

Fertilizer practices and soil properties in durian orchards during the fruit-bearing stage: A case in Cai Lay district, Tien Giang province

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ARTICLE INFO	ABSTRACT
Research Paper Received: February 01, 2024 Revised: February 29, 2024 Accepted: March 13, 2024 Keywords Durian orchard Fertilizer practices Fruit-bearing stage Soil properties *Corresponding author Thai Nguyen Diem Huong Email: tndhuong@hcmuaf.edu.vn	This research aimed to assess the fertilizer practices during the fruit-bearing stage of durian cultivation. A total of 60 durian farmers in Cai Lay district were interviewed using structured questionnaires. Subsequently, 20 soil samples (0 - 50 cm) were collected from durian orchards post-harvest to analyze basic physical-chemical properties. Findings revealed substantial variation in fertilizer utilization among durian orchards in the Cai Lay district, Tien Giang province, with 68.18% employing imported organic fertilizers. The application of inorganic fertilizers displayed an imbalanced pattern, notably characterized by excessive phosphorus supplementation. Primary use of inorganic fertilizers was in the form of multi-macronutrient (NPK) formulations, strategically applied during critical developmental stages, including new shoot emergence, flowering, and fruit development. The practice of incorporating lime, applied as limestone directly to the soil surface post-harvest, combined with extensive chemical fertilizer use, led to be acidic to very acidic soil. The soil analysis indicated that the soil in the durian orchards prominently exhibited a heavy mechanical composition classified as clay, clay loam and loam. Despite farmers' attention to applying organic fertilizer on durian, the content of organic matter in the soil remained low (1.4 - 3.8%). The soil in the study area demonstrated varying levels of total and available nutrients, with total nitrogen ranging from 0.15% to 0.25%, total potassium (K₂O) from 1.7% to 1.9%, and exchangeable K from 0.4 to 0.8 meq/100 g. Additionally, exchangeable calcium ranged from 5.5 to 9.5 meq/100 g, and exchangeable magnesium from 1.7 to 3.7 meq/100 g. The phosphorus content was notably high, with total phosphorus ranging from 0.13% to 0.23% and available phosphorus from 39.4 to 81.6 mg/100g. Cation exchange capacity varied from low to medium, spanning from 11.6 to 19.8 meq/100 g.

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1. Introduction

Durian (*Durio zibethinus* Murr.), a key fruit crop earmarked for strategic plan until 2030 according to the Ministry of Agriculture and Rural Development (MARD, 2022), holds particular significance in the Mekong River Delta. Tien Giang province, hosting the largest durian cultivation area in the region, notably in Cai Lay district, has demonstrated its pivotal role, encompassing 9,125 ha in 2019 and standing as the oldest durian cultivation area in Tien Giang (MARD, 2021). In optimizing durian productivity, meticulous attention to fertilization practices, alongside cultivar selection and pest management, play a critically important role. Despite the presence of fertilizer programs designed for durian cultivation, significant disparities persist owing to variables such as soil characteristics, sites, cultivar diversity, and the age of the trees. This variety is noticeable in recommendations from distinct sources, including SOFRI (2003), MARD (2021) in Vietnam, Somsri (2008) and Salakpetch (2000) in Thailand. As a result, farmers striving for increased durian fruit productivity often engage in excessive fertilizer application. This practice not only jeopardizes nutrient absorption by plants but also leads to soil pollution and heightened greenhouse gas emissions (Serpil, 2012; Chali, 2023). Therefore, the objectives of the research were to investigate fertilizer application patterns in Cai Lay district, Tien Giang province and to assess the nutritional status of durian soil through both soil physical and chemical analysis.

2. Materials and Methods

2.1. Surveying the fertilizer practices on durian orchards in Cai Lay district, Tien Giang province

Sites: Tam Binh, Ngu Hiep, and Long Tien communes which have large areas of bearing durian orchards in the district (over 1,400 ha) were chosen as the survey sites.

Orchards: The orchards selected randomly for inclusion in this study comprise durian cultivation sites currently in the bearing stage, possessing a minimum area of 2,000 m². Furthermore, these orchards are requisite to possess a minimum of seven years of experiential expertise in the cultivation of durian.

Survey method: The survey employed direct interviews with farmers utilizing pre-prepared questionnaire forms. The survey encompassed inquiries into general farmer information, specifics regarding fertilizer dosage, type, and the timing of application.

Number of participating farmers: The study involved interviews with a total of 60 farmers, distributed across different communes, including 30 farmers from Tam Binh, 20 from Ngu Hiep, and 10 from Long Tien. Each farmer completed an individual survey form.

2.2. Assessing properties of durian growing soil in Cai Lay, Tien Giang province

Selected sites for soil sampling:

In accordance with survey findings, a randomized selection was undertaken to identify 20 durian orchards aged between 17 and 21 years. The selected orchards exhibited a uniform utilization of fertilizers at a standard level within the local context. Soil samples were collected from the orchards owned by the surveyed farmers. Specifically, orchards in the post-harvest stage, yet to undergo fertilization for the forthcoming crop, were chosen as the sampling units.

Soil sampling procedure:

For each durian orchard, five samples corresponding to five distinct trees, were randomly selected within the orchard using a zig-zag pattern. Each tree contributed subsamples from four positions situated in four different directions, extracted from the soil layer from 0 to 50 cm. During the sampling process, the topsoil layer (0 - 2 cm) was carefully removed to eliminate any residual plant material. A sterilized auger, treated with alcohol as per established protocols, was utilized to extract soil samples

at a depth of 0 to 50 cm, specifically at $\frac{3}{4}$ of the canopy diameter (Masri, 1991). Subsequently, the collected subsamples from each tree were mixed to form a composite 1-kg sample. Immediate transportation to the laboratory ensued following collection, where samples were stored in a dry environment, placed within labeled zip bags, clearly denoting the site and specific sampling location, in accordance with established procedures (Forster, 1995). General information about 20 orchards collecting soil samples is shown in Table 1.

Table 1. General information of soil sampling orchards

Number	Commune	Location	Age of durian (year)	Number	Commune	Location	Age of durian (year)
1	Tam Binh	10°19'11,8"N, 106°9'13,2"E	18	11	Ngu Hiep	10°18'15,8"N, 106°9'38,4"E	17
2	Tam Binh	10°19'17,2"N, 106°9'10,4"E	20	12	Ngu Hiep	10°18'4,5"N, 106°9'1,4"E	17
3	Tam Binh	10°19'11,5"N, 106°9'7,9"E	18	13	Ngu Hiep	10°18'9,2"N, 106°8'36,8"E	21
4	Tam Binh	10°19'12,8"N, 106°9'4,7"E	20	14	Ngu Hiep	10°18'2,8"N, 106°6'27,2"E	20
5	Tam Binh	10°19'20,1"N, 106°9'14,7"E	21	15	Long Tien	10°20'45,6"N, 106°9'39,5"E	18
6	Tam Binh	10°19'28"N, 106°9'4,3"E	21	16	Long Tien	10°21'22,7"N, 106°9'4,5"E	17
7	Tam Binh	10°19'36,2"N, 106°9'12,3"E	19	17	Long Tien	10°19'59,2"N, 106°9'43,3"E	19
8	Ngu Hiep	10°17'30,9"N, 106°8'50,5"E	21	18	Long Tien	10°20'47,6"N, 106°9'0,8"E	20
9	Ngu Hiep	10°17'39,2"N, 106°9'9,4"E	19	19	Long Tien	10°21'7,1"N, 106°9'26,5"E	20
10	Ngu Hiep	10°17'36,9"N, 106°7'6,9"E	18	20	Long Tien	10°20'30,1"N, 106°9'12,5"E	19

Soil properties measurement.

The soil analysis, incorporating both physical and chemical assessments, was conducted in adherence to established procedures. The following standard methods were employed:

Soil texture was determined using a hydrometer (Lavkulich, 1981; Gee & Bauder, 1986). Soil pH was measured using a pH meter. Organic matter content was assessed using the Walkley-Black method (FAO & GLOSOLAN, 2019). Total nitrogen was quantified using the Kjeldahl method (FAO & GLOSOLAN, 2021). Total phosphorus was analyzed using the Olsen & Sommer method (1982), while available phosphorus content was determined using the Bray & Kurtz P-1 method (1945). Total potassium was measured using a Flame photometer. Exchangeable potassium, calcium, and magnesium were quantified using Atomic Absorption Spectrophotometry (FAO & GLOSOLAN, 2022). Cation exchange capacity (CEC) was assessed using the ammonium acetate method at pH = 7 (FAO & GLOSOLAN, 2022).

Data analysis

The collected data were analyzed by Microsoft Excel software. Standard deviation was employed as a statistical measure to categorize and group certain survey information, ensuring a robust and systematic approach to data examination.

3. Results and Discussion

3.1. Information about the durian orchards

In Cai Lay district, a major durian-growing region in Tien Giang province, farmers tend to have relatively small durian orchards (less than 6,000 m²). Because of their limited area, meticulous agricultural practices, including fertilization, fruit thinning, and pesticide

application, are consistently employed by farmers to ensure the optimal care of their durian trees. An examination of the age distribution of durian orchards in the region reveals a noteworthy distribution, with approximately 50% falling within the 16 to 20 years age bracket. Additionally, a substantial portion (26.67%) is observed in the 20 to 22 years age category, while the remaining orchards are younger, aged below 16 years (Table 2). The economic significance of durian in Cai Lay is evident, particularly during the fruit-bearing stage when market prices are favorable, underscoring the role of durian as a primary income source for local farmers. The Ri6 cultivar emerges as the predominant choice among durian cultivators in Cai Lay, with 20% exclusively cultivating this variety. Moreover, a significant proportion (66.67%) engage in intercropping, combining the Ri6 with the Monthong cultivar, while 11.67% concurrently intercrop the Ri6 with both Monthong and Chuong Bo cultivars. The appeal of Ri6 durian in the market is attributed to its distinctive features, including yellow flesh and a flat seed.

Significant variations in durian planting spacing were notable among orchards, ranging from 9 x 9 m to 5 x 5 m, corresponding to tree densities of 120 - 400 trees per ha. The 7 x 7 m planting spacing was most prevalent, accounting for 33.33% of cases, followed by 6 x 6 m and 8 x 8 m, utilized by 21.67% and 20% of farmers, respectively. The "Others" category, comprising alternative planting spacings, predominantly featured the 6.5 x 6.5 m configuration. Notably, the durian planting spacing observed in the sites appeared to be narrower and characterized by high tree density comparing with durian cultivation in Southeast and Central Highland provinces.

Table 2. General information about durian orchards

Parameters	Level	Orchard (%)
Area (m ²)	< 6,000	46.67
	6,000 - < 9,000	30.00
	≥ 9,000	23.33
	Mean: 6,233.33; SD: ± 2,757.83; Min: 2,000; Max: 15,000	
Tree age (year)	< 16	23.33
	16 - < 20	50.00
	≥ 20	26.67
	Mean: 15.88; SD: ± 4.23; Min: 7; Max: 22	
Cultivar	Ri 6	20.00
	Ri 6 + Monthong	66.67
	Monthong + Chuong bo	1.67
	Ri 6 + Monthong + Chuong bo	11.67
Tree spacing (m x m)	6 x 6	21.67
	7 x 7	33.33
	8 x 8	20.00
	Others	25.00

3.2. Lime application practices in durian orchards in Cai Lay district, Tien Giang province

Within the agroecosystem of the region, the conscientious implementation of lime application practices in durian cultivation is a remarkable aspect of agricultural management. Survey outcomes revealed a pervasive adherence to lime application among durian farmers, with a 100% prevalence rate. This annual practice is consistently executed during the post-harvest stage and primarily entails the widespread distribution of lime onto the soil. Lime dosage ranged from 1.5 to 4.5 kg/tree per year, typically

falling within the range of 2 to 3 kg/tree per year. It was predominantly administered in the form of limestone. Especially, a subset of durian farmers (21.7%) opted for the application of quicklime (CaO) at a lower dosage of approximately 2 kg per tree annually and the number of farmers in Long Tien commune who used this type was higher than in other communes (Table 3). However, a subsequent field assessment conducted one year post-lime application unveiled a significant residual presence of undissolved lime, particularly notable in cases where limestone was employed. This observation underscores the inefficacy of limestone-based applications.

Table 3. Lime application practices in durian orchards across various communes in Cai Lay district, Tien Giang province

Lime dosage (kg/tree per year)	Proportion of farmers (%) used			
	Tam Binh	Ngu Hiep	Long Tien	Mean
≤ 2	26.7	10.0	30.0	21.7
$> 2 - 3$	50.0	50.0	60.0	51.7
> 3	23.3	40.0	10.0	26.6

3.3. Fertilizer utilization for durian in Cai Lay district, Tien Giang province

3.3.1. Organic fertilizer

In alignment with contemporary development emphasizing green and sustainable agricultural practices, the application of fertilizers has garnered substantial attention, particularly within the context of high-value crops such as durian. Additionally, it is essential to ensure that the concentration of soil organic matter remains above the threshold level in order to enhance soil quality (Dadi & Damtev, 2021). Survey results underscored the popular integration of organic fertilizer among durian farmers in the region, with a full adoption rate of 100%. The selection of organic fertilizers employed exhibited remarkable diversity, comprising 22 distinct types. A predominant proportion (68.18%) was sourced from international markets, while the remaining 31.82% originated from local entities with longstanding presence in the domestic market. Noteworthy variations surfaced among durian farmers concerning the selection and application of organic fertilizers. The array of

organic fertilizers utilized exhibited considerable heterogeneity. The Table 4 shows at Tam Binh commune, there was 33.3% of farmers applied Organic Booster fertilizer to durian orchards. Meanwhile, the farmers at Ngu Hiep commune were interested in using organic fertilizer on durian, the common organic fertilizer in Cai Lay district was applied by 20 - 30% of farmers with Black Bounce fertilizer was the most common (30.0% of farmers used). At Long Tien commune, 60.0% of farmers used imported chicken manure from Japan and 50% of farmers employed Super Humic fertilizer from Hop Tri company on their durian orchards.

The majority of farmers employed one to three types annually. Moreover, the frequency of organic fertilizer application displayed considerable variance, averaging between 3 to 7 times per year. Each fertilizer type was specifically applied at different stages; cow manure, for example, was mainly used after harvest, while other organic fertilizers were strategically applied during the new shoot stage or at the beginning of the rainy season.

Table 4. Types of organic fertilizer used in durian across various communes in Cai Lay district, Tien Giang province

Types of organic fertilizer	Composition	Origin	Proportion of farmers (%) used			
			Tam Binh	Ngu Hiep	Long Tien	Mean
Con Ca	22% OM (organic matter), 5% N, 2% P ₂ O ₅ , 2% K ₂ O, 2% humic acid	ADC fertilizer factory	6.7	20.0	30.0	15.0
Cow manure		Domestic	16.7	10.0	10.0	13.3
Bat guano		Domestic	20.0	25.0	20.0	21.7
Bounce Back	≥ 40% OM, 2% N, 2% P ₂ O ₅ , 2% K ₂ O	Australia	10.0	30.0	0.0	15.0
Hop Tri Super Humic	70% Humic acid	Hop Tri Investment Corporation	16.7	20.0	50.0	23.3
Fertiplus 65 OM	65% OM, 3.5% N, 2% K ₂ O, C/N: 12	Netherland (Imported and distributed by Vinh Thanh Trading Company Limited)	13.3	20.0	10.0	15.00
Chicken manure	≥ 60% OM	Japan (Imported by many companies)	16.7	20.0	60.0	23.3
Organic Booster	65% OM, 2% N, 2% P ₂ O ₅ , 2.9% K ₂ O	Australia (Distributed by TOBA Company Limited)	33.3	25.0	10.0	26.7

3.3.2. Inorganic fertilizer

The incorporation of inorganic fertilizers holds pivotal significance in the cultivation of crops, with particular relevance to durian cultivation. Inorganic fertilizers play a crucial role in delivering timely and efficient nutrient supply to plants (Omidire et al., 2015). Yet, it is crucial to recognize that improper use of inorganic fertilizers may undermine their effectiveness in promoting plant growth. The survey results underline the widespread reliance on inorganic fertilizers among durian farmers in the research region. Farmers reported utilizing approximately 3 to 5 distinct types of inorganic fertilizers within a single fruit crop, corresponding to a one-year

cycle. Despite the diversity in fertilizer types, the frequency of fertilization events was notably high, ranging from 9 to 16 times per year, with certain farmers engaging in as many as 22 times (at an interval of once every 15 days). This rigorous fertilization routine exemplifies significant dedication and enthusiasm demonstrated by durian farmers in Cai Lay district, Tien Giang province, towards the cultivation and nurturing of durian trees. This heightened interest may be attributed, in part, to the elevated market price of durian fruit in recent years, prompting farmers to make considerable investments in both financial resources and labor efforts to ensure the optimal growth and development of durian trees within their orchards.

Table 5. Types of inorganic fertilizer used in durian across various communes in Cai Lay district, Tien Giang province

Types of fertilizer	Composition	Proportion of farmers (%) used			
		Tam Binh	Ngu Hiep	Long Tien	Mean
DAP	18% N, 46% P ₂ O ₅	83.3	45.0	40.0	63.3
NPK 12 - 12 - 17	12% N, 12% P ₂ O ₅ , 17% K ₂ O	36.7	5.0	20.0	23.2
NPK 15 - 15 - 15	15% N, 15% P ₂ O ₅ , 15% K ₂ O	36.7	50.0	30.0	40.0
NPK 16 - 16 - 16	16% N, 16% P ₂ O ₅ , 16% K ₂ O	16.7	40.0	50.0	30.0
NPK 20 - 10 - 10	20% N, 10% P ₂ O ₅ , 10% K ₂ O	30.0	15.0	30.0	25.0
Superphosphate	16% P ₂ O ₅ , 10% S, 15% Ca	23.3	40.0	60.0	35.0
YaraMila Complex	12% N, 11% P ₂ O ₅ , 18% K ₂ O, 2.65% MgO, 19.9% SO ₃ , 0.02% Zn, 0.015% B	43.3	35.0	40.0	40.0
YaraLiva Nitrabor	15.4% N, 26% CaO, 0.3% B	40.0	25.0	30.0	33.3

A comprehensive exploration of inorganic fertilizer practices among durian cultivators in Cai Lay district, Tien Giang province, revealed there were 20 inorganic fertilizers used for durian. Diammonium Phosphate (DAP) emerged as the predominant choice, constituting 63.3% of the overall usage, with a significant concentration observed in Tam Binh commune, where 83.3% of durian farmers utilized this fertilizer (Table 5). DAP was initially utilized for flowering treatment although some farmers extended its application to fulfill nutritional needs throughout the flowering and fruit growth phases. The survey also highlighted a substantial reliance on superphosphate, employed regularly by 60.0% of farmers at Long Tien commune to aid in the differentiation of durian flower buds. Consequently, inadvertent soil acidification resulting from this practice was noted, adversely affecting soil pH. The NPK fertilizers, owing to their convenience, were prominently favored in the region with YaraMila Complex (utilized by 40% of farmers) and NPK 15 - 15 - 15 being the most employed types.

The Table 6 shows the farmers at three communes of Cai Lay district applied nitrogen, phosphorus and magnesium to durian at the same level but there was a difference in dosage of potassium and calcium used. Specifically, the dose of potassium was applied to durian at the lowest at Tam Binh commune, while calcium was employed at the highest level at Ngu Hiep commune when comparing the three communes. Farmers engaged in comprehensive fertilization, incorporating nitrogen, phosphorus, potassium, calcium and magnesium. However, a notable disparity was observed in nutrient proportions when compared to established research by Ng & Thamboo (1967) and Jamil (1966). This may be attributed to the elevated amount of phosphorus applied to durian during the reproductive stage in Cai Lay, Tien Giang province. These inorganic fertilizers were predominantly applied during the shoot, flower, and fruit growth stages (Table 6).

Table 6. Status of fertilizer application in durian across various communes in Cai Lay district, Tien Giang province

Element	Dosage (kg/tree per year) *				Time of fertilization
	Tam Binh	Ngu Hiep	Long Tien	Mean	
N	1.15 ± 0.21	1.27 ± 0.38	1.24 ± 0.39	1.21 ± 0.31	Shoot, flower, fruit growth
P ₂₀ 5	1.41 ± 0.1	1.41 ± 0.49	1.55 ± 0.48	1.44 ± 0.50	Shoot, flower induction, flower and fruit growth
K ₂ O	0.67 ± 0.27	0.87 ± 0.28	0.80 ± 0.29	0.76 ± 0.29	Shoot, flower, fruit growth
CaO	0.78 ± 0.35	0.62 ± 0.39	0.85 ± 0.29	0.73 ± 0.36	Flower, fruit growth
MgO	0.54 ± 0.21	0.58 ± 0.20	0.54 ± 0.47	0.55 ± 0.25	Flower, fruit growth

* Account for famers using inorganic fertilizers; Mean ± SD.

3.4. Properties of durian growing soil in Cai Lay, Tien Giang province

Table 7. Physical and chemical properties of durian growing soil across various communes in Cai Lay district, Tien Giang province

Parameter	Tam Binh	Ngu Hiep	Long Tien	Mean
Texture				
- Sand (%)	29.5 ± 7.3	36.2 ± 5.6	28.3 ± 7.5	31.5 ± 7.4
- Silt (%)	23.8 ± 4.9	38.1 ± 4.7	30.0 ± 5.6	30.7 ± 7.8
- Clay (%)	46.7 ± 6.4	25.7 ± 3.7	41.7 ± 12.6	37.8 ± 12.1
pH _{H₂O} (1:5)	5.0 ± 0.4	5.1 ± 0.4	5.0 ± 0.3	5.1 ± 0.4
Organic matter (%)	2.4 ± 1.0	3.0 ± 1.4	2.2 ± 1.1	2.6 ± 1.2
N (%)	0.15 ± 0.07	0.23 ± 0.03	0.21 ± 0.02	0.20 ± 0.05
C/N	12.3 ± 9.8	7.5 ± 3.0	6.1 ± 3.1	8.8 ± 6.6
P (%)	0.15 ± 0.03	0.20 ± 0.06	0.21 ± 0.05	0.18 ± 0.05
K ₂ O (%)	1.9 ± 0.1	1.8 ± 0.1	1.8 ± 0.1	1.8 ± 0.1
P (mg/100 g)	50.1 ± 16.5	68.5 ± 21.9	63.2 ± 23.2	60.5 ± 21.1
K ⁺ (meq/100 g)	0.5 ± 0.1	0.7 ± 0.2	0.6 ± 0.2	0.6 ± 0.2
Ca ²⁺ (meq/100 g)	7.7 ± 1.5	7.3 ± 2.5	7.5 ± 2.3	7.5 ± 2.0
Mg ²⁺ (meq/100 g)	3.0 ± 1.1	1.9 ± 0.4	3.3 ± 1.0	2.7 ± 1.0
CEC (meq/100 g)	16.8 ± 5.1	14.3 ± 2.6	16.0 ± 4.4	15.7 ± 4.1

Mean ± SD; CEC: cation exchange capacity.

The examination of physical and chemical properties in durian growing soil of the research region, plays a pivotal role in understanding the factors influencing crop growth, yield, and quality. These properties are intricately linked to both inherent soil characteristics and anthropogenic interventions, including fertilization, liming, and watering practices. Table 7 shows the distribution of three soil textures across the investigated communes in Cai Lay district, based on USDA classifications (1960): clay (accounting for 45%), clay loam (30%) and loam (25%). Clay texture is predominant in Tam Binh commune, while clay loam texture is commonly found in Long Tien commune, and loam texture is observed in Ngu Hiep commune. The heavy

mechanical composition soil characteristics confer compactness, water and nutrient retention capabilities, albeit with compromised hydraulic conductivity and slow drainage (Phogat et al., 2015; Abdulkadir, 2016; Al-saeedi, 2022).

The active acidity of durian soil, expressed through pH values (pH_{H₂O}), exhibited a spectrum from very acidic to slightly acidic (Slavich & Petterson, 1993). Although lime and fertilizer usage among durian farmers varied among the communes, pH values did not differ. This is partly due to the inappropriate use of fertilizers. For instance, the proportion of farmers in Long Tien commune using quicklime is high, but the use of superphosphate or extensive use of inorganic fertilizers raises concerns about

potential generation upon the release of acid ions into the soil (Jote, 2023). Besides, a large amount of undissolved limestone remaining on the soil surface also partly affects its pH-improving effect in durian soil.

Soil organic content exhibited significant variation, ranging from low to high levels (organic matter from 0.89% to 5.71%) (Rayment & Lions, 2011). Despite 100% of farmers applying organic fertilizer (Table 3), the organic matter content remained predominantly low, potentially due to high rates of organic mineralization in the soil, as indicated by total N content predominantly at good and high levels (Swangjang, 2015). The average C/N ratio of 8.8 suggests a heightened decomposition rate of organic matter, possibly attributed to microbial activity converting organic materials into nitrogen-containing compounds (Mot et al., 2021). Especially, the average C/N ratio in soil samples collected in Long Tien commune was the lowest among the three communes, possibly due to applying a large amount of chicken manure to the soil (Rayment & Lions, 2011).

The analysis divulged that total and available phosphorus, total potassium in the soil recorded at high levels, while exchangeable potassium was at medium to high. Specifically, the exchangeable potassium content in the soil in Ngu Hiep commune was higher than in the other two communes, consistent with the results of the farmer survey; durian farmers in Ngu Hiep commune applied potassium at a higher dose (Table 6). In particular, the use of phosphorus to stimulate durian flower production and the application of NPK throughout durian crop led to a substantial increase in both total and available phosphorus content in the soil. The results showed that the content of available potassium,

calcium and magnesium was at medium level. Consequently, cation exchange capacity (CEC) in soil was at medium level, about 15.7 meq/100 g (Rayment & Lions, 2011).

4. Conclusions

Despite the evident interest among durian farmers in Cai Lay toward the application of organic fertilizers, the prevalence of durian orchards characterized by high organic matter content remains disproportionately low. The existing scenario is further compounded by the consequences of unbalanced fertilization practices, using a large amount of phosphorus to induce durian to flower. The analytical results indicated prominently a heavy mechanical composition of durian growing soil classified as clay and clay loam. The soil analysis also revealed a low pH, a medium level of CEC, with the content of total and available nutrients exhibiting variations from medium to high levels. In particular, the content of total and available phosphorus were at high level in durian soil at the post-harvest stage. Given these findings, targeted interventions are essential to enhance soil conditions by applying lime and organic fertilizer. The primary focus should encompass pH improvement and a meticulous adjustment of the fertilizer formula tailored specifically for durian cultivation.

This comprehensive understanding provides a foundation for implementing strategic soil management practices, ensuring a more favorable environment for durian cultivation. By addressing the identified challenges, durian farmers in Cai Lay, Tien Giang province can enhance both the quality and yield of their crops, contributing to the overall sustainability and success of durian cultivation in the region.

Conflict of interest

The authors have no conflicts of interest to declare.

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