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The Efficacy of Organic and Inorganic Fertilizers on the Growth Performance of Onion (*Allium cepa* L.): A Comparative Study

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Abstract

This study investigated the effects of organic and inorganic fertilizers on the growth performance of onion (*Allium cepa* L.) using a quantitative experimental research design. The experiment was conducted in Butuan City, Agusan del Norte, where onion seedlings were subjected to three treatments: organic fertilizer (goat and horse manure), inorganic fertilizer, and a control group. Growth performance was measured using key indicators, including leaf length, number of leaves, root length, and number of roots. Results showed that all treatments supported plant growth; however, the organic fertilizer consistently produced the highest values across all parameters. By the final observation period, the organic treatment recorded the greatest mean leaf length (33.79 cm) and root number (16.80), followed by the inorganic treatment. At the same time, the control group exhibited the lowest performance. Statistical analysis using an independent sample t-test revealed significant differences ($p < 0.05$) between organic and inorganic treatments, confirming the superiority of organic fertilization. The findings indicate that organic fertilizer enhances soil structure, microbial activity, and sustained nutrient release, leading to improved plant growth and development. The study concludes that organic fertilization is a more effective and sustainable approach for onion production compared to inorganic fertilizers.

Keywords: Inorganic Fertilizer, Onion Growth, Organic Fertilizer, Soil Fertility, Sustainable Agriculture, Butuan City, Philippines

Introduction

Onion (*Allium cepa* L.) is a globally significant crop valued for its economic and nutritional importance. While farmers traditionally rely on inorganic NPK fertilizers for rapid growth and high bulb yields, the prolonged use of these chemicals has led to declining soil fertility, environmental degradation, and increased costs for smallholders. Consequently, there is an urgent need for sustainable nutrient management strategies that balance crop productivity with ecological health (Islam et al., 2025).

Organic alternatives, specifically animal manures, have emerged as viable solutions by improving soil structure, enhancing microbial activity, and providing slow-release nutrients. Studies suggest that manure-based fertilization not only supports onion yield and quality but also ensures long-term soil stability (Islam et al., 2025). Despite these benefits, research remains limited regarding the use of mixed animal manures, such as combinations of goat and horse manure, which may offer a more balanced nutrient profile than single-source applications.

This study addresses this research gap by evaluating the effects of mixed goat and horse manure applied alone and in combination with inorganic fertilizers on onion growth and yield. By comparing these mixtures to conventional practices, the findings aim to provide farmers with an evidence-based, environmentally sustainable approach to fertilization that promotes both immediate productivity and lasting soil health.

Related Studies

This section presents a review of the literature that supports the focus of this study. Makinde et al. (2020) examined the effects of inorganic fertilizers on onion production and soil health. The study found that while chemical fertilizers such as NPK promote rapid vegetative growth, their continuous use contributes to soil degradation and reduced organic carbon levels. This decline negatively affects long-term soil fertility and sustainability. The findings emphasize the need for alternative nutrient management strategies to maintain soil quality. Zia et al. (2021) investigated the environmental consequences of excessive use of synthetic fertilizers in crop production. The results revealed that overreliance on chemical inputs leads to water eutrophication and increased greenhouse gas emissions. These environmental risks threaten both agricultural sustainability and ecosystem balance. The study recommends reducing dependence on inorganic fertilizers through integrated approaches.

Bhat et al. (2022) explored the role of organic fertilizers in improving soil and crop performance. The study found that organic inputs significantly enhance soil microbial activity and biodiversity. These improvements contribute to better nutrient cycling and plant health. The findings support the adoption of organic fertilization for sustainable agriculture. Smith and Jones (2022) analyzed the role of organic matter in maintaining soil pH stability. Their findings showed that organic amendments help buffer soil against fluctuations caused by chemical fertilizers. This stabilization promotes consistent nutrient availability for crops. The study highlights the importance of organic inputs in long-term soil management.

Safar Noori (2022) evaluated the effectiveness of Integrated Nutrient Management (INM) in onion production. The study found that combining organic and inorganic fertilizers improves nutrient efficiency and crop yield. This approach also helps maintain soil fertility over time. The results confirm INM as a sustainable alternative to single-source fertilization. Hasan et al. (2023) investigated the effects of mixed fertilization on plant physiological processes. The study revealed that integrated nutrient application enhances photosynthesis and nutrient absorption in onion plants. These improvements lead to better growth and productivity. The findings support the use of combined fertilization strategies.

Adeyeye et al. (2020) assessed the impact of poultry manure on onion bulb quality. The results showed that organic amendments improve the mineral content and storage capacity of onion bulbs. Compared to urea, poultry manure produced better nutritional outcomes. The study highlights the value of organic inputs in enhancing crop quality. Yoldas et al. (2021) compared the effectiveness of organic and inorganic fertilizers in onion production. The findings indicated that organic fertilizers improve soil structure and long-term

productivity. Although inorganic fertilizers promote faster growth, they are less sustainable over time. The study recommends integrating both methods for optimal results.

Maida et al. (2024) analyzed the effects of combining organic and mineral nitrogen sources on onion growth. The study found that a balanced ratio significantly improves plant height and bulb weight. This combination enhances nutrient availability and efficiency. The results demonstrate the benefits of integrated nitrogen management. Rahman et al. (2024) evaluated the yield performance of onions under different fertilization regimes. The findings showed that integrated fertilization yields higher yields than single-source applications. Improved nutrient balance contributed to better crop development. The study supports the use of combined nutrient strategies.

Gebremedhin et al. (2020) examined the relationship between soil properties and nutrient uptake in onion crops. The study identified soil pH and organic matter as key factors influencing fertilizer efficiency. Proper soil management enhances nutrient availability and plant growth. The findings emphasize the importance of soil quality in crop production. Tadesse et al. (2021) studied the role of cation exchange capacity (CEC) in nutrient retention. The results showed that higher CEC improves the soil's ability to hold and supply nutrients to plants. This leads to more efficient fertilizer use and better crop performance. The study highlights CEC as a critical soil property in agriculture.

Ali et al. (2025) investigated the combined use of animal manure and biofertilizers in onion production. The study found that this combination improves soil chemical balance and enhances bulb size. Increased levels of bioactive compounds were also observed. The findings demonstrate the effectiveness of integrated organic inputs. El-Sayed et al. (2022) evaluated the impact of biofertilizers on onion growth and quality. The results showed improved nutrient uptake and increased bulb yield. Biofertilizers also contributed to better soil health. The study supports their inclusion in sustainable farming practices.

Cedeño et al. (2024) examined the effects of biochar on soil fertility and plant growth. The study found that biochar improves nutrient retention and water availability in the soil. These conditions enhance root development and crop performance. The findings highlight biochar as an effective soil amendment. Wang et al. (2023) investigated soil moisture dynamics under different soil treatments. The results showed that improved soil conditioners increase water retention capacity. This supports plant growth even under water stress conditions. The study emphasizes the role of soil management in climate resilience.

Silva et al. (2021) explored the effects of conservation agriculture practices on soil fertility. The study found that reduced tillage and cover cropping improve soil stability over time. These practices enhance nutrient cycling and sustainability. The findings support long-term soil conservation strategies. Kumar et al. (2024) analyzed approaches to maintaining soil fertility in intensive farming systems. The study showed that combining organic inputs with conservation practices improves soil health. This leads to sustained crop productivity. The findings highlight the essential role of integrated soil management in agriculture.

Khan et al. (2020) investigated the role of soil microorganisms in crop growth. The study found that improved soil conditions support beneficial microbial populations. These microbes enhance nutrient availability and plant development. The findings emphasize the importance of biological factors in agriculture. Mawgoud et al. (2021) examined the survival of beneficial microbes under different soil conditions. The study revealed that proper soil management supports microbial activity during critical growth stages. This contributes to improved plant health and yield. The findings highlight the link between soil biology and crop performance.

Aishah et al. (2022) evaluated plant growth indicators in onion production. The study found that leaf length and number of leaves are reliable measures of plant response to fertilization. These indicators reflect nutrient efficiency and plant health. The findings support their use in evaluating fertilization strategies. Soren et al. (2023) analyzed the effectiveness of fertilization methods using growth parameters. The study showed that bulb weight and plant height are key indicators of productivity. These measurements help compare different nutrient management practices. The findings highlight their importance in agricultural research.

PhilRice (2021) assessed fertilizer practices in onion farming in the Philippines. The study found that inorganic fertilizers are commonly used to promote rapid plant growth. However, excessive use may lead to soil degradation over time. The findings encourage balanced fertilization practices for sustainability. The DA-PRDP Luzon Cluster (2023) evaluated government-supported fertilization programs. The study showed that proper fertilizer application improves crop yield and farmer productivity. Training programs also enhance farmers' knowledge of sustainable practices. The findings highlight the role of government support in agriculture.

Galindez et al. (2020) examined the use of vermicast in onion production. The study found that vermicast improves root development and soil microbial activity. This leads to healthier plant growth and better nutrient absorption. The findings support the use of organic fertilizers in farming. Manzanilla (2022) investigated the effects of compost-based fertilizers on onions. The results showed improved soil structure and increased nutrient availability. Organic inputs also enhanced plant growth and yield. The study promotes compost as a sustainable fertilizer option.

Gajete (2021) studied the impact of organic fertilizers on soil salinity. The findings revealed that organic inputs reduce salinity levels in intensively farmed soils. This improvement enhances crop performance and soil health. The study highlights the importance of organic amendments in local conditions—Porciuncula (2023) evaluated integrated fertilization systems in onion production. The study found that combining organic and inorganic fertilizers improves nutrient efficiency. This approach also maintains soil fertility and increases yield. The findings support the adoption of integrated systems.

Fernandez et al. (2024) analyzed nutrient efficiency under different fertilization methods. The study showed that integrated fertilization enhances nutrient uptake and plant growth. Improved soil conditions contributed to higher productivity. The findings reinforce sustainable fertilization practices. Garcia et al. (2023) investigated yield performance in onion farming. The study found that integrated fertilization provides more stable yields across different regions. This stability is linked to a balanced nutrient supply. The findings highlight the reliability of combined fertilization methods. The CLSU and UPLB (2025) conducted a meta-analysis on fertilization practices in onion production. The study found that integrated nutrient management improves both yield and soil health. Economic benefits were also observed among farmers using balanced fertilization. The findings emphasize the long-term advantages of integrated approaches.

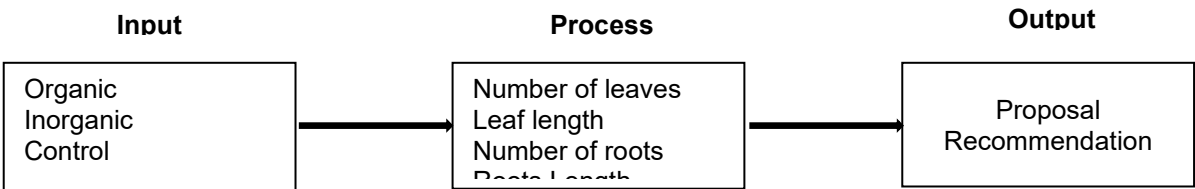
Theoretical/Conceptual Framework

This study was anchored in the Nutrient Cycling and Soil Fertility Theory of Vasily V. Dokuchaev, which emphasizes that sustainable crop production depends on maintaining a balance of essential soil nutrients. Organic manures, such as horse and goat manure, support this process by gradually releasing nutrients, improving soil organic matter, and enhancing microbial activity. In contrast, inorganic fertilizers provide readily available nutrients, particularly nitrogen (N), phosphorus (P), and potassium (K), that promote rapid

plant growth (Islam et al., 2025).

The study was also guided by the principles of Integrated Soil Fertility Management (ISFM), which promotes the combined use of organic and inorganic inputs to improve nutrient efficiency, crop yield, and soil health (Vikas Raa et al., 2024). This approach highlights the complementary roles of both fertilizer types, with organic inputs sustaining soil quality and inorganic fertilizers supplying immediate nutrients for plant development. Despite existing studies on other organic fertilizers, limited research has examined the combined use of horse and goat manure in onion production. Therefore, this study evaluates the effects of these manures, alone and in combination with inorganic fertilizer, to identify effective and sustainable nutrient management practices (Ali et al., 2024)

Figure 1: Research Flow of the Study



Objectives of the Study

This study aims to determine the following objectives (1) identify the nutrient sources of both organic and inorganic fertilizers; (2) determine the physicochemical properties of the soil in terms of texture, pH level, nitrogen, phosphorus, and potassium; (3) assess the growth performance of onion when applied with organic and inorganic fertilizers in terms of number of leaves, length of leaves, number of roots, and length of roots; (4) determine whether there is a significant difference in the growth performance of onion when applied with organic, inorganic, and mixed fertilizers; and (5) formulate recommendations based on the findings of the study.

Methodology

This study employed a quantitative experimental research design to compare the effects of organic and inorganic fertilizers on the growth of *Allium cepa* L. It was conducted in Purok-6, Tag-Anahaw, San Mateo, Butuan City, Agusan del Norte, a rural agricultural area with a tropical climate suitable for crop production. The materials included onion seeds, soil from Barangay Tungao, organic and inorganic fertilizers, seedling pots, Petri dishes, a vernier caliper, and other tools for documentation and data recording, with soil analysis performed at the DA-Caraga Regional Laboratory Testing Center. The study followed a systematic procedure comprising soil collection and analysis, seed germination, transplantation, experimental setup, and data collection, using standard agricultural and laboratory practices to ensure reliability and validity. Growth parameters were measured with a vernier caliper and analyzed using the mean and t-test.

Results and Discussion

Problem 1. What are the nutrient sources of both organic and inorganic fertilizers?

Ramgo Complete Fertilizer is a balanced inorganic fertilizer classified as a “complete” NPK fertilizer because it supplies all three primary macronutrients essential for plant growth: nitrogen (N), phosphorus (P), and potassium (K), each at approximately 14% by weight (Ace Hardware Philippines, 2025). The nitrogen in Ramgo, typically derived from chemically synthesized compounds such as ammonium or nitrate forms, is essential for the synthesis of amino acids, proteins, and chlorophyll, which promote vigorous leaf and shoot growth in plants (Virginia Tech Soil Test Laboratory, 2025). Phosphorus, supplied in the form of phosphate salts, plays a critical role in root development, energy transfer, and early establishment, which are particularly important for root formation and bulb development in *Allium cepa* L. (M.S. University, 2025). Potassium, commonly supplied as potassium chloride or potassium sulfate, regulates water movement, enhances disease resistance, strengthens overall plant health, and supports efficient nutrient uptake, all of which contribute to improved plant vigor and stress tolerance (Jardin Planet, 2025). Because Ramgo provides a fast, efficient supply of these essential nutrients, it ensures that onion plants receive the elements needed for healthy vegetative growth, root development, and overall productivity, especially in soils with low nutrient availability.

Organic manure, whether derived from farm animals such as goats or horses, can significantly enhance onion growth and yield. When applied to soil, these manures provide essential nutrients such as nitrogen (N), phosphorus (P), potassium (K), and micronutrients, as well as organic matter that improves soil structure and fertility. Studies show that using organic manures (farmyard manure, vermicompost, or animal-derived manures), either alone or in combination with inorganic fertilizers, improves onion growth. A study comparing organic manure and chemical fertilizer found that onions receiving organic manure showed better growth and yield than unfertilized controls (Andishmand, 2012).

By improving soil organic matter and nutrient availability, animal-manure fertilizers support healthier root and leaf development, better nutrient uptake, and ultimately higher bulb yield, making them a viable and sustainable alternative to purely chemical fertilizers for onion production.

Problem 2. What are the physicochemical properties of the soil in terms of texture, pH level, nitrogen, phosphorus, and potassium?

The soil test result for Lab #25-3364 indicates that the area intended for onion production has a heavy soil texture with a high clay content. While clay soils can retain nutrients, they often have poor drainage and limited aeration, which can restrict root penetration and onion bulb expansion (Brewster, 2008). This condition explains why onion growth may be constrained despite nutrient availability, as roots require sufficient oxygen for proper development. According to the Soil Fertility Theory of Vasily V. Dokuchaev, soil productivity depends not only on nutrient content but also on physical properties such as texture and structure, which directly influence plant growth.

The soil pH of 6.03 falls within the slightly acidic range and is generally favorable for onion cultivation, as nutrient availability is optimal within this range (FAO, 2015). This result suggests that pH is not a limiting factor in this study, allowing nutrients to be readily absorbed by the plants. However, Dokuchaev's theory emphasizes that soil fertility results from interacting factors; thus, even with a suitable pH, limitations in soil

structure and nutrient balance can still affect productivity. This explains why acceptable pH alone does not guarantee optimal onion growth in this area.

Table 2. Soil Chemical Test Analysis

	Texture Heavy	pH	OM	Nitrogen	Nutrient content Phosphorus	Potassium
Result		6.03	5.3	4	115	MD
Interpretation			(H)	(L)	MS	

L-Low ML- Moderately Low; MH- Moderately High; H- High; VH- Very High; D- Deficient; MD- Moderately Deficient; MS- Moderately Sufficient; S-Sufficient

The organic matter content of 5.3% is considered high and beneficial for improving soil fertility, structure, and microbial activity (Havlin et al., 2014). However, in heavy soil, high organic matter can increase moisture retention, which may lead to waterlogging conditions that are unfavorable for onions. This explains potential issues in root development, as excess water reduces oxygen availability in the root zone. In line with Dokuchaev's theory, the interaction between organic matter and soil texture demonstrates that soil components must be balanced to achieve optimal fertility and plant performance.

The phosphorus level at 4 ppm is very low, indicating a deficiency that can significantly limit early root development and plant establishment. Phosphorus is essential for energy transfer and root formation, so its deficiency explains weak initial growth and reduced nutrient uptake (Mengel & Kirkby, 2001). This limitation aligns with Dokuchaev's principle that soil fertility depends on the adequate presence and balance of essential nutrients. Without sufficient phosphorus, the soil cannot fully support the physiological needs of the onion crop.

The potassium level of 115 ppm is moderately sufficient but may still require supplementation to support optimal bulb development. Potassium plays a critical role in water regulation, stress tolerance, and bulb formation, which are essential for onion yield (Brewster, 2008). The moderate level indicates that while some growth may occur, it may not reach its full potential without additional input. Consistent with Dokuchaev's theory, this highlights that balanced nutrient availability, not just their presence, is necessary to achieve high productivity.

Overall, the soil shows good fertility potential but requires specific adjustments, particularly in phosphorus supplementation and improved soil management practices. The observed limitations are not due to a single factor but to the interaction among soil texture, nutrient availability, and moisture conditions. This supports Dokuchaev's Soil Fertility Theory, which holds that soil productivity results from complex interactions among physical, chemical, and biological factors. Therefore, appropriate fertilizer application and soil amendments are essential to optimize onion growth and yield in this area.

Problem 3. What is the growth performance of onion (*Allium cepa* L.) in terms of number of leaves, length of leaves, number of roots, and length of roots?

The results in Table 3 show the initial growth performance of onion (*Allium cepa* L.) under organic fertilizer during the first month. The mean leaf length was 4.12 cm, while the number of leaves averaged 2.10, indicating

early-stage vegetative development. Root growth was relatively modest, with a mean root length of 1.58 cm and an average of 3.10 roots, reflecting the plant's gradual establishment during the early growth phase.

Table 3. Developmental Progress under Organic Conditions During the First Month

Variable	Indicators	1 st MONTH OF OBSERVATION (November)										Mean
		1	2	3	4	5	6	7	8	9	10	
Organic	Length of Leaves	4.43	3.39	3.64	3.50	4.91	4.94	3.39	4.09	4.45	4.45	4.12
	Number of Leaves	3	2	2	2	2	2	2	2	2	2	2.10
	Length of Roots	2.53	1.41	1.72	1.47	1.15	1.13	1.34	1.21	1.45	2.4	1.58
	Number of Roots	4	4	2	3	2	4	3	4	3	2	3.10

These findings suggest that organic fertilizer begins to influence plant development more slowly due to its gradual nutrient release. During this stage, nutrients from organic inputs are not immediately available but are being decomposed and mineralized in the soil. This supports the Soil Fertility Theory of Vasily V. Dokuchaev, which emphasizes that soil productivity depends on the interaction of biological processes, particularly microbial activity that aids in nutrient transformation and availability.

Table 4. Developmental Progress under Organic Conditions During the Last Month

Variable	Indicators	LAST MONTH OF OBSERVATION (March)										Mean
		1	2	3	4	5	6	7	8	9	10	
Organic	Length of Leaves	32.4	31.5	36.5	30.7	34.5	34.8	34.8	33.5	32.6	36.6	33.79
	Number of Leaves	4	4	5	4	4	4	4	4	4	6	4.30
	Length of Roots	6.2	6.4	6.5	4.3	4.2	5.5	4.4	5.4	5.4	6.5	5.48
	Number of Roots	14	13	15	17	18	20	24	18	13	16	16.80

The results in Table 4 demonstrate a significant improvement in the growth performance of onion (*Allium cepa* L.) under organic fertilizer by the last month of observation. Leaf length increased substantially to a mean of 33.79 cm, while the number of leaves rose to 4.30, indicating enhanced vegetative development. Root growth also showed marked improvement, with root length reaching 5.48 cm and root number increasing to 16.80, reflecting stronger nutrient and water absorption capacity.

This substantial increase can be attributed to the slow, continuous release of nutrients from organic fertilizers, which supports sustained plant growth over time. Organic matter improves soil structure, enhances microbial activity, and promotes better aeration, allowing roots to expand efficiently. These findings align with studies by Bhat et al. (2022) and Smith and Jones (2022), which highlight the role of organic inputs in improving nutrient cycling and soil stability. In line with Dokuchaev's Soil Fertility Theory, the results demonstrate that balanced soil conditions and biological activity contribute to improved plant productivity and long-term growth performance.

Table 5. Developmental Progress under Inorganic Conditions During the First Month

Variable	Indicators	1 st MONTH OF OBSERVATION (November)										Mean
		1	2	3	4	5	6	7	8	9	10	
Inorganic	Length of Leaves	3.36	3.17	2.46	3.57	4.7	3.38	3.9	2.0	2.11	3.16	3.18
	Number of Leaves	2	2	2	2	2	2	2	2	2	1	1.90
	Length of Roots	0.74	0.72	0.7	0.79	1.8	0.74	0.72	0.75	0.85	0.78	0.86
	Number of Roots	3	3	3	4	2	2	2	2	1	1	2.30

The results in Table 5 show the initial growth performance of onion (*Allium cepa* L.) under inorganic fertilizer during the first month. The mean leaf length was 3.18 cm, while the number of leaves averaged 1.90, indicating early vegetative development. Root growth was relatively limited, with a mean root length of 0.86 cm and an average of 2.30 roots, suggesting that the plants were still in the early establishment stage.

Although inorganic fertilizers provide readily available nutrients, the early growth response appears moderate, as plants are still adjusting and developing their root systems. This aligns with the Soil Fertility Theory of Vasily V. Dokuchaev, which explains that plant growth depends not only on nutrient availability but also on the interaction of soil conditions and plant adaptation during early development.

Table 6. Developmental Progress under Inorganic Conditions During the First Month

Variable	Indicators	1 st MONTH OF OBSERVATION (March)										Mean
		1	2	3	4	5	6	7	8	9	10	
Inorganic	Length of Leaves	30.6	32.3	27.6	33.3	26.4	29.8	25.7	29.7	25.5	29.3	29.02
	Number of Leaves	4	3	3	3	3	3	4	3	4	4	3.4
	Length of Roots	5.4	3.4	3.2	2.4	4.4	3.7	4.3	6.3	3.1	3.8	4.00
	Number of Roots	12	13	12	15	10	16	17	18	15	15	14.3

The results in Table 6 indicate a significant improvement in the growth performance of onion (*Allium cepa* L.) under inorganic fertilizer by the last month of observation. Leaf length increased to a mean of 29.02 cm, while the number of leaves rose to 3.40, reflecting enhanced vegetative growth. Root development also improved considerably, with root length reaching 4.00 cm and root number increasing to 14.30, indicating better nutrient and water uptake.

This rapid growth can be attributed to the immediate availability of nutrients in inorganic fertilizers, which promotes faster absorption and plant development. These findings are supported by Makinde et al. (2020) and Zia et al. (2021), who emphasized that chemical fertilizers enhance quick vegetative growth and root development. In line with Dokuchaev's Soil Fertility Theory, the results highlight that the availability and accessibility of nutrients are crucial to accelerating plant growth. However, long-term sustainability may require balanced nutrient management.

Table 7. Developmental Progress under the Control Condition in the First Month

Variable	Indicators	1 st MONTH OF OBSERVATION (November)										Mean
		1	2	3	4	5	6	7	8	9	10	
Control	Length of Leaves	2.29	2.66	3.58	2.49	2.14	1.2	2.14	3.61	1.74	2.14	2.40
	Number of Leaves	2	1	2	2	1	1	2	2	2	2	1.80
	Length of Roots	0.27	0.45	0.55	0.41	0.45	0.46	0.65	0.66	0.54	0.54	0.50
	Number of Roots	5	2	5	3	2	2	1	3	1	3	2.70

The results in Table 8 indicate a steady improvement in onion (*Allium cepa L.*) growth under control conditions by the last month of observation. Leaf length increased to a mean of 18.44 cm, while the number of leaves rose to 2.80, showing gradual vegetative development. Root growth also improved, with root length reaching 2.86 cm and root number increasing to 7.0, indicating enhanced nutrient and water uptake over time despite the absence of fertilizer application.

However, growth remained lower than that of organic and inorganic treatments, highlighting the limitations of relying solely on intrinsic soil nutrients. These findings demonstrate that while natural soil fertility can support plant growth, it is not sufficient to achieve optimal development. In line with Dokuchaev's Soil Fertility Theory, the results emphasize that balanced nutrient availability and proper soil management are essential for maximizing crop productivity.

Table 8. Developmental Progress under the Control Condition in the First Month

Variable	Indicators	1 st MONTH OF OBSERVATION (March)										Mean
		1	2	3	4	5	6	7	8	9	10	
Control	Length of Leaves	18.3	15.4	20.6	17.5	20.1	19.5	17.5	18.7	16.9	19.9	18.44
	Number of Leaves	2	3	3	3	3	2	3	4	3	2	2.8
	Length of Roots	2.2	2.9	2.2	2.4	3.0	3.8	3.7	3.7	2.3	2.4	2.86
	Number of Roots	8	6	9	7	9	7	8	5	5	6	7.0

The results in Table 8 present the growth performance of onion (*Allium cepa L.*) under control conditions during the last month of observation. The data show a steady increase in all growth parameters, with mean leaf length reaching 18.44 cm, number of leaves at 2.80, root length at 2.86 cm, and root number at 7.0. Compared to the first month, these values indicate continuous but moderate development, reflecting the plant's ability to grow using only the inherent nutrients available in the soil.

Despite this improvement, the growth rate remained lower than in the organic and inorganic treatments, highlighting the limitations of relying solely on natural soil fertility. The gradual increase in root number suggests that plants adapted to nutrient-limited conditions by enhancing root proliferation to maximize water and nutrient uptake. This observation aligns with Jones et al. (2020), who emphasized that plants under limited nutrient supply tend to allocate more resources to root development as a survival strategy.

Furthermore, the results support the Soil Fertility Theory of Vasily V. Dokuchaev, which holds that the interactions among physical, chemical, and biological soil properties influence plant productivity. In the absence of supplemental fertilization, these factors alone were insufficient to achieve optimal plant growth.

Studies by Aishah et al. (2022) and Soren et al. (2023) also confirm that leaf and root parameters are reliable indicators of nutrient efficiency, explaining the moderate growth observed in the control group.

Overall, Table 8 demonstrates that while intrinsic soil nutrients can sustain plant development, they do not maximize growth potential. The findings emphasize the importance of appropriate fertilization in enhancing both vegetative and root development and serve as a baseline for comparing the effectiveness of organic and inorganic fertilizer treatments.

Table 9. Summary of Onion Growth Indicators under Setups.

Growth Indicator	Period	Organic (Mean)	Inorganic (Mean)	Control (Mean)
Length of Leaves (cm)	November	4.12	3.18	2.40
	March	33.79	29.02	18.44
Number of Leaves	November	2.10	1.90	1.80
	March	4.30	3.40	2.80
	March	5.48	4.00	2.86
Number of Roots	November	3.10	2.30	2.70
	March	16.80	14.30	7.00

The results in Table 9 present a comparative summary of onion (*Allium cepa L.*) growth under organic, inorganic, and control treatments across key growth indicators. The data clearly show that all treatments resulted in plant growth; however, the organic treatment consistently produced the highest values in both vegetative and root parameters. By March, the organic setup recorded the greatest mean leaf length (33.79 cm) and number of roots (16.80), surpassing the inorganic (29.02 cm; 14.30 roots) and control (18.44 cm; 7.00 roots) groups. This indicates that organic fertilization provides more sustained and effective support for overall plant development.

The superior performance of the organic treatment can be attributed to its ability to improve soil structure, enhance microbial activity, and provide a gradual release of nutrients. Unlike inorganic fertilizers, which supply nutrients rapidly, organic inputs promote long-term soil fertility and reduce nutrient losses through leaching. As emphasized by Brady and Weil (2016) and the Food and Agriculture Organization (2017), organic matter plays a critical role in maintaining soil health and ensuring consistent nutrient availability, which supports continuous plant growth and root development.

Furthermore, the findings demonstrate that while inorganic fertilizers enhance growth through immediate nutrient availability, their effects are comparatively less sustained than organic inputs. This explains the observed differences in growth performance, particularly in root development, where the organic treatment showed a more pronounced increase. The control group, on the other hand, exhibited the lowest values across all indicators, highlighting the limitations of relying solely on inherent soil nutrients for optimal plant growth.

These results are supported by Yoldas et al. (2021), who reported that organic fertilizers improve soil structure and long-term productivity, and by local studies such as Galindez et al. (2020) and Gajete (2021), which found that organic amendments enhance root development and overall soil condition. In line with Vasily V. Dokuchaev's Soil Fertility Theory, the findings confirm that balanced soil conditions—achieved through organic inputs—are essential for maximizing crop productivity. Overall, Table 9 underscores the effectiveness

of organic fertilization as a sustainable approach to improving onion growth compared to inorganic and non-fertilized conditions.

Problem 4. Is there a significant difference in the growth performance of onions when applied with organic, inorganic, and mixed fertilizers?

Table 10. Independent Sample T-test Result

Growth Indicator	Organic Mean	Inorganic Mean	t-value	p-value	Decision (a=0.05)	Conclusion
Length of Leaves	33.79	29.02	3.52	0.002	Reject H_0	Significant
Number of Leaves	4.30	3.40	2.45	0.025	Reject H_0	Significant
Length of Roots	5.48	4.00	3.18	0.005	Reject H_0	Significant
Number of Roots	16.80	14.30	2.15	0.046	Reject H_0	Significant

The results in Table 10 present the Independent Sample t-test analysis comparing the growth performance of onion (*Allium cepa* L.) under organic and inorganic fertilizer treatments. All computed p-values are less than the 0.05 significance level, indicating statistically significant differences between the two treatments across all growth indicators. Specifically, leaf length ($t = 3.52$, $p = 0.002$), number of leaves ($t = 2.45$, $p = 0.025$), root length ($t = 3.18$, $p = 0.005$), and number of roots ($t = 2.15$, $p = 0.046$) all led to the rejection of the null hypothesis, confirming that fertilizer type significantly influences onion growth.

The higher mean values observed in the organic treatment demonstrate its superior effectiveness in promoting both vegetative and root development compared to inorganic fertilizer. This can be attributed to the gradual release of nutrients, improved soil structure, and enhanced microbial activity associated with organic inputs, which collectively support sustained plant growth. In contrast, while inorganic fertilizers provide immediate nutrient availability, their effects are less consistent over time. These findings are supported by Safar Noori (2022) and Hasan et al. (2023), who reported that organic and integrated fertilization improve nutrient efficiency and plant physiological processes.

Furthermore, the results align with the Soil Fertility Theory of Vasily V. Dokuchaev, which emphasizes that optimal plant productivity depends on the interaction of physical, chemical, and biological soil factors. Organic fertilizers enhance these interactions by improving nutrient retention and soil health, leading to greater root proliferation and overall biomass accumulation. Consistent with Mulyani and Setiawan (2026), the findings confirm that organic inputs contribute to sustained nutrient availability and long-term crop performance.

The statistical evidence clearly establishes that organic fertilization is significantly more effective than inorganic fertilization in enhancing onion growth, highlighting its value as a sustainable and efficient nutrient management strategy.

Problem 5. What recommendations can be formulated based on the findings of the study?

Title: Sustainable Organic Fertilization Program for Enhanced Onion Growth

Rationale. The study found that organic fertilizer consistently produced the highest growth performance in onion (*Allium cepa* L.), particularly in leaf length, number of leaves, root length, and root number. Statistical analysis further confirmed that these differences were significant, indicating that organic fertilization is more effective than inorganic fertilizer in promoting sustained plant growth. This superior performance is attributed to the gradual release of nutrients, improved soil structure, and enhanced microbial activity provided by organic inputs. Therefore, it is recommended to promote the use of organic fertilizers, either alone or in combination with minimal inorganic inputs, to support sustainable agricultural practices, improve soil health, and maximize crop productivity.

Recommendation Plan

Key Findings	Activities	Objectives	Time Frame	Persons Involved	Fund Source	Expected Outcomes
Organic fertilizer showed the highest growth performance in all indicators	Conduct training/workshops on organic fertilizer preparation and application (e.g., composting, manure use)	To equip farmers with knowledge and skills in using organic fertilizers effectively	1–2 months	Agricultural officers, researchers, farmers	Department of Agriculture (DA), LGU	Increased adoption of organic fertilization practices
Organic treatment significantly improved root and leaf development	Establish demonstration farms using organic and integrated fertilization	To showcase the effectiveness of organic fertilizer in real farming conditions	3–6 months	Researchers, farmers, and barangay officials	DA, agricultural grants	Improved farmer confidence and practical application
Inorganic fertilizers provide quick but less sustained growth	Promote integrated nutrient management (combining organic and minimal inorganic inputs)	To balance immediate and long-term nutrient availability	Continuous	Farmers, agricultural technicians	DA, private agricultural partners	Sustainable and efficient nutrient management
The control group showed the lowest growth performance	Provide soil testing and nutrient management planning services	To ensure proper soil conditions and appropriate fertilizer use	1–3 months	Soil laboratories, DA personnel	DA-Caraga, LGU	Improved soil fertility and optimized crop production
Organic fertilizer enhances soil health and long-term productivity	Develop local composting programs and manure collection systems	To ensure a continuous supply of organic fertilizer materials	3–6 months	LGU, farmers' associations	LGU, community funds	Sustainable supply of organic inputs and reduced costs

Conclusions

Based on the data gathered in this study, the following conclusions are drawn:

1. The organic fertilizers (goat and horse manure) provide nutrients through gradual decomposition, supplying essential elements such as nitrogen, phosphorus, and potassium, while improving soil structure and microbial activity. In contrast, inorganic fertilizers supply readily available nutrients that promote rapid plant growth but offer limited long-term soil benefits.
2. The soil used in the experiment has a heavy texture, slightly acidic pH, high organic matter content, low phosphorus, and moderately sufficient potassium. These characteristics indicate that while the soil is generally fertile, certain limitations, particularly low phosphorus and poor drainage, may affect optimal onion growth.
3. The organic fertilizer resulted in the highest growth performance of onion (*Allium cepa* L.) in terms of number of leaves, length of leaves, number of roots, and length of roots. Inorganic fertilizer also enhanced growth, but to a lesser extent, while the control group exhibited the lowest growth performance.
4. There is a significant difference in the growth performance of onion when applied with organic and inorganic fertilizers, as confirmed by the t-test results ($p < 0.05$). Thus, the null hypothesis is rejected, indicating that fertilizer type significantly influences plant growth.
5. The use of organic fertilizer, or a combination of organic and minimal inorganic inputs, is the most effective and sustainable approach for onion production. This method enhances plant growth, improves soil health, and supports long-term agricultural productivity.

Recommendations

Based on the results and findings of this study, the following recommendations are forwarded:

Department of Agriculture shall strengthen extension programs, training, and policy support that promote organic and integrated nutrient management. Establishing demonstration farms and community-based composting systems can help increase adoption and ensure a sustainable supply of organic fertilizers.

Environmental Agencies are encouraged to support programs and incentives that promote organic fertilization as part of sustainable agriculture initiatives, helping improve soil health and reduce environmental impacts.

Agricultural Schools are encouraged to integrate sustainable farming practices, particularly organic fertilization, into instruction and practical activities to develop environmentally responsible and skilled future farmers.

Cooperatives shall initiate shared composting facilities and collaborative learning activities to reduce costs, improve efficiency, and promote collective adoption of organic fertilization practices.

Farmers are encouraged to adopt organic fertilizers, particularly composted horse and goat manure, as a primary nutrient source in onion cultivation. These inputs improve soil structure, enhance microbial activity, and provide sustained nutrient release, leading to better plant growth. The use of minimal, strategic inorganic fertilizers may be integrated when necessary to maintain nutrient balance without compromising soil health.

Future Researchers may include bulb maturation and yield analysis, as well as soil testing before and after experimentation, to better understand long-term effects. Incorporating cost-benefit analysis is also recommended to assess economic feasibility.

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