Original Research Article

THE EFFECT OF VARYING POULTRY MANURE CONCENTRATIONS MIXED WITH CLAY SOIL ON PLUMULE EMERGENCE AND SEEDLING GROWTH OF *SOLANUM LYCOPERSICUM* (TOMATO)

ABSTRACT

Soil fertility, which denotes the soil's capacity to supply essential nutrients to plants, is a limiting factor in many agricultural regions, especially where soils are inherently poor or have become degraded due to over use or erosion.

AIM: This study aimed at evaluating the effect of varying poultry manure (P.M) concentrations mixed with clay soil (C.S) on plumule emergence and early seedling growth of *Solanum lycopersicum*.

Study Design: Complete Randomized Design was used for this study.

Place and duration of the study: This study was conducted at the experimental farm of the Department of Plant Science and Biotechnology, Ekiti State University, Ado-Ekiti, Ekiti State, Nigeria between August – November, 2025.

Methodology: Present study was subjected to seven treatments viz: 10%, 20%, 30%, 40%, 50%, 100% P.M and 100% clay soil. **Stage 1:** One hundred and forty viable seeds of *Solanum lycopersicum* were divided into seven groups and sown separately in the treatments filled into plastic germination pots arranged in a Completely Randomized Design with three replicates. Emergence was observed and recorded daily for twenty days. The data obtained were expressed in percentage. **Stage 2:** Two uniform seedlings of *Solanum lycopersicum* at three weeks old were transplanted into the germination plastic pots filled with the seven treatments used for this study and were allowed to stabilize for a week after which growth assessment commenced and were carried out for twelve weeks. Parameter assessed were plant height, stem girth, number of leaves, leaf area, number of flowers and number of fruits.

Result: Results obtained revealed that plumule emergence of *Solanum lycopersicum* was at its peak (80%) in the 10% PM treatment and this was followed by 100% clay soil treatment with mean value of 70%. The 10% PM treatment recorded the tallest mean plant height (120.00 cm) at week 12, while the

20% PM treatment produced the highest number of leaves (298 leaves), thickest stem girth (18.99cm) largest leaf area (127.00 cm²) and highest number of flower (6.00) at week twelve (12) after transplant. Moderate P.M Concentrations (10–20%) generally promoted superior vegetative growth and reproductive performance as 10% P.M treatment yielded the highest number of fruits (6.00). Whereas higher PM concentrations (≥30%) suppressed emergence and early development.

Conclusion: Conclusively, mixing poultry manure with clay soil at moderate rates (10–20%) improved tomato seedling establishment while excessive PM should be avoided.

Keywords: clay soil, plumule emergence, poultry manure, seedling growth, Solanum lycopersicum

INTRODUCTION

Solanum lycopersicum, commonly known as tomato is a globally cultivated vegetable crop of significant nutritional, economic and agronomic value. It is an excellent source of vitamins A and C, lycopene, potassium and folate, making it an essential component of healthy diets (Ewelina, 2012). Due to its economic importance and dietary benefits, the enhancement of tomato production remains a priority in many developing countries, including Nigeria. However, achieving optimal growth and yield in tomato cultivation depends greatly on the availability and fertility of soil, particularly during the early stages such as plumule emergence and seedling development (Adeyeye *et al*, 2020).

Solanum lycopersicum belongs to Solanaceae family. It is a short-lived perennial often grown as an annual in tropical and subtropical regions. Tomatoes are valued for their versatility in cooking and their rich nutritional content, which includes vitamin C, potassium, folate and bioactive compounds such as lycopene and beta-carotene (Ugona *et al*., 2015). Lycopene, a potent antioxidant found in abundance in tomatoes, has been linked to numerous health benefits, including reduced risks of cardiovascular diseases and certain cancers (Sanjiv and Akkinapally, 2000). Tomato is a rich source of vitamins (A, C, E), minerals (such as potassium and phosphorus) and antioxidants especially lycopene, a potent carotenoid known for its role in reducing the risk of chronic diseases such as cancer and cardiovascular disorders (Cyrille *et al*., 2022). The crop is sensitive to adverse environmental conditions, particularly during its early growth stages, such as germination and seedling emergence (Melkanu, 2025).

The increasing global demand for tomatoes (*Solanum lycopersicum*) has underscored the need for improved cultivation practices to ensure high yields, quality produce and sustainable production systems. Tomato is widely cultivated across tropical and subtropical regions due to its high nutritional value and economic importance. It serves as a source of essential nutrients such as vitamin C, lycopene and beta-carotene, while also contributing significantly to farmers' income (Shakirat *et al*., 2025). However, the productivity of tomato crops, especially during early growth stages, is heavily influenced by soil fertility and physical properties, particularly when cultivated in marginal soils such as clay-rich substrates.

Tomato cultivation has grown significantly in many parts of Africa, including Nigeria, due to increasing consumer demand and the crop's adaptability to different climatic conditions. Despite its importance, the productivity of *S. lycopersicum* remains below potential in many developing countries due to constraints such as soil fertility degradation, pest and disease infestation, poor seedling emergence and inadequate agronomic practices (Shamsu and Abdu, 2016). The early stages of growth which include seed germination and plumule emergence are critical for successful crop establishment and final yield.

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Solanum lycopersicum responds well to improved soil conditions, particularly when supplemented with organic fertilizers like poultry manure. Research shows that organic amendments can enhance tomato root growth, increase biomass accumulation and improve photosynthetic efficiency, thereby facilitating early seedling development (Gungula and Tame, 2006).

Clay soil, known for its high-water retention and nutrient-holding capacities, is one of soil type that poses both challenges and opportunities for crop growth. While clay soils can retain nutrients better than clay soils, their heavy texture and poor aeration can hinder seed germination and early seedling development if not properly managed (Adekiya and Ojeniyi, 2002). Clay soil suffers from poor drainage, low porosity and compaction, which can hinder root penetration and gas exchange (Sawrab *et al*., 2005). Seed germination and plumule emergence depend heavily on adequate oxygen, soil warmth and moisture all of which may be restricted in untreated or poorly managed clay soils (Giuseppe *et al*., 2000).

The chemical properties of clay soils such as pH, salinity and mineral availability can influence nutrient solubility and microbial populations. For example, low pH (acidic conditions) commonly found in tropical clay soils can lead to nutrient lock-up, limiting the bioavailability of phosphorus and certain micronutrients essential for early seedling growth (Chike *et al*., 2021). Clay soils are particularly reactive to amendments because of their high cation exchange capacity (CEC), which allows them to retain essential nutrients like calcium, magnesium and potassium more effectively than clay soils. However, they are also prone to waterlogging during rainy seasons and hard crusting during dry spells conditions that impair seedling emergence and overall plant performance (Wang *et al*., 2026).

Organic fertilizers, particularly poultry manure, are increasingly recognized as sustainable alternatives to chemical fertilizers. Poultry manure is not only rich in essential nutrients like nitrogen, phosphorus and potassium but also improves soil texture, microbial activity and moisture retention (Kolawole *et al*., 2023).

To improve the structure and nutrient status of clay soils, the application of organic amendments like poultry manure has received considerable attention. Poultry manure is rich in essential macro- and micronutrients, such as nitrogen, phosphorus, potassium, calcium and trace elements, making it a valuable soil amendment (Adekiya and Agbede, 2009). Its application improves soil microbial activity, water infiltration and nutrient availability, thereby enhancing plant growth and productivity (Merga, 2025). Poultry manure is increasingly promoted as a sustainable alternative to synthetic fertilisers (Mohammadi et al., 2024) due to its cost-effectiveness, environmental friendliness and role in promoting soil organic buildup (Mohammadi et al., 2024). (Mohammadi 2024). etal., 2011). However, the concentration or application rate of poultry manure is critical, as excessive amounts may lead to nutrient imbalances, salt accumulation, or phytotoxicity, which can potentially harm seedling growth (Yitian et al., 2024). 2024). Poultry manure enhances microbial activity and nutrient mineralization, thereby making essential elements readily available for uptake (Ewulo *et al*., 2008). Improved soil conditions, including neutral pH and increased cation exchange capacity, have been linked to better germination indices and uniform seedling emergence (Sawrab *et al*, 2025). Therefore, it is imperative to understand how varying concentrations of poultry manure, particularly when mixed with a specific soil type like clay influence key developmental stages such as plumule emergence and seedling growth in tomato plants as over-application of poultry manure can result in nutrient leaching, particularly nitrate pollution and may introduce pathogens or phytotoxic substances if not properly composted or aged (Juma *et al*., 2020).

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Given the environmental concerns associated with chemical fertilizers and the growing advocacy for organic farming, there is an urgent need to explore the agronomic potential of poultry manure under different soil conditions. Hence, this study seeks to evaluate the effect of varying poultry manure concentrations mixed with clay soil on plumule emergence and seedling growth of *Solanum lycopersicum*. The findings are expected to guide sustainable soil fertility management strategies, improve tomato productivity and enhance food security in resource-constrained farming systems.

MATERIALS AND METHODS / EXPERIMENTAL DETAILS / METHODOLOGY

Seed Source

Certified seeds of *Solanum lycopersicum* were obtained from a reputable agro-input dealer in Ado-Ekiti, Nigeria. The seeds were healthy and uniform, ensuring good viability and consistency throughout the experiment.

Viability Test

This was done by immersing the whole lot of seeds in water and considered those that sink inside water viable and those that floated on the water were considered non-viable.

Sample Collection

Both Clay soil and Well-decomposed poultry manure were respectively collected from the experimental and animal farms of the Faculty of Agriculture, Ekiti State University, Ado-Ekiti, Ekiti State, Nigeria.

Sample Analysis

Clay soil (CS) and the poultry manure (PM) were air dried for two weeks, after which the poultry manure was ground into powder according to (Agromisa foundation, 2005). The powder thus obtained from the poultry manure and the air-dried soil were sieved and chemically analysed at the soil laboratory of the Faculty of Agriculture, Ekiti State University, Ado-Ekiti. to determine their physio-chemical properties before they were used for the study.

Experimental Site

This study was conducted in the experimental field of Plant Science and Biotechnology Department, Ekiti State University, Ado-Ekiti, Ekiti State, Nigeria.

Methodology and Data Collection

The experiment was conducted using a Completely Randomized Design (CRD) with seven treatments containing three replicates each. One hundred and forty (140) seeds of *Solanum lycopersicum* were divided into seven (7) parts and sown into black polythene bags separately filled with seven treatments viz; 10%PM + 90% CS, 20%PM + 80% CS, 30%PM + 70% CS, 40%PM + 60% CS, 50%PM + 50% CS, 100% PM (control 1) and 100% CS (Control 2). The experiment was subjected to natural conditions favourable for germination. Germination initiation was observed for twenty (20) days when the total emergence we re counted and recorded. Assessment of growth parameters commenced two (2) weeks after epicotyls emerged and was done once weekly for twelve (12) weeks. The parameters assessed were plant heights, stem girth, number of leaves, leaf area, number of flowers and number of fruits.

Data Analysis

Data collected were summarized using descriptive statistics such as means and percentages. The data were further subjected to One-way Analysis of Variance (ANOVA) and the means were separated using Duncan's Multiple Range Test (DMRT) at a 5% probability level. Statistical analyses were performed using SPSS version 25 and Microsoft Excel 2019.

RESULTS

Physico-chemical properties of soil and poultry manure used

The results presented in Table 1 indicate that the clay soil used for the study was acidic with a pH of 5.62, while the poultry manure was slightly alkaline with a pH of 7.23. The poultry manure recorded a substantially higher organic carbon content (223.75 g/kg) compared to the clay soil (2.55 g/kg). Similarly, higher concentrations of essential nutrients such as nitrogen (25.25 g/kg), calcium (38.56 cmol/kg), magnesium (18.31 cmol/kg), and potassium (42.23 cmol/kg) were observed in poultry manure than in the clay soil, which recorded comparatively low values. The clay soil contained low available phosphorus (2.05 mg/kg), while poultry manure recorded a lower phosphorus value. Particle size distribution of the soil showed sand, silt, and clay contents of 55.62%, 19.50%, and 24.88%, respectively, classifying the soil as sandy clay loam. Overall, the results suggest that poultry manure is a rich source of organic matter and nutrients capable of improving the fertility of nutrient-poor clay soil when applied as an organic amendment, thereby enhancing soil productivity and supporting plant growth.

Plumule emergence

The results from Table 2 showed that plumule emergence was highest in seed grown on 10% P.M + 90% C.S with 80.00% emergence and this was followed seed sown in 100% C.S (control 2) with mean emergence of 70.00%. Seedlings in 20% P.M + 80% C.S recorded 40% emergence, while 30% P.M + 70% C.S had 20% emergence. No emergence was observed in seed sown on 40% and 50% P.M + C.S, as well as in 100% PM (Control 1). The results indicated that lower concentrations of poultry manure mixed with clay soil promoted higher plumule emergence, whereas higher concentrations were less effective.

Plant height (cm)

Table 3 showed that the 10% P.M + 90% C.S treatment produced the tallest seedlings at week twelve with a mean height of 120.00 cm. This was followed by 20% P.M + 80% C.S with mean value of 105.00cm. Seedlings on control 2 (100% C.S) had appreciable mean value of 98.00 while seedlings on 30% P.M + 70% C.S, 40% P.M + 60% C.S and 50% P.M + 50% C.S decreases in values as the percentage concentration increases with mean value of 82.00cm, 89.9cm and 32.24 cm respectively. While seedling on the pure poultry manure (Control 1) treatment could not make it till the end of the experiment as they died before week three of the experiment Statistical analysis revealed significant differences among the treatments.

Stem Girth

Results obtained in Table 4 showed that seedlings grown on 20% P.M + 80% C.S recorded the highest stem girth (18.99 cm) at week twelve. This was followed by seedling grown on 100% C.S (control 2) with mean stem girth of 7.10 cm at week twelve. Seedlings on 10% P.M + 90% C.S, 40% P.M + 60% C.S and

50% P.M + 50% C.S, showed no significant differences with stem girths of 4.66cm, 4.94 cm and 4.68 cm respectively. Seedlings in 30% P.M + 70% C.S produced slightly lower stem girth (4.) when compared to other treatments. Seedlings in Control 1 were recorded throughout the study, but showed minimal or negligible growth. The 20% P.M + 80% C.S treatment consistently promoted the fastest stem girth development

Number of Leaves

Results on number of leaves is presented Table 5. Seedlings grown on 20% P.M + 80% C.S consistently produced the highest number of leaves, reaching 298 leaves at week twelve. This was followed by seedlings on 10% P.M + 90% C. S (203 leaves) and 50% P.M + 50% C.S (189 leaves). Seedlings on 30% P.M + 70% C.S had 118 leaves and seedlings on 40% P.M + 60% C.S had 83 leaves and 118 at week twelve. Control 2 (100% C.S) produced 182 leaves, while Control 1 (100% P.M) showed no leaf development from week two of the experiment. The 20% P.M + 80% C.S treatment promoted the most rapid and sustained leaf development throughout the study.

Leaf Area

Table 8 showed that seedlings grown on 20% P.M + 80% C.S recorded the largest leaf area, reaching 127.00 cm² at week twelve after transplant. This was followed by 10% P.M + 90% C.S (57.76 cm²). Control 2 produced mean leaf area of 22.70 cm² at week twelve. Seedlings in 30% P.M + 70% C.S and 40% P.M + 60% C.S recorded smaller leaf areas of 20.02 cm² and 19.65 cm² respectively at week twelve, while 50% P.M + 50% C.S showed minimal leaf expansion (9.09 cm²). No Leaf area was recorded in 100%P.M treatment at twelve weeks completion of the experiment. The 20% P.M + 80% C.S treatment consistently promoted the highest and most sustained leaf expansion throughout the study

Number of flowers

Table 6 present the results on number of flowers. Seedlings grown on 20% P.M + 80% C.S produced the highest number of flowers (6.00) at week twelve. This was followed by seedlings on 10% P.M + 90% and

100% C.S (control 2) with the same mean value of 5.00, seedlings on 40% P.M + 60% C.S and 50% P.M + 50% C.S treatments also produced same mean value of 4.00 while 30% P.M + 70% C.S treatment produced seedlings with 3.00 number of flowers. Seedlings on Control 1 (100% P.M) showed no flowering throughout the period of the experiment. The 20% P.M + 80% C.S treatment consistently promoted earlier and higher flower production compared to other treatments.

Number of fruits

The results from Table 7 showed that seedlings grown on 10% P.M + 90% C.S produced the highest number of fruits, reaching 6 fruits at week twelve. This was followed by seedlings on 100% C.S (control 2) with mean value of 5.00. Seedlings on 20% P.M + 80% C.S, 30% P.M + 70% C.S and 40% P.M + 60% C.S produced same number of fruits (3.00). During the study period, Seedlings on 50% P.M + 50% C.S produced only 1.00 fruit. While seedlings in Control 2 showed no fruit development. Fruiting commenced from week five in most treatments and increased gradually over time. The 10% P.M + 90% C.S treatment consistently supported higher and more sustained fruit production compared to other treatments.

Table 1: physico-chemical properties of soil and poultry manure used for the study

PARAMETERS	CLAY SOIL	POULTRY MANURE
pH (H_2O)	5.62	7.23
Organic Carbon (g/kg)	2.55	223.75
Ca (cmol/kg)	1.74	38.56
Mg (cmol/kg)	0.84	18.31

K (cmol/kg)	0.17	42.23
Available P (mg/kg)	2.05	0.74
N (g/kg)	0.89	25.25
Sand (%)	55.62	–
Silt (%)	19.50	–
Clay (%)	24.88	–
Textural Class	Sandy clay loam	–

Table 2: Effects of varying concentration of poultry manure mixed with clay soil on Seedling Emergence (%) of *Solanum lycopersicum*

Treatment	Emergence (%)
10% PM + 90% C.S	80.00%[a]
20% PM + 80% C.S	40.00%[c]
30% PM + 70% C.S	20.00%[d]

40% PM + 60% C.S	0.00%
50% PM + 50% C.S	0.00%
Control 1 (Poultry manure)	0.00%
Control 2 (Clay soil)	70.00%^{b}

Values with the same letter within the column are not significantly different at p ≤ 0.05 according to Duncan Range Multiple Test (DRMT).

P.M= poultry manure, C.S = clay soil

Table 3: Effects of varying concentration of poultry manure mixed with clay soil on plant height of *Solanum lycopersicum*

Treatment	Plant height (cm)// weeks after planting											
	One	two	three	Four	Five	Six	seven	eight	Nine	Ten	eleven	Twelve
10% PM + 90% C.S	13.60^{a}	18.00^{b}	32.50^{a}	43.40^{b}	54.30^{a}	65.20^{b}	76.10^{a}	87.00^{a}	91.00^{a}	99.00^{a}	110.00^{a}	120.00^{a}
20% PM + 80% C.S	7.50^{c}	12.00^{d}	14.00^{e}	16.00^{d}	18.00^{f}	20.00^{f}	22.00^{f}	24.00^{f}	26.00^{f}	28.20^{e}	30.02^{f}	105.20^{b}

30% PM + 70% C.S	1.20^{d}	3.40^{e}	6.50^{f}	12.90^{e}	19.30^{e}	25.70^{e}	32.10^{e}	48.50^{e}	52.96^{e}	61.00^{d}	75.90^{d}	82.00^{d}
40% PM + 60% C.S	12.60^{b}	14.00^{c}	19.00^{d}	30.00^{c}	41.00^{c}	52.00^{c}	63.00^{c}	74.00^{c}	82.00^{c}	92.00^{b}	98.50^{b}	69.99^{e}
50% PM + 50% C.S	14.00^{a}	19.00^{a}	30.00^{b}	45.00^{a}	53.00^{b}	68.00^{a}	75.00^{b}	82.00^{b}	89.20^{b}	90.00^{c}	95.00^{c}	32.24^{f}
Control 1 (100% P.M)	1.00^{d}	1.21^{f}	-	-	-	-	-	-	-	-	-	-
Control 2 (100% C.S)	1.70^{d}	18.30^{b}	25.00^{c}	30.30^{c}	35.60^{d}	40.90^{d}	46.20^{d}	51.50^{d}	59.00^{d}	61.02^{d}	66.00^{e}	98.00^{c}

Values with the same letter within the column are not significantly different at $p \leq 0.05$ according to Duncan Range Multiple Test (DRMT).
P.M= poultry manure, C.S = clay soil

Table 4: Effects of varying concentration of poultry manure mixed with clay soil on stem girth of *Solanum lycopersicum*

Treatment	stem girth (cm)/ weeks after planting											
	One	Two	three	Four	Five	six	seven	eight	Nine	Ten	Eleven	Twelve
10% PM + 90% C.S	1.30ab	2.00^{a}	2.40^{a}	2.80^{b}	3.00^{c}	3.30^{c}	3.60^{c}	3.82^{c}	4.00^{c}	4.22^{c}	4.52^{c}	4.66^{c}
20% PM + 80% C.S	1.20^{b}	1.80^{a}	2.00^{a}	4.20^{a}	6.40^{a}	8.60^{a}	10.80^{a}	13.00^{a}	15.21^{a}	17.09^{a}	18.01^{a}	18.99^{a}
30% PM + 70% C.S	0.20^{b}	0.70^{b}	1.90ab	2.00^{c}	2.20	2.50cd	2.80cd	2.92^{d}	3.02^{d}	3.56cd	3.87^{d}	4.02^{d}
40% PM + 60% C.S	1.50^{a}	1.80^{a}	2.20^{a}	2.50bc	2.80^{c}	3.10^{c}	3.40^{c}	3.70^{c}	4.00^{c}	4.32^{c}	4.66^{c}	4.94^{c}
50% PM + 50% C.S	1.80^{a}	2.01^{a}	2.30^{a}	2.65	2.88^{c}	3.10^{c}	3.30^{c}	3.61^{c}	3.92^{c}	4.00^{c}	4.33^{c}	4.68^{c}
Control 1 (100% P.M)	0.06^{c}	0.06^{c}	-	-	-	-	-	-	-	-	-	-
Control 2 (100% C.S)	1.40^{ab}	1.70^{a}	2.60^{a}	3.10^{b}	3.60^{b}	4.10^{b}	4.60^{b}	5.10^{b}	5.60^{b}	6.10^{b}	6.50^{b}	7.10^{b}

Values with the same letter within the column are not significantly different at $p \leq 0.05$ according to Duncan Range Multiple Test (DRMT).

P.M= poultry manure, C.S = clay soil

Table 5: Effects of varying concentration of poultry manure mixed with clay soil on numbers of leaves of *Solanum lycopersicum* Treatment

	Number of leaves/ weeks after planting											
	One	Two	three	Four	Five	six	seven	eight	Nine	Ten	Eleven	Twelve
10% PM + 90% C.S	20.50^{a}	46.00^{a}	65.00^{b}	76.00^{c}	82.00^{c}	94.00^{c}	110.00^{c}	118.00^{d}	135.00^{c}	152.00^{c}	188.00^{b}	203.00^{b}
20% PM + 80% C.S	16.00^{c}	34.00^{b}	60.00^{a}	92.00^{a}	124.00^{a}	156.00^{a}	188.00^{a}	195.25^{a}	224.00^{a}	258.00^{a}	282.00^{a}	298.00^{a}
30% PM + 70% C.S	5.00^{d}	13.00^{d}	20.00^{f}	30.00^{f}	43.00^{f}	52.00^{f}	68.00^{e}	70.13^{e}	82.00^{d}	93.00^{e}	109.00^{e}	118.00^{e}
40% PM + 60% C.S	19.00^{b}	34.00^{b}	47.00^{d}	49.00^{e}	51.00^{e}	53.00^{e}	55.00^{f}	60.00^{f}	62.00^{e}	69.00^{f}	75.00^{f}	83.00^{f}
50% PM + 50% C.S	$19.oo^{b}$	34.00^{b}	57.00^{c}	89.00^{b}	95.00^{b}	102.00^{b}	120.00^{b}	139.00^{b}	145.00^{b}	156.00^{b}	172.00^{b}	189.00^{c}
Control 1 (100% P.M)	3.00^{e}	2.00^{e}	-	-	-	-	-	-	-	-	-	-
Control 2 (100% C.S)	21.00^{a}	28.00^{c}	41.00^{e}	58.00^{d}	75.00^{d}	92.00^{d}	109.00^{d}	126.00^{c}	135.00^{c}	148.00^{d}	169.00^{d}	182.00^{d}

Values with the same letter within the column are not significantly different at $p \leq 0.05$ according to Duncan Range Multiple Test (DRMT).

P.M= poultry manure, C.S = clay soil

Table 6: Effects of varying concentration of poultry manure mixed with clay soil on leaf area of *Solanum lycopersicum*

Treatments	Leaf Area (cm^2)/ weeks after transplant											
	One	two	three	Four	Five	six	seven	eight	nine	Ten	eleven	Twelve
10% PM + 90% C.S	5.98^c	12.74^c	24.68^b	37.02^b	26.22^b	32.20^b	43.13^b	51.50^b	46.20^b	48.00^b	57.76^b	57.76^b
20% PM + 80% C.S	13.12^a	25.44^a	37.20^a	46.74^a	62.36^a	81.93^a	102.00^a	89.00^a	96.00^a	82.06^a	89.00a	127.00^a
30% PM + 70% C.S	2.08^d	6.31^e	9.52^f	13.02^e	9.79^e	15.00^e	15.66^d	19.00^e	19.97^d	20.00^d	20.65^d	20.02^e
40% PM + 60% C.S	12.00^b	12.96^c	13.20^d	13.66^d	14.60^d	14.99^e	15.99^d	16.81^d	17.80^e	17.99^e	18.02^e	19.00^e
50% PM + 50% C.S	13.12^a	7.64^d	10.20^e	9.68^f	7.88^f	6.58^f	8.80^e	10.11^e	10.90^f	8.68^f	8.96^f	9.09^f
Control 1 (100% P.M)	1.02^d	0.07^f	-	-	-	-	-	-	-	-	-	-
Control 2 (100% C.S)	12.71^b	14.22^b	16.82^c	18.72^c	17.82^c	18.00^c	18.92^c	19.99^c	20.25^c	21.82c`	22.56^c	22.70^c

Values with the same letter within the column are not significantly different at $p \leq 0.05$ according to Duncan Range Multiple Test (DRMT).

P.M= poultry manure, C.S = clay soil

Table 7: Effects of varying concentration of poultry manure mixed with clay soil on number of flowers of *Solanum lycopersicum*

Treatment	Number of flower / weeks after Transplant											
	One	two	three	Four	Five	Six	Seven	eight	nine	Ten	Eleven	Twelve
10% PM + 90% C.S	–	–	–	–	–	3.00^{b}	4.00^{b}	5.00^{b}	6.00^{b}	3.00^{d}	4.00^{b}	5.00^{a}
20% PM + 80% C.S	–	–	–	–	–	–	5.00^{a}	6.00^{a}	8.00^{a}	6.00^{b}	5.00^{a}	6.00^{c}
30% PM + 70% C.S	–	–	–	–	–	1.00^{c}	2.00^{d}	3.00^{c}	2.00^{d}	1.00^{f}	3.00^{c}	3.00^{d}
40% PM + 60% C.S	–	–	–	–	–	–	–	6.00^{a}	3.00^{c}	4.00^{c}	5.00^{a}	4.00$^{\mathbf{b}}$
50% PM + 50% C.S	–	–	–	–	–	–	4.00^{b}	5.00^{b}	5.00^{c}	2.00^{c}	4.00^{b}	4.00^{b}
Control 1 (100% P.M)	–	–	–	–	–	-	-	-	-	-	-	-
Control 2 (100% C.S)	–	–	–	–	–	–	3.00^{c}	5.00$^{\mathbf{b}}$	6.00$^{\mathbf{b}}$	8.00^{a}	2.00^{d}	5.00^{c}

Values with the same letter within the column are not significantly different at $p \leq 0.05$ according to Duncan Range Multiple Test (DRMT).

P.M= poultry manure, C.S = clay soil

Table 8: Effects of varying concentration of poultry manure mixed with clay soil on number of fruit of *Solanum lycopersicum*

Treatment	Number of fruit/ weeks after transplant											
	One	Two	Three	four	Five	Six	seven	eight	nine	ten	eleven	Twelve
10% PM + 90% C.S	–	–	–	–	2.00^{a}	3.00^{a}	5.00^{b}	6.00^{b}	3.00^{b}	5.00^{a}	4.00^{a}	6.00^{a}
20% PM + 80% C.S	–	–	–	–	–	3.00^{a}	5.00^{a}	7.00^{a}	3.00^{b}	2.00^{c}	2.00^{b}	3.00^{c}
30% PM + 70% C.S	–	–	–	–	1.00^{b}	2.00^{b}	3.00^{c}	2.00^{c}	1.00^{c}	3.00^{b}	2.00^{b}	3.00^{c}
40% PM + 60% C.S	–	–	–	–	–	2.00^{b}	4.00^{b}	5.00^{c}	5.00^{a}	2.00^{c}	4.00^{a}	3.00^{c}
50% PM + 50% C.S	–	–	–	–	–	1.00c`	2.00^{d}	2.00^{e}	1.00^{c}	2.00^{c}	1.00^{c}	1.00^{d}
Control 1 (Poultry manure)	–	–	–	–	-	-	-	-	-	-	-	-
Control 2 (Clay soil)	–	–	–	–	1.00^{b}	3.00^{a}	3.00^{c}	4.00^{d}	3.00^{b}	3.00^{b}	4.00^{a}	5.00^{b}

Values with the same letter within the column are not significantly different at $p \leq 0.05$ according to Duncan Range Multiple Test (DRMT).

P.M= poultry manure, C.S = clay soil

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Discussion

Solanum lycopersicum, commonly known as tomato, is an important vegetable crop valued for its nutritional and economic contributions. Findings of this study revealed that seed sown on 10% poultry manure has the highest plumule emergence and seedling on this treatment also has the tallest height when compared with other treatments including that of 100% clay soil. Reason for this could be that little addition of poultry manure to clay soil greatly amended the soil to support *Solanum lycopersicum* emergence and plant height. This finding corroborates findings of Ewulo *et al*. (2008) who ascertained that poultry manure application significantly increased the emergence rate and seedling vigour in tomato compared to control plots without amendment. Also, Ram *et al*. (2025) reported that tomato seedlings are sensitive to soil physical and chemical conditions, especially in their early developmental stages. Poor soil aeration, nutrient deficiency and high bulk density common in clay soils can hinder plumule emergence and root penetration.

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Seedlings grown on 20% P.M consistently performed better in terms of tem girth, number of leaves, leaf area and number of flowers. Seedlings in 10% P.M exhibited moderate growth in this reference but higher poultry manure concentrations (≥30%) completely suppressed seedling emergence and early development. The optimal performance observed in 20% P.M can be attributed to balanced nutrient availability, improved soil aeration and water retention, which supported vigorous root and shoot development. This finding aligns with Gungula and Tame (2006), who reported that moderate organic amendments enhance nutrient uptake, root proliferation and seedling resilience. Also, Excessive application may lead to nutrient toxicity or salinity buildup, which can impair seedling health (Olajide *et al*., 2023). Furthermore, Shanika and Thayamini (2020) ascertained that high concentrations of poultry manure can lead to salinity buildup or excessive ammonia levels, which can inhibit germination and damage young seedlings.

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Similarly, the stem girth of seedlings varied significantly with poultry manure mixed with clay soil. The highest stem girth was recorded in 20% P.M, followed by 10% P.M, indicating that moderate poultry manure promotes stem thickening and structural development. This corroborates the observation of Tama *et al*. (2024), who reported enhanced stem girth in seedlings grown on a mixture of organic and mineral media.

Leaf development followed a similar pattern. Seedlings grown on 20% P.M produced the highest number of leaves and largest leaf area, while 10% P.M and Control 2 had moderate leaf production. Limited or no leaf development was observed in seedlings grown on higher P.M concentrations, suggesting that excessive poultry manure may inhibit leaf initiation, possibly due to nutrient toxicity or osmotic stress. These results agree with Agyeman *et al*. (2014), who reported higher leaf production in seedlings grown on a moderate mixture of organic and mineral soil.

Flowering of *Solanum lycopersicum* were also influenced by poultry manure mixed with clay soil. The highest number of flowers were recorded in seedlings grown on 20% P.M Seedlings in higher P.M treatments did not produce appreciable number of flower, indicating that moderate P.M concentrations optimize vegetative growth, while excessive manure may only partially support reproductive development in surviving seedlings. This pattern is consistent with findings by Wahab *et al*. (2019) who reported that moderate organic fertilizer rates enhance reproductive traits such as flowering and fruit set in tomato, whereas excessive application promotes vegetative growth at the

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expense of reproduction.

Furthermore, fruiting of *Solanum lycopersicum* were positively affected by addition of 10% poultry manure. Indicating that vegetative growth of *Solanum lycopersicum* is supported by minimum or moderate poultry manure application. This findings agrees with Fucheng *et al*. (2023) who observed that moderate poultry manure application yielded the best vegetative growth in tomato seedlings. Thus, the results confirm that controlled, moderate poultry manure supplementation supports optimal transition from vegetative to reproductive growth, while higher concentrations can suppress or delay flowering and fruiting.

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Overall, the study indicates that moderate poultry manure concentrations (10–20% P.M) mixed with clay soil provide the most suitable conditions for plumule emergence, seedling growth and early reproductive development of *Solanum lycopersicum*. Excessive poultry manure suppresses emergence and early growth, highlighting the importance of proper nutrient management in tomato cultivation.

Conclusion

This study has made significant contributions to our understanding of the effects of different poultry manure concentrations mixed with clay soil on the growth and development of *Solanum lycopersicum* (tomato). The findings of this study have important implications for agricultural practice and demonstrate the potential of *Solanum lycopersicum* as a crop for sustainable vegetable production. The results have shown that application rate of poultry manure has a significant impact on seedling emergence, plant height, stem girth, number of leaves, leaf area, flowering and fruiting of tomato seedlings. Based on the findings of this study, 20% P.M which is the most suitable growth medium for optimal seedling growth and productivity, followed by 10% P.M which greatly enhances emergence and fruiting are recommended while higher poultry manure concentrations (≥30%) which were the least suitable should not be considered to amend clay soil for the production of this plant species.

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