

Effect of Cattle Manure Fertilization on N, P, and K Uptake of Red Chili (*Capsicum annuum* L.) Grown in Alluvial Soil

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ABSTRACT

Cabai merah (*Capsicum annuum* L.) termasuk dalam famili Solanaceae dan dapat dibudidayakan baik di dataran rendah maupun di dataran tinggi. Kalimantan Barat memiliki potensi besar untuk produksi cabai pada tanah aluvial. Penelitian ini bertujuan untuk mengevaluasi pengaruh pemberian pupuk kandang sapi terhadap serapan hara (N, P, K) dan hasil tanaman cabai merah. Penelitian dilakukan di Pontianak, Kalimantan Barat, dengan menggunakan Rancangan Acak Lengkap (RAL) non-faktorial yang terdiri atas lima perlakuan dan lima ulangan, sehingga diperoleh 25 unit percobaan. Perlakuan terdiri dari P0 (kontrol), P1 (30 ton/ha), P2 (60 ton/ha), P3 (90 ton/ha), dan P4 (120 ton/ha). Hasil penelitian menunjukkan bahwa perlakuan terbaik adalah P3 (90 ton/ha), yang meningkatkan bobot kering sebesar 10,29%, serapan N sebesar 21,42%, serapan P sebesar 16,66%, dan serapan K sebesar 17,61%. Temuan ini menunjukkan bahwa aplikasi pupuk kandang sapi pada dosis 90 ton/ha secara signifikan meningkatkan serapan hara dan pertumbuhan cabai merah pada tanah aluvial.

Keyword: Cabai merah; *Capsicum annuum* L.; pupuk kandang sapi; serapan hara; tanah aluvial; NPK

ABSTRAK

Red chili (*Capsicum annuum* L.) belongs to the Solanaceae family and can be cultivated in both lowland and highland areas. West Kalimantan has great potential for chili production on alluvial soils. This study aimed to evaluate the effect of cattle manure application on nutrient (N, P, K) uptake and yield of red chili. The experiment was conducted in Pontianak, West Kalimantan, using a Completely Randomized Design (CRD) with five treatments and five replications, resulting in 25 experimental units. Treatments consisted of P0 (control), P1 (30 tons/ha), P2 (60 tons/ha), P3 (90 tons/ha), and P4 (120 tons/ha). Results indicated that P3 (90 tons/ha) was the most effective treatment, increasing dry weight by 10.29%, N uptake by 21.42%, P uptake by 16.66%, and K uptake by 17.61%. These findings suggest that cattle manure application at 90 tons/ha significantly enhances nutrient uptake and growth of red chili in alluvial soils.

Keyword: Red chili; *Capsicum annuum* L.; cattle manure; nutrient uptake; alluvial soil; NPK



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1. Introduction

Alluvial soils in Indonesia have considerable potential for agricultural development. In West Kalimantan, alluvial soils cover approximately 1.79 million hectares, accounting for about 24.42% of the province's total land area (Setiawan, 2025).

However, the productivity of red chili (*Capsicum annuum* L.) in Indonesia remains relatively low. Contributing factors include the use of low-quality seeds, inefficient cultivation techniques, and the cultivation of chili cultivars that are susceptible to pests and diseases (Aldi et al., 2008).

In 2017, the Department of Agriculture of West Kalimantan reported a production of 1,665 tons of large red chili and 4,719 tons of bird's eye chili, with a total harvested area reaching approximately 1,000 hectares. This data underscores the considerable potential in West Kalimantan for developing vegetable crops, particularly red chili, on alluvial soils.

Utilizing alluvial soils for agriculture presents several challenges that can hinder the growth and yield of red chili. The primary issues include high soil acidity, low organic matter content, and deficiencies in essential nutrients such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg). To enhance the productivity of alluvial soils, effective management strategies are required, including the application of organic materials like cattle manure (Andrayani et al., 2024; Susilawati et al., 2023).

Cattle manure is an organic fertilizer derived from cow dung, rich in essential nutrients like nitrogen, phosphorus, and potassium, which are vital for plant growth. Additionally, the use of cattle manure can improve soil organic matter content, reduce dependence on chemical fertilizers, and promote sustainable agricultural practices (Fathin et al., 2019).

Efforts to increase red chili production can be achieved by improving nutrient availability in the soil. One effective method is the addition of cattle manure, which supplies the necessary nutrients and enhances soil fertility, thereby supporting sustainable chili cultivation.

2. Materials and Methods

The study was conducted at Jl. Gusti Hamzah, Gang Pancasila 4, Pontianak Kota District, Pontianak City, with soil chemical analyses performed at the Soil Chemistry and Fertility Laboratory. The research period lasted approximately six months, from preparation to report writing. The materials used in this study included alluvial soil collected from Parit Demang Purnama 2, red chili seeds (Laju F1 variety) and cattle manure obtained from local agricultural stores, basal NPK compound fertilizer (Mutiar 16-16-16), lime, 40 × 50 cm polybags, and other chemicals for laboratory soil analysis.

Equipment used included machetes, sample rings, knives, pH meters, sacks, polybags, scales, stationery, labels, cameras, and other laboratory instruments. The experiment was conducted as a field study using a Completely Randomized Design (CRD) non-factorial with five treatments and five replications, resulting in 25 experimental units. The treatments consisted of a control (0 g/polybag), 157 g/polybag (30 tons/ha), 315 g/polybag (60 tons/ha), 473 g/polybag (90 tons/ha), and 631 g/polybag (120 tons/ha) (Ristiyono, 2021). Soil samples from a depth of 0–20 cm were collected and analyzed to determine initial soil chemical properties. Cattle manure and alluvial soil were incubated together for one month. Chili seeds were sown and grown for three weeks until seedlings were ready for transplanting into polybags according to the treatment. NPK fertilizer (16-16-16) was applied at 30 g/polybag one week before the end of incubation. Plants were watered once daily in the morning, while weed and pest management was performed using appropriate pesticides and insecticides. The parameters measured in this study included plant dry weight, nitrogen (N) uptake, phosphorus (P) uptake, and potassium (K) uptake. Data were analyzed using ANOVA, and if significant differences among treatments were detected, Duncan's Multiple Range Test (DMRT) was conducted at a 5% significance level.

3. Result and Discussion.

3.1. Initial Soil Characteristics

The soil used as the planting medium in this study was alluvial soil collected from Jalan Parit Demang, Purnama, Pontianak City. The results of the initial analysis of the alluvial soil are presented in Table 1.

The initial analysis of the alluvial soil at the study site revealed several key chemical properties relevant for red chili cultivation. The soil was very acidic, with a pH of 4.29, which could limit the availability of essential nutrients such as phosphorus and calcium while increasing potentially toxic elements like aluminum and manganese.

Table 1. Initial Chemical Properties of Alluvial Soil at Parit Demang Purnama 2, Pontianak City

Soil Analysis Parameter	Unit	Value	Criteria
pH H ₂ O	–	4.29	Very acidic
Organic Carbon (C)	%	2.72	Moderate
Total Nitrogen (N)	%	0.44	Moderate
Available P ₂ O ₅	ppm	35.04	Very high
Calcium (Ca)	cmol(+) kg ⁻¹	3.95	Low
Magnesium (Mg)	cmol(+) kg ⁻¹	0.68	Low
Potassium (K)	cmol(+) kg ⁻¹	0.23	High
Sodium (Na)	cmol(+) kg ⁻¹	0.24	Low
Cation Exchange Capacity (CEC)	cmol(+) kg ⁻¹	17.26	Moderate
Base Saturation (BS)	%	29.55	Moderate

Calcium and magnesium levels were low (3.95 and 0.68 cmol(+) kg⁻¹, respectively), which may require lime and magnesium supplementation to optimize plant growth. Potassium was high (0.23 cmol(+) kg⁻¹), supporting protein synthesis and stress tolerance, while sodium was low (0.24 cmol(+) kg⁻¹), indicating no salinity issues. Cation exchange capacity (CEC) and base saturation were moderate (17.26 cmol(+) kg⁻¹ and 29.55%, respectively), suggesting a reasonable capacity to retain and supply nutrients. Overall, the soil has good potential for red chili cultivation, though management interventions such as liming and magnesium application are recommended to improve pH and nutrient availability (Agri Kompas, 2023; Setiawan et al., 2022; Hutapea et al., 2021; Mitra Bertani, 2022).

3.2 Dry Weight of Red Chili Plants

The graph illustrates the effect of different doses of cattle manure on the dry weight of red chili plants (*Capsicum annum* L.). Treatments ranged from P0 (control, 0 g/polybag) to P4 (631 g/polybag, equivalent to 120 tons/ha). The highest dry weight was observed in treatment P2 (315 g/polybag, 60 tons/ha) at 1.38 g, indicating that this dose provided the most favorable conditions for plant growth.

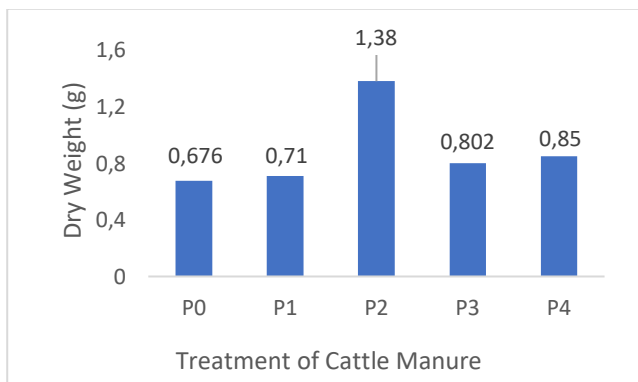


Figure 1. Dry Weight of Red Chili Plants under Different Cattle Manure Treatments

The control treatment (P0) produced the lowest dry weight at 0.676 g. Treatments P1, P3, and P4 resulted in dry weights of 0.71 g, 0.802 g, and 0.85 g, respectively, suggesting that both lower and higher manure doses compared to P2 were less optimal for promoting dry matter accumulation.

These results indicate a clear positive response of red chili plants to moderate doses of organic fertilizer, consistent with previous studies showing that appropriate cattle manure application can improve soil nutrient availability and plant biomass production (Hutapea et al., 2021; Setiawan et al., 2022). Excessive manure

application, as in P4, may not proportionally increase plant dry weight due to potential nutrient imbalance or saturation effects.

3.3 Plant Nitrogen Uptake

The results of the study indicate that the application of cow manure significantly affects plant nitrogen uptake. The average plant nitrogen uptake is presented in Table 2

Table 2. Nitrogen Uptake Values of Red Chili Plants

Treatment	Value
P0 (no treatment)	0.028a
P1 (157 g cow manure)	0.034ab
P2 (315 g cow manure)	0.058abc
P3 (473 g cow manure)	0.088c
P4 (631 g cow manure)	0.075bc

The effect of cow manure on nitrogen (N) uptake in red chili plants is shown in Table 2. Nitrogen uptake increased significantly with manure application, with the highest value observed at 473 g per plant (P3, 0.088). The control treatment (P0) exhibited the lowest N uptake (0.028). Notably, further increasing the manure to 631 g (P4) slightly reduced N uptake to 0.075, suggesting that excessive organic input may not proportionally enhance nutrient absorption, possibly due to nutrient saturation or imbalance.

These results indicate that moderate cow manure application optimizes N uptake, supporting plant growth and productivity, in agreement with previous studies on organic fertilizer benefits for nutrient availability and plant nutrition (Brady & Weil, 2010; Marschner, 2012).

3.4 Phosphorus Uptake of Red Chili Plants

The effect of cow manure on phosphorus (P) uptake in red chili plants is presented in Table 3.

Table 3. Phosphorus Uptake Values of Red Chili Plants

Treatment	Value
P0 (no treatment)	0.003a
P1 (157 g cow manure)	0.004ab
P2 (315 g cow manure)	0.007abc
P3 (473 g cow manure)	0.008c
P4 (631 g cow manure)	0.007bc

Note: Similar letters following the values in the same column indicate no significant difference according to the DMRT at 5% level.

Phosphorus uptake increased significantly with manure application, with the highest value observed at 473 g per plant (P3, 0.008). The control treatment (P0) showed the lowest uptake (0.003). Interestingly, further increasing the manure to 631 g (P4) slightly reduced P uptake to 0.007, indicating that excessive organic input may not proportionally enhance nutrient absorption, possibly due to nutrient saturation or imbalance.

These results suggest that moderate cow manure application optimizes P uptake, thereby supporting plant growth and productivity, consistent with previous studies on the positive effects of organic fertilizers on nutrient availability and plant nutrition (Brady & Weil, 2010; Marschner, 2012).

3.5 Potassium Uptake of Red Chili Plants

The results of this study indicate that cow manure application had a significant effect on potassium (K) uptake in red chili plants. The average K uptake under different treatments is presented in Table 4.

Table 4. Potassium Uptake Values of Red Chili Plants

Treatment	Value
P0 (no treatment)	0.021a
P1 (157 g cow manure)	0.027a
P2 (315 g cow manure)	0.058b
P3 (473 g cow manure)	0.036ab
P4 (631 g cow manure)	0.041ab

Note: Similar letters following the values in the same column indicate no significant difference according to the DMRT at 5% level.

Table 4 shows that treatment P2 (315 g cow manure) was significantly different from P0 and P1, but not significantly different from P3 and P4. The highest K uptake was observed in P2. This may occur because sufficient potassium supply enhances leaf function during fruit development and facilitates photosynthate transport within the plant. Potassium plays a crucial role in maintaining plant osmotic potential, regulating stomatal opening and closing, and thereby maintaining plant water status. Adequate K supply can improve water use efficiency in plants (Dodi Irawan & Idwar, 2017).

Potassium is essential for plant metabolic processes and is absorbed mainly as K^+ ions, particularly when located near root surfaces or in available forms. Soil K concentration is influenced by parent material and soil pH. Acidic soil increases potassium fixation, reducing the available K in the soil (Sangkala & Sumardi, 2023). Potassium is a mobile nutrient within the plant, moving through cells, tissues, xylem, and phloem. While total K content in soil may be high, only a small portion is available for plant uptake. The availability of K in soil is affected by factors such as soil pH, and plants absorb K in its ionic form (K^+) (Indrawati & Alhaddad, 2023).

4. Conclusion

Cow manure application significantly enhances nutrient uptake in red chili plants. Optimal uptake of nitrogen and phosphorus occurred at 473 g per plant, while potassium uptake peaked at 315 g per plant. Moderate manure application improves nutrient availability, plant metabolism, and water use efficiency, whereas excessive application may slightly reduce uptake due to nutrient imbalance. Therefore, applying cow manure at appropriate dosages effectively supports sustainable growth and productivity of red chili plants.

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