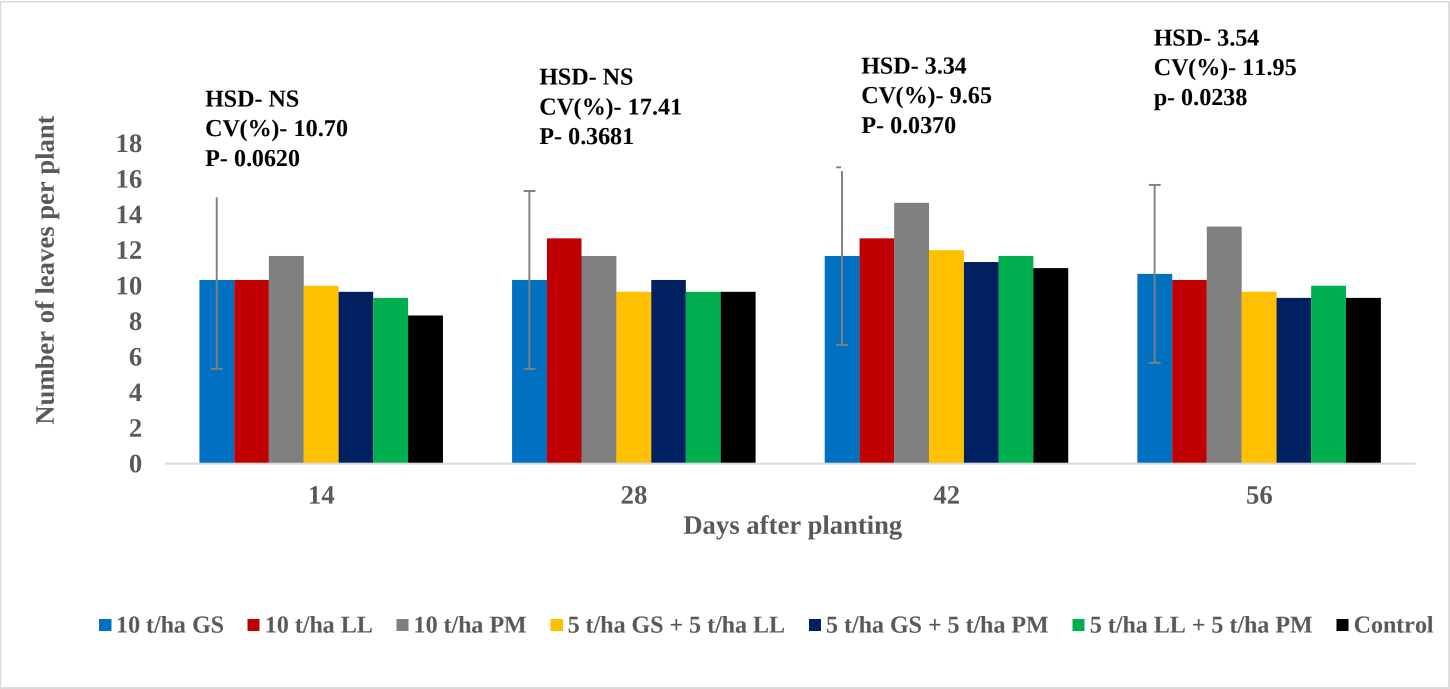


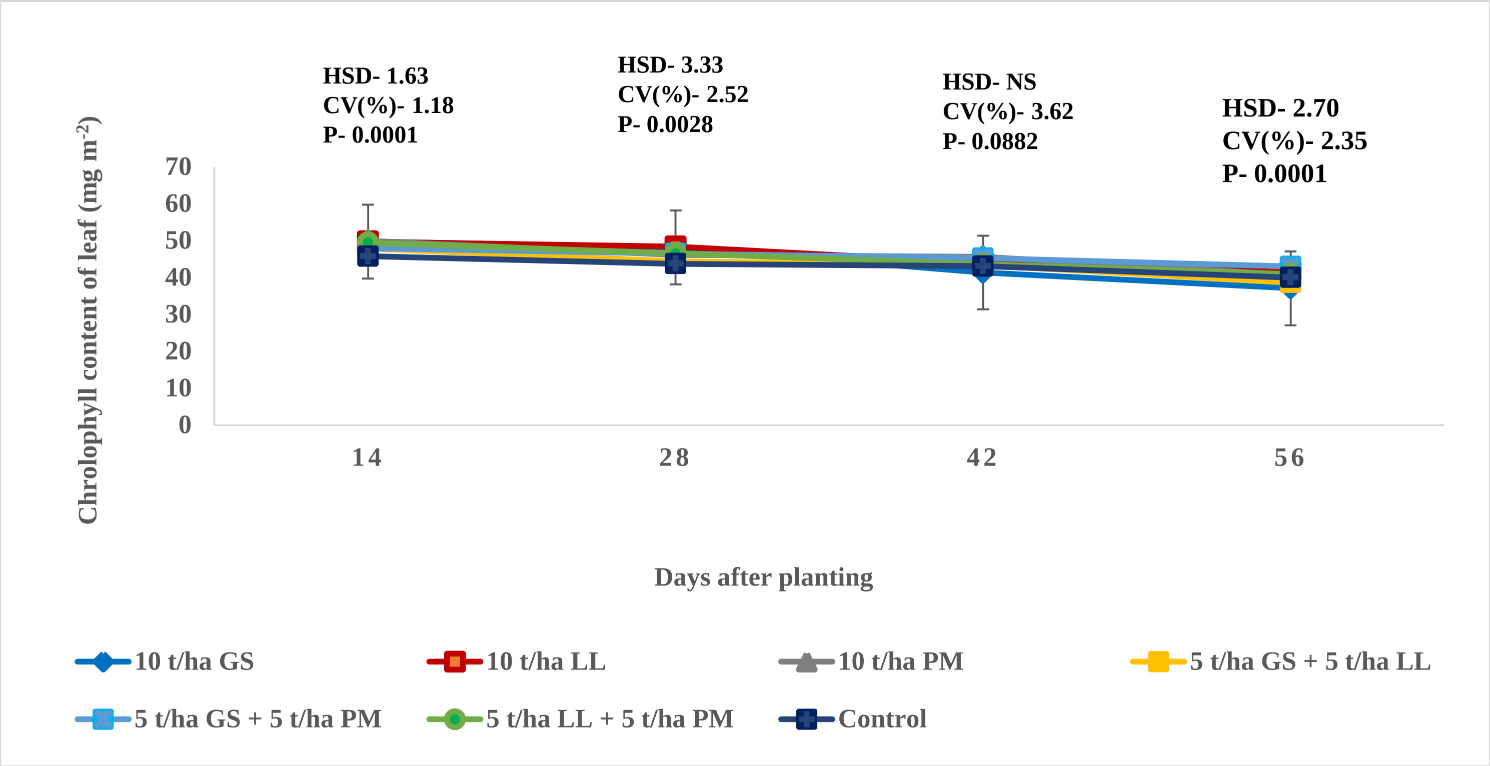
Figure 4.2: Number of leaves per plant of cucumber as affected by legume tree prunings and poultry manure application at Asante Mampong and Adanwomase.

4.4.3 Chlorophyll content of leaf (CCL)

Figures 4.3 shows the chlorophyll content of leaf (CCL) as influenced by legume tree pruning and poultry manure application at Asante Mampong and Adanwomase. At Asante Mampong, CCL decreased consistently from 14 to 56 days after planting (DAP). Significant ($P \leq 0.05$) differences were observed among treatment means at 14, 28, and 56 DAP, while no significant difference was recorded at 42 DAP. Poultry manure-treated plots had the highest CCL at 14 and 42 DAP, whereas at 28 DAP, the highest CCL was observed in plots treated with *Gliricidia sepium*. At 56 DAP, the highest CCL was recorded in plots that received *Gliricidia sepium* + poultry manure. Overall, the control plots exhibited the lowest chlorophyll content of leaf throughout the study.

At Adanwomase, the Chlorophyll content of leaf (CCL) increased from the 14 DAP to the 42 DAP until at 56 DAP, where it decreased. There was some significant ($P \geq 0.05$) difference recorded among the treatment means from 14 DAP to 28 DAP. However, from 42 DAP to 56 DAP, no significant ($P \leq 0.05$) difference was recorded between the treatment means (Figure 4.6). The highest Chlorophyll content of leaf at 14 DAP and 28 DAP was recorded by *Gliricidia sepium + poultry* manure treated plots whereas from 42 DAP to 56 DAP, the highest Chlorophyll content of leaf was recorded by plots that received poultry manure only amendment. The control plot generally had the lowest Chlorophyll content of leaf.

(A) Asante Mampong



(A) Adanwomase

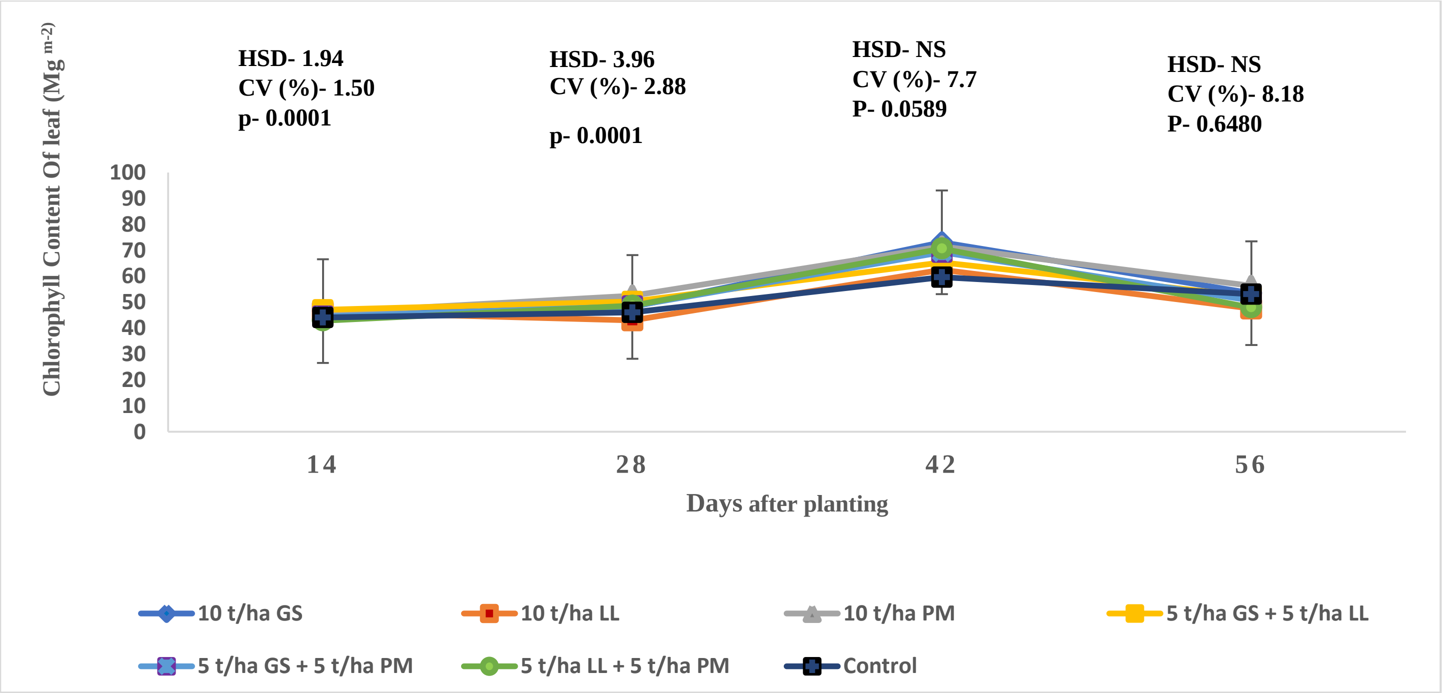
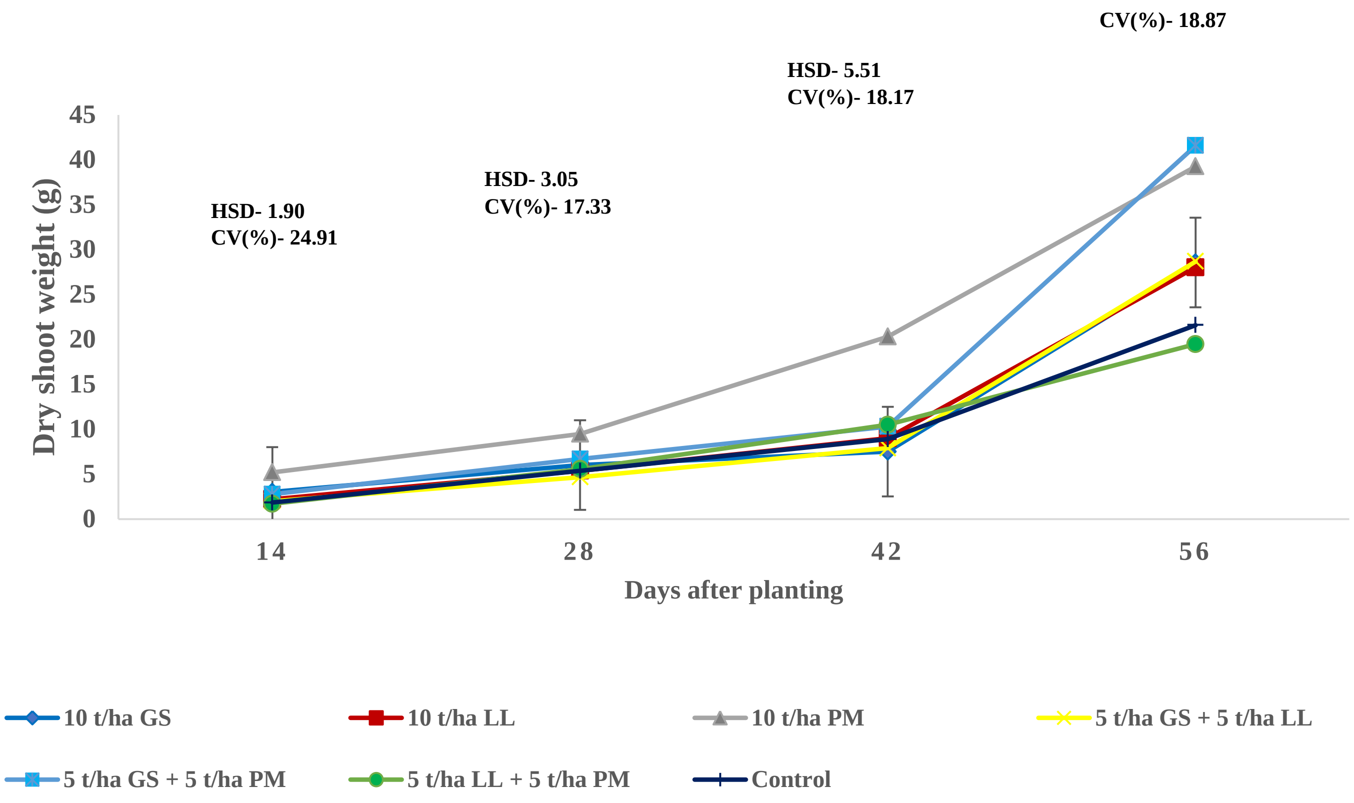


Figure 4.3: Chlorophyll content of leaf of cucumber as affected by legume tree pruning and poultry manure application at Asante Mampong and Adanwomase.

4 Dry shoot weight

Figure 4.4 shows the dry shoot weight of cucumber as affected by legume tree pruning and poultry manure application at Asante Mampong and Adanwomase. The dry shoot weight increased from 14 DAP to 56 DAP at both locations. Significant ($P \leq 0.05$), differences existed among the treatment means at both locations. Plots treated with the 10 t/ha poultry manure recorded the greatest dry shoot weight at both Asante Mampong and Adanwomase. The control treated plot generally had the least dry shoot weight (Figure 4.4). For location, significant difference was only observed at 28 and 42 DAP whereas at 14 DAP and 56 DAP at both locations no significant difference existed. For treatment application, the means differed significantly among each other at both locations. For location x treatment interaction, difference were observed at 28 DAP. However, at 14 DAP, 42 DAP and 56 DAP, no significant difference existed between the treatment means

A. Asante Mampong



B. Adanwomase

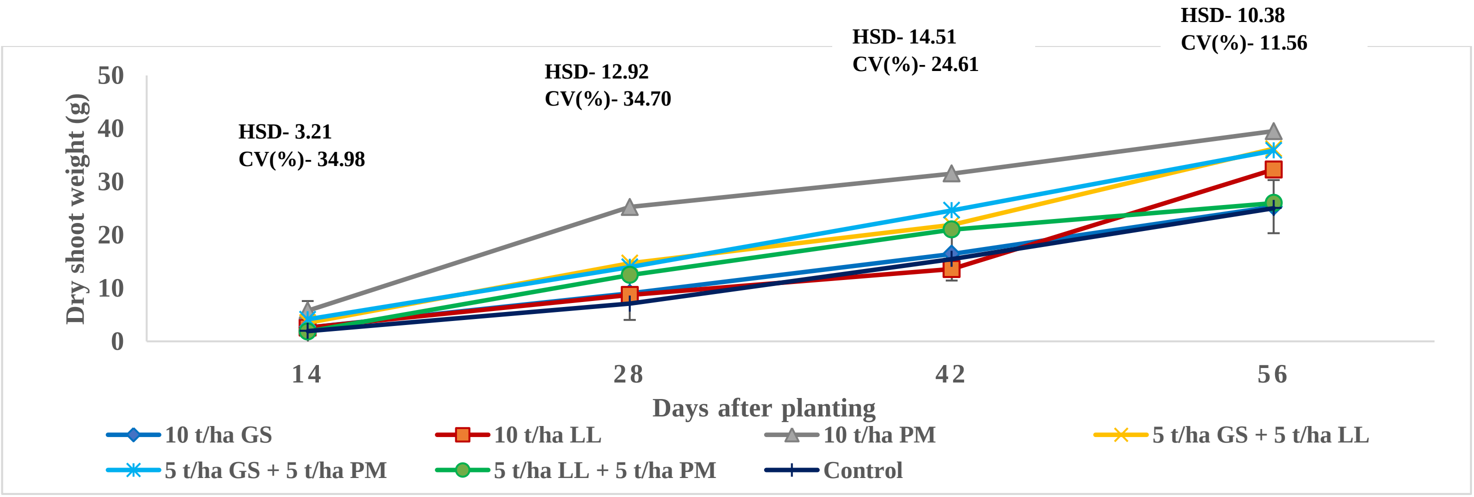


Figure 4.4: Dry shoot weight cucumber as affected by legume tree pruning and poultry manure application at Asante Mampong and Adanwomase

4.5 Yield and yield components

4.5.1 Fruit length, fruit diameter, fruit weight per plot, and total fruit yield

Table 4.8 shows the fruit length, fruit diameter, and total fruit weight per plot of cucumber as affected by legume tree pruning and poultry manure application at Asante Mampong and Adanwomase.

For fruit length, plots that received 5 t/ha *Leucaena leucocephala* + 5 t/ha poultry manure recorded the longest fruit length followed by plots that had the poultry manure only application at both locations. The control plot recorded the shortest fruit length at both Asante Mampong and Adanwomase. Apart from the treatment application which showed significant ($P \leq 0.05$), difference between the treatment means, location and location x treatment interaction did not differ significantly between the treatment means.

For fruit diameter, plots that received 5 t/ha *Leucaena leucocephala* + 5 t/ha poultry manure recorded the widest fruit diameter at Asante Mampong whereas at Adanwomase, the widest fruit diameter was recorded from plots treated with poultry manure only. The control plot generally had the narrowest fruit diameter at both locations. The treatment application showed significant ($P \leq 0.05$) difference between the treatment means. However, for location and location x treatment interaction, no significant difference was recorded between the treatment means (Table 4.8).

Table 4.8: Fruit length and fruit diameter of cucumber as affected by legume tree prunings and poultry manure application at Asante Mampong and Adanwomase.

Treatment	**Fruit length (cm)**			**Fruit diameter (cm)**		
	M	**A**	**Mean**	**M**	**A**	**Mean**
10 t/ha GS	7.17c	6.08e	**6.63**	6.26ab	6.01a	**6.14**
10 t/ha LL	12.92b	10.25cd	**11.59**	6.45ab	5.65a	**6.05**
10 t/ha PM	15.27ab	15.28ab	**15.28**	6.53ab	7.85a	**7.19**
5 t/ha GS + 5 t/ha LL	12.81b	11.74cd	**12.28**	6.17ab	6.54a	**6.36**
5 t/ha GS + 5 t/ha PM	12.19b	12.86bc	**12.53**	6.33ab	6.22a	**6.28**
5 t/ha LL + 5 t/ha PM	16.63a	16.63a	**16.63**	9.46a	7.71a	**8.59**
Control	8.40c	9.14d	**8.77**	5.73b	5.37a	**5.55**
Mean	**12.20**	**11.71**	**11.96**	**6.70**	**6.48**	**6.59**
HSD (P ≤ 0.05)	**3.44**	**2.64**		**3.64**	**2.58**	
CV (%)	**9.89**	**7.88**		**19.01**	**13.97**	

Location =	*HSD=NS*	*P=0.1722*	*HSD=NS*	*P=0.5063*
Treatment =	*HSD=2.07*	*P=0.0001*	*HSD=2.01*	*P=0.0014*
Location Treatment =*	*HSD=NS*	*P=0.1519*	*HSD=NS*	*P=0.3648*

Means followed by or sharing the same letters within a column are not significantly different at 5% level of significance; CV = coefficient of variation; HSD = Honestly significant difference, DAP = Days after planting; M = Mampong, A = Adanwomase; NS = Non-significance; L L= Leucaena leucocephala; GS = Gliricidia sepium; PM = Poultry manure; GS + LL = Gliricidia sepium + Leucaena leucocephala; GS + PM = Gliricidia sepium + Poultry manure; LL + PM = Leucaena leucocephala + Poultry manure.

Results in Table 4.9 shows the total fruit weight per plot and the total fruit yield of cucumber as affected by legume tree pruning and poultry manure application at Mampong and Adanwomase. For total fruit weight per plot, the 10 t/ha poultry manure treatment recorded the greatest at both locations followed by 10 t/ha *Leucaena leucocephala* application. The application of 10 t/ha *Gliricidia sepium* generally had the least total fruit weight per plot at both locations followed by the control treated plot (Table 4.9). The treatment application showed significant (P≤0.05) difference between the treatment means. However, for location and location x treatment interaction, no significant difference was recorded between the treatment means.

Likewise for total yield, the application of 10 t/ha poultry manure treatment plot recorded significantly ($P \leq 0.05$) greatest fruit yield (36.04 t ha^{-1} and 36.88 t ha^{-1} respectively) at both locations. The application of 10 t/ha *Gliricidia sepium* generally had the least fruit yield (20.10 t ha^{-1} and 19.54 t ha^{-1} respectively) at both locations followed by the control treated plot which recorded 25.22 t ha^{-1} and 25.06 t ha^{-1} at Asante Mampong and Adanwomase (Table 4.9). There was a significant ($P \leq 0.05$**)** difference recorded between the treatment applications. However, for location and location x treatment interaction, no significant difference was recorded between the treatment means.

Table 4.9: Fruit weight per plot and total fruit yield (t/ha) of cucumber as affected by legume tree pruning and poultry manure application at Asante Mampong and Adanwomase.

Treatment	**Total fruit weight per plot (kg/plot)**			**Total fruit yield (t ha^{-1})**		
	M	**A**	**Mean**	**M**	**A**	**Mean**
10 t/ha GS	9.65c	9.38c	**9.52**	20.10c	19.54c	**19.82**
10 t/ha LL	16.30a	15.80ab	**16.05**	33.96a	32.92ab	**33.44**
10 t/ha PM	17.30a	17.70a	**17.50**	36.04a	36.88a	**36.46**
5 t/ha GS + 5 t/ha LL	13.68b	13.49b	**13.59**	28.50b	28.10b	**28.30**
5 t/ha GS + 5 t/ha PM	12.73b	12.93bc	**12.83**	26.53b	26.93bc	**26.73**
5 t/ha LL + 5 t/ha PM	16.15a	15.42ab	**15.79**	33.64a	32.13ab	**32.89**
Control	12.11b	12.03bc	**12.07**	25.22b	25.06bc	**25.14**
Mean	**13.99**	**13.82**	**13.91**	**29.14**	**28.79**	**28.97**
HSD ($P \leq 0.05$)	**1.69**	**4.04**		**3.52**	**8.41**	
CV (%)	**4.24**	**10.23**		**4.24**	**10.23**	
Location =	*HSD=NS*	*P=0.6187*		*HSD=NS*		*P=0.6187*
Treatment =	*HSD=2.07*	*P=0.0001*		*HSD=4.09*		*P=0.0001*
Location Treatment =*	*HSD=NS*	*P=0.9749*		*HSD=NS*		*P=0.9749*

Means followed by or sharing the same letters within a column are not significantly different at 5% level of significance; CV = coefficient of variation; HSD = Honestly significant difference, DAP = Days after planting; M = Mampong, A = Adanwomase; NS = Non-significance; L L= Leucaena leucocephala; GS = Gliricidia sepium; PM = Poultry manure; GS + LL = Gliricidia sepium + Leucaena leucocephala; GS + PM = Gliricidia sepium + Poultry manure; LL + PM = Leucaena leucocephala + Poultry manure.

CHAPTER FIVE: DISCUSSION

5.1 Influence of legume tree pruning and poultry manure application on physico-chemical properties of soil at the experimental sites.

The differences in the physico-chemical properties of soils at Asante Mampong and Adanwomase can be attributed to variations in soil formation, land use history, and environmental factors such as climate and topography. The lower pH at Asante Mampong indicates higher soil acidity compared to Adanwomase. As stated by Amare *et al*. (2024), this increased acidity may be due to natural weathering, leaching of essential cations (Ca^{2+} , Mg^{2+} , K^{+}), or prolonged cultivation without adequate nutrient replenishment. The higher exchangeable acidity at Mampong further supports this, reflecting a greater presence of exchangeable hydrogen (H^{+}) and aluminum (Al^{3+}), which contribute to soil acidification. The higher phosphorus (P) content at Asante Mampong compared to Adanwomase could be influenced by differences in parent material, organic matter decomposition, or previous fertilizer applications. Additionally, since phosphorus availability is affected by soil pH, the slightly lower pH at Asante Mampong may have influenced its solubility and mobility. In contrast, Adanwomase recorded higher levels of nitrogen (N), potassium (K), magnesium (Mg), and organic matter, likely due to better organic matter content, enhanced microbial activity, and more efficient nutrient cycling. According to Singh *et al.* (2024), increased organic matter supports nitrogen mineralization and nutrient retention, contributing to improved soil fertility. Asante Mampong exhibited higher calcium (Ca) and magnesium (Mg) levels, potentially due to differences in parent material or lower leaching rates compared to Adanwomase. While acidic soils often experience nutrient leaching, the relatively higher concentrations of these elements at Asante Mampong suggest a steady supply from mineral weathering or past soil amendments. Both locations have sandy soils, indicating rapid drainage and limited water-holding capacity. The initially higher sand percentage at Adanwomase may point to a more weathered and leached soil profile, whereas the greater silt content at Asante Mampong could enhance moisture retention. The post-harvest shift in particle size distribution, with increased sand content at Asante Mampong and more silt at Adanwomase, could result from soil erosion, cultivation practices, or organic matter decomposition affecting it

The final soil analysis following manure application demonstrated notable variations in soil pH, nutrient availability, and organic matter content, influenced by the type and quantity of organic amendments applied. Studies by Wang *et al*. (2024) showed that these differences may be from variations in decomposition rates, nutrient composition, and interactions with soil properties. The highest soil pH was recorded in plots treated with 5 t/ha *Leucaena leucocephala* + 5 t/ha Poultry manure at both locations, while the least was observed in plots that received 10 t/ha Poultry manure. According to Madhubala *et al*. (2025), the higher acidity in poultry manure-treated plots can be attributed to the high ammonium (NH_4^+) content, which undergoes nitrification, releasing hydrogen ions (H^+) and acidifying the soil. In contrast, *Leucaena leucocephala,* as a leguminous plant, enhances cation exchange capacity (CEC) and releases basic cations (Ca^{2+}, Mg^{2+}, K^+), which counteract soil acidity and contribute to a higher pH. Phosphorus availability was highest in plots treated with 5 t/ha *Gliricidia sepium* + 5 t/ha Poultry manure, whereas the lowest levels were recorded in 10 t/ha *Gliricidia sepium*-treated plots. The combination of *Gliricidia sepium* and poultry manure likely enhanced phosphorus mineralization and availability, as poultry manure supplies readily available phosphorus, while *Gliricidia sepium* improves microbial activity and soil structure, aiding phosphorus solubilization. However, the application of 10 t/ha *Gliricidia sepium* alone may have led to phosphorus immobilization due to its high carbon content, which could slow phosphorus release. Nitrogen levels were highest in plots receiving 5 t/ha *Leucaena leucocephala* + 5 t/ha Poultry manure at both locations. This outcome can be attributed to the nitrogen-fixing capability of *Leucaena leucocephala* and the nitrogen-rich content of poultry manure. Their combined application likely provided both immediate nitrogen from poultry manure and sustained nitrogen release from *Leucaena* decomposition, improving overall soil nitrogen levels (Omari *et al*., 2016). The highest concentrations of Potassium (K), Calcium (Ca), and Magnesium (Mg) were found in plots treated with 10 t/ha *Leucaena leucocephala*, suggesting that increasing the application rate of *Leucaena* contributed to greater cation release during decomposition. Leguminous plants like *Leucaena* accumulate substantial amounts of Ca and Mg, which are released upon decomposition, enriching the soil with these essential nutrients. Organic carbon was highest in plots treated with 5 t/ha *Leucaena leucocephala* + 5 t/ha Poultry manure, while total organic matter content peaked in 10 t/ha *Leucaena leucocephala*-treated plots. The higher organic matter content in the 10 t/ha *Leucaena* treatment likely resulted from the large biomass contribution of *Leucaena,* which decomposes slowly, thereby adding more organic residues to the soil. As stated by Kumar *et al.* (2020), the combination of *Leucaena* and poultry manure provided an optimal balance, offering both immediate nutrient release from poultry manure and a gradual increase in organic carbon from *Leucaena* decomposition, thereby improving soil structure and fertility.

5.2 Influence of legume tree prunings and poultry manure application on phenology and growth of cucumber at Asante Mampong and Adanwomase.

The lack of significant differences in days to 50% emergence and days to 50% flowering of cucumber across locations, treatments, and their interactions (location × treatment) indicates that legume tree pruning and poultry manure application had minimal influence on emergence rates.

Cucumber seeds typically exhibit uniform and rapid germination under favourable environmental conditions. Studies by Poonia *et al.* (2024) indicated that if temperature, soil moisture, and aeration were optimal across all treatments and locations, seed emergence would likely occur within a consistent timeframe, reducing variability. Additionally, poultry manure and legume tree pruning materials primarily enhance soil fertility and plant growth over time rather than exerting an immediate effect on seed germination. Priya *et al.* (2024) stated that the gradual decomposition of organic materials means nutrient release occurs later, making their impact on early-stage emergence negligible. Furthermore, if soil temperature, moisture levels, and other environmental conditions remained relatively uniform at Asante Mampong and Adanwomase during germination, a consistent emergence pattern across locations would be expected, leading to the observed lack of significant differences. This is in line with the work done by Poonia *et al.* (2024).

The significant differences in vine length across treatments from 14 to 56 days after planting (DAP) at both Asante Mampong and Adanwomase suggest that legume tree pruning and poultry manure application had a considerable impact on cucumber growth. According to Agbede *et al.* (2024), poultry manure is a rich source of nitrogen, phosphorus, and potassium which are key nutrients that promote vegetative growth. This explains why plots treated with 10 t/ha poultry manure consistently exhibited the greatest vine length, particularly during the early growth stages (14–42 DAP). The combination of 5 t/ha *Leucaena leucocephala* prunings and 5 t/ha poultry manure likely improved soil organic matter content, enhancing nutrient retention and soil structure, which contributed to better plant growth. At Asante Mampong, 10 t/ha poultry manure consistently resulted in the tallest plants throughout the growing period, followed by 5 t/ha *Leucaena leucocephala* + 5 t/ha poultry manure, suggesting that the soil conditions at this location responded more favorably to poultry manure application. At Adanwomase, a similar trend was observed, with 10 t/ha poultry manure-treated plots leading in vine length from 14 to 42 DAP. However, by 56 DAP, the combination of 5 t/ha *Gliricidia sepium* + 5 t/ha poultry manure produced the tallest plants. This could indicate a delayed nutrient release from *Gliricidia* s*epium* prunings, which may have contributed to sustained growth at later stages. This agrees with findings by Kimaro (2023).The control plots consistently recorded the shortest plants, confirming the critical role of nutrient supplementation in cucumber growth. The significant treatment effects indicate that organic amendments directly influenced vine length. However, variations between Asante Mampong and Adanwomase at later growth stages suggest that soil properties and environmental conditions at each site may have affected the timing and availability of nutrients.

The application of 10 t/ha poultry manure resulted in the greatest number of leaves per plant at both locations, which is expected due to its high nutrient content, particularly nitrogen, which supports vegetative growth and leaf expansion. *Leucaena leucocephala* prunings also enhanced leaf production, though to a lesser extent than poultry manure. This may be attributed to its relatively faster decomposition, making nutrients available earlier in the growth cycle. At Asante Mampong, 5 t/ha *Gliricidia sepium* + 5 t/ha poultry manure recorded the least leaf count, possibly due to slower nutrient release or potential allelopathic effects from *Gliricidia sepium*, which might have temporarily suppressed leaf development. Leaf production at both Asante Mampong and Adanwomase increased steadily from 14 to 42 DAP but showed a slight decline at 56 DAP. According to Carillo & Ferrante (2025), this decrease in the number of leaves per plant could be linked to natural leaf senescence or increased competition for nutrients as plants transitioned into the reproductive stage. The control plots consistently recorded the fewest leaves, highlighting that the inherent soil fertility was insufficient to support vigorous leaf growth. As stated by Mahamadu & Abdul (2025), insufficient nutrients in the soil affects plant growth and development.

Chlorophyll content of leaf is closely linked to nitrogen availability, as nitrogen is a key component of chlorophyll molecules (Wang & Shi, 2024). The 10 t/ha poultry manure-treated plots consistently exhibited higher chlorophyll content of leaf (CCL), particularly at Asante Mampong at 14 and 42 DAP and at Adanwomase from 42 to 56 DAP. This is attributed to the rich nitrogen content of poultry manure, which promotes chlorophyll synthesis and enhances leaf greenness. As opined by Shaaban *et al*. (2024), nitrogen content of poultry manure promotes chlorophyll synthesis and enhances leaf greenness of plants. The 10 t/ha *Gliricidia sepium*-treated plots recorded the highest CCL at 28 DAP at Asante Mampong and from 14 to 28 DAP at Adanwomase, suggesting that *Gliricidia* prunings contributed to nitrogen supply after a certain period, likely due to gradual decomposition and nutrient release. Additionally, the effect of *Gliricidia* + poultry manure at 56 DAP at Asante Mampong indicates a delayed nutrient release, which sustained chlorophyll retention at later growth stages. The control plots consistently had the lowest CCL, suggesting that natural soil fertility alone was insufficient to maintain high chlorophyll production. At Asante Mampong, CCL declined steadily from 14 to 56 DAP, likely due to plant aging and progressive nutrient depletion. The significant differences observed at 14, 28, and 56 DAP suggest that nutrient uptake varied across treatments at specific growth stages, influencing chlorophyll accumulation. Conversely, at Adanwomase, CCL increased from 14 to 42 DAP before declining at 56 DAP, indicating peak photosynthetic activity during vegetative growth, followed by a reduction as plants transitioned to the reproductive stage. This decline in CCL at 56 DAP at both locations suggests that as plants matured, nutrient redistribution toward reproductive structures reduced chlorophyll concentration in older leaves. Liu *et al.* (2024) asserted that such a physiological response is expected, as older leaves contribute less to photosynthesis while younger leaves and reproductive organs become priority nutrient sinks.

The steady increase in dry shoot weight over time aligns with the natural vegetative growth and biomass accumulation of cucumber plants. Studies by Kumar *et al.* (2020) indicated that the sustained availability of nutrients from poultry manure and decomposing legume prunings likely supported continuous growth, leading to higher dry shoot weight at later stages. The 10 t/ha poultry manure-treated plots recorded the highest dry shoot weight, attributed to its rich nutrient content,] particularly nitrogen, phosphorus, and potassium, which are essential for vigorous vegetative growth. Findings by Arshad *et al.* (2024), stated that poultry manure improves soil structure, enhances moisture retention, and stimulates microbial activity, all of which contribute to better nutrient uptake and overall plant development. Conversely, the control plots exhibited the lowest dry shoot weight, likely due to the absence of external nutrient inputs, which limited growth and biomass accumulation.

5.3 Influence of legume tree prunings and poultry manure application on yield and yield components of cucumber at Asante Mampong and Adanwomase.

The combination of 5 t/ha poultry manure and 5 t/ha *Leucaena leucocephala* provided a well-balanced supply of essential nutrients, particularly nitrogen (N), phosphorus (P), and potassium (K), which are crucial for fruit development and elongation. According to Sallam *et al.* (2021), poultry manure enhances soil organic matter, improving nutrient availability, water retention, and microbial activity, all of which contribute to optimal cucumber growth. Meanwhile, *Leucaena* prunings release nitrogen gradually, supporting sustained plant growth and allowing fruits to reach their full potential. In contrast, the control plots, which lacked nutrient amendments, exhibited stunted fruit development, highlighting the critical role of nutrient availability in determining cucumber fruit length.

The 5 t/ha *Leucaena leucocephala* + 5 t/ha poultry manure produced the widest fruit diameter at Asante Mampong, while 10 t/ha poultry manure had the widest at Adanwomase The combined application of 5 t/ha *Leucaena leucocephala* prunings and 5 t/ha poultry manure at Asante Mampong likely facilitated a steady nutrient release, particularly nitrogen, which enhanced overall plant vigour and contributed to improved fruit expansion. At Adanwomase, 10 t/ha poultry manure alone was more effective in increasing fruit diameter, possibly due to variations in soil properties that influenced nutrient availability. As observed with fruit length, nutrient deficiency in the control plots limited fruit expansion, resulting in a smaller fruit diameter. According to Kumar *et al.* (2024), this highlights the importance of adequate nutrient supply in achieving optimal cucumber fruit development.

Agaba *et al.* (2023) opined that poultry manure provides readily available nutrients, promoting higher fruit set and improved fruit development, ultimately leading to greater fruit yield. The organic matter from 10 t/ha poultry manure enhances soil fertility, strengthening the plant’s ability to sustain fruit production. The next highest yield was recorded with 10 t/ha *Leucaena leucocephala*, suggesting that while *Leucaena* prunings contribute nitrogen, their slower decomposition results in a more gradual nutrient release, which may slightly delay yield benefits compared to poultry manure. In contrast, 10 t/ha *Gliricidia sepium* recorded the lowest fruit yield, indicating that its prunings decompose even more slowly than *Leucaena*, leading to delayed nutrient availability that may not be sufficient to support high cucumber yields.

The significantly higher cucumber fruit yields recorded under the 10 t/ha poultry manure-treated plots (36.04 t/ha at Asante Mampong and 36.88 t/ha at Adanwomase) can be attributed to high nutrient content and fast nutrient release from poultry manure. According to Oke *et al.* (2020), poultry manure is rich in essential macro- and micronutrients, particularly nitrogen (N), phosphorus (P), and potassium (K), which are required in large amounts for cucumber development. Adekiya (2019) also noted that poultry manure contains these nutrients in readily available forms, leading to quick uptake by plants, enhanced vegetative growth, increased flowering and fruit set, and improved fruit development and yield. Stacey *et al*. (2024) reported that due to its low carbon-to-nitrogen (C: N) ratio, poultry manure decomposes rapidly in the soil, making nutrients available during the critical growth stages of cucumber. Poultry manure improves soil structure, aeration, and water-holding capacity, all of which support healthy root development and nutrient uptake, ultimately resulting in higher yields. The low fruit yields recorded with *Gliricidia sepium* application (20.10 t/ha at Asante Mampong and 19.54 t/ha at Adanwomase) may be high lignin and polyphenol content. Studies by (Kaba, 2017) reported that, Gliricidia leaves contain relatively high levels of lignin and polyphenols, which slow down decomposition, delay nutrient release, and may temporarily immobilize nitrogen due to high C:N ratio. The control plots (25.22 t/ha at Asante Mampong and 25.06 t/ha at Adanwomase), which received no organic amendment, had intermediate yields, higher than Gliricidia but significantly lower than poultry manure. This indicates that, natural soil fertility supported some level of crop growth. However, the absence of nutrient supplementation limited the potential yield.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Objective 1:

- The soils at Adanwomase had higher pH and nutrient levels (N, K, Mg, and organic matter), while Asante Mampong recorded higher P, Ca, and exchangeable acidity. Both locations had sandy soils with varying sand and silt proportions. Fertilizer application influenced soil fertility, with 5 t/ha *Leucaena leucocephala* + 5 t/ha Poultry manure improving pH, N, and organic carbon, while 10 t/ha *Leucaena leucocephala* increased K, Ca, and Mg. The highest exchangeable acidity was higher in 10 t/ha Poultry manure.

Objective 2:

- The 10 t/ha poultry manure was the best-performing treatment across most phenology and vegetative growth parameters. It consistently led to the earliest flowering, highest vine length, greatest number of leaves, highest chlorophyll content of leaf, and the highest fresh and dry shoot weights at both Asante Mampong and Adanwomase.

Objective 3:

- The 10 t/ha poultry manure produced the highest total fruit weight and fruit yield at both locations, followed by 10 t/ha *Leucaena leucocephala*. The combination of 5 t/ha *Leucaena* + 5 t/ha poultry manure resulted in the longest fruits, while 10 t/ha poultry manure and 5 t/ha *Leucaena* + 5 t/ha poultry manure recorded the widest fruit diameters at Adanwomase and Asante Mampong, respectively.
- Overall, 10 t/ha poultry manure was the most effective treatment, producing the highest vegetative growth, and fruit yield. Combining 5t/ha poultry manure + 5t/ha leucaena also showed promise in enhancing fruit quality, particularly in improving fruit length and

diameter. These results highlight poultry manure as a highly effective organic amendment for boosting cucumber production, with potential benefits from combining it with *Leucaena* prunings for improved fruit characteristics.

6.2 Recommendations and further research

Based on the findings of this study, the following recommendations are made for optimizing cucumber production:

- Farmers should apply 10 t/ha of poultry manure to enhance vegetative growth, and overall fruit yield. This treatment consistently resulted in the best plant performance at both Asante Mampong and Adanwomase.
- For farmers aiming to improve cucumber fruit size, a combination of 5 t/ha *Leucaena leucocephala* + 5 t/ha poultry manure is recommended. This treatment produced the longest and widest fruits, indicating a well-balanced nutrient supply that enhances fruit development.
- *Gliricidia sepium* (10 t/ha) prunnings should be combined with poultry manure and allowed to decompose further when applied.
- Future studies should explore on the decomposition rates and nutrient release patterns of *Leucaena leucocephala* and *Gliricidia sepium* since it could provide further insights into their suitability for different cropping systems.

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APPENDIX: Guide to interpretation of soil analytical data in Ghana

Nutrients	**Rank/ Grade**
Total nitrogen	
<0.1%	Low
0.1-0.2	Medium
>0.2	Adequate
Organic matter	
<1.5%	Low
1.5-3.0	Medium
>3.0	High
Phosphorus, P (ppm), (Bray 1)	
<10-20	Low
10-20	Medium
>20	High
Bray's K	
<50 mg/kg soil	Low
50-100	Medium
>100	High
Calcium, Ca (ppm)/Meg=0.25Ca	
<5.0	Low
5.0-10.0	Medium
>10.0	High
ECEC (cmol (+)/kg	
<10	Low
10-20	Moderate
>20	High
Soil pH (Distilled water method)	
<5.0	Very acidic
5.1-5.5	Acidic
5.6-6.0	Moderately Acidic
6.0-6.5	Slightly acidic
6.5-7.0	Neutral
7.0-7.5	Slightly Alkaline
7.6-8.5	Alkaline
>8.5	Very alkaline
Exchangeable potassium (cmol (+)/kg	
<0.2	Low
0.2-0.4	Moderate
>0.4	High

Source: (SRI, 2007)