



Influence of NPK Rates of Fertilizer on Soil Properties and Growth Performance of Durian Seedlings During Nursery Stage

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ABSTRACT

Durian (Durio zibethinus), often referred to as the “King of Fruits” in Asia, holds significant economic potential for farmers and exporters. To meet the high demand for durian, it is essential to improve the methods and challenges of cultivating durian seedlings during the nursery stage. This study aims to determine the optimal NPK fertilizer rates for durian seedlings, supporting vegetative growth, and assessing their impact on soil properties. The research was carried out at the greenhouse of Ladang 15, Faculty of Agriculture, UPM, from April to September 2022. Newly grafted durian seedlings of two cultivars, IOI (D168) and Musang King (D197), were transplanted into polybags filled with limed topsoil. Four NPK Fertilizer treatments were tested: T1 (2.5 g), T2 (5 g), T3 (7.5 g), and T4 (10 g). The experimental units were arranged in a Randomized Complete Block Design (RCBD) with four replications. Data was statistically analyzed using the Statistical Analysis System (SAS) software. The results indicated that the varying NPK rates affected the growth performance of both IOI and Musang King seedlings.

Key words: Durian, soil fertility, growth performance, nursery stage

INTRODUCTION

Durian (*Durio zibethinus*) is a tropical plant that has gained global recognition for its distinctive flavor and aroma. Durian's popularity is deeply rooted in Southeast Asian culinary traditions, where it is consumed fresh, processed into snacks, or used in desserts and beverages. In recent years, durian's reputation as a luxury fruit in important markets like China, Hong Kong, and Singapore has contributed to a recent increase in demand for the fruit worldwide. According to a statement by the Agriculture and Agro-Based Ministry in 2018, Minister Datuk Salahuddin Ayub said that durian production surged by 61.9% that year. This means the production rose to 341,000 metric tons as compared to 2017, with 211,000 metric tons of production. It was expected to increase approximately 1,000 metric tons of Malaysia's frozen whole durian to penetrate the Chinese market monthly, especially premium varieties such as Musang King and Black Thorn. The increased forecasted production was mainly contributed to by the establishment of the Durian Export Protocol in 2018 to China, worth RM9.44 million, equivalent to 235.62 metric tons (News Straits Times, 2019). Thus, farmers are investing in durian cultivation, including the intense production of durian seedlings in nurseries, which has had a huge impact on the agricultural landscape.

The cultivation of durian (*Durio zibethinus* Murr.) seedlings requires suitable soil conditions and nutrient management to ensure optimal growth during their vegetative phases. The application of fertilizers is crucial for enhancing soil fertility and promoting plant growth. The application of NPK fertilizers that consist of essential macronutrients such as nitrogen (N), phosphorus (P), and potassium (K) can influence soil nutrient content and improve plant growth and development (Wang *et al.*, 2021). Nitrogen is essential for chlorophyll, photosynthesis, and overall plant growth, while phosphorus is crucial for root development and energy transmission (Lyzenga *et al.*, 2023). Potassium supports regulating water absorption,

stomatal function, and enzyme activation (Johnson *et al.*, 2022). Studies show that N, P, and K fertilization improves soil pH and nutrient availability, leading to better root traits and overall plant growth (Liu *et al.*, 2024). The balanced application of these nutrients can significantly impact both the seedling's development and the properties of the soil.

Soil health is directly impacted by fertilizer application, microbial activity, nutrient availability, and water retention. The interaction of these factors determines plant nutrient uptake efficiency, which influences growth performance and soil fertility. Durian seedlings, with their unique physiology, require balanced nutrient input to support the establishment of strong root systems and healthy vegetative growth. Soil fertility is one of the determining factors in the successful cultivation of durian. Optimal plant growth occurs in fertile soils rich in organic matter, with soil organic matter playing a crucial role in soil fertility and crop productivity (Oldfield *et al.*, 2020). Furthermore, the addition of NPK fertilizers can modify soil pH, nutrient content, and cation exchange capacity, thereby enhancing the availability of nutrients to plants.

Thus, in the cultivation of tropical fruits like durian, determining the right NPK ratios is essential for improving nursery techniques and maintaining sustainable agricultural output. However, there is a lack of comprehensive research on how different NPK fertilizer rates affect soil characteristics and plant growth in nursery environments, especially for durian seedlings. Besides, insufficient or excessive fertilizers can impact the seedling's growth, and imbalances in the availability of nutrients in the soil. For example, nitrogen deficiency can lead to lower chlorophyll content, yellowing leaves, and stunted growth (Sen *et al.*, 2016), whereas excessive nitrogen in the soil can inhibit root growth (Firdaus *et al.*, 2023). Similarly, phosphorus deficiency can result in necrotic spots on the leaves and delayed seedling growth (Bentamra *et al.*, 2023), while too much phosphorus can cause soil acidification (Ma *et al.*, 2024). Next, inadequate potassium can decrease leaf expansion and reduce root elongation (Attia *et al.*, 2022); meanwhile, excessive potassium input can hinder plant growth (Xu *et al.*, 2021).

Therefore, understanding the appropriate rates of NPK fertilizer is essential for enhancing seedling performance and maintaining soil fertility, particularly in durian cultivation, which has specific requirements. Despite the crop's economic significance, research on optimal NPK fertilization for durian seedlings remains limited. Hence, this study aims to evaluate the effects of varying NPK fertilizer rates on both the growth performance of durian seedlings and the associated changes in soil properties under nursery conditions. The findings are expected to support more effective and sustainable durian cultivation practices, helping growers meet increasing market demand while ensuring responsible nutrient management and soil conservation in tropical fruit production.

MATERIALS AND METHODS

Research area and experimental design

The experiment was conducted in the greenhouse at Field 15, Faculty of Agriculture, University of Putra Malaysia (UPM), Serdang, located at (2°59'30.07"N 101°42'58.64" E). Two durian cultivars, IOI (D168) and Musang King (D197), were selected as the test crop. Grafted seedlings were sourced from Durian Monthong Tani Company, Gua Musang, Kelantan. This experiment consists of the treatment of different rates of fertilizers, which were T1: NPK (2.5g), T2: NPK (5g), T3: NPK (7.5g), and T4: NPK (10g). Fertilizers (treatments) were applied manually at monthly intervals. The experiment was conducted over five months, from April 2022 to August 2022. Irrigation was provided twice daily using a drip system. The experiment followed a Randomized Complete Block Design (RCBD) comprising four treatments and three replications. Each replication included two cultivars, resulting in a total of 24 plants. Before transplanting the seedlings, the soil was limed with dolomite at 30.27 g/tree

for a pH of 6. Post-harvest data were analyzed at the Department of Land Management and Crop Science Laboratory, Faculty of Agriculture, UPM.

Soil properties

Soil samples for each polybag were collected during the harvest stage and brought to the laboratory. Then, the soil samples were oven-dried and sieved through a 2.0 mm sieve to determine the soil properties. Soil pH was determined with the pH meter in the ratio of 1:2.5 soil to distilled water, and soil electrical conductivity (EC) was determined by the EC meter in the ratio of 1:5 soil to distilled water (Japakumar *et al.*, 2021). CNS analysis was to determine the total nitrogen, total carbon, and total sulfur in 5g of soil using the CNS analyzer (LECO TruMac CNS Analyzer, USA). Available phosphorus was analyzed by the Bray and Kurtz II method (Amran *et al.*, 2023). Exchangeable bases (Ca^{2+} , Mg^{2+} , K^+ , Na^+) and cation exchange capacity (CEC) were determined using the leaching method NH_4 buffered at pH 7.0, and later on using Perkin Elmer Model AAS 3110 atomic absorption spectrophotometers (AAS).

Growth performance

The growth performance of durian seedlings was measured every two weeks for non-destructive parameters such as plant height increment, stem diameter, and number of leaves. Plant height was measured using a measuring tape, stem diameter was measured 1 cm above the soil surface level with a vernier caliper, and the number of leaves was counted manually. Then, the plant part samples (leaves, stems, and roots) of both durian seedling varieties were weighed using an electronic balance and oven-dried at 60 °C for 72 hours or until a constant dry weight was achieved. After that, the plant samples were weighed again to determine the plant biomass. Next, the dry samples were ground into powder for plant analysis. The total nitrogen content of the plant was determined using the Kjeldahl method. Plant total phosphorus (P), potassium (K), Calcium (Ca), and magnesium (Mg) content were determined using the dry ashing method. Nutrient uptake was calculated by the formula (Chowdhury *et al.*, 2021). The amount of chlorophyll present in the plant leaf was determined using the Coombs method, which was analyzed by a spectrophotometer (Model: Varian Cary 50 UV-Vis, Australia) at wavelengths of 647 nm and 664 nm.

Statistical analysis

All collected data were analyzed using the Statistical Analysis System (SAS) software. Analysis of Variance (ANOVA) was performed to assess significant differences among treatment effects on the measured parameters. Where significant differences were detected, mean separation was conducted using Tukey's Honestly Significant Difference (HSD) test. Statistical significance was determined at a probability level of $p < 0.05$.

RESULTS AND DISCUSSION

Soil properties

Soil properties are fundamental in determining the soil's suitability for agriculture and its impact on plant growth. These characteristics include nutrient storage and availability, soil texture, and water-holding capacity (Sung *et al.*, 2017). **Table 1** shows the baseline of soil properties used before fertilizer application, which provides an initial knowledge of the soil conditions under which the experiment was conducted. Based on **Table 1**, the soil has a low pH of 4.9, representing acidic soil. Amran *et al.* (2023) stated that the optimal soil pH for durian cultivation is between 5.5 and 6.5. Plants absorb nutrients most efficiently in this range, enhancing healthy growth and fruit yield. To address this problem, soil liming was used to raise the pH to 6.0, which aligned with the standards for optimal durian cultivation. Liming reduces

soil acidity and enhances soil structure, microbial activity, and nutrient availability. Another important characteristic in soil evaluation is electrical conductivity (EC), commonly used to measure soil salinity. Salinity levels serve as an indicator of nutrient availability in the soil, which significantly impacts crop growth; however, excessive salinity reduces productivity in many crops (Machado & Serralheiro, 2017).

Meanwhile, soil cation exchange capacity (CEC) refers to the soil's ability to exchange positively charged chemical ions like Potassium (K^+), Calcium (Ca^{2+}), and Magnesium (Mg^{2+}). The soil EC and CEC values used for this study were 0.02 mS cm^{-1} and $3.33 \text{ cmol}(+) \text{ kg}^{-1}$. Next, examining the soil texture provides further information on the soil's physical qualities. Based on the USDA soil texture class, this soil texture was determined as clay soil, which was composed of 34.92% sand, 6.36% silt particles, and 58.72% clay. Clay has a high ability to hold water compared to other soil textures like sand or silt due to its physical and chemical properties. Bulk density and total porosity are also important physical properties to consider when assessing soil. The bulk density of the soil was measured at 1.4 g cm^{-3} , and its total porosity was 39%. Both parameters' value falls within the ideal range for soils. Ideal bulk density for clay soil typically ranges from $1.1 - 1.6 \text{ g cm}^{-3}$, while ideal total porosity is between 30% to 60% (Government Local Land Services, 2020). Bulk density represents the soil's compactness, influencing root penetration and water movement. Lower bulk densities typically imply better soil structure, including adequate pore spaces for air and water. The porosity score of 39% indicates a moderate quantity of pore space, supporting adequate aeration and water movement required for good root growth and microbial activity.

Table 1: Baseline of soil physicochemical properties before treatment application in the experiment.

Soil Properties	Values	Unit
pH	4.90 ± 0.03	-
pH (after liming)	6.00 ± 0.04	-
Electrical conductivity (EC)	0.02 ± 0.00	mS cm^{-1}
Cation exchange capacity (CEC)	5.75 ± 0.05	$\text{cmol}(+) \text{ kg}^{-1}$
Total nitrogen (TN)	0.12 ± 0.03	%
Available phosphorus (Avail. P)	3.02 ± 0.18	mg/kg
Exchangeable cation		
K	0.14 ± 0.01	$\text{cmol}(+) \text{ kg}^{-1}$
Ca	0.31 ± 0.00	$\text{cmol}(+) \text{ kg}^{-1}$
Mg	0.07 ± 0.05	$\text{cmol}(+) \text{ kg}^{-1}$
Particle size distribution		
Soil Texture	Clay	-
Sand	28.48	%
Silt	4.58	%
Clay	66.94	%

Effect of fertilizer rate on soil properties

The results of soil properties after different fertilizer rate applications were shown in **Figure 1** for soil pH. There was a significant difference ($P < 0.05$) among different rates of NPK fertilizer for soil, where the pH for the IOI variety only which was observed on T1 (NPK 2.5g) with 7.18, followed by T2 (NPK 5g) with 7.10 compared by T3 (NPK 7.5g), with 6.54, and the lowest was T4 (NPK 10g) with 6.23. The pH readings for treatments T1 and T2 indicate that NPK with lower dosages (2.5g and 5g) helped maintain a neutral pH level (Muslimah *et al.*, 2025). Whereas, treatment T3 and T4 of NPK with higher dosages (7.5g and 10g) result in a slightly acidic pH level. Moreover, acidic soil can impact the solubility and uptake of essential nutrients such as phosphorus, calcium, and magnesium. According to Tkaczyk *et al.* (2020),

research indicates that applying fertilizers at rates exceeding crop requirements can significantly acidify the soil, particularly due to excessive nitrogen use. Therefore, maintaining a suitable soil pH is essential because it controls nutrient availability, microbial activity, and root development for seedlings.

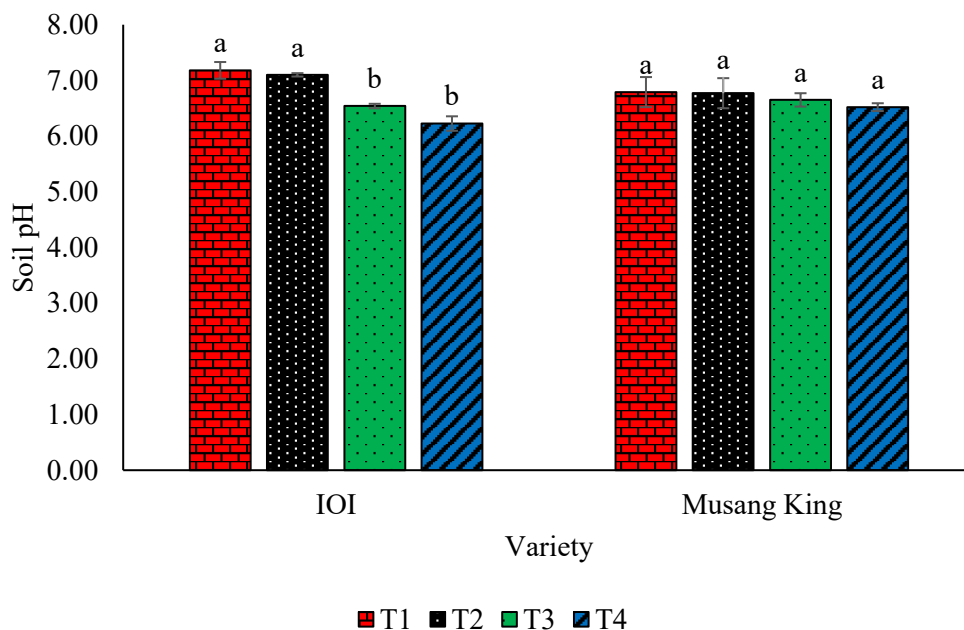


Figure 1. Effect of different rates of fertilizers (T1: NPK 2.5g, T2: NPK 5g, T3: NPK 7.5g, and T4: NPK 10g) on the soil pH under both varieties.

Next, there was no significant difference in other soil properties, namely electrical conductivity (EC), cation exchange capacity (CEC), total nitrogen (N), available phosphorus (P), exchangeable potassium (K), calcium (Ca), magnesium (Mg), and sodium (Na), for both varieties (IOI and Musang King). These findings show that the short experimental duration, possible nutrient leaching that reduced residual nutrient accumulation in the soil, and high or fast nutrient uptake by seedlings, which influenced the non-difference effect of different rates of fertilizers.

Effect of fertilizer rate on the growth performance of durian seedlings

Researchers commonly use non-destructive and destructive for evaluate plant growth analysis. The non-destructive data analysis, such as plant height increment, stem diameter, and number of leaves, was observed and recorded for monitoring durian seedling growth and development response toward different fertilizer rates. However, there were no significant differences for all non-destructive parameters measured (**Table 2**), suggesting that external morphological changes were not markedly influenced within the study period.

The result of NPK fertilizer application rates on durian seedlings for total plant dry weight was presented in **Figure 2**. Figure 2 shows that the total plant dry weight of the IOI durian variety differed significantly among NPK treatments. The highest dry weights were recorded in T4 (NPK 10 g) and T3 (NPK 7.5 g), with values of 53.86 g and 49.67 g, respectively, and these were significantly higher than those obtained in T2 (NPK 5 g; 34.48 g) and T1 (NPK 2.5 g; 32.73 g). These results suggest that higher NPK application rates promoted greater biomass accumulation in the IOI variety, possibly due to enhanced nutrient availability that supported plant growth and dry matter production.

Table 2: Non-destructive parameters analysis of durian seedlings under different varieties and fertilizer treatments.

Variety	Treatment	Plant Height (cm)	Stem Diameter (mm)	Number of leaves
IOI	T1 (NPK 2.5g)	53.33 ± 5.71 ^a	8.57 ± 0.48 ^a	42.00 ± 5.51 ^a
	T2 (NPK 5g)	54.73 ± 6.44 ^a	8.20 ± 0.40 ^a	46.67 ± 0.88 ^a
	T3 (NPK 7.5g)	54.90 ± 6.31 ^a	8.90 ± 0.25 ^a	65.67 ± 5.61 ^a
	T4 (NPK 10g)	63.67 ± 3.61 ^a	9.43 ± 0.30 ^a	57.67 ± 9.67 ^a
MUSANG KING	T1 (NPK 2.5g)	44.23 ± 2.65 ^a	7.67 ± 0.42 ^a	31.00 ± 1.15 ^a
	T2 (NPK 5g)	51.43 ± 6.59 ^a	7.63 ± 0.27 ^a	32.00 ± 5.00 ^a
	T3 (NPK 7.5g)	55.23 ± 2.60 ^a	8.50 ± 0.45 ^a	37.00 ± 10.02 ^a
	T4 (NPK 10g)	49.17 ± 0.60 ^a	9.10 ± 0.40 ^a	49.00 ± 1.73 ^a

Notes: Values (mean ± SD) with the same letter within the same column are not significantly different by Tukey's Student Range (HSD) test at $P > 0.05$

While for the Musang King variety, no significant differences in total plant dry weight were observed among the different NPK application rates. This suggests that within the range of NPK rates evaluated, the growth response of Musang King was relatively stable and did not exhibit a significant increase in dry matter accumulation with increased fertilizer application. The differences in response between Musang King and IOI indicate possible varietal differences in nutrient requirements or growth responses to fertilizer application. This finding is similar to Suwardi (2025), that the variation in growth responses among different cultivars under the same nutrient management has been reported on durian growth.

Based on **Table 3**, there was a significant difference ($P < 0.05$) in the total N content of the plants between the two varieties. For the IOI variety observed on T4 (NPK 10g), with 3.30% N, T3 (NPK 7.5g) and T2 (NPK 5g) had 3.04% N, and the lowest was on T1 (NPK 2.5g) with 2.63% N. The significantly higher N content in T2, T3, and T4 compared with T1 suggests that increasing the NPK application rate from 2.5 g to 5 g improved N accumulation in IOI seedlings. However, no further significant increase in N content was observed when the fertilizer rate was increased beyond 5 g, indicating that higher NPK application rates did not provide additional improvement in total plant N accumulation.

As for the Musang King variety, result showed T4 (NPK 10g) with 3.62% of N, followed by T3 (NPK 7.5g) with 3.55% of N, T2 (NPK 5g) with 3.21% of N, and T1 (NPK 2.5g) with 2.93% of N. The Musang King showed a gradual increase in total plant N content from 2.5g to 10g, with the highest N content at 10 g. This finding indicates that the Musang King exhibited greater N accumulation with increasing NPK rates within the tested range (2.5 - 10 g), whereas the IOI variety showed a plateau in N accumulation after 5 g NPK, showing a different response pattern between the two types. This variation could be linked to genotypic differences in nitrogen uptake, transport, and assimilation efficiency, as various plant genotypes have varying nutrient acquisition and use properties (Weih, 2018). Such changes may influence each variety's ability to absorb and accumulate nitrogen under the same fertilizer delivery, resulting in the divergent nitrogen accumulation patterns seen in this study.

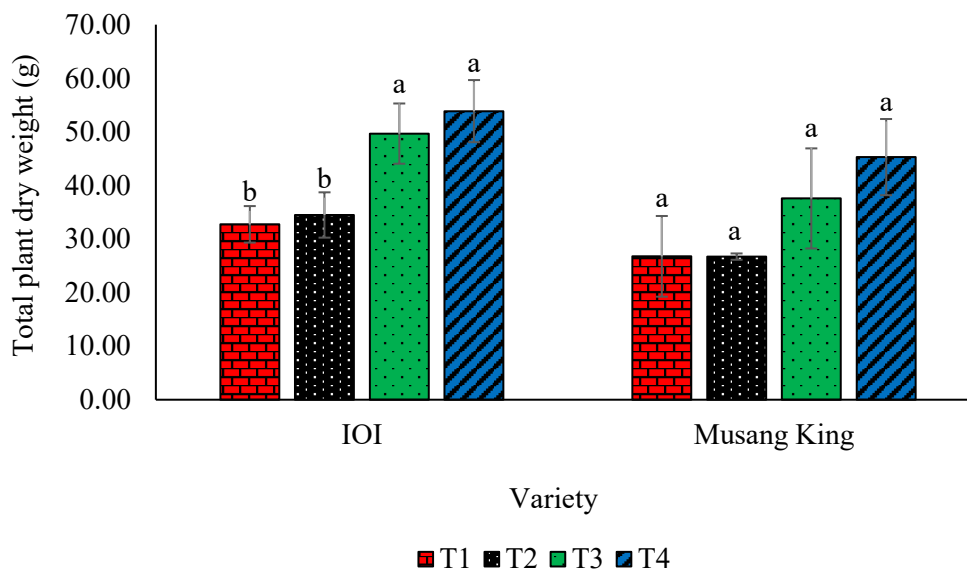


Figure 2. Effect of different rates of fertilizers (T1: NPK 2.5g, T2: NPK 5g, T3: NPK 7.5g, and T4: NPK 10g) on the total plant dry weight under both varieties.

Next, for the N, K, and Mg uptake of the IOI variety, seedlings treated with T4 (NPK 10 g) showed the highest N, K, and Mg uptake, compared to T2 (NPK 5 g) and T1 (NPK 2.5 g), which recorded the lowest N, K, and Mg uptake (**Table 4**). The significant increase in total N, K, and Mg uptake, as well as a considerable rise in total plant dry weight for the IOI variety, which is associated with Ngala *et al.* (2021), which shows that the increased nutrient input improves both nutrient uptake and dry matter accumulation. Both analysis findings suggest that for the IOI variety, T3 (NPK 7.5 g) was an adequate rate as it was not significantly different from T4 (NPK 10 g).

Table 3: Total nutrient content of durian seedlings under different varieties and fertilizer treatments.

Variety	Treatment	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium
----- (%) -----						
IOI	T1 (NPK 2.5g)	2.63 ± 0.14 ^b	0.22 ± 0.02 ^a	2.32 ± 0.07 ^a	2.61 ± 0.06 ^a	0.88 ± 0.03 ^a
	T2 (NPK 5g)	3.04 ± 0.08 ^a	0.19 ± 0.03 ^a	2.49 ± 0.07 ^a	2.70 ± 0.60 ^a	0.83 ± 0.08 ^a
	T3 (NPK 7.5g)	3.04 ± 0.05 ^a	0.18 ± 0.04 ^a	2.58 ± 0.11 ^a	2.12 ± 0.05 ^a	0.72 ± 0.01 ^a
	T4 (NPK 10g)	3.30 ± 0.06 ^a	0.18 ± 0.02 ^a	2.62 ± 0.14 ^a	2.41 ± 0.19 ^a	0.80 ± 0.04 ^a
MUSANG KING	T1 (NPK 2.5g)	2.93 ± 0.12 ^c	0.23 ± 0.05 ^a	2.33 ± 0.16 ^a	2.67 ± 0.14 ^a	0.91 ± 0.05 ^a
	T2 (NPK 5g)	3.21 ± 0.04 ^{bc}	0.19 ± 0.01 ^a	2.50 ± 0.11 ^a	2.70 ± 0.08 ^a	0.93 ± 0.04 ^a
	T3 (NPK 7.5g)	3.55 ± 0.10 ^{ab}	0.16 ± 0.02 ^a	2.64 ± 0.14 ^a	2.55 ± 0.16 ^a	0.85 ± 0.10 ^a
	T4 (NPK 10g)	3.62 ± 0.10 ^a	0.20 ± 0.01 ^a	2.80 ± 0.03 ^a	2.55 ± 0.08 ^a	0.90 ± 0.04 ^a

Notes: Values (mean ± SD) with the same letter within the same column are not significantly different by Tukey's Student Range (HSD) test at P<0.05

Based on **Table 5**, durian seedlings treated with T4 (NPK 10 g) had considerably greater total chlorophyll content (4.80 mg cm⁻² in the IOI variety and 4.37 mg cm⁻² in the Musang King variety), compared to T1 (NPK 2.5 g) and T2 (NPK 5 g). This increase could be due to a larger nitrogen supply from the fertilizer, as nitrogen is an important component in chlorophyll production. Khatun and Mollah (2023) confirmed similar findings, observing that NPK application boosted chlorophyll content in soybean plants when compared to other fertilizers. However, T3 (NPK 7.5 g) revealed no significant difference from T4 (NPK 10 g) in both types, implying that 7.5 g may be sufficient to produce equivalent chlorophyll accumulation without requiring a higher fertilizer rate.

Table 4: Total nutrient uptake of durian seedlings under different varieties and fertilizer treatments.

Variety	Treatment	Nitrogen (N) Uptake	Phosphorus (P) Uptake	Potassium (K) Uptake	Calcium (Ca) Uptake	Magnesium (Mg) Uptake
----- (g/plant) -----						
IOI	T1 (NPK 2.5g)	0.31 ± 0.04 ^c	0.03 ± 0.00 ^a	0.28 ± 0.04 ^b	0.31 ± 0.04 ^a	0.11 ± 0.01 ^b
	T2 (NPK 5g)	0.38 ± 0.06 ^{bc}	0.03 ± 0.00 ^a	0.31 ± 0.06 ^b	0.31 ± 0.04 ^a	0.10 ± 0.01 ^b
	T3 (NPK 7.5g)	0.56 ± 0.06 ^{ab}	0.03 ± 0.01 ^a	0.47 ± 0.07 ^a	0.40 ± 0.06 ^a	0.13 ± 0.01 ^{ab}
	T4 (NPK 10g)	0.65 ± 0.07 ^a	0.03 ± 0.00 ^a	0.51 ± 0.04 ^a	0.49 ± 0.08 ^a	0.15 ± 0.01 ^a
MUSANG KING	T1 (NPK 2.5g)	0.30 ± 0.11 ^a	0.02 ± 0.01 ^a	0.24 ± 0.10 ^a	0.27 ± 0.10 ^a	0.09 ± 0.03 ^a
	T2 (NPK 5g)	0.30 ± 0.02 ^a	0.02 ± 0.00 ^a	0.25 ± 0.03 ^a	0.27 ± 0.01 ^a	0.09 ± 0.00 ^a
	T3 (NPK 7.5g)	0.50 ± 0.13 ^a	0.02 ± 0.01 ^a	0.37 ± 0.10 ^a	0.39 ± 0.11 ^a	0.11 ± 0.02 ^a
	T4 (NPK 10g)	0.65 ± 0.11 ^a	0.03 ± 0.01 ^a	0.45 ± 0.08 ^a	0.43 ± 0.07 ^a	0.14 ± 0.02 ^a

Notes: Values (mean ± SD) with the same letter within the same column are not significantly different by Tukey's Student Range (HSD) test at P>0.05

Table 5: Effect of different fertilizer rates and durian seedling varieties on chlorophyll a (Chl_a), chlorophyll b (Chl_b), and total chlorophyll content (Chl_{a+b}).

Variety	Treatment	Chl _a (mg cm ⁻²)	Chl _b (mg cm ⁻²)	Total Chlorophyll (Chl _{a+b}) (mg cm ⁻²)
IOI	T1 (NPK 2.5g)	2.34 ± 0.34 ^b	0.83 ± 0.04 ^b	2.78 ± 0.32 ^b
	T2 (NPK 5g)	2.38 ± 0.10 ^b	0.85 ± 0.11 ^b	2.83 ± 0.17 ^b
	T3 (NPK 7.5g)	2.76 ± 0.39 ^{ab}	0.89 ± 0.15 ^b	3.20 ± 0.47 ^{ab}
	T4 (NPK 10g)	4.03 ± 0.10 ^a	1.46 ± 0.13 ^a	4.80 ± 0.20 ^a
Musang King	T1 (NPK 2.5g)	1.70 ± 0.22 ^b	0.63 ± 0.07 ^b	2.04 ± 0.16 ^b
	T2 (NPK 5g)	2.30 ± 0.45 ^{ab}	0.66 ± 0.09 ^b	2.59 ± 0.47 ^b
	T3 (NPK 7.5g)	2.64 ± 0.05 ^{ab}	0.80 ± 0.06 ^{ab}	3.01 ± 0.08 ^{ab}
	T4 (NPK 10g)	3.77 ± 0.26 ^a	1.23 ± 0.20 ^a	4.37 ± 0.37 ^a

Notes: Values (mean ± SD) with the same letter within the same column are not significantly different by Tukey's Student Range (HSD) test at P>0.05.

CONCLUSION

In conclusion, the growth performance of durian seedlings responded differently to varying rates of NPK fertilizer (2.5 g, 5 g, 7.5 g, and 10 g) depending on the variety. The IOI variety was more responsive to fertilizer application, with significant gains in total plant dry weight, total plant nitrogen, potassium, and magnesium uptake, and total chlorophyll content. Based on these data, an NPK rate of 7.5 g (T3) appears to be the best option for IOI seedlings, as it produced equivalent outcomes to the maximum rate (10 g) while requiring less fertilizer. In contrast, the Musang King variety exhibited a limited response across most parameters, with no significant differences across treatments. This indicates that a lower NPK rate of 2.5 g (T1) was enough throughout the nursery stage. These findings emphasize the need to use variety-specific fertilizer management systems in durian nurseries to maximize nitrogen consumption and increase seedling growth performance without affecting environmental sustainability. Future research should look into how other durian cultivars respond to different NPK fertilizer rates, as varietal differences can affect nutrient uptake and growth performance. Furthermore, a longer nursery period should be considered to better examine the growth response. Further research into nitrogen partitioning and root development could provide a better understanding of varietal differences in fertilizer responsiveness. These investigations would help to improve fertilizer management tactics for durian seedling production.

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