Pertanika J. Trop. Agric. Sci. 49 (3): 1269 - 1283 (2026)

TROPICAL AGRICULTURAL SCIENCE

Journal homepage: http://www.pertanika.upm.edu.my/

Influence of NPK Compound Fertiliser Fertigation on Guava Fruit Yield and Quality in Nghe An Province, Vietnam

Hien Huu Nguyen[1]*, Hai Minh Hoang[2], Athakorn Promwee[3], Mai Thanh Thi Nguyen[1], and Thuy Nguyen Thi[1]

[1]*School of Agriculture and Natural Resources, Vinh University, 182 Le Duan Street, Truong Thi Ward, Vinh City, 461010 Nghe An Province, Vietnam*

[2]*Khang Thinh Irrigation Technology Joint Stock Company, A1 Street 672, Quarter 1, Phuoc Long B Ward, Thu Duc City, Nghe An Province, 46000 Vinh, Vietnam*

[3]*School of Agricultural Technology and Food Industry, Walailak University, 80160 Nakhon Si Thammarat, Thailand*

ABSTRACT

Nitrogen (N), phosphorus (P), and potassium are the most important macronutrients for plants, particularly for guava trees, which are in the flowering, fruiting stage, and fruit development. The objective of this research was to determine the impact of levels of NPK compound Fertiliser applied via irrigation system on guava fruit yield and quality. The experiment was set up in a randomised complete block design with seven treatments and three replications. The NPK compound Fertiliser (19-19-19 + 3CaO + Te) was applied through drip irrigation according to six levels of treatment (Fertiliser amounts of 400, 600, 800, 1000, 1200, and 1400 g/plant/year) and control. The number of flowers, yield components, and quality parameters were measured. The results demonstrated that fertigation with 1000 g/plant/year of NPK compound Fertiliser led to significant increases of the fruits set (168.5 fruits/plant), haverst fruits (91.8 fruits/plant), fruit weight (368.4 g), yield (22.5 tons/ha), pulp thickness (29.1 mm), core thickness (44.9 mm), fruit diameter (70.9 mm), fruit flesh weight ratio (76.6 %), and total soluble solids (9.8 %). The results can be used to develop technical standards to produce the best guava yield and quality under the ecological situation of Nghe An Province.

Keywords: Fertigation, guava, NPK compound fertiliser

ARTICLE INFO

Article history:
Received: 01 November 2025
Accepted: 08 June 2026
Published: 26 June 2026

DOI: https://doi.org/10.47836/pjtas.49.3.14

E-mail addresses:
hiennh@vinhuni.edu.vn (Hien Huu Nguyen)
hai.netafim@gmail.com (Hai Hoang Minh)
athakorn.pr@wu.ac.th (Athakorn Promwee)
maintt@vinhuni.edu.vn (Mai Thanh Thị Nguyen)
thuynt@vinhuni.edu.vn (Thuy Nguyen Thi)
* Corresponding author

e-ISSN: 2231-8542

INTRODUCTION

Guava (*Psidium guajava* L.) is one of the most popular fruit plants in Vietnam and the world. Guava fruit has high nutritional value with high vitamin C content (75-260 mg/100 g) and is a good source of thiamine (0.03-0.07 mg/100 g), riboflavin (0.02-0.04 mg/100 g), phosphorus (22.5-40 mg/100 g), calcium (10-30 mg/100 g), iron (20-25 mg/100 g), pectin (0.5-1.8%) and many antioxidants that help control blood pressure (Shukla et al., 2009). The Taiwanese pear guava was introduced to Vietnam last year. The guava is easy to grow and can be grown in various climatic and soil conditions in Vietnam. This variety has high yield and quality and produces 3-4 crops every year.

Guava plants start blooming and giving fruit at the same time; hence, it is important to meet their nutritional demands. Nitrogen (N), phosphorus (P), potassium (K) (Nutrients are called macronutrients), micronutrients, and secondary nutrients are essential for guava. Lack of these nutrients during the flowering period and fruit formation will affect yield and fruit quality. Increasing the level of NPK Fertiliser resulted in an increase in fruit set, fruit numbers/tree, and fruit weight (Khan et al., 2018). Successive increases in the rate of NPK fertilisation from 65:30:30 to 135:60:60 g/tree increased the number of fruits, fruit weight, diameter and fruit yield. The best fruit yield and fruit quality were obtained by applying NPK Fertiliser to guava plants at 135:60:60 g/plant (Thirupathi et al., 2016). Using inorganic, organic, and micronutrient Fertilisers resulted in significantly higher flowering, diameter, length, number of fruits, and fruit yield (Gupta et al., 2019). Guava plants' nutrient demands are influenced by both soil fertility (ability to provide nutrients) and plant population. When guava is grown at a planting distance of 2 × 1m, the recommended dosage for maximum yield and fruit quality is 400 g N, 200 g P_2O_5, and 200 g K_2O (Guleria & Singh, 2023). There is a lower requirement for each plant when the planting density is 3 x 3m (300 g N, 150 g P_2O_5, and 150 g K_2O) (Chavan et al., 2020). Applying Fertilisers through irrigation systems will ensure sufficient water and Fertiliser supplies to guava trees while reducing Fertiliser and labour costs. Drip irrigation significantly affects yield and guava fruit quality while reducing the cost of Fertilisers (Challa et al., 2021). Fertiliser application through irrigation using soluble Fertiliser decreased 25% of the Fertiliser used while maintaining guava yield and quality (Janaki et al., 2020).

One of the wards in Nghe An province with a large guava production is Tay Hieu. Applying soluble macronutrients, micronutrients, and trace elements through the irrigation system supplies water and nutrients constantly to ensure the continuous flowering and bearing of guava plants. Although there have been many studies on guava Fertilisers in Vietnam, the studies on the use of soluble complex Fertilisers via the irrigation system are scarce. Thus, the purpose of this study is to identify the optimal dose of NPK 19-19-19 + 3CaO + Te complex Fertiliser applied through a drip irrigation system to demonstrate high yield and quality production of the Taiwanese pear guava variety in the ecosystem of Nghe An province.

MATERIALS AND METHODS

Treatments and Experimental Design

The study was performed from October 2023 to October 2024 in the guava garden of Tay Hieu ward, Nghe An province (105.28°N, 19.10°E). The experiment was performed on Veti-Acric Ferralsol with soil with the chemical properties of the soil in Table 1, and the temperature, rainfall, and humidity during the experiment in Figure 1.

The reproductive success and yield of guava are heavily controlled by environmental factors, especially temperature and soil characteristics, which in turn affect the response to NPK compound Fertiliser on drip irrigation. This work combines the temperature inferred

Table 1
Soil chemical properties at the study site (0 - 20 cm depth)

Properties	Values	Properties	Values
pH (1: 2.5 soil water suspension)	4.71	DTPA-extractable Mn (mg/kg)	192
ECe (mS/cm)	0.283	DTPA-extractable Fe (mg/kg)	134
Organic Carbon (%)	0.7	DTPA-extractable Cu (mg/kg)	2.83
Total N (%)	0.12	Soil Texture	
Available P (mg/kg)	71.56	Sand (%)	32.0
Exchangeable K (mg/kg)	65.54	Silt (%)	23.0
Exchangeable Ca (mg/kg)	359	Clay (%)	45.0
Exchangeable Mg (mg/kg)	103	Soil classification	Veti-Acric Ferralsol
DTPA-extractable Zn (mg/kg)	3.56		

Note. Soil samples were analysed at the Centre for Environmental Analysis and Technology Transfer (CEATT), Vietnam Academy of Agricultural Sciences (VAAS), Hanoi, Vietnam

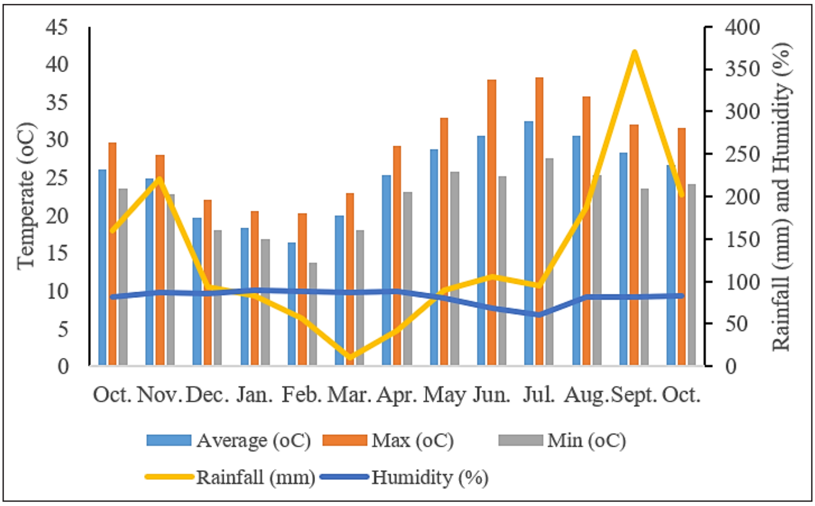

Figure 1. Temperature, rainfall and humidity during the study

from weather reports during the study conducted in Nghe An Province, Vietnam, and the estimated soil chemical properties inferred from the study's context (Figure 1 and Table 1). Temperatures optimal for flowering and fruiting (23-28 °C) decrease the reproductive potential of guava, which stunts the growing process at temperatures below 15.5 °C and substantially halts growth at -3 °C (Fischer & Melgarejo, 2021; Haokip et al., 2020).

Variations in temperature over time from suboptimal winter temperatures (Phase 2) to optimal summer temperatures (Phases 3-4) corresponded well with fruit set changes, respectively, lowest in Phase 2 and highest in Phases 3-4. There were no freezes (-3 °C), preventing severe damage, but Phase 2's lower temperatures (15-20 °C) likely caused growth inhibition, consistent with the 15.5 °C minimum metabolic temperature for guava (Haokip et al., 2020).

The experiment was conducted on a Taiwanese pear guava variety grafted onto wild guava rootstock. The plants were planted in 2018 with a planting density of 666 plants per hectare (3.0 m × 5.0 m). All of the orchards were managed in a standard way, including water stress management with drip irrigation, pruning, mowing, fruit wrapping, and disease control.

In this study, we applied a compound Fertiliser, NPK 19 (N)-19 (P) -19 (K) + 3CaO + Te from the Israeli company ICL. The Fertiliser has a nutritional composition of: Macronutrients: 19% N, 19% P_2O_5, 19% K_2O; secondary nutrients: 3% CaO; micronutrients (ppm): Fe: 400, Mn: 200, Zn: 100, Cu: 50, Mo: 50, Bo: 360. The second Fertiliser used was a base Fertiliser of composted cow manure from the Green Earth product line by Nong Sinh company.

A micro-irrigation system by Netafim, Israel (Dripnet PC 16150) was used for this study. It has a double line of drip heads, with a distance of 1 meter from the plant base. Emitters are 0.5 meters apart and have a flow rate of 1.0 litres/hour. With plants spaced 3 meters apart, 6 meters of irrigation line is dedicated to each plant (12 drip heads). Thus, each plant receives 12 litres/hour (12 drip heads×1.0 liter/hour/drip head).

The experiment was conducted in a randomised complete block design (RCB) with seven irrigation treatments and 3 replications. Each of the replications had 5 guava plants of similar age and canopy that were selected for data recording. In all, a total of 105 guava plants were used with a total plot size of 1,575 m^2. Details of experimental treatments are shown in Table 2.

Control (T7) follows local farming practices. The total Fertiliser applied per plant for each year is 940 g of N, 480 g of P_2O_5, and 840 g of K_2O. Fertilising for flowering: For each plant, apply 300 g of NPK 16-16-8 + Te (Cu: 100 ppm, Zn: 100 ppm) and 100 g of Urea. It must be applied just after pruning (October, 2023) to induce flowering. Fertilising for fruit: For each plant, apply 200 g of NPK 16-16-8 + Te, 100 g of Urea, and 100 g of KCl. Apply 1.5 months after the flowering fertilisation. Make the application every 15

Table 2
Fertiliser rates for experimental treatments

Treatment	Fertiliser Type	Amount of Fertiliser (g/plant /year)	Amount of Fertiliser (kg/ha/year)	Number of Irrigations/year	Amount of Fertiliser (g/15 plants/time)	Nutrient concentration (ppm)
T1	NPK 19-19-19+3CaO+TE	400	266.4	28	214.3	214.3
T2	NPK 19-19-19+3CaO+TE	600	399.6	28	321.4	321.4
T3	NPK 19-19-19+3CaO+TE	800	532.8	28	428.6	428.6
T4	NPK 19-19-19+3CaO+TE	1,000	666.0	28	535.7	535.7
T5	NPK 19-19-19+3CaO+TE	1,200	799.2	28	642.9	642.9
T6	NPK 19-19-19+3CaO+TE	1,400	932.4	28	750.0	750.0
T7 (Control)	Farmer practice					

days and the same weight for 10 applications during the experiment. Fertilising method: Excavate a trench around the canopy volume, 0.7 m from the trunk. Place Fertiliser in the groove and fill with soil.

Basal fertilisation: In October 2023, all formulas were fertilised with 22 kg of composted cow manure and 1 kg of lime powder per plant annually.

Pruning and shaping: Prune any diseased fruits and branches. Also, remove branches with excessive fruit, small branches, those near the ground, and excess branches in the canopy.

Bagging: When the guava fruit is 2.5-3 cm in diameter, wrap it with a foam and plastic bag with holes.

Water calculation for guava plants: all formulas were under the same drip irrigation system. The use of water was the same in all formulas, calculated and presented in Table 3.

Table 3
Calculation of water quantity for guava plants during the experimental period

Month. Year	ETo	KC	Etc	Efr	IWN1	IWN2	IWN3
Oct. 2023	110.2	0.6	66.1	63.0	3.1	31.2	4.9
Nov.2023	106.4	0.7	74.5	68.5	6.0	59.8	9.4
Dec. 2023	93.2	0.8	74.6	67.6	7.0	69.6	11.0
Jan. 2024	93.9	0.9	84.5	8.0	76.5	765.1	120.5
Feb. 2024	100.9	1.0	100.9	4.0	96.9	969.0	152.6
Mar. 2024	123.4	1.1	135.7	4.0	131.7	1317.4	207.5
Apr. 2024	133.0	1.2	159.6	2.0	157.6	1576.0	248.2
May. 2024	161.9	1.3	210.5	2.0	208.5	2084.7	328.3
Jun. 2024	171.2	1.3	222.6	5.0	217.6	2175.6	342.7
Jul. 2024	175.6	1.3	228.3	5.0	223.3	2232.8	351.7
Aug. 2024	133.2	1.2	159.8	48.8	111.0	1110.4	174.9
Sept. 2024	110.3	0.8	88.2	60.4	27.8	278.4	43.8
Oct. 2024	102.8	0.6	61.7	60.5	1.2	11.8	1.9

Note. ETo: Evapotranspiration (mm/month). KC: Crop coefficient. ETc: plant-water requirement (mm/month). Efr: Effective rainfall (mm/month). IWN1: Irrigation water need (mm/month). Irrigation water need: IWN2 (m^3/month/ha). Irrigation water need: IWN3 (m^3/month/1575.5 m^2)

Data Collection and Analysis

Five plants in each replication were used to collect data. So, 15 plants were surveyed per treatment. A total of 105 plants were used.

Number of Flowers per Plant

In each plant, four major branches in the canopy outer part were marked to monitor and record the number of flowers per plant during flowering periods

Number of Fruits per Plant

Count the number of fruits per plant in each harvest.

Fruit Set

The calculation for fruit set can be found in Equation 1.

$$\text{Fruit set (\%)} = \frac{\text{Number of fruits per plant}}{\text{Number of flowers per plant}} \times 100 \quad [1]$$

Average Yield per Plant (kg/plant)

Weigh all commercial fruits at each harvest and calculate the total during the experimental period.

Average Yield per ha (ton/ha)

Average yield (kg/plant) × plant density.

Fruit Drop

The calculation for fruit drop can be found in Equation 2.

$$\text{Fruit drop (\%)} = \frac{\text{Number of dropped fruits per plant}}{\text{Total number of fruits per plant}} \times 100 \quad [2]$$

Fruit Indicators

Select and harvest ripe fruit. The sample size for measurement is 2 fruits per plant, which totals 10 fruits per replication and 30 fruits per treatment

Average Fruit Weight (grams)

Weigh the selected fruit in each treatment using an electronic scale with an accuracy of ± 0.01 grams. Pulp thickness (mm): Cut the fruit lengthwise, then measure from the skin to the part adjacent to the fruit pulp and calculate the average value.

Fruit Flesh Weight Ratio

The calculation for fruit flesh weight ratio can be found in Equation 3.

$$\text{Fruit flesh weight ratio (\%)} = \frac{\text{Fruit flesh weight}}{\text{Fruit weight}} \times 100 \quad [3]$$

Total soluble solids (TSS) (%)

The guava fruits were selected, juice was extracted and measured using a portable refractometer AS ONE (Japan).

Statistical Analysis

All data were analysed using IRRISTAT version 5.0. One-way analysis of variance (ANOVA) was conducted to evaluate treatment effects, and mean differences were separated using the Least Significant Difference (LSD) test at a 5% significance level ($P \leq 0.05$).

RESULTS AND DISCUSSION

Flowering and Fruit Setting of Guava Plants

Flowering and fruit set performance are vital factors affecting productivity in fruit plants, including guava plants. Several factors, such as climate, management practices, and, importantly, macronutrient supply, affect the flowering and fruit set processes in guava plants (Rangare et al., 2025). Four phases of the flowering and fruiting process were detected in the guava plants: Phase 1 (November-December 2023), Phase 2 (January-February 2024), Phase 3 (April-May 2024), and Phase 4 (June-July 2024). The Least Significant Difference (LSD) test ($P < 0.05$) and low coefficient of variation (CV%, 1.1-8.9%) ensure statistical consistency and the precision of the data. Rates, which may be due to the chemically unbalanced NPK Fertilisers, are conducive to leaf and shoot development

Table 4 shows the effect of NPK Fertiliser on guava growth during four phases of flowering, about flowers/plant, fruits set/plant, and fruit set (%). During the first phase, the number of flowers per plant ranged from 36.9 to 50.2, and the number of fruits set per plant ranged from 17.4 to 26.2. The highest number of flowers and fruits was set with statistically significant differences to other Fertiliser rates, and the control was produced when 1000 g per plant of NPK compound Fertiliser was applied. The fruit set in this phase was between 44.4% and 52.2%. The application rates of NPK compound Fertilisers of 400, 750, and 1000 g per plant showed a high fruit set; nevertheless, above 1000 g, the trend of fruit set was downwards. These results indicate that higher rates of N in the NPK compound Fertilisers make plants focus on their leaf and stem growth rather than flowering and fruit set. This result is similar to that of Kumari et al. (2018), who showed that higher levels of N from 600 to 800 g per plant tended to reduce the fruit set. The number of flowers in the second phase varied between 48.9 and 57.6 flowers per plant. Despite a greater number of flowers compared to the first phase, fewer fruits were set, and percentages of fruit set ranged from 17.3 to 24.5 fruits per plant and 33.9% to 42.5%, respectively (Table 4). The dripping rain and low temperatures of this period may play a role in the low fruit set (Table 3). These effects have also been reported in tropical and subtropical fruit species like mango, guava,

Table 4
Effect of NPK compound Fertiliser application through irrigation system on flowering and fruit setting of guava plants

Fertiliser Rate (g/plant)	**Phase 1 (From November to December 2023)**			**Phase 2 (From January to February 2024)**			**Phase 3 (From April to May 2024)**			**Phase 4 (From June to July 2024)**		
	Flowers/ Plant	Fruit Set/ Plant	Fruit Set (%)	Flowers/ Plant	Fruit Set/ Plant	Fruit Set (%)	Flowers/ Plant	Fruit Set/ Plant	Fruit Set (%)	Flowers/ Plant	Fruit Set/ Plant	Fruit Set (%)
400	41.9^{b}	21.7^{bc}	51.8^{a}	56.6^{a}	20.5^{bc}	36.2^{bc}	57.5^{b}	51.4^{b}	89.3^{ab}	53.1^{b}	46.1^{b}	86.7^{ab}
600	43.5^{b}	22.6^{b}	52.1^{a}	59.5^{a}	21.8^{ab}	36.6^{bc}	58.6^{b}	53.3^{b}	90.9^{a}	56.6^{b}	49.9^{b}	88.2^{a}
800	44.7^{b}	23.1^{b}	51.8^{a}	53.1^{ab}	21.6^{ab}	38.8^{ab}	58.9^{b}	52.3^{b}	89.0^{ab}	57.6^{b}	50.1^{b}	87.1^{a}
1000	50.2^{a}	26.2^{a}	52.2^{a}	57.6^{a}	24.5^{a}	42.5^{a}	63.5^{a}	59.3^{a}	93.4^{a}	65.3^{a}	58.5^{a}	89.6^{a}
1200	42.5^{b}	19.7^{cd}	46.5^{b}	54.8^{ab}	18.6^{bc}	33.9^{c}	51.3^{c}	43.9^{c}	85.5^{bc}	44.0^{c}	36.8^{c}	83.6^{bc}
1400	42.8^{b}	19.0^{d}	44.4^{b}	54.0^{ab}	19.8^{bc}	36.7^{bc}	48.9^{c}	43.9^{c}	89.8^{ab}	44.5^{c}	36.5^{c}	82.0^{c}
Control	36.9^{c}	17.4^{d}	47.4^{b}	48.9^{b}	17.3^{c}	35.4^{bc}	41.5^{d}	34.6^{d}	83.3^{c}	46.7^{c}	38.0^{c}	81.3^{c}
$LSD_{0.05}$	4.4	2.3	3.5	6.4	3.7	4.2	3.3	3.4	4.3	6.2	5	3.1
CV %	5.8	6.3	4.1	5.3	5.9	6.8	3.4	3.9	2.8	6.7	6.3	2.0

Note. Different letters within columns indicate significant differences at $P \leq 0.05$

and lychee, where low temperature during flowering results in disrupted flowering, high flowering drop, and fruit set (Haokip et al., 2020).

In the third phase, the number of flowers in plants ranged from 41.5 to 63.5, with no significant difference in comparison to the second phase. But the growth in fruit set was encouraging. The highest numbers of flowers and fruits set per plant were at an NPK application rate of 1000 g, rating the peak, and showing a statistically significant difference when compared to other rates and the control. Stunningly, the fruit set increased from 83.3% to 93.4%, with 1000 g, claiming the highest rate of fruit set. The more favourable climatic conditions at this phase, with an average temperature of 28.7 °C, as well as day maximum and minimum of 32.9 °C and 25.7 °C (Table 3), respectively, certainly contributed to such a remarkable fruit setting percentage. Indeed, the work of Fischer and Melgarejo (2021) highlights this observation, showing that guava plants have optimum growth between 15 °C and 30 °C; beyond this, flower loss (drop) and consequent reduction in fruit set increase.

In the fourth phase, the phenomenon continued to amaze, with the number of flowers and fruits set per plant ranging from 46.7 to 65.3 and 36.5 to 58.5, respectively. In line with the previous results, flower and fruit set counts were the highest with the treatment of 1000 g of NPK compound Fertiliser per plant, with significant differences from other rates of applications and the control. Fruit set was also impressive with values between 81.3% and 89.6%. Interestingly, the fruit set ranged from 61.5% to 89.6% with NPK applications from 400 g to 1000 g per plant. But with higher applications (above 1000 g per plant), fruit set gradually declined. This trend is presumably a result of the negative impact of excessive NPK applications, promoting an increase in vegetation. Thus, the shoots at leaf axils turned into leaves, which limited the process of flowering and fruit setting for guava plants, as pointed out by Samant and Kishore (2020).

Guava Yield

The response of NPK compound Fertiliser, applied through irrigation system, on guava yield was studied by examining the key yield paramentters - number of fruits set per plant, fruit drop (%), number of harvested fruits per plant, average fruit weight (g), and yield per plant (kg/plant), and per hectare (ton/ha) at harvest (Table 5). A quadratic effect of Fertiliser treatments was found, with an optimum in yield parameters at 1000 g/plant and a subsequent decrease, which was likely caused by unbalanced nutrition with a shift in plant physiology towards a higher vegetative growth and smaller yield in this particular guava variety. These findings are discussed in relation to the literature on guava and other fruit trees, highlighting the need for balanced fertilisation for yield optimisation.

The number of fruits per plant varied between 107.3 and 168.5 fruits per plant. This was observed as a quadratic response, where increasing Fertiliser rates from 400 to 1000 g/plant increased the fruit set, which peaked at 168.5 fruits per plant at 1000 g/plant. This was followed by a decline in fruit set as the rate increased further, producing 119.0 and

Table 5
Effect of NPK compound Fertiliser application through the drip irrigation system on guava yield

Fertiliser Rate (g/plant)	No. of Fruits/ Plant	Fruit drop (%)	Harvested Fruits/ plant	Average Fruit Weight (g)	Yield (kg/plant)	Yield (ton/ha)	Yield Increase vs. Control (%)
400	139.7^{b}	48.2^{a}	72.4^{bc}	300.8^{e}	21.8^{bc}	14.5^{bc}	27.6
600	147.6^{b}	47.4^{a}	77.6^{b}	315.3^{de}	24.5^{b}	16.3^{b}	35.6
800	147.1^{b}	45.3^{a}	80.5^{b}	321.5^{cd}	25.9^{b}	17.2^{b}	39.0
1000	168.5^{a}	45.5^{a}	91.8^{a}	368.4^{a}	33.8^{a}	22.5^{a}	53.3
1200	119.0^{c}	43.6^{a}	67.1^{c}	342.8^{b}	23.0^{b}	15.3^{b}	31.4
1400	119.2^{c}	43.8^{a}	67.0^{c}	336.5^{bc}	22.5^{bc}	15.0^{b}	30.0
Control	107.3^{c}	46.2^{a}	57.7^{d}	272.1^{f}	15.7^{c}	10.5^{c}	0.0
$LSD_{0.05}$	18.8	4.7	8.4	16.8	7.2	4.2	
CV %	8.3	6.5	7.3	8.9	6.3	5.9	

Note. Different letters within columns indicate significant differences at $P \leq 0.05$

119.2 fruits per plant with the 1200 and 1400 g/plant rates, respectively. This finding aligns with Widyastuti et al. (2023), who reported that higher rates of NPK from 250 to 500 g/plant increased the number of flowers and fruits of guava, but higher rates decreased fruit set, likely due to the promotion of vegetative growth that may inhibit fruit development.

There was significant variability in the number of fruits harvested and average fruit weight. The lowest were in the control treatment (57.7 fruits per plant, 272.1 g per fruit). With higher fertilisation (400-1000 g/plant), the number of fruits increased from 72.4 to 91.8 fruits per plant, and average fruit weight from 300.8 to 368.4 g per fruit, the latter being the maximum value. At higher levels (1200-1400 g/plant), both parameters decreased to 67.0 fruits per plant and 336.5 g per fruit at 1400 g/plant, which were not significantly different from 400 g/plant. This suggests that there is a threshold level of fertilisation at 1000 g/plant, above which excess nutrients may limit or affect the development of fruit set, which can be due to high nutrition stress or malformation of fruits due to hormone and/or growth-regulator disruption. Khan et al. (2018) also found the fruit set, fruit weight, and yield to be optimum at 828:240:288 g/tree of NPK Fertiliser. Increasing the amount of NPK Fertilisers beyond this threshold did not have notable differences in these parameters.

Trailing yield (fruit drop) was found to range from 43.6% to 48.2%, with no significant difference between treatments or control treatment (46.2%). There was a slight decrease in fruit drop as the Fertiliser amount increased from 400 g/plant (48.2%) to 1400 g/plant (43.8%), but the difference was not statistically significant. This indicates that factors other than Fertiliser rates, such as weather conditions (temperature and rainfall), are the main drivers of fruit drop.

Yield was determined as the average yield/plant and yield/hectare, from 15.7 to 33.8 kg/plant and 10.5 to 22.5 tons/ha. Every NPK application improved yield by 27.6-53.3%

over the control (using recommended practice for fertilisation). Maximum yield (33.8 kg/plant and 22.5 tons/ha) was observed with 1000 g/plant and was significantly ($P \leq 0.05$) higher than other levels of Fertilisers and treatment control. Over-fertilisation with higher rates (1200-1400 g/plant) led to a decline in yield (15.0-15.3 tons/ha), suggesting that over-fertilisation with high NPK rates can adversely affect guava yield. This is in agreement with Khan et al. (2018). Similarly, Nghi and Lan (2016) observed that treatment with 200 g of urea per plant produced optimum yield and sugar content; modest increases in urea rate (300 g/plant) did not result in significant increases in yield, irrespective of the total sugar content.

The quadratic response is consistent with other studies in guava and other fruit trees. Arshad (2015) found that NPK application at 1000 g/plant yielded maximum fruit numbers and weight, as well as yield of guava, in line with the optimal yield observed at 1000 g/plant in the current study. Moreover, Sharma et al. (2011) reported that supplementing nitrogen application with drip irrigation effectively increased guava yield relative to conventional fertilisation, suggesting that the use of irrigation to provide NPK is effective. These results are consistent with reports on other fruit trees, including mango, where a balanced NPK Fertiliser (1000 g N, 750 g P, and 750 g K per plant) maximised the yield and fruit quality, while higher rates decreased fruit retention because of excessive vegetative development (Azam et al., 2022).

Guava Fruit Quality

Nitrogen (N), phosphorus (P), and potassium (K) are vital components of guava plant development, affecting crop productivity and fruit quality. In this study, the application of NPK compound Fertilisers via drip irrigation was assessed in terms of the quality of guava fruit, as outlined in Table 6.

Table 6
Effect of NPK compound Fertiliser application through drip irrigation on guava fruit quality

Fertiliser Rate (g/plant)	Pulp Thickness (mm)	Core Thickness (mm)	Fruit Diameter (mm)	Fruit Flesh Weight Ratio (%)	TSS (%)
400	23.4^{c}	34.8^{c}	58.2^{c}	67.3^{b}	9.5^{b}
600	24.2^{c}	35.4^{c}	59.6^{c}	68.3^{b}	9.5^{b}
800	24.2^{c}	36.3^{bc}	60.6^{c}	66.6^{b}	9.6^{ab}
1000	29.1^{a}	38.1^{b}	67.2^{b}	76.6^{a}	9.8^{a}
1200	26.0^{b}	44.9^{a}	70.9^{a}	57.8^{c}	9.4^{b}
1400	24.9^{bc}	45.3^{a}	70.3^{ab}	55.0^{c}	9.5^{b}
Control	20.9^{d}	36.7^{bc}	57.6^{c}	57.2^{c}	9.1^{c}
$LSD_{0.05}$	1.7	2.2	3.2	3.8	0.2
CV %	3.8	3.2	3.1	3.3	1.1

Note. Different letters within columns indicate significant differences at $P \leq 0.05$

In the guava fruit, pulp thickness is a critical quality parameter, with increased pulp thickness leading to juicy fruit and high quality. With different levels of NPK Fertilisers, the pulp thickness varied from 20.9 to 29.1 mm. This measurement increased as the amount of Fertiliser increased, reaching a maximum level of 29.1 mm with the application of 1000 g/plant of NPK. But, there was a decrease in pulp thickness with NPK above 1000 g/plant. As for core thickness with seeds, the range was 34.8-45.3 mm. Maintaining an adequate level of NPK improved the nutrient uptake and translocation to the fruit and consequently increased the internode thickness and ratio of remaining fruit weight to flesh weight, and decreased pulp thickness. These results are consistent with Chavan et al. (2020), who found that the fruit pulp weight showed an increasing trend when applying nitrogen, phosphorus, and potassium (NPK) up to 300:150:150 g/plant but tended to decrease when applying higher NPK.

As for core thickness containing seeds, it varied from 34.8 to 45.3 mm. The maximum core thickness was recorded at the highest NPK levels (1400 g/plant), which were significantly higher than other formulations and the control treatment ($P \leq 0.05$). A linear increase was observed for core thickness with increasing rates of NPK Fertiliser, suggesting a positive association of NPK.

The fruit diameter increased with increasing Fertiliser rates and showed the highest thickness at 1200 g NPK/plant (70.9 mm) rates, then decreased at the highest Fertiliser rates. The ratio of fruit flesh weight varied from 57.2% to 76.6%, and it was highest at 1000 g NPK/plant, which was significantly higher than other fertilisation rates.

Increased TSS values indicate a higher content of sugar, which makes the fruit juice sweeter and tastier, giving an indication of increased fruit quality. Like other quality characters, the TSS value was significantly increased from 9.1% (control) to 9.5% by application of 400 g/plant. By increasing the Fertiliser doses to 1000 g/plant, the TSS value increased to the highest value (9.8%) and then began to decline with subsequent increases in Fertiliser doses. According to Kumar et al. (2009), increasing the amount of N and P did not improve the TSS of guava fruit. The TSS content, according to Arshad (2015), was found to be the highest (9.48%) with the level of fertilisation at 800:800:800 g NPK/plant and then decreased with the further addition of NPK.

Therefore, 1000 g/plant/year of NPK soluble compound Fertiliser with the drip irrigation system showed the highest pulp thickness, fruit flesh weight ratio, and TSS value, with significant differences in yield quantity as well as quality parameters from other levels of NPK.

CONCLUSION

This experiment demonstrated that using soluble NPK Fertiliser delivered via a drip irrigation system to guava trees increases their fruit set, yield and quality parameters. The highest yield (22.5 tons/ha) and TSS (9.8 %) were found with an application rate of 1000 g/tree/year. The result should be applied to guava farmers in the ecological conditions of Nghe An Province.

But this finding was only in the first year and for one variety. More research needs to be done to test the economic viability of using soluble Fertilisers applied by drip irrigation in different guava varieties.

ACKNOWLEDGMENT

The authors are grateful to the School of Agriculture and Natural Resources, Vinh University staff, for providing laboratory facilities.

REFERENCES

Arshad, I. (2015). Integrated application of NPK fertilisers on the growth and yield of guava (*Psidium guajava* L.) in arid region of lower Sindh, Pakistan. *International Research Journal of Plant and Crop Sciences*, *2*(1), 19-23. https://doi.org/10.25046/aj010103

Azam, M., Qadri, R., Aslam, A., Khan, M. I., Khan, A. S., Anwar, R., Ghani, M. A., Ejaz, S., Hussain, Z., Iqbal, M. A., & Cheng, J. (2022). Effects of different combinations of N, P and K at different time interval on vegetative, reproductive, yield and quality traits of mango (*Mangifera indica* L.) cv. Dusehri. *Brazilian Journal of Biology*, *82*, Article e235612. https://doi.org/10.1590/1519-6984.235612

Challa, L. P., Behera, B. P., & Pradhan, P. C. (2021). Water requirement and nutrient management of guava (cv. Arka amulya) using drip under high density plantation in coastal Odisha. *The Pharma Innovation Journal*, *10*(3S), 243-247. https://doi.org/10.22271/tpi.2021.v10.i3Sd.6167

Chavan, M. T., Thutte, A. S., Kakade, A. R., & Solanke, A. A. (2020). Effect of levels of N, P, K on yield and quality of guava (*Psidium guajava* L.) under high density planting. *Journal of Pharmacognosy and Phytochemistry*, *9*(6), 1290-1293.

Fischer, G., & Melgarejo, L. M. (2021). Ecophysiological aspects of guava (*Psidium guajava* L.): A review. *Revista Colombiana de Ciencias Hortícolas*, *15*(2), Article e12355. https://doi.org/10.17584/rcch.2021v15i2.12355

Guleria, K., & Singh, D. (2023). Effects of levels of N:P: K on yield and quality of guava (*Psidium guajava* L.) under meadow orchard system. *International Journal of Plant & Soil Science*, *35*(17), 467-472. https://doi.org/10.9734/ijpss/2023/v35i173231

Gupta, P., Singh, D., Prasad, V. M., & Kumar, V. (2019). Effect of integrated nutrient management on growth and yield of guava (*Psidium guajava* L.) cv. Allahabad Safeda under high density planting. *Journal of Pharmacognosy and Phytochemistry*, *8*(1), 1233-1236.

Haokip, S. W., Shankar, K., & Lalrinngheta, J. (2020). Climate change and its impact on fruit crops. *Journal of Pharmacognosy and Phytochemistry*, *9*(1), 435-438.

Janaki, D., Poorniammal, R., & Rajangam, J. (2020). Effect of drip fertigation on yield and quality of guava under ultra high density planting in Tamil Nadu. *International Journal of Chemical Studies*, *8*(2), 2720-2722. https://doi.org/10.22271/chemi.2020.v8.i2ap.9161

Khan, S., Kumar, A., & Sharma, J. R. (2018). Impact of NPK application on growth and yield of guava cv. Hisar Safeda. *International Journal of Current Microbiology and Applied Sciences*, *7*(7), 286-290. https://doi.org/10.20546/ijcmas.2018.707.034

Kumar, D., Pandey, V., Anjaneyulu, K., & Nath, V. (2009). Optimisation of major nutrient for guava yield and quality under east coastal condition. *Indian Journal of Horticulture*, *66*(1), 18-21.

Kumari, B., Prakash, S., Jaiswal, U. S., & Radheyshyam. (2018). Impact of nitrogen and boron on some vegetative, reproductive and quality of guava (*Psidium guajava* L.). *International Journal of Current Microbiology and Applied Sciences*, *7*(4), 1752-1760. https://doi.org/10.20546/ijcmas.2018.704.199

Nghi, Q. D., & Lan, V. T. Đ. (2016). Nghiên cứu một số biện pháp kỹ thuật nhằm rải vụ thu hoạch và nâng cao hiệu quả sản xuất ổi OĐL1 trái vụ trên địa bàn thành phố Hà Nội [Research on technical measures for harvest extension and production efficiency of off-season ODL1 guava in Hanoi]. *Tạp chí Nông nghiệp và Phát triển nông thôn*, *1*, 64-70.

Rangare, N. R., Lal, N., Shiurkar, G., Banjare, K., Singh, P., Jangre, N., Sahu, N., & Patel, R. K. (2025). Impact of climate change on guava production: Challenges and adaptive strategies. *Applied Fruit Science*, *67*(5), Article 404. https://doi.org/10.1007/s10341-025-01637-8

Samant, D., & Kishore, K. (2020). Response of guava var. Arka Amulya to branch bending during winter and summer in the Eastern tropical region of India. *Journal of Environmental Biology*, *42*(3), 720-726. https://doi.org/10.22438/jeb/42/3/MRN-1581

Sharma, S., Patra, S. K., & Ray, R. (2011). Effect of drip fertigation on growth and yield of guava cv Khaja. *Environment and Ecology*, *29*(1), 34-38.

Shukla, A. K., Sarolia, D. K., Kumari, B., Kaushik, R. A., Mahawer, L. N., & Bairwa, H. L. (2009). Evaluation of substrate dynamics for integrated nutrient management under high density planting of guava (*Psidium guajava* L.) cv. Sardar. *Indian Journal of Horticulture*, *66*(4), 461-464.

Thirupathi, N., Kumar, M. R., Kumar, A. K., Sridhar, D., & Kumar, S. S. (2016). Studies on the effect of nitrogen, phosphorous and potassium on growth and yield of guava (*Psidium guajava* L.) cultivars under meadow system of planting. *Research in Environment and Life Sciences*, *9*(2), 241-244.

Widyastuti, R. A. D., Pujisiswanto, H., Warganegara, H. A., & Sutriana, E. S. (2023). Plant reproductive responses of guava 'Crystal' under different paclobutrazol and NPK fertiliser doses. *Journal of Tropical Crop Science*, *10*(3), 238-243. https://doi.org/10.29244/jtcs.10.03.238-243