

# Effect of organic fertilizer types and dosage on yield and nutrient uptake of red ginger in an Alfisol

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**Abstract.** Setyaningrum D, Suhita CP, Paryanto E, Ningsih H, Arifin Z, Suryadi D, Suprihatin DN, Nurhidayati F, Pradana AGR, Hantari D. 2025. Effect of organic fertilizer types and dosage on yield and nutrient uptake of red ginger in an Alfisol. *Asian J Agric* 9: 636-644. Declining red ginger production in Indonesia, partly due to reduced optimal land availability, has prompted the use of suboptimal soils, such as Alfisols are known to be fertile soils with relatively high concentrations of essential nutrients. This study evaluated the effects of animal manure type (cow, goat, and chicken) and application dosage (0, 10, 20, and 30 tons.ha<sup>-1</sup>) on yield performance and nitrogen (N), phosphorus (P), and potassium (K) uptake of red ginger (*Zingiber officinale* var. *rubrum*) in Alfisol. A randomized complete block design with a split-plot arrangement was applied. Results showed that both manure type and dosage significantly influenced yield and nutrient uptake. Goat manure at 30 tons.ha<sup>-1</sup> produced the highest fresh weight, biomass, rhizome weight, and N and P uptake. Rhizome weight and volume were positively correlated with N and P uptake, indicating that improved nutrient absorption efficiency contributed to yield enhancement. Increasing manure dosage consistently elevated biomass, rhizome volume, and K uptake, with optimal results at 30 tons.ha<sup>-1</sup>. These findings demonstrate that organic fertilization, particularly with goat manure at 30 tons.ha<sup>-1</sup>, is an effective strategy to boost red ginger productivity and nutrient use efficiency on marginal Alfisol soil. The approach supports sustainable cultivation and could help meet increasing market demand, although long-term impacts on soil health require further investigation.

**Keywords:** Alfisol, manure management, red ginger yield, soil fertility, sustainable agriculture

## INTRODUCTION

Red ginger, a herbal medicine and spice, contains phenolics such as gingerol, shogaol, and paradol, which have antioxidant, anti-inflammatory, antimicrobial, and anticancer activities (Marwan et al. 2023; Nugraha et al. 2025). This potential increases demand for red ginger in Indonesia annually (Nisa' et al. 2023). According to the Indonesian Central Bureau of Statistics, the average weekly consumption of red ginger reaches 2,756 (BPS 2024a). One province in Indonesia, East Java, reported annual household consumption of red ginger in 2021 of 302,088 tons. High demand for red ginger must be balanced by high production. However, red ginger production in Indonesia fluctuates, reaching 307,240 tons in 2021 and declining annually, reaching only 198,870 tons in 2023. One of the causes of the decline in red ginger production is the reduction in the area of red ginger cultivation in Indonesia. The area of red ginger cultivation in 2022 reached 10,409.3877 ha, decreasing every year, namely in 2023 it was 8,343.2551 ha and in 2024 it was only 7,492.2114 ha (BPS 2024b). This decrease in land area is caused by the low availability of agricultural land, which is only 187,938.7 thousand hectares due to high land conversion (Gandharum et al. 2024). A substantial 78.2% of this farm land area, with an area of 108,775,830 ha, is suboptimal, consisting of dry, acidic soils, including Alfisols

(Khumairah et al. 2025). The availability of Alfisol land is quite high and has not been optimally utilized so that it can be used for red ginger cultivation.

In Indonesia, there is a lot of Alfisol soil with high acidity characteristics (Li et al. 2022; Setyaningrum et al. 2025a, b). The interaction between soil minerals and organic carbon components is low, so Alfisol lack soil binding agents, resulting in poor aggregate stability (Chen et al. 2025). Furthermore, these soils have a high density of organic matter, low pore aeration, and low water-holding capacity, thus limiting root penetration (Maro'ah et al. 2025). The sustainable management of Alfisol soils necessitates the application of organic fertilizers, such as manure (Pan et al. 2025; Shifa et al. 2025) since various fertilizer types influence the soil's physical, chemical, and biological characteristics differently (Li et al. 2024; Culas et al. 2025). In contrast, prolonged use of chemical fertilizers may lead to decreased soil fertility and the depletion of organic carbon reserves (Liang et al. 2021). Fertilization with animal manure can increase the abundance of oligotrophic bacterial taxa associated with carbon metabolism and net soil C acquisition in Alfisol soil (Mao et al. 2024). Animal manure can have a greater impact on the metabolic activity of soil carbon sources than chemical fertilizers (Hu et al. 2022). Animal manure can increase the abundance and change the community composition of denitrifying bacteria related to N<sub>2</sub>O

emissions in the soil because it can increase soil nutrients and organic matter and change soil pH values (Zheng et al. 2024). Animal manure improves soil quality indices better than organic plant fertilizers (Liu et al. 2025). Several previous studies used fertilization strategies with organic animal manure to enhance soil quality, supporting plant growth and yield. Recent research shows that cow manure can improve soil quality, reduce nutrient loss, and increase plant height, leaf number, and yield (Pradhan et al. 2025). This is supported by increased soil phosphorus availability after cow manure application, resulting in plant growth rates, net photosynthesis rates, and optimal yields (Ali and Ali 2025). Chicken manure can reduce soil bulk density and increase porosity, water content, and chemical properties, increasing crop yield and seed mineral composition at a dose of 15 tons.ha<sup>-1</sup> (Agbede 2025).

Red ginger cultivation requires cultivation strategies such as fertilization because the enlarged root system, reduced palisade and spongy parenchyma, and thickened fibrous root cortex collectively cause low red ginger rhizome productivity (Zhao et al. 2025). Fertilization strategies in red ginger cultivation have been carried out with a combination of 10 tons.ha<sup>-1</sup> of rice husk biochar and 250 kg ha<sup>-1</sup> of chemical fertilizers, which showed high plant height, tiller formation, and fresh rhizome weight (Masulili et al. 2025). Goat manure fertilizer can increase the fresh weight of red ginger rhizomes in agroforestry systems (Setyaningrum et al. 2024, 2025a, b). Combining bokashi planting media, rice husk charcoal, and coconut fiber, with 4.5 cc.l<sup>-1</sup> liquid organic fertilizer, resulted in shoot growth and high fresh rhizome weight per plant and biomass. A dose of 2 kg/m<sup>2</sup> of cow manure fertilizer can increase the growth and yield of red ginger (Supriyono et al. 2021). Research by Setyaningrum et al. (2024) on the types of local organic fertilizers on the absorption of nitrogen, phosphate, and potassium nutrients in red ginger in an agroforestry system. Meanwhile, research by Azizah et al. (2022) on the optimal dose of potassium for absorption efficiency and antioxidant quality. Comparative studies on the types and doses of organic fertilizer for red ginger on Alfisol soil are still lacking. The novelty of this study lies in comparing the type and dose of organic animal manure fertilizer on the yield and absorption of nitrogen, phosphate, and potassium in red ginger in Alfisol soil. The study aims to examine the role and dose of organic animal manure fertilizer on the yield and absorption of nitrogen, phosphate, and potassium in red ginger in Alfisol soil.

## MATERIALS AND METHODS

### Study area

The research was conducted in the Field Laboratory of the Faculty of Agriculture, Universitas Sebelas Maret, located in Sukosari Village, Jumantono District, Karanganyar District, Central Java, Indonesia, with coordinates 07°38.070' South Latitude and 110°56.851" East Longitude, and an altitude of 176 meters above sea level. The research location has an average temperature and humidity of 31.14-32.38°C and 71.4-76.28% at noon.

Average rainfall at the research site is 142 mm per month. Animal manures and initial soil analysis were conducted at the Soil Chemistry Laboratory, Faculty of Agriculture, Universitas Sebelas Maret. Soil pH analysis was carried out using the potentiometric method using a pH meter, nitrogen analysis using the Kjeldahl method, phosphorus analysis using the Bray method, potassium analysis using ammonium acetate extraction, and organic matter analysis using the Walkley-Black method. The soil type in the research area is Alfisol with a soil pH of 6.1 (low); total nitrogen 0.373% (moderate); total phosphorus 0.242% (very low); total potassium 0.030% (very low); and organic carbon 0.463 ppm (very low).

### Research design

The study used a randomized completely block design with a split plot pattern to manage land diversity, with organic fertilizer as the type of fertilizer in the main plot and organic fertilizer dosage as the subplot. The fertilizer consists of four levels: without fertilizer, cow manure, goat manure, and chicken manure. The dosage of organic fertilizer consists of three levels, namely 10, 20, and 30 tons.ha<sup>-1</sup>. Replication was carried out three times. Soil organic carbon and fertilizer analysis using the ashing method. Total soil nitrogen analysis using the Kjeldahl method. Phosphorus analysis using the Olsen method and potassium analysis using the 25% HCl extraction method. Cow manure fertilizer contains 32.13% organic carbon, 0.96% total nitrogen, 1.02% total phosphorus, and 11.49% organic potassium. Goat manure fertilizer contains 52.58% organic carbon, 2.23% total nitrogen, 1.67% total phosphorus, and 1.56% total potassium. Chicken manure fertilizer contains 42.58% organic carbon, 2.18% total nitrogen, 1.04% total phosphorus, and 1.38% total potassium. The planting distance of red ginger is 50×40 cm, and there was a population of 20 plants per treatment. The materials used in this study were red ginger rhizomes of the Jahira I variety, cow manure fertilizer, chicken manure fertilizer, goat manure fertilizer, fungicides, and plant tissue analysis materials. The research contained a population of 40 plants for each treatment with a treatment plot size of 8 m<sup>2</sup> with a plot length of 1.6 meters and a width of 3.5 meters. Fertilization was carried out before planting, eight weeks after planting and sixteen weeks after planting.

Observation variables included yield and nutrient uptake of nitrogen, phosphate, and potassium. Yield variables were observed at twenty-eight weeks after planting: rhizome weight, fresh weight, plant biomass, rhizome volume, and thickness. Rhizome volume was observed using the Displacement Method. Plant tissue analysis was carried out at the maximum vegetative phase, sixteen weeks after planting. Tissue nitrogen analysis used the Kjeldahl method by carrying out destruction, distillation, and titration of the tissue solution (Sjölund et al. 2025). Tissue phosphorus analysis used a spectrophotometric tool with the P-Bray method (Kaur et al. 2024). Potassium analysis used the ammonium acetate extraction method and flame photometry (Suriyagoda et al. 2024). Nutrient uptake to evaluate the plant's ability to

absorb nitrogen from the environment was calculated by multiplying biomass by the plant tissue's nutrient content divided by one hundred.

### Data analysis

Data analysis was performed using Statistical Product and Service Solutions version 21 with Analysis of Variance at the 5%. If significant, further testing was performed using Duncan's Multiple Range Test at the 5% level. Relationships between variables were analyzed using Pearson correlation analysis.

## RESULTS AND DISCUSSION

### Red ginger yield

The type and dosage of animal manure affected the fresh weight of red ginger plants (Figure 1). Goat manure produced the highest fresh weight of red ginger plants, at 227.41 g plant<sup>-1</sup>, significantly different from cow and chicken manure. This is because goat manure application increases soil pH and organic matter (Katakula et al. 2021). The pH of Alfisol soils determines the rate of cation exchange and nutrient retention, so increasing pH can increase nutrient availability and soil cation exchange capacity. This facilitates increased absorption of essential elements by plants (Budistuti et al. 2023). Organic matter in goat manure acts as a bacterial inoculum and stimulates soil microbial activity for mineralization and nutrient cycling (Verma et al. 2024). Increased microbial activity accelerates the breakdown of complex organic compounds into forms available to plants. Soil with a manure dose of 30 tons.ha<sup>-1</sup> showed the highest results and significantly differed from 10 and 20 tons.ha<sup>-1</sup>. Applying a dose of 20 tons.ha<sup>-1</sup> has increased the fresh weight of red ginger plants by 64.3% compared to a dose of 0 tons.ha<sup>-1</sup> and 13.61% compared to a dose of 10 tons.ha<sup>-1</sup>. These results are due to an increase in the supply of nutrients such as N, P, and K and soil organic matter supported by the characteristics of organic fertilizer. The dose of organic fertilizer can increase soil pH, organic carbon, and organic nitrogen, thereby increasing the diversity and activity of microorganisms (Louati et al. 2025). Improved soil properties facilitate root development and nutrient absorption, so plants efficiently receive nutrients to support cell division and plant growth. The results of this study by Kumar et al. (2025) show that higher doses of organic fertilizer can improve plant growth and yield attributes because they improve the physical and chemical properties of the soil. The application of manure can increase the content of organic matter, total nitrogen, hydrolyzable nitrogen, available phosphorus, and available potassium in the 0-40 cm soil layer, increase the number of bacteria, fungi, and actinomyces, thereby encouraging growth and increasing plant yields (Zhao et al. 2025).

The type and dosage of manure affect the biomass of red ginger plants (Figure 2). Goat and chicken manure at a dose of 30 tons.ha<sup>-1</sup> showed high biomass and was not significantly different. Goat manure fertilizer at a dose of 10 tons.ha<sup>-1</sup> was not significantly different from doses of 20

and 30 tons.ha<sup>-1</sup> and was able to increase biomass by 30% compared to a dose of 0 tons.ha<sup>-1</sup>. This is because the organic material in goat manure is high in carbon, so it improves soil structure and water retention capacity, thereby increasing the efficiency of nutrient absorption. Organic fertilizer can increase the proportion of aggregates >0.25 mm, soil organic carbon, soil microbial biomass carbon and nitrogen, and soil enzyme activity (Yang et al. 2022). This encourages an increase in fresh weight and plant biomass by 75-138% (Kominko et al. 2022). Goat manure and chicken manure fertilizers contain high nitrogen at 2.23% and 2.18%, respectively. The high nitrogen content in goat and chicken manure modulates leaf photosynthesis by allocation to Rubisco, an electron transport protein, and a key enzyme of the Calvin cycle (Kang et al. 2023). Total plant biomass increased by 21.05% and 16.85% with nitrogen fertilizer application (Li et al. 2025). This is due to the role of nitrogen in influencing plant biomass distribution and photosynthetic activity (Mu and Chen 2021). Red ginger plant biomass increased with increasing doses of organic fertilizer (Figure 2). This is supported by the high nitrogen and potassium content of the animal manures, which play a role in stomatal conduction, affecting water use and nutrient absorption. High nutrient absorption encourages sugar assimilation in leaves and rhizomes by regulating enzyme expression (Xiao et al. 2024). The application of manure with high nitrogen content can increase the abundance of genes in the carbon, nitrogen, phosphorus, and organic acid cycles of root exudates (Liao et al. 2024). This encourages microbial activity that contributes to the production of extracellular enzymes that mediate the decomposition of organic matter, releasing nutrients in a form accessible to plants (Le et al. 2025), improving soil structure and thus enhancing root growth (Qi et al. 2025). Plant nitrogen content has important implications for improving plant growth by influencing photosynthesis and sugar transport (Wu et al. 2024).

The combination of organic fertilizer types and doses affected the weight of red ginger rhizomes (Table 1). Chicken manure and goat manure at 30 tons.ha<sup>-1</sup> doses showed high rhizome weights of 168.17 and 132.06 g plant<sup>-1</sup>, respectively. Application of goat manure at a dose of 10 tons.ha<sup>-1</sup> increased rhizome weight by 43% compared to a dose of 0 tons.ha<sup>-1</sup>. This was supported by the high organic carbon content of 42.08% (Erdogdu et al. 2019). Organic carbon, as a highly available carbonaceous organic material, can encourage the activity, composition, and diversity of soil microorganisms to increase plant nutrient availability (Zhang et al. 2025). In addition, goat manure's high organic carbon content can increase the cation exchange capacity and water holding capacity of the soil, thereby supporting root absorption activity (Rana and Roy 2024). Water retention can encourage hormones that stimulate root development and the expansion of red ginger root hairs (Zaghloul et al. 2024). Organic carbon contributes to humus formation, increasing soil aggregation and porosity, resulting in a more stable and prolonged water supply to the root zone to develop and expand red ginger rhizomes. Cell expansion and nutrient uptake in red

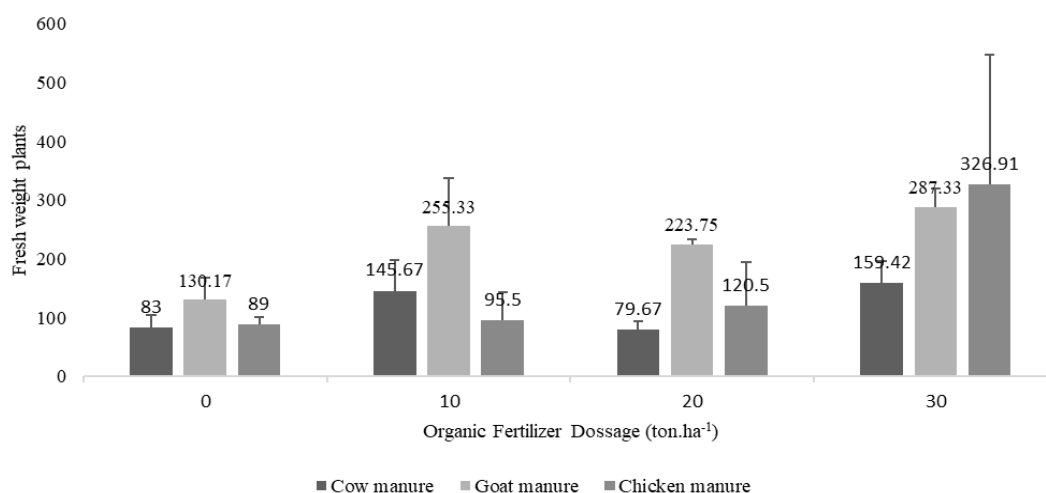
ginger depend on moisture, so water availability facilitates nutrient transport and metabolic processes. High organic carbon increases cation exchange capacity, thus promoting nutrient accessibility to plants, supporting rhizome growth (Haruna et al. 2020; Alwitwat 2022). Rhizome weight positively correlates with red ginger's nitrogen and phosphate uptake (Table 4). These results are consistent with Sarathambal et al. (2024), who found that red ginger

rhizome weight is positively correlated with plant growth and nutrient uptake, which is influenced by organic nutrients. Applying organic fertilizer with high organic carbon content can stimulate soil biological activity by increasing microbial populations and activities, thereby accelerating nutrient cycling and the transformation of organic substrates into forms easily accessible to plants.

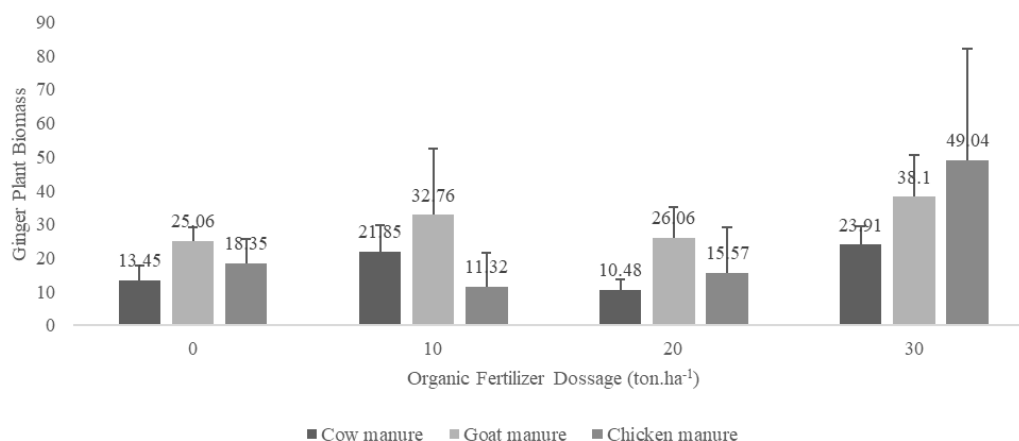
**Table 1.** Effect of type and dose of organic fertilizer on the weight of red ginger rhizome (g plant<sup>-1</sup>)

Types of fertilizer	Organic fertilizer dosage (ton.ha <sup>-1</sup> )				Average
	0	10	20	30	
Cow manure	38.25±7.23 a	55.91±18.47 ab	33.25±7.80 a	65.75±13.18 ab	48.29 a
Goat manure	65.50±11.23ab	94.08±51.86 bc	165.37±18.91 d	168.17±26.46 d	122.91 c
Chicken manure	50.58±18.06 ab	56.49±4.59 ab	58.98±16.36 ab	132.06±60.29 cd	74.53 b
Average	51.44 a	68.83 ab	85.38 b	121.99 c	+

Note: Numbers followed by the same letter indicate no significant difference based on the 5% DMRT. Values followed by ± indicate standard deviation. +: Interaction



**Figure 1.** Effect of type and dose of organic fertilizer on fresh weight of red ginger plants (g plant<sup>-1</sup>)



**Figure 2.** Effect of type and dose of organic fertilizer on red ginger plant biomass (g plant<sup>-1</sup>)

The combination of type and dose affected the volume of red ginger rhizomes (Table 2). The highest rhizome volume was achieved with chicken manure at a dose of 30 tons.ha<sup>-1</sup>, at 139.50 cm<sup>3</sup>, and was not significantly different from that with goat manure at a dose of 30 tons.ha<sup>-1</sup>. These results are supported by the higher organic carbon and organic matter content in chicken and goat manure than in cow manure. Organic matter increases soil porosity and aggregate stability, resulting in high water retention capacity, facilitating nutrient absorption and biomass production (Li et al. 2025). High organic matter content can improve the soil's physical structure by increasing water retention, thus maintaining root zone moisture and facilitating deeper root penetration and expansion. This encourages plant nutrient absorption, resulting in red ginger rhizome development. In addition, organic matter can stimulate microbial activity, accelerating nutrient mineralization, thereby increasing nutrient absorption and correlating with increased red ginger biomass and rhizome development.

### Red ginger nutrient uptake

The combination of goat manure at a dose of 30 tons.ha<sup>-1</sup> showed the highest nitrogen uptake at 121.97%, and was not significantly different from the 20 tons.ha<sup>-1</sup> dose. Goat manure at a dose of 10 tons/ha could not increase red ginger nitrogen uptake in Alfisol soil (Table 3). Nitrogen uptake in the combination of chicken manure at 30 tons.ha<sup>-1</sup> was not significantly different from that in the 20 and 30 tons.ha<sup>-1</sup> doses of goat manure. Nitrogen uptake at doses of 10 and 20 tons.ha<sup>-1</sup> of chicken manure was not significantly different from that at a dose of 0 tons.ha<sup>-1</sup>. This is because the rate of decomposition and nutrient release from organic fertilizer depends on the quality and quantity of the organic fertilizer. The results of this study are consistent with Li et al. (2024), that goat manure can increase water retention by 4.2%, promoting plant nitrogen uptake. This is because organic fertilizers can change alkaline hydrolyzed nitrogen content, phosphorus, potassium, and soil water content in

various layers, affecting nitrogen absorption (Hou et al. 2025). Furthermore, organic fertilizers can reduce soil acidity and increase the soil's carbon sequestration capacity, encouraging plant nutrient uptake (Gu et al. 2025). Nitrogen uptake is correlated with red ginger plant biomass. This is because increased nitrogen uptake encourages photosynthetic capacity, plant biomass accumulation, and leaf area index (Zhai et al. 2024).

Fertilizer dosage affects phosphorus absorption in red ginger (Figure 3). Application of higher doses of organic fertilizer encourages increased phosphorus nutrient absorption. Goat manure fertilizer with a dose of 30 tons.ha<sup>-1</sup> showed the highest phosphorus absorption of 9.96 and was not significantly different from goat manure fertilizer with a dose of 20 tons.ha<sup>-1</sup>. Goat manure fertilizer with a dose of 20 tons.ha<sup>-1</sup> can increase phosphorus absorption by 5.88% compared to a dose of 0 tons/ha. Organic fertilizer can increase pH and cation exchange capacity to mobilize phosphorus (Li et al. 2019; Nobile et al. 2020). Goat manure fertilizer contains higher nitrogen and phosphorus than chicken and cow manure fertilizers (Washaya and Washaya 2023). Goat manure fertilizer has a low C:N, contributing to nutrient mineralization. Furthermore, goat manure contains high levels of organic matter, providing sufficient N, P, and K for most plants (Purnomo et al. 2022). Research by Ndung et al. (2021) indicates that applying goat manure, with its high organic carbon and total nitrogen content, increases microbial enzymatic activity, increasing crop yields by 85-142%. Application of goat and chicken manure can increase soil calcium, magnesium, and phosphorus (Mbatha et al. 2021). A dose of 10 tons/ha did not show a significantly different phosphorus uptake by red ginger plants compared to a dose of 0 tons.ha<sup>-1</sup>. This may be because nutrient release and absorption depend on the type and dose of organic fertilizer (Azwardi et al. 2021; Soliaman et al. 2022). Phosphorus availability in Alfisol soils is low, so applying low-nutrient organic fertilizers does not address soil phosphorus limitations (Joseph et al. 2021; Blankson et al. 2025).

**Table 2.** Effect of type and dose of organic fertilizer on the volume of red ginger rhizome (cm<sup>3</sup>)

Types of fertilizer	Organic fertilizer dosage (ton.ha <sup>-1</sup> )				Average
	0	10	20	30	
Cow manure	38.75±8.75 a	66.25±8.75 ab	50.48±6.72 a	67.50±15.20 ab	55.74 a
Goat manure	68.42±11.86 ab	111.67±30.88 bc	76.86±4.44 ab	111.67±37.96bc	75.47 b
Chicken manure	51.25±18.02 a	47.83±12.78 a	63.33±19.13 ab	139.50±60.40 c	91.06 b
Average	52.80 a	75.25 b	62.10 ab	106.22 c	+

Note: Numbers followed by the same letter indicate no significant difference based on the 5% DMRT. Values followed by ± indicate standard deviation. +: Interaction

**Table 3.** Effect of type and dose of organic fertilizer on nitrogen absorption of red ginger (g plant<sup>-1</sup>)

Types of fertilizer	Organic fertilizer dosage (ton.ha <sup>-1</sup> )				Average
	0	10	20	30	
Cow manure	50.95±26.63 a	71.08±29.61 ab	52.47±20.47 a	54.52±18.13 a	57.25 a
Goat manure	59.61±10.55 ab	88.79±35.73 abc	98.29±15.97 abc	144.79±50.70 c	97.47 b
Chicken manure	38.60±16.94 a	56.43±14.47 ab	121.97±79.44 bc	56.61±13.03ab	68.40 a
Average	49.72 a	72.10 ab	90.38 b	85.31 b	+

Note: Numbers followed by the same letter indicate no significant difference based on the 5% DMRT. Values followed by ± indicate standard deviation. +: Interaction

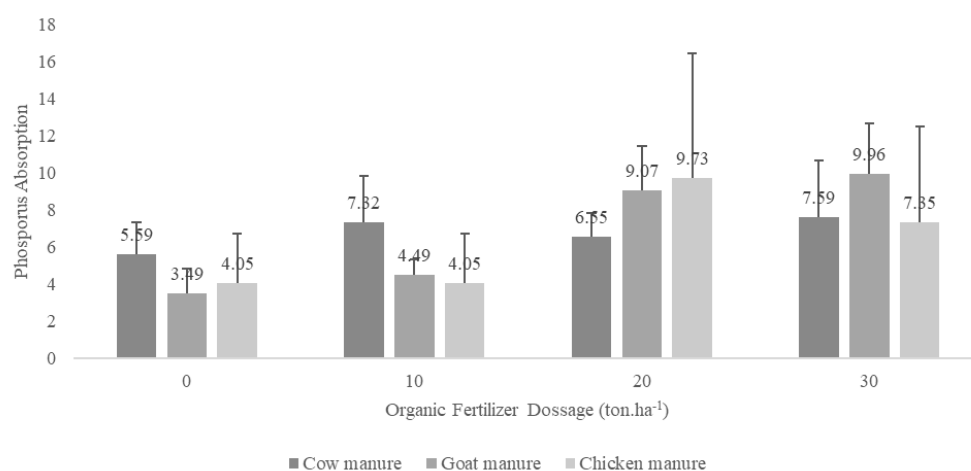
Organic fertilizer dosage affects potassium uptake (Figure 4). A 30 tons.ha<sup>-1</sup> dosage showed the highest potassium uptake of 221.67 g plant<sup>-1</sup> and was not significantly different from a dosage of 20 tons.ha<sup>-1</sup>. A dosage of 10 tons.ha<sup>-1</sup> increased potassium uptake by 100% compared to a 0 tons/ha dosage. This indicates that organic fertilizers' organic matter and organic carbon content play a role in modulating soil nutrient dynamics, thereby encouraging plant nutrient uptake (Friedel and Ardakani 2021). Goat and chicken manure contain high levels of

organic matter and organic carbon, thus increasing the organic carbon of Alfisol soil with low soil fertility. In addition, organic carbon in animal manure can increase soil aggregation, water retention, and cation exchange capacity, and stimulate microbial communities responsible for nutrient mineralization (Wang et al. 2022). Increasing soil organic carbon encourages converting complex organic matter into mineral nutrients, including potassium, thereby increasing plant availability (Dhaliwal et al. 2024).

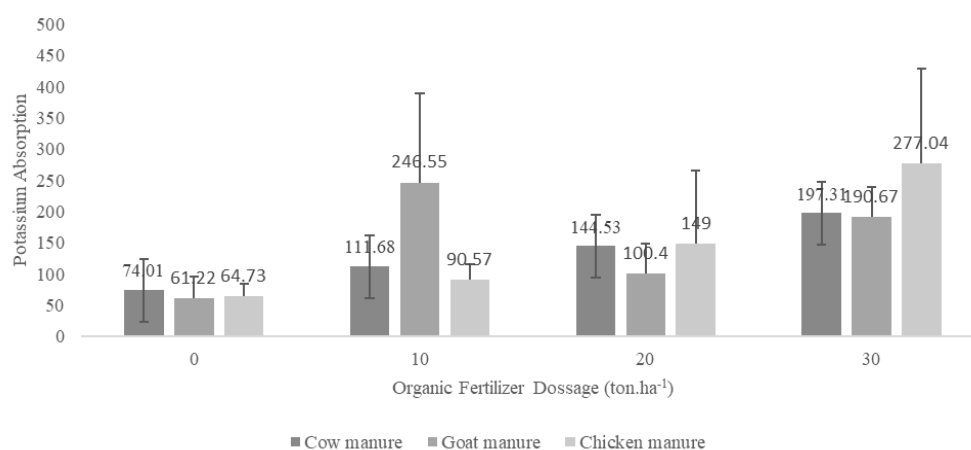
**Table 4.** Correlation between yield and nutrient uptake of red ginger

	Fresh plant weight	Plant biomass	Rhizome weight	Rhizome volume	Nitrogen uptake	Phosphorus uptake	Potassium uptake
Fresh plant weight	1	0.912**	0.827**	0.892**	0.457**	0.421*	0.239
Plant biomass	0.912**	1	0.739**	0.907**	0.408*	0.440**	0.229
Rhizome weight	0.827**	0.739**	1	0.719**	0.519**	0.414*	0.301
Rhizome volume	0.892**	0.907**	0.719**	1	0.390*	0.358*	0.442**
Nitrogen uptake	0.457**	0.408*	0.519**	0.390*	1	0.553**	0.160
Phosphorus uptake	0.421*	0.440**	0.414*	0.358*	0.553**	1	0.090
Potassium uptake	0.239	0.229	0.301	0.442**	0.160	0.090	1

Note: \*\*: Correlation is significant at the 0.01 level (2-tailed), \*: Correlation is significant at the 0.05 level (2-tailed)



**Figure 3.** Effect of type and dose of organic fertilizer on phosphorus absorption of red ginger (g plant<sup>-1</sup>)



**Figure 4.** Effect of type and dose of organic fertilizer on potassium absorption of red ginger (g plant<sup>-1</sup>)

In conclusion, the type and dosage of organic fertilizer affect red ginger's yield and nutrient uptake in Alfisol. Animal manure at a dosage of 30 tons.ha<sup>-1</sup> produced the highest fresh weight, biomass, rhizome weight, and nitrogen and phosphate uptake. Rhizome weight and volume were positively correlated with nitrogen and phosphorus uptake, indicating a link between increased yield and nutrient uptake efficiency. Higher fertilizer dosages increased biomass, rhizome volume, and potassium uptake, with the best results achieved at 30 tons.ha<sup>-1</sup>. This strategy supports sustainable cultivation in marginal lands, though long-term effects on soil health warrant further study.

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