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The Effect of Various Types of Animal Manure on The Growth and Production of Mustard (Brassica *juncea* L.) on Ultisol Soil

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A B S T R A C T

This study aimed to analyze the effects of different types of animal manure on the growth and production of mustard plants cultivated on Ultisol soil media. Observational data were analyzed using Analysis of Variance (ANSIRA), and significant differences were further tested using the Honestly Significant Difference (HSD) test at the 5% significance level. The results showed that the application of different types of manure significantly affected the growth and yield parameters of mustard plants, including plant height, number of leaves, and fresh weight. The best treatment for increasing plant height and leaf number was O3 (topsoil: cow manure = 2:1), which produced the tallest plants and the highest number of leaves compared to other treatments. Meanwhile, the best treatment for fresh weight production is O2 (topsoil: buffalo manure = 2:1). Differences in growth and production responses were influenced by manure purity, particle size, nutrient availability, and the slow-release characteristics of organic fertilizers, which affect nutrient uptake dynamics in mustard plants.

INTRODUCTION

Mustard greens (Brassica *juncea* L.) are leafy vegetable crops with high economic value and are widely cultivated due to their relatively short harvest period and stable market demand. The growth of mustard plants is highly dependent on the vegetative phase; therefore, production success is strongly influenced by nutrient availability, particularly nitrogen (Haridamar et al., 2018). Nitrogen plays an important role in chlorophyll synthesis, photosynthetic activity, and protein formation that directly affect stem and leaf growth (Laira et al., 2025). Insufficient nitrogen availability may inhibit vegetative development and reduce leaf formation (Hidayati et al., 2021).

Productivity of mustard greens is not only influenced by fertilization practices but also by soil characteristics as a growing medium. Ultisol is one of the most widely distributed soil types in tropical regions and is characterized by high acidity, high aluminum saturation, and low availability of macronutrients (Sharma et al., 2025). Generally, Ultisol soils contain low organic matter, limiting their capacity to supply nutrients for plant growth (Lin et al., 2023). These conditions result in low soil fertility and reduced crop productivity if proper soil management is not implemented (Azuka et al., 2024).

Various studies have reported the influence of manure on plant growth. However, studies specifically examining the effect of different types of manure on mustard growth in Ultisol soil are still relatively limited. Research integrating manure type, Ultisol soil characteristics, and vegetative growth response of mustard greens in a quantitative approach remains scarce. This information is crucial as a basis for determining appropriate organic fertilization strategies adapted to marginal soil characteristics. Based on these conditions, research on the effect of manure application on plant height and leaf number of mustard greens (Brassica juncea L.) grown in Ultisol soil becomes important. This study is expected to provide scientific information regarding the effectiveness of different types of manure in improving vegetative growth and to support the development of sustainable and environmentally friendly vegetable cultivation systems.

THEORETICAL REVIEW

Role of Nitrogen in Vegetative Growth

Nitrogen is a primary macronutrient essential for plant growth and development. It is a fundamental component of amino acids, proteins, enzymes, nucleic acids, and chlorophyll molecules (Haridamar et al., 2018; Laira et al., 2025). In leafy vegetables such as mustard greens, nitrogen availability directly influences vegetative growth parameters including plant height and leaf number.

Nitrogen enhances chlorophyll formation and increases photosynthetic rate, resulting in higher biomass accumulation (Hidayati et al., 2021). Adequate nitrogen promotes cell division and enlargement, which contribute to stem elongation and leaf expansion. Conversely, nitrogen deficiency causes chlorosis, reduced leaf formation, and stunted growth.

Characteristics of Ultisol Soil

Ultisol soils are characterized by high acidity, high aluminum saturation, and low base saturation (Sharma et al., 2025). These properties reduce nutrient availability and may inhibit root development. Low organic matter content in Ultisol soils also limits cation exchange capacity and nutrient retention (Lin et al., 2023). Without proper management, Ultisol soils have low capacity to support optimal plant growth (Azuka et al., 2024). Therefore, soil fertility improvement strategies are necessary to enhance productivity on this type of land.

Organic Fertilizer and Manure as Soil Amendments

Improvement of Ultisol soil quality requires management strategies focused on increasing soil organic matter and improving chemical properties. Organic materials have been proven to enhance soil structure, increase cation exchange capacity, and improve nutrient balance (Wu et al., 2025). The addition of organic matter can also reduce soil acidity and improve nutrient availability (Sharma et al., 2025). Manure is a functional organic fertilizer that serves both as a nutrient source and soil conditioner. It increases soil organic matter content, improves aggregate structure, and supports root growth and nutrient absorption (Wu et al., 2025). Nutrients contained in manure are gradually released through decomposition and mineralization processes (Li et al., 2025). This slow-release characteristic provides a more stable nutrient supply during the plant growth period (Li et al., 2025). The effectiveness of manure application is influenced by the type of manure used. Different livestock manures have varying physical and chemical characteristics, including nutrient content, particle size, decomposition level, and nutrient release rate (Gyadi et al., 2025). These differences affect nutrient availability in soil and plant growth response (Polii & Raintung, 2022; Bhoki et al., 2021). Therefore, manure type is an important factor in determining the success of organic-based cultivation systems.

METHODOLOGY

Place and Time

This research was conducted in the village Halong, District Baguala, Ambon City. Analysis land and plant conducted at the Soil Laboratory, Faculty of Agriculture, University Pattimura. Research conducted in September to December 2025.

Material and Tools

The materials used in this study were mustard greens of the Prima Tosakan variety, polybags, topsoil of Ultisol soil, chicken, cow, buffalo and other manure fertilizers. goat, furadan 3G and other ingredients support research this, while the tools used in this research These are hoes, hand splitters, scales, boards, nails, meters, plastic ropes, buckets, and other tools that support research.

Method Study

The design used in this research is Design Non-factorial randomized block Design (RAK) with various manure (O) treatments consisting of 5 treatment levels. The treatments are various manures (O) as follows:

O0 : Without giving fertilizer pen
O1 : Top soil: Chicken manure (2:1)
O2 : Top soil: Dirt Buffalo (2:1)
O3 : Top soil: Cow dung (2:1)
O4 : Top soil: Dirt Goat (2:1)

The observation data were analyzed statistically using analysis of variance (ANSIRA), and if the calculated F was greater than the F table, it was continued with the Honest Significant Difference (HSD) Test at the 5% level.

Observation

1. Tall plant (cm)
   Plant height measurements were taken using a tape measure. Plant height observations began after the plants were two weeks old. after planting (MST) and measurements are taken every 1 Sunday once until the plant is 30 days after planting. Measurements are made by examining the plant leaves.
2. Amount leaf (strand)
   Observations on the number of leaves were carried out when the plants were 2 weeks after planting (WAP) and further observations were made 1 week after planting. The method is counting all fully opened leaves on the sample plant.

RESULTS AND DISCUSSION

Tall Plant (cm)

Observation data on plant height after analysis of variance showed that various types of manure significantly affected the height of mustard greens. The average height of mustard greens after further testing using BNJ at the 5% level can be seen in Table 1 below:

Table 1. Average Height of Mustard Greens (cm) with Treatment of Providing Various Types of Manure

Treatment of various manures	Average number of leaves
O0 (Top soil without manure)	23.85 b
O1 (Top soil: Chicken Manure (2:1))	32.98 ab
O2 (Top soil: Buffalo Dung (2:1))	33.89 ab
O3 (Top soil: Cow dung (2:1))	35.45 a
O4 (Top soil: Goat manure (2:1))	28.19 ab
KK = 12.35%	BNJ: 10.73

Notes: Numbers on column Which followed by letter small Which The same is No different real according to BNJ's further test at the 5% level.

Based on Table 1, the treatment of various types of manure on the soil Ultisol showed an increase in the best plant height in the O3 treatment (Top soil: Cow dung (2:1)) namely plant height of 35.45 cm, where O3 is significantly different from O0 (Top soil without manure), although not significantly different from O1 (Top soil: Chicken Manure (2:1), O2 (Top soil: Buffalo Manure (2:1) and O4 (Top soil: Goat Manure (2:1). Meanwhile, the second-best increase in height was shown in the O2 treatment (Top soil: Buffalo Manure (2:1), but not significantly different from the O0 treatment.

Treatment O3 provides the highest growth of mustard greens and If sorted from the highest plant height to the lowest, then the height treatment plants that were given more cow dung big from buffalo dung, buffalo dung is bigger than chicken dung, and dung more chicken big from dirt goat, goat droppings are larger than control.

Plant heights fertilized with cow manure were higher than those of other manures and the control. This is due to the cow manure used in this study. pure without any mixture and particle size finer, whereas buffalo and chicken dung used in this study less pure because it is mixed with a lot with coarse powder. Meanwhile, the goat manure used in this study was still in a round, unpolished form, making it difficult to release nutrients. This is especially true for short-lived plants like mustard greens, as the released nutrients are not fully utilized due to *the slow-release nature of organic fertilizers.*

The nutrient content of manure varies between livestock species, particularly in nitrogen, phosphorus, and potassium, which play a direct role in supporting plant vegetative growth (Lussy et al., 2017). These differences in nutrient composition influence plant growth responses to each type of manure applied (Martinus et al., 2017). The *slow-release nature* of organic fertilizers causes nutrient release to occur gradually, so their availability does not always align with the nutritional needs of short-lived plants such as leafy vegetables (Wu et al., 2025). Plants with short growth cycles have limited time to utilize nutrients that are slowly released from organic matter (da Silva et al., 2024). The availability of macro- and micronutrients is a major factor determining plant growth rates and vegetative biomass formation (Sharma et al., 2025).

In this study, cow manure actually resulted in higher plant height. This was due to two factors: the purity and particle size of the manure, which significantly influence mustard greens growth. This finding aligns with the research of Mao et al. (2025), who reported that long-term application of cow manure can increase vegetable productivity by improving the quality of soil organic matter, functional microbial activity, and more stable nutrient availability for plants. The purity of cow manure plays a crucial role in creating a soil environment that supports more efficient nutrient mineralization, ensuring sustainable nutrient availability for plant vegetative growth. Furthermore, Kumar et al. (2025) explained that the physical characteristics of cow manure-based organic matter, including finer particle size and higher decomposition rates, contribute to improved soil quality and nutrient release efficiency. Smaller fertilizer particle sizes accelerate contact between organic matter and soil microorganisms, thereby accelerating nutrient

release and enhancing the plant's ability to absorb nutrients needed for growth, particularly during the vegetative phase, such as plant height development.

In Ultisol soils, the application of organic fertilizers plays an important role in improving soil physical properties, enhancing soil chemical quality, and increasing nutrient availability for plants through the contribution of organic matter. This is in accordance with the results of research by Wijaya et al. (2025) who reported that the application of organic amendments, either alone or integrated with inorganic fertilizers, can increase the fertility of degraded Ultisol soils by increasing soil organic matter content, improving soil structure, and increasing the availability of essential nutrients for plants. Nasreen et al. (2025) also emphasized that organic matter acts as a nutrient source and soil buffer agent that can improve the chemical properties of acidic soils, increase cation exchange capacity, and stabilize nutrient dynamics in the soil so that they are more easily absorbed by plants. In addition, the results of a meta-analysis by Zhang et al. (2025) showed that the application of carbon-based organic materials, including biochar and other organic amendments, is consistently able to reduce soil acidity, increase nutrient availability, and improve acidic soil conditions, which ultimately supports more optimal plant growth and productivity.

Applying manure to Ultisol soil can improve soil chemical properties by increasing organic matter content and cation exchange capacity. Organic matter from manure can increase soil pH, thereby reducing acidity and decreasing aluminum toxicity (da Silva et al., 2024). Furthermore, manure also contributes macro and micro nutrients needed by plants, especially nitrogen, which plays a crucial role in vegetative growth by increasing nutrient availability and nutrient uptake efficiency by plants (Piash et al., 2025). Physically, manure improves soil structure by increasing soil aggregation and porosity (Uddin et al., 2025). A looser soil structure allows for better root development and increases the soil's ability to retain water (Bhardwaj et al., 2026). Under these conditions, water and nutrient uptake by roots is more optimal (Uddin et al., 2025). In a way biological, addition fertilizer pen increases activity microorganisms land that plays a role in the process of decomposition and mineralization material organic. This process produce element more nutrients easy absorbed by plants. Improvement activity biological land Also support balance ecosystem land so that fertility land increase in a way sustainable (Ortiz-Carmona et al., 2026).

With increasing fertility land ultisol consequence giving fertilizer cage, availability and absorption element Hara become Better (Unagwu et al., 2023; Rusli et al., 2022). Nitrogen is an essential nutrient that plays a vital role in chlorophyll formation, protein synthesis, and plant vegetative growth (Liu et al., 2025). Theoretically, manure with a higher nitrogen content has the potential to provide a greater vegetative growth response because nitrogen plays a direct role in cell division, vegetative tissue formation, and increased plant photosynthetic activity (Liu et al., 2025). Sufficient nitrogen will stimulate division and elongation cells, so that growth stem become increasing. Development optimal roots too support efficiency photosynthesis and formation biomass plants.

Amount Leaf (Strand)

Observation data on the number of leaves after analysis of variance showed that various types of manure had a significant effect on the number of leaves of mustard greens. The average number of leaves of mustard greens after further testing of BNJ at the 5% level can be seen in Table 2. Based on Table 2, the treatment of various types of manure on the soil Ultisol showed an increase in the number of best leaves in the O3 treatment (Top soil: Cow dung (2:1) namely the number of leaves 11.07 cm, where O3 is significantly different from O0 (Top soil without manure), although not significantly different from O1 (Top soil: Chicken Manure (2:1), O2 (Top soil: Buffalo Manure (2:1) and O4 (Top soil: Goat Manure (2:1). Meanwhile, the second-best increase in height was shown in the O2 treatment (Top soil: Buffalo Manure (2:1), but not significantly different from the O0 treatment.

Table 2. Average amount leaf (strand) with treatment giving various type fertilizer pen

Treatment of various manures	Average number of leaves
O0 (Top soil without manure)	10.01 b
O1 (Top soil: Chicken Manure (2:1))	10.25 ab
O2 (Top soil: Buffalo Dung (2:1))	10.33 ab
O3 (Top soil: Cow dung (2:1))	11.07 a
O4 (Top soil: Goat manure (2:1))	9.81 b
KK = 4.50%	BNJ: 1.32

Description: The numbers in the rows and columns that follow by the same lowercase letter is no different real according to BNJ's further test at 5% level.

O3 treatment (Top soil: Cow dung (2:1)) had an effect The O3 treatment had the best effect on leaf number parameters. This occurred because the O3 treatment had a high availability of nutrients such as nitrogen and others, which mustard plants require for their growth. The application of manure is closely related to increased fertility in Ultisol soils, which in turn affects the increase in plant leaf number (Umoh et al., 2023). Ultisol soils generally have high acidity levels, low organic matter content, low cation exchange capacity (CEC), and limited availability of macronutrients such as nitrogen (N), phosphorus (P), and potassium (K). These conditions result in suboptimal plant vegetative growth, including leaf formation and development (Ebido & Umeugokwe, 2026).

The addition of manure to Ultisol soil increases the soil's organic matter content. This organic matter plays a role in improving soil chemical properties by increasing soil pH, thereby reducing acidity and decreasing aluminum (Al) toxicity (Lauricella et al., 2020). Furthermore, manure also contributes essential nutrients, particularly nitrogen, which plays a crucial role in chlorophyll formation and the growth of vegetative tissue, including leaves (Ahmad et al., 2025). Physically, manure improves soil structure, making it looser and more porous, allowing plant roots to develop better (Bashir et al., 2021). An optimally developed root system enhances the plant's ability to absorb water and nutrients

(Nasreen et al., 2025). More efficient nutrient absorption supports photosynthesis and new tissue formation, including leaf growth (Lin et al., 2024). Biologically, the organic matter in manure increases the activity of soil microorganisms, which aid in the decomposition and mineralization of nutrients. This process produces nutrients in a form that is more readily available to plants, so that the nutritional needs for leaf formation can be met sustainably (Sharma et al., 2025).

Increased growth is due to increased metabolic processes, the primary of which is increased photosynthesis due to the high availability of nitrogen. Physiologically, plant growth occurs through cell division and cell enlargement, which contribute to increased biomass, leaf area, and vegetative tissue development. Plant growth is also influenced by the availability of nutrients, water, light intensity, and environmental conditions that support plant metabolic activity (Sharma et al., 2025).

Nutrients contained in manure, especially nitrogen, are absorbed by the roots and translocated to plant tissues to support the process of vegetative tissue formation (Liu et al., 2025). Nitrogen plays a role in accelerating cell division and enlargement so that young leaves develop more quickly and achieve a perfect morphological form (Liu et al., 2025). This process contributes directly to the increase in the number of mustard green leaves (Wu et al., 2025). The relatively low number of leaves in the O0 and O4 treatments indicates limited availability of nutrients that can be utilized by plants during the growth phase (Sharma et al., 2025). Treatments without manure cause the soil to be unable to provide optimal macro and micro nutrients for mustard green growth (Sharma et al., 2025). Meanwhile, goat manure that has not been optimally decomposed causes the release of nutrients to be slow, so it cannot meet the nutritional needs of plants during the vegetative growth period (Wu et al., 2025).

The increased fertility of Ultisol soil due to the application of manure improves the availability of nitrogen and other nutrients. Adequate nitrogen stimulates cell division and differentiation at the growing point, resulting in increased new leaf formation. Therefore, the application of manure positively influences leaf increase by creating more fertile soil conditions and supporting optimal vegetative plant growth.

CONCLUSIONS AND RECOMMENDATIONS

Based on the research results, it can be concluded that manure application significantly affected plant height, number of leaves, and fresh weight of mustard greens (*Brassica juncea* L.) grown on Ultisol soil. The results indicate that organic fertilization plays an important role in improving vegetative growth performance under marginal soil conditions. Among the treatments tested, the O3 treatment (Top soil: Cow Manure = 2:1) showed the best results in increasing plant height and leaf number. This finding suggests that the appropriate proportion of cow manure can improve nutrient availability and enhance soil physical properties, thereby supporting optimal vegetative growth. The improvement in growth parameters demonstrates that manure application contributes to increased nitrogen availability and better soil fertility conditions in Ultisol soil. Therefore,

organic fertilization using cow manure can be considered an effective strategy to improve mustard productivity cultivated on acidic and low-organic-matter soils.

Recommendations

Based on the findings of this study, the use of cow manure with a topsoil ratio of 2:1 (O3 treatment) is recommended for cultivating mustard greens on Ultisol soil to improve vegetative growth performance. For farmers managing Ultisol land, the incorporation of organic fertilizers is suggested as a sustainable soil fertility management strategy to enhance nutrient availability, improve soil structure, and increase crop productivity. Further research is recommended to evaluate the long-term effects of different manure types on soil chemical properties and nutrient dynamics, as well as to assess their impact on yield quality and economic feasibility under field-scale conditions. Additionally, future studies may investigate combinations of organic and inorganic fertilizers to determine integrated nutrient management strategies that optimize productivity while maintaining soil sustainability.

FURTHER STUDY

Further research is recommended to explore the combined application of various types of animal manure with inorganic fertilizers to determine their interactive effects on the growth and yield of mustard (Brassica juncea L.) cultivated on Ultisol soils. Future studies should also investigate a wider range of application rates and timing to identify the most efficient and sustainable fertilization practices. In addition, it is important to include more comprehensive parameters such as soil nutrient dynamics, microbial activity, and crop quality attributes to provide deeper insights. Expanding the research across different soil types and agroclimatic conditions is also suggested to enhance the generalizability and practical applicability of the findings.

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