



## The effect of various manures on the availability and uptake of nitrogen, and chlorophyll content of rice plants in inceptisols †

[Efecto de diversos abonos sobre la disponibilidad y absorción de nitrógeno, y el contenido de clorofila de las plantas de arroz en inceptisoles]

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### SUMMARY

**Background.** The threat of ecological damage caused by chemical pollution in agricultural practices has led to the emergence of environmentally safe alternatives, such as organic farming. Inceptisols are acidic soil that has low levels of essential nutrients, especially nutrients N, P and K, so that additional nutrients are needed from outside through organic fertilisation using manure. **Objective.** To find local potential manure that is expected to overcome the problem of Inceptisols, which are low in nutrients, especially N. **Methodology.** This research uses a Randomized Complete Block Design (RCBD) with 10 treatments: P1 = control; P2 = NPK 200 kg ha<sup>-1</sup>; P3 = Cow manure 10 t ha<sup>-1</sup>; P4 = Chicken manure 10 t ha<sup>-1</sup>; P5 = Goat manure 10 t ha<sup>-1</sup>; P6 = Quail manure 10 t ha<sup>-1</sup>; P7 = Cow manure 5 t ha<sup>-1</sup> + NPK 100 kg ha<sup>-1</sup>; P8 = Chicken manure 5 t ha<sup>-1</sup> + NPK 100 kg ha<sup>-1</sup>; P9 = Goat manure 5 t ha<sup>-1</sup> + NPK 100 kg ha<sup>-1</sup>; P10 = Quail manure 5 t ha<sup>-1</sup> + NPK 100 kg ha<sup>-1</sup>. Soil parameters include: Soil N-Total, pH H<sub>2</sub>O, CEC, and C-Organic. Plant parameters include: Plant tissue N, plant N uptake, and chlorophyll content. **Results.** The results showed that manure had an effect in increasing soil N-total content, N uptake, and chlorophyll content of rice plants. The treatment of 5 t ha<sup>-1</sup> quail manure + 100 kg ha<sup>-1</sup> NPK gave the highest N-total of 0.29%, N uptake of 130.59 g plant<sup>-1</sup> and chlorophyll content of rice. **Implications.** The application of local potential manure can reduce the use of chemical fertilisers. **Conclusion.** The application of various types of manure can increase nitrogen (N) availability, N nutrient uptake, and chlorophyll levels, and reduce the need for high doses of chemical fertilisers.

**Key words.** Inceptisols; animal manure; nitrogen; chlorophyll.

### RESUMEN

**Antecedentes.** La amenaza de los daños ecológicos causados por la contaminación química en las prácticas agrícolas ha fomentado la aparición de una agricultura alternativa segura para el medio ambiente, concretamente la agricultura ecológica. El inceptisol es un suelo ácido que tiene bajos niveles de nutrientes esenciales, especialmente de N, P y K, por lo que se necesitan nutrientes adicionales del exterior mediante la fertilización orgánica con estiércol. **Objetivo.** Encontrar localmente el estiércol con potencial para ayudar a resolver el problema de baja en nutrientes en inceptisoles, especialmente N. **Metodología.** Esta investigación utiliza un diseño de bloques completos aleatorizados (RCBD) con 10 tratamientos: P1 = control; P2 = NPK 200 kg ha<sup>-1</sup>; P3 = estiércol de vaca 10 t ha<sup>-1</sup>; P4 = estiércol de pollo 10 t ha<sup>-1</sup>; P5 = estiércol de cabra 10 t ha<sup>-1</sup>; P6 = estiércol de codorniz 10 t ha<sup>-1</sup>; P7 = Estiércol de vaca 5 t ha<sup>-1</sup> + NPK 100 kg ha<sup>-1</sup>; P8 = Estiércol de pollo 5 t ha<sup>-1</sup> + NPK 100 kg ha<sup>-1</sup>; P9 = Estiércol de cabra 5 t ha<sup>-1</sup> + NPK 100 kg ha<sup>-1</sup>; P10 = Estiércol de codorniz 5 t ha + NPK 100 kg ha<sup>-1</sup>. Los parámetros del suelo incluyen: N-Total del suelo, pH H<sub>2</sub>O, CEC y C-Orgánico. Los parámetros de la planta incluyen: N del tejido vegetal, absorción de N por la planta y contenido de clorofila. **Resultados.** Los resultados mostraron que el estiércol tuvo un efecto en el aumento del contenido de N-total del suelo, la absorción de N, y el contenido de clorofila de las plantas de arroz. El tratamiento

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de 5 t ha<sup>-1</sup> de estiércol de codorniz + 100 kg ha<sup>-1</sup> de NPK dio el mayor contenido de N-total de 0.29%, la absorción de N de 130.59 g planta<sup>-1</sup> y el contenido de clorofila del arroz. **Implicaciones.** La aplicación de estiércol de granjas locales puede reducir el uso de fertilizantes químicos. **Conclusiones.** La aplicación de varios tipos de estiércol puede aumentar la disponibilidad de N, la absorción de N, los niveles de clorofila, y puede reducir el uso de altas dosis de fertilizantes.

**Palabras clave.** Inceptisol; estiércol animal; nitrógeno; clorofila.

## INTRODUCTION

The threat of ecological damage caused by chemical pollution in agricultural practices has led to the emergence of environmentally safe alternatives, such as organic farming. Organic farming, which has developed rapidly in various parts of Indonesia in response to environmental issues and to produce healthy food, is an important initiative to implement. Organic farming is a farming practice that utilises only organic fertilisers, such as animal manure and composted crop residues. Manure can be applied to get maximum production in organic farming. Manure is an organic fertiliser derived from animals. The application of local potential manure can reduce the use of chemical fertilisers. The addition of manure helps maintain soil nutrient balance, improves soil structure, and is more beneficial to environmental protection than chemical fertilisers alone (Zhang *et al.*, 2020). Adding manure to arable land will reduce the loss of N from the environment. The addition of manure is a practice that is effective in increasing the effectiveness of nitrogen use in fertilisers (Whalen, Thomas and Sharifi, 2019). Manure can be applied to various soil types. The soil type at the research location is Inceptisols.

Inceptisol is a soil that has a low level of soil fertility (low N, P, K and base saturation) (Chairuman *et al.*, 2023) (Herdiansyah, Arifin and Suriadikusumah, 2022). The low content of C-organic, N, P, and K is a challenge in utilising Inceptisols as agricultural land, or in other words, the fertility status of Inceptisols is low (Syamsiyah *et al.*, 2018). Nutrient N is an essential nutrient in the soil for productivity and soil fertility. N is highly mobile and can be easily lost through various means, including NH<sub>3</sub> volatilisation, denitrification, chemical and microbial fixation, and leaching (Kumar *et al.*, 2014). Nitrogen also plays a role as a constituent of chlorophyll, which is responsible for the green colour of leaves. Measurement of chlorophyll content can be used to predict nitrogen status in leaves (Kalaji *et al.*, 2017). For Inceptisols to be utilised as agricultural land, physical, chemical, and biological improvements must be made through fertilisation (Mustikawati, Suntoro,. One effort that can be made is organic fertilisation using manure. This manure fertilisation aims to increase the availability of nutrients. The type of manure used is local manure, which is abundant in the research location, making it easily accessible. Local manure is expected to overcome the problem of Inceptisol soils that are low in nutrients, especially nitrogen.

The manure used consists of cow manure, chicken manure, goat manure, and quail manure. Manure has a

very complete micronutrient content, even in small amounts. Manure can chemically add nutrients, especially NPK and can increase soil cation exchange capacity (CEC). Manure can increase the organic matter and nutrient availability of N, P, and K by adding total nutrients and controlling mineralisation-immobilisation patterns (Almaz *et al.*, 2017). The absorption of nutrients provided in the form of N fertiliser is more efficient when given in conjunction with manure. The use of manure and inorganic fertilisers has been shown to increase soil pH, organic matter content, cation exchange capacity and soil N, P, and K status (Amusan *et al.*, 2011). This study was conducted to determine the effect of local potential manure on soil N-total, N content of plant tissue, plant N uptake, and chlorophyll content of rice plants.

## MATERIALS AND METHODS

### Study area

This research was conducted in Gempol, Karanganyar, Klaten Regency, Central Java. The soil type belongs to the Inceptisol (Soil Survey Staff, 2022). Soil and plant analysis were conducted at the Soil Chemistry and Fertility Laboratory, Faculty of Agriculture, Sebelas Maret University, Surakarta.

### Experimental design

This study employed an experimental method using a Randomised Complete Block Design. There were 10 treatments with three replications, resulting in 30 experimental plots. Plots measured 4 m x 2.5 m. The spacing of rice plants is 25 x 25 cm. The rice variety used was Rojolele. The treatments used are shown in Table 1.

**Table 1. Treatments in the research.**

Code	Treatments	Dosage (kg ha <sup>-1</sup> )	
		Manure	NPK Fertilizer
P1	Control	0	0
P2	NPK	0	200
P3	Cow Manure	10.000	0
P4	Chicken Manure	10.000	0
P5	Goat Manure	10.000	0
P6	Quail Manure	10.000	0
P7	Cow Manure + NPK	5.000	100
P8	Chicken Manure + NPK	5.000	100
P9	Goat Manure + NPK	5.000	100
P10	Quail Manure + NPK	5.000	100

Ploughing involved plowing the soil until it was muddy and clearing weeds and plant residues. The experimental plots used were 4 x 2.5 m in size. The application of manure was done after tillage, 6 days before planting. NPK fertilisation was done twice, at 7 days after planting (DAP) and 21 DAP. Maintenance included irrigation, weeding, replanting, and pest and disease control. Soil sampling was conducted at the beginning, before planting, and in the vegetative phase (60 days after planting). Plant sampling was conducted at the vegetative phase (60 days). Soil samples were taken from each plot (30 samples), and plants included the wet and dry weight of the upper plant and plant roots.

### Soil and Plant Analysis

Soil analysis includes: pH (electrometric method); CEC (ammonium acetate extraction method); C-Organic (Walkley and Black Method); Soil N-Total (Kjeldahl Method). Plant analysis included: Plant tissue N (Kjeldahl Method); (Soil Research Center, 2009) Chlorophyll content (Arnon Method). The nutrient uptake of the upper plant (shoot) is obtained from the multiplication of the dry weight of the upper plant with the upper nutrient content. Green fertiliser analysis includes: pH (electrometric method), total N (Kjeldahl Method), total P (extraction with HClO<sub>4</sub> and HNO<sub>3</sub>), and total K (extraction with HClO<sub>4</sub> and HNO<sub>3</sub>).

### Data analysis

The results obtained were analysed using Analysis of Variance (ANOVA), followed by the Duncan Multiple Range Test (DMRT) at a 95% confidence level to identify the most significant effect, and Pearson Correlation Analysis to determine the relationship between the observed variables.

## RESULTS AND DISCUSSION

### Soil characteristics

The soil at the study site belongs to the Inceptisols (Soil Survey Staff, 2022). Inceptisols characteristics are neutral to acid when reacting with high clay content. (Shi *et al.*, 2023), This soil has a pH of 6.71 (neutral), C-organic content of 1.39% (low), CEC of 17.64 meq/100 g soil (medium), and N-Total of 0.12% (low) (Table 2). (Sharma *et al.*, 2015), There is no doubt that Inceptisols are important for agriculture, but they also pose serious problems, including soil erosion, low fertility, nutrient imbalance, and low soil organic matter, which limit productivity in the long run.

### Manure characteristics

The sources of organic matter that are abundant and readily available at the research location are cow manure, chicken manure, goat manure, and quail manure. The source of organic matter is used as

manure, which is expected to overcome the problems in the soil of the research location. The nutrient content of N, P, K, and C/N in the four sources of organic matter differs. The four sources of organic matter have considerable potential for use as fertilisers. The characteristics of the four types of potential local manure are presented in Table 3.

**Table 2. Soil characteristics at the research locations.**

Analysis	Value	Classification
pH	6.71	Neutral
C-Organic (%)	1.39	Low
KTK (me 100g <sup>-1</sup> )	17.81	Medium
Total N (%)	0.12	Low

Description: Classification based on (Balai Pengujian Standar Instrumen Tanah dan pupuk, 2023).

### Effect of manure on soil chemical characteristics

Soil pH has a significant impact on the availability of nutrients for plants. A neutral pH (6-7) optimises nutrient availability by balancing the amount and type of nutrients in the soil. (Neina, 2019), when soil pH increases, the amount of dissolved organic matter also increases, and as a result, C and N can be mineralised. The addition of manure can raise soil pH, with the highest result achieved in the treatment of quail manure at 5 t ha<sup>-1</sup> + NPK 100 kg ha<sup>-1</sup>, which is 6.83 (Table 4).

The application of manure has a significant effect on soil organic carbon. Soil organic matter plays an important role in maintaining soil fertility and productivity (Lin *et al.*, 2019). The addition of manure provides plants with carbon and other essential nutrients. Soil organic matter derived from manure plays an important role in humification, which creates a stable humus fraction and is responsible for nutrient cycling in the soil (Githongo *et al.*, 2021). The addition of manure adds a high carbon input into the soil. The highest yield was shown in the treatment of quail manure 5 t ha<sup>-1</sup> + 100 kg ha<sup>-1</sup> NPK, which was 26.90 me/100g. The addition of organic matter, such as quail manure, to the soil will enable the decomposition and degradation of these compounds into ions that plants can absorb (Supramudho *et al.*, 2012). Manure application also had a significant effect on soil CEC. The highest result was shown in the treatment of quail manure 5 t ha<sup>-1</sup> + NPK 100 kg ha<sup>-1</sup>, which was 2.97%. The Soil CEC value refers to the amount of exchangeable cations adsorbed on the surface of soil particles, which is commonly used as an indicator of soil fertility (Liu *et al.*, 2020)—the higher the soil CEC value. These more cations can be exchanged. The clay content and the amount of organic matter present in the soil determine the high and low content of CEC in the soil.

**Table 3. Characteristics of manure.**

Analysis	Cow manure	Chicken manure	Goat manure	Quail manure
pH	9.06	7.68	8.85	9.64
C-Organic (%)	30.09	31.56	27.25	32.14
N (%)	2.03	2.44	2.29	3.32
P (%)	0.62	0.26	0.16	1.67
K (%)	15.57	8.88	7.91	12.75
C/N	14.8	13.0	11.9	9.7

**Table 4. Effect of treatments on soil chemical characteristics.**

Code	Treatments	pH	Organic carbon (%)	CEC (me 100g <sup>-1</sup> )
P1	Control	6.85 ± 0.02 <sup>c</sup>	1.30 ± 0.20 <sup>a</sup>	20.00 ± 1.82 <sup>a</sup>
P2	NPK	6.36 ± 0.07 <sup>a</sup>	1.43 ± 0.12 <sup>a</sup>	23.78 ± 1.39 <sup>bc</sup>
P3	Cow Manure	6.51 ± 0.08 <sup>ab</sup>	2.38 ± 0.49 <sup>bcd</sup>	22.11 ± 0.36 <sup>ab</sup>
P4	Chicken Manure	6.68 ± 0.03 <sup>bc</sup>	2.17 ± 0.62 <sup>bc</sup>	22.72 ± 1.92 <sup>bc</sup>
P5	Goat Manure	6.70 ± 0.09 <sup>bc</sup>	1.85 ± 0.11 <sup>ab</sup>	24.68 ± 2.06 <sup>cd</sup>
P6	Quail Manure	6.80 ± 0.10 <sup>c</sup>	2.69 ± 0.10 <sup>cd</sup>	22.21 ± 1.90 <sup>abc</sup>
P7	Cow Manure + NPK	6.78 ± 0.03 <sup>c</sup>	2.43 ± 0.25 <sup>bcd</sup>	20.03 ± 1.43 <sup>a</sup>
P8	Chicken Manure + NPK	6.79 ± 0.01 <sup>c</sup>	2.35 ± 0.22 <sup>bcd</sup>	22.26 ± 2.12 <sup>abc</sup>
P9	Goat Manure + NPK	6.67 ± 0.02 <sup>bc</sup>	2.54 ± 0.21 <sup>cd</sup>	23.39 ± 2.42 <sup>bc</sup>
P10	Quail Manure + NPK	6.83 ± 0.04 <sup>c</sup>	2.97 ± 0.16 <sup>d</sup>	26.90 ± 2.63 <sup>d</sup>

Note: Numbers followed by the same letter in one column are not significantly different at the 5% DMRT level.

#### Effect of treatments on soil total N and nitrogen uptake

Plant growth will occur optimally if the soil contains sufficient nutrients that can be absorbed by plants. The results of the analysis of variance showed that the addition of manure had a significant effect on the availability and uptake of Nitrogen, as shown in the figure below.

The addition of manure had a significant effect on soil N-total. The highest result was found in the treatment of quail manure 5 t ha<sup>-1</sup> + NPK 100 kg ha<sup>-1</sup> which was 0.29%. Poultry manure provides a range of nutrients, particularly nitrogen. ((Bibiano *et al.*, 2019). The addition of quail manure to the soil will increase the content of essential nutrients, especially macronutrients N, P, and K. The addition of manure has a significant effect on plant biomass. The highest yield was found in the treatment of quail manure 5 t ha<sup>-1</sup> + NPK 100 kg ha<sup>-1</sup> which was 44.33 g shoot<sup>-1</sup>, while the lowest yield was found in the treatment of chicken manure 5 t ha<sup>-1</sup> + NPK

100 kg ha<sup>-1</sup> compared to the control. (Maciel *et al.*, 2024), Plant biomass production is influenced by different biotic and abiotic factors such as plant age, temperature, water (irrigation system or rainfall), soil fertility, and cultivation methods. These values will differ from study to study. The addition of manure also significantly affected N content in plant tissue and plant N uptake. The highest results were shown by quail manure 5 t ha<sup>-1</sup> + 100 kg ha<sup>-1</sup> NPK with N content plant tissue of 2.91% and plant N uptake of 129.19 g shoot<sup>-1</sup>. Nitrogen (N) is needed by plants in the vegetative phase in terms of plant tissue formation (Elinda *et al.*, 2022). The need for nitrogen in the generative phase is not as much as in the vegetative phase, so that the maximum absorption of nitrogen elements occurs in the vegetative phase and begins to decline when entering the generative phase. (Sholihah, Sugianto and Lestari, 2023) Research results show a strong correlation between N content and N uptake. This indicates that increasing the N content in the soil affects N uptake in rice plants through the use of organic fertiliser.

**Table 5. Effect of treatments on soil total N and nitrogen uptake.**

Code	Treatments	Soil total N (%)	N Content of plant tissue (%)	Plant biomass (g shoot <sup>-1</sup> )	Plant N uptake (g shoot <sup>-1</sup> )
P1	Control	0.15 ± 0.02 <sup>a</sup>	1.84 ± 0.17 <sup>a</sup>	8.33 ± 0.88 <sup>a</sup>	14.75 ± 0.32 <sup>a</sup>
P2	NPK	0.23 ± 0.00 <sup>b</sup>	2.38 ± 0.34 <sup>ab</sup>	33.67 ± 2.33 <sup>c</sup>	80.84 ± 0.49 <sup>b</sup>
P3	Cow Manure	0.24 ± 0.02 <sup>b</sup>	1.93 ± 0.84 <sup>ab</sup>	33.00 ± 1.00 <sup>bc</sup>	64.28 ± 0.99 <sup>b</sup>
P4	Chicken Manure	0.24 ± 0.03 <sup>b</sup>	2.12 ± 0.67 <sup>ab</sup>	29.33 ± 0.88 <sup>bc</sup>	61.60 ± 0.82 <sup>b</sup>
P5	Goat Manure	0.22 ± 0.02 <sup>b</sup>	2.44 ± 0.21 <sup>ab</sup>	36.00 ± 4.36 <sup>c</sup>	86.82 ± 0.36 <sup>b</sup>
P6	Quail Manure	0.25 ± 0.02 <sup>b</sup>	2.86 ± 0.15 <sup>b</sup>	36.33 ± 4.91 <sup>c</sup>	105.34 ± 0.30 <sup>c</sup>
P7	Cow Manure + NPK	0.22 ± 0.01 <sup>b</sup>	2.65 ± 0.50 <sup>ab</sup>	34.33 ± 1.86 <sup>c</sup>	91.05 ± 0.65 <sup>bc</sup>
P8	Chicken Manure + NPK	0.22 ± 0.01 <sup>b</sup>	2.71 ± 0.76 <sup>ab</sup>	25.33 ± 1.20 <sup>b</sup>	69.38 ± 0.92 <sup>b</sup>
P9	Goat Manure + NPK	0.24 ± 0.02 <sup>b</sup>	2.57 ± 0.60 <sup>ab</sup>	34.33 ± 0.88 <sup>c</sup>	88.01 ± 0.75 <sup>b</sup>
P10	Quail Manure + NPK	0.29 ± 0.02 <sup>c</sup>	2.91 ± 0.18 <sup>b</sup>	44.33 ± 4.33 <sup>d</sup>	130.59 ± 0.33 <sup>c</sup>

Note: Numbers followed by the same letter in one column are not significantly different at the 5% DMRT level.

### Effect of treatment on chlorophyll content

Nitrogen plays a crucial role as a constituent of chlorophyll, which gives leaves their characteristic green colour. The increase in chlorophyll content is due to the higher concentration of total N in the leaf tissue, because 50-70% of total soil N enters the leaves as enzymes associated with chloroplasts (Schlichting *et al.*, 2015). The addition of manure causes significant differences. The analysis results are presented in the figure below.

The highest result of adding manure to chlorophyll-a is observed in the treatment with chicken manure at 10 t ha<sup>-1</sup>. The highest results for chlorophyll-b and total chlorophyll are achieved in the treatment with a combination of quail manure at 5 t ha<sup>-1</sup> and NPK at 100 kg ha<sup>-1</sup>. This is because chlorophyll levels are closely related to the nutrient nitrogen (N). Nitrogen (N) is an integral part of the chlorophyll molecule; therefore, the addition of sufficient N will result in lush vegetative growth and a dark green leaf colour. (Al-Gaadi, Madugundu and Tola, 2019), Poultry manure is higher in increasing chlorophyll content compared to cow manure.

### Correlation between soil variables and plant variables

Based on the results of the correlation analysis in Table 5, soil total N showed a significant correlation with a strong and positive relationship to tissue N content ( $r = 0.474$ ) and plant N uptake ( $r = 0.707$ ). Total N levels affect tissue N levels and N uptake of rice plants. The higher the soil N-total value, the tissue N content and

plant N uptake will also increase. The higher the N uptake, the higher the N uptake efficiency.

The results of the correlation test between soil N total and chlorophyll-a levels ( $r = 0.634$ ) and total chlorophyll ( $r = 0.393$ ) revealed a very strong and positive relationship. Nitrogen is closely related to chlorophyll formation (Moharana and Dutta, 2016). An increase in Nitrogen in plant tissues will result in the formation of more leaf chlorophyll, so that plant growth and yield will be higher. The higher the N in the soil, the higher the levels of chlorophyll-a, b, and total in rice plants. High nitrogen content makes the leaves greener and last longer. As a structural unit of chlorophyll, N forms porphyrins that are used in metabolism by chlorophyll (Suntoro *et al.*, 2018). Soil total N showed a significant correlation with a strong and positive relationship to plant biomass ( $r = 0.767$ ). The presence of nitrogen in paddy soil has a significant impact on the vegetative growth of rice plants. Plants that meet their N needs can maintain the photosynthesis process, which can increase plant biomass and plant seed yield.

Organic carbon showed a very significant correlation with a positive relationship to chlorophyllia ( $r=0.484$ ), plant N uptake ( $r=0.582$ ) and plant biomass ( $r=0.564$ ). Increases the amount of organic matter, which is beneficial for increasing plant N content. Plants rich in nitrogen elements will produce high chlorophyll content and play a role in plant photosynthesis, which will further affect the height and biomass of rice plants. The higher the chlorophyll content in the leaves, the greater the photosynthetically active area becomes, resulting in improved plant growth and development, and increased assimilate production (Wasaya *et al.*, 2017).

**Table 6. Effect of Treatment on Chlorophyll Content.**

Code	Treatments	Chlorophyll-a (mg g <sup>-1</sup> leaf)	Chlorophyll-b (mg g <sup>-1</sup> leaf)	Total chlorophyll (mg g <sup>-1</sup> leaf)
P1	Control	0.94 ± 0.02 <sup>a</sup>	0.58 ± 0.06 <sup>a</sup>	20.00 ± 0.13 <sup>a</sup>
P2	NPK	1.20 ± 0.02 <sup>b</sup>	1.68 ± 0.24 <sup>c</sup>	23.78 ± 0.23 <sup>bc</sup>
P3	Cow Manure	1.20 ± 0.05 <sup>b</sup>	0.80 ± 0.25 <sup>ab</sup>	22.11 ± 0.28 <sup>ab</sup>
P4	Chicken Manure	1.23 ± 0.03 <sup>b</sup>	0.82 ± 0.17 <sup>ab</sup>	22.72 ± 0.20 <sup>bc</sup>
P5	Goat Manure	1.18 ± 0.00 <sup>b</sup>	1.52 ± 0.47 <sup>bc</sup>	24.68 ± 0.46 <sup>cd</sup>
P6	Quail Manure	1.21 ± 0.02 <sup>b</sup>	1.48 ± 0.31 <sup>bc</sup>	22.21 ± 0.29 <sup>abc</sup>
P7	Cow Manure + NPK	1.19 ± 0.02 <sup>b</sup>	1.34 ± 0.44 <sup>abc</sup>	20.03 ± 0.44 <sup>a</sup>
P8	Chicken Manure + NPK	1.21 ± 0.01 <sup>b</sup>	1.59 ± 0.09 <sup>bc</sup>	22.26 ± 0.09 <sup>abc</sup>
P9	Goat Manure + NPK	1.19 ± 0.06 <sup>b</sup>	0.76 ± 0.20 <sup>ab</sup>	23.39 ± 0.25 <sup>bc</sup>
P10	Quail Manure + NPK	1.21 ± 0.02 <sup>b</sup>	1.71 ± 0.25 <sup>c</sup>	26.90 ± 0.23 <sup>d</sup>

Note: Numbers followed by the same letter in one column are not significantly different at the 5% DMRT level.

**Table 7. Correlation between soil variables and plant variables.**

Variable	Coefficient of Correlation (r)					
	Chlorophyll-a	Chlorophyll-b	Total chlorophyll	The content of plant tissue	Plant N uptake	Plant biomass
Total N	<b>0.634**</b>	0.336 <sup>ns</sup>	0.393*	<b>0.474**</b>	<b>0.707**</b>	<b>0.767**</b>
Organic carbon	<b>0.484**</b>	0.276 <sup>ns</sup>	0.341 <sup>ns</sup>	0.348 <sup>ns</sup>	<b>0.582**</b>	<b>0.564**</b>
CEC	0.355 <sup>ns</sup>	0.462*	<b>0.497**</b>	0.310 <sup>ns</sup>	0.437*	<b>0.519**</b>

Description: ns = non significant, \* = significant, \*\* = very significant

The correlation test results for CEC and chlorophyll-b ( $r = 0.462$ ) and plant N uptake ( $r = 0.437$ ) showed a significant correlation and a positive relationship. With this positive and real correlation, the increase in soil CEC will be accompanied by an increase in plant N uptake, thereby achieving maximum plant N uptake efficiency. The results of the correlation analysis between CEC and total chlorophyll ( $r = 0.497$ ) and plant biomass ( $r = 0.519$ ) showed a significant correlation with a positive relationship. The addition of organic matter, such as manure, will increase the CEC and nutrients in Inceptisol soil, particularly N, which is closely related to chlorophyll levels. The more total chlorophyll, the higher the rate of photosynthesis will be. The photosynthetic performance of plants is influenced by various environmental factors, including light, temperature, and CO<sub>2</sub> concentration (Gotoh *et al.*, 2018). The increased rate of photosynthesis will enhance the uptake of nutrients from the soil, thereby increasing plant dry weight.

### CONCLUSION

The addition of manure significantly affected the total N in soil, N uptake, and leaf chlorophyll content of rice plants. Combining manure with inorganic fertiliser showed higher results, but not significantly different. The results showed that manure had an effect in increasing soil N-total content, N uptake, and chlorophyll content of rice plants. The treatment of 5 t ha<sup>-1</sup> quail manure + 100 kg ha<sup>-1</sup>kg NPK gave the highest N-total of 0.29%, N uptake of 130.59 g plant<sup>-1</sup> and chlorophyll content of rice. The availability of N nutrients in the soil, N levels in rice plant tissues, and chlorophyll levels of rice plants, including both chlorophyll a and b, as well as total chlorophyll, showed a positive correlation. Based on this study, manure is a potential fertiliser for addressing the problems found in Inceptisol soil and can reduce the need for high doses of chemical fertilisers.

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