

SABRAO Journal of Breeding and Genetics
 58 (3) 1334-1344, 2026
<http://doi.org/10.54910/sabrao2026.58.3.36>
<http://sabraojournal.org/>
 pISSN 1029-7073; eISSN 2224-8978



FERTILIZER, PLANT SPACING, AND PRUNING EFFECTS ON CULTIVATION OF TOMATILLO (*PHYSALIS PHILADELPHICA*) IN AN GIANG PROVINCE, VIETNAM

N.T.M. DUYEN, T.M. KHOI, B.P. TAM*, and T.N. KHANG*

Faculty of Agriculture and Natural Resources, An Giang University, Vietnam National University, Ho Chi Minh City, Vietnam

*Corresponding author's email: bptam@agu.edu.vn; tnkhang@agu.edu.vn
 Email addresses of co-authors: ntmduyen@agu.edu.vn, trinhminhkhoi96@gmail.com

SUMMARY

The tomatillo (*Physalis philadelphica*) is a newly developed crop, gaining popularity as a tasty fruit with numerous medicinal properties in Vietnam. For tomatillo long-term cultivation, this study aimed to determine the effects of fertilizer combinations, plant spacing, and pruning on growth, yield, and fruit quality traits of tomatillo grown in An Giang Province, Vietnam. The results revealed the optimal fertilizer formula for promoting plant growth and development and quality traits of tomatillos, including the mineral-organic fertilizer 'Dau Trau HCMK4,' NPK (16-16-8+TE), and urea. The plant spacing of 70 cm × 60 cm helped increase stem diameter, leaf length and width, and fruit quality; however, it reduced plant height. Although plant pruning improved fruit diameter and size, it did not significantly affect the growth and yield-related traits. These data will aid in designing experiments and selecting appropriate cultivation methods for tomatillo to achieve higher and better-quality yields.

Keywords: Tomatillo (*P. philadelphica*), fertilizer combinations, plant spacing, pruning, growth and development, fruit yield and quality

Key findings: In cultivating tomatillo (*P. philadelphica*), the combination of organic and inorganic fertilizers considerably enhanced plant growth and development and fruit yield with better quality. Additionally, proper plant spacing and pruning also showed positive effects on plant growth and fruit yield.

Communicating Editor: Dr. Tabynbaeva Laila

Manuscript received: September 13, 2025; Accepted: April 22, 2026.

© Society for the Advancement of Breeding Research in Asia and Oceania (SABRAO) 2026

Citation: Duyen NTM, Khoi TM, Tam BP, Khang TN (2026). Fertilizer, plant spacing, and pruning effects on cultivation of tomatillo (*Physalis philadelphica*) in An Giang Province, Vietnam. *SABRAO J. Breed. Genet.* 58 (3) 1334-1344. <http://doi.org/10.54910/sabrao2026.58.3.36>.

INTRODUCTION

Tomatillo (*Physalis philadelphica*), also known as husk tomato, is a native fruit of Mexico and Central America; however, it also grows in tropical and subtropical climates worldwide (González-Pérez and Guerrero-Beltrán, 2021). Tomatillo belongs to the family Solanaceae and the genus *Physalis* ($2n = 24$) and is a partially self-incompatible plant (Solís-Montero *et al.*, 2021). The growth duration of tomatillo is brief (3 to 4 months). Tomatillo fruits are mostly available in various colors, including green, yellow, purple, and purple-green (González-Pérez and Guerrero-Beltrán, 2021).

Physalis philadelphica fruits and plants have a crucial role in both nutrition and commerce (Pretz and Deanna, 2020). Its fruits contain various carbohydrates, minerals, vitamins, phenolic compounds, and phytosteroids (Shah and Bora, 2019). Tomatillo also widely serves as a fruit, food, ornamental plant, and especially, as a medicinal component to treat numerous diseases, including cancer, in many countries (Maldonado *et al.*, 2011; García-Mendieta *et al.*, 2012; González-Pérez and Guerrero-Beltrán, 2021).

Tomatillo, as a new plant, has become the subject of agricultural systems in numerous countries, including its breeding, selection, production, and commercial values (Solís-Montero *et al.*, 2021; Santos *et al.*, 2021; Vdovenko *et al.*, 2021). Vietnam is an agricultural country with a tropical climate quite suitable for cultivating and further developing the tomatillo (*P. philadelphica*). Although the tomatillo fruit has optimal nutritional and medicinal values, currently, its proper cultivation and use are lacking in Vietnam.

At present, only a few farmers spontaneously grow the single tomatillo cultivar on a small area. Besides, local cultivation techniques and propagation methods for the tomatillo plant still require in-depth study and exploration. Therefore, the concerned study aimed to evaluate the effects and propose fertilizer levels, plant spacing, and pruning methods to optimize the growth and development, fruit yield, and quality of the

tomatillo (*P. philadelphica*) grown in An Giang Province, Vietnam.

MATERIALS AND METHODS

Experimental site and procedure

On tomatillo (*P. philadelphica*), experiment 1 began at the Nguyen Nhu Farm in Long Xuyen City and a farmer's field in Dong Son 2 hamlet, Nui Sap town, Thoai Son District, An Giang Province, Vietnam, from December 2023 to April 2024. Experiment 2 commenced at An Giang University's Experimental Station, An Giang Province, Vietnam, from December 2024 to April 2025.

The experimental areas are alluvial soil with average total nitrogen content (0.28%–0.30%), average total phosphorus content (0.066%–0.068%), low available nitrogen content (4.80–4.90 mg kg⁻¹ NH₄⁺-N and 2.20–2.26 mg kg⁻¹ NO₃⁻-N), and low available phosphorus content (11.0–12.0 mg kg⁻¹). Moreover, it has moderate acidity (pH 4.8–4.9), average organic matter content (8.75%–9.00%), and low electrical conductivity (0.54–0.56); hence, it did not affect the crops. The weather conditions recorded during the experiment were as follows: temperature = 22 °C–27 °C, humidity = 83.3%–97.6%, sunshine hours = 3.2–4.8 hours, radiation = 198.54–239.64 W m⁻², and rainfall = 0–12.2 mm.

Plant material and fertilizers

Imported tomatillo (*P. philadelphica*) seeds came from the True Leaf Market Seed Company at 175 West 2700 South, Salt Lake City, Utah 84115, USA. Cow manure compost (CMC) from a local source received treatment with the *Trichoderma* fungus. The procured mineral-organic fertilizer 'Dau Trau HCMK4' (organic 15%, A1Ps 12%, P₂O₅ 3%, K₂O 1%, CaO 0.05%, MgO 0.15%, B 300 ppm, Zn 500 ppm, and Cu 300 ppm) (MOF) and the chemical fertilizer NPK (16-16-8+TE) came from Binh Dien Fertilizer JSC, Vietnam. Obtaining the fertilizer urea (N 46.3%) was from PVFCCo, Vietnam.

Exp. 1: Fertilizer effect on tomatillo growth, yield, and quality

The first experiment, as conducted, comprised five fertilizer treatments at the two growing locations (Long Xuyen City and Thoai Son District, An Giang Province, Vietnam). The experiment was in a randomized complete block design (RCBD) with three replications. Each replication was a 10-m² plot with 32 plants (plant spacing 50 cm × 60 cm). Five fertilizer treatments for each 10-m² plot have specific descriptions, as follows. F1 = completely organic (2300 g cow manure compost, CMC); F2 = mineral-organic (800 g—'Dau Trau HCMK4,' MOF); F3 = combination of organic and inorganic (2000 g CMC + 300 g NPK—16-16-8+TE + 300 g urea); F4 = combination of mineral-organic and inorganic (500 g MOF + 300 g NPK—16-16-8+TE + 300 g urea); and F5 = completely inorganic (300 g NPK—16-16-8+TE + 300 g urea).

Exp. 2: Spacing and pruning effect on tomatillo growth, yield, and quality

The second experiment consisted of three plant spacing treatments. In each treatment, using no plant pruning in the control (C) and pruning (P) sustained evaluation. The study also applied three-stem pruning in this experiment, conducted in an RCBD with three replications. Each replication was a 10-m² plot, with three plant spacing treatments described as follows: S1: 50 cm × 60 cm (32 plants/10 m²), S2: 50 cm × 70 cm (28 plants/10 m²), and S3: 70 cm × 60 cm (24 plants/10 m²).

Crop management

The experimental plot designs had the soil ridges 5 m long, 2 m wide, and 10 cm high for good drainage. The experiment comprised six plots, spaced 0.5 m apart. The tomatillo seeds' soaking in warm water (45 °C–50 °C) took 2–4 hours before sowing them in the substrate. The seedbed's watering and covering maintained soil humidity and protected the seeds. Seeds germinated after seven to 14 days of sowing; afterward, transplanting the 14-day-old seedlings with two true leaves into

experimental plots proceeded under garden conditions. The watering of plants once or twice, in the early morning or in the late afternoon, depended on weather conditions. After a week of planting, the base of the plants was mounded. The regular cleaning of weeds in the experimental plots continued to avoid affecting the tomatillo experiment.

Fertilizer application had several stages. The basal fertilizer, when applied to the experimental plots, occurred one to two days before transplanting. The treatments F1 and F3 received 2000 g CMC for each 10-m² plot, while the treatments F2 and F4 acquired 500 g MOF, and the treatment F5 did not use basal fertilizer. Main fertilization continued four times periodically. The first fertilization was at 10 days after transplanting (DAT) to promote plant growth and development. The treatment F1 obtained 60 g CMC for each 10-m² plot, with the treatment F2 applied with 60 g MOF and the treatments F3, F4, and F5 fertilized with 60 g urea and 60 g NPK. The second fertilization ensued at 22–25 DAT, when the plant began to bud. The treatment F1 used 70 g CMC for each 10-m² plot, the treatment F2 applied 70 g MOF, and the treatments F3, F4, and F5 employed 70 g urea and 70 g NPK. The third fertilization happened when the flowers were in full bloom. The treatment F1 had 100 g CMC for each 10-m² plot, while the treatment F2 used 100 g MOF. The treatments F3, F4, and F5 had fertilizers of 100 g urea and 100 g NPK. The final fertilization was right after the first fruit harvest. The F1 treatment involved 70 g CMC for each 10-m² plot, the treatment F2 comprised 70 g MOF, and the treatments F3, F4, and F5 had 70 g urea and 70 g NPK. Pesticide uses were at permissible levels to control pests in the tomatillo experiments.

Traits measurement and data analysis

In both tomatillo experiments, the recorded data consisted of plant height (cm), stem base diameter (mm), leaf length and width (cm), the number of primary and secondary branches, and flowers per plant. Traits on fruits included fruits per plant, fruit weight per plant (g), and fruit quality indicators such as Grade-1 fruits (%), fruit diameter (mm), and

Brix content (%). The grade-1 fruits (good fruits) were 30 mm and even more in diameter, with a beautiful yellow shine and no external defects (mold, bruises, punctures, and blemishes) (Zhang *et al.*, 2014). Measuring Brix concentration took place at the Atago PAL-1, Japan. Recording of traits ensued on 10 plants per replication, with qualitative traits (fruit diameter and Brix content) recorded on 10 fruits per replication. All data compilation and analysis proceeded using Microsoft Excel, with the variance and Duncan analyses using SPSS 26 software.

RESULTS AND DISCUSSION

Fertilizer effect on the growth of *P. philadelphica*

Tomatillo (*P. philadelphica*) plants markedly showed different growth performance with different fertilizer levels and over growing time (Figure 1). In the first two weeks, the fertilizer treatments had no considerable impact on the general plant growth for plant height, stem diameter, and primary and secondary branches. However, after two weeks, the plant began to grow rapidly and revealed varied effects in growth traits due to different fertilizer treatments. On leaf size, during the first six weeks, the leaf length and width grew slowly; however, by the ninth week, leaf length and leaf width increased by 30%–40% and 40%–50%, respectively. In a previous study on tomatillo, the growth parameters developed rapidly 4 to 6 weeks after transplanting and reached their maximum size 60 days after transplanting (Shamim *et al.*, 2022). This data also has implications for studying suitable cultivation methods related to the growth of tomatillo.

According to fertilizer treatments, the growth traits of tomatillo trended from high to low, specifically $F4 > F3 > F5 > F2 > F1$. However, the combined organic and inorganic fertilization formula (F4 and then F3) showed the best performance for plant height (Figure 1A), leaf length (Figure 1B), leaf width (Figure 1C), stem base diameter (Figure 1D), primary branches (Figure 1E), and secondary branches

(Figure 1F) after two, six, and nine weeks of transplanting. Previous studies on plant and fertilizer interactions also recommend that applying organic and inorganic fertilizers simultaneously should be consistent to improve growth-related traits significantly. Such a type of combined application of organic and inorganic fertilizers can considerably increase plant growth and development in various species of the family Solanaceae (Hernawan *et al.*, 2023; Karangwa *et al.*, 2023).

Fertilizer effect on *P. philadelphica* yield

Under cultivation conditions in An Giang Province, Vietnam, the results revealed tomatillos began to flower first at 14–16 DAT, while fruit setting started in the next 6–8 days. After 29–33 DAT, the fruits reached their maximum size and physiologically became mature. Compared with the previous study in tomatillo (*P. philadelphica* and *P. ixocarpa*) by González-Pérez and Guerrero-Beltrán (2021), the flowering and fruiting durations were earlier, which may be due to the influence of different cultivation and environmental conditions.

In fertilizer treatments and two planting locations, the flowers per plant ranged from 357.9 to 504.6; however, the number of successfully pollinated and mature fruits was only 3.9%–7.5% of the total number of flowers. The reason for this phenomenon is that in tomatillo, the flower structure is fragile, especially the pedicel, and easily affected by environmental conditions and pests. Many flowers fall off before forming the fruits. In contrast, the flowers gain natural pollination from insects and the wind. If the tomatillo flowers' pollination is late, the flowers will close, turn white, and fall off (Peña-Lomelí *et al.*, 2017; González-Pérez and Guerrero-Beltrán, 2021). The total fruit weight and yield per plant in the experimental treatments ranged from 488.7 to 1819.8 g, among which the tomatillos grown in Long Xuyen with the F4 fertilizer treatment provided the highest fruit yield. Meanwhile, tomatillos cultivated in Thoai Son with F1 fertilizer treatment had the lowest fruit yield (Table 1).

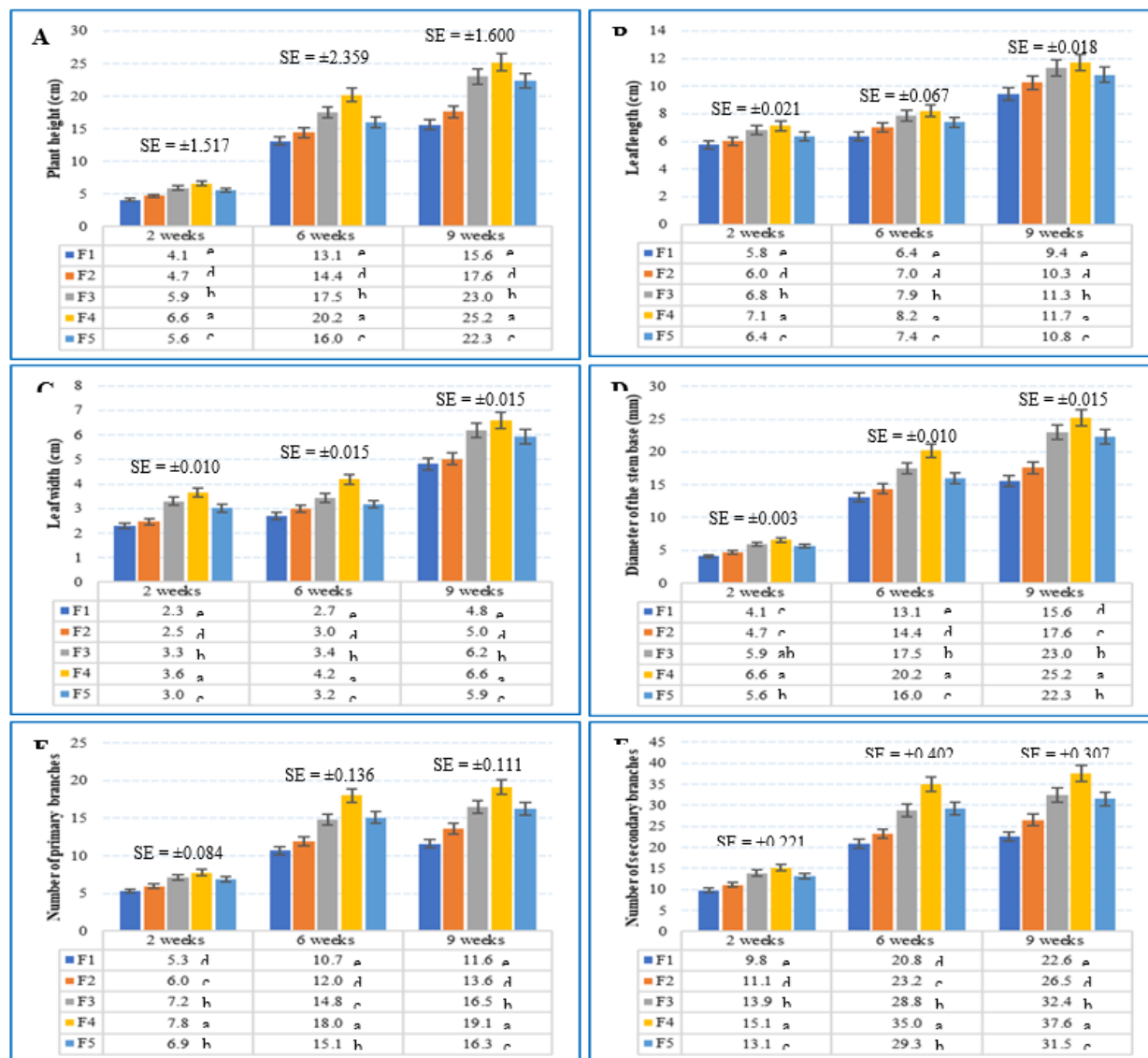


Figure 1. Effect of fertilizers on (A) plant height, (B) leaf length, (C) leaf width, (D) diameter of the stem base, (E) primary branches, and (F) secondary branches.

Regarding testing locations, the results detailed that, on average, flowers per plant, fruits per plant, and the total fruit weight per plant in Long Xuyen were higher than in Thoai Son. According to fertilizer treatments, the results revealed the number of flowers, the number of fruits, and fruit yield per plant gradually went from high to low, specifically F4 > F3 > F5 > F2 > F1. The F4 fertilizer treatment (MOF + NPK [16-16-8+TE] + urea) was the optimal formula for growth and development and fruiting in tomatillo, followed

by the F3 treatment (a combination of CMC and inorganic fertilizers), while the ineffective treatment was the F1 treatment (CMC only). Findings of Hernawan *et al.* (2023) and Karangwa *et al.* (2023) revealed the combination of organic and inorganic fertilizers helps enhance fruit yield and increase the fertilizer use efficiency in various species of the family Solanaceae. Moreover, the micronutrients, such as zinc, iron, manganese, copper, boron, and magnesium, play a crucial role in crop physiological processes. The

Table 1. Effect of fertilizers on the flowers, fruits, and yield of *Physalis philadelphica*.

Treatments	Flowers plant ⁻¹			Fruits plant ⁻¹			Fruit weight plant ⁻¹ (g)		
	LX	TS	Means (B)	LX	TS	Means (B)	LX	TS	Means (B)
F1	407.9	357.9	382.9e	23.3	13.9	18.6e	1094.0	488.7	791.3e
F2	423.5	386.1	404.8d	26.2	16.6	21.4d	1248.2	636.5	942.4d
F3	462.2	415.5	438.9b	33.0	24.3	28.7b	1618.3	1002.3	1310.3b
F4	504.6	451.4	478.0a	38.0	26.1	32.1a	1819.8	1216.7	1518.3a
F5	447.3	402.5	424.9c	31.0	21.9	26.5c	1519.0	870.8	1195.0c
Means (A)	449.1a	402.7b		30.3a	20.6b		1459.9a	843.0b	
F _A	*			*			*		
F _B	*			*			*		
F _{A,B}	*			*			*		
CV (%)	2.02			2.87			1.84		

Notes: F1-F5: Treatments of fertilizer; LX: Long Xuyen location; TS: Thoai Son location; F_A: Probability of fertilizer treatments; F_B: Probability of location treatments; F_{A,B}: Probability of the combination of fertilizer and location treatments; *: Significant at the 0.05 probability level; The same letter within measured traits indicates nonsignificant difference at $p \leq 0.05$.

micronutrients are pivotal in plant growth and development, appearing to be necessary for plants to thrive vegetatively and enhance the fruit yield in tomato (*S. lycopersicum* L.) (Azeem and Ahmed, 2011; Yadav *et al.*, 2024).

Fertilizer effect on *P. philadelphica* quality

Tomatillo fruits with a round shape tended to be the preferred type for consumers (Elsayed *et al.*, 2023). Tomatillo fruits with a beautiful, shiny yellow shade, with no defects and a uniform shape and a diameter of over 3 cm, are often consumers’ choice, with such types of fruits classified as grade-1 fruits (Zhang *et al.*, 2014). The latest results showed the rate of grade-1 fruit was the highest, ranging from 73.6% to 95.3% of the total harvested fruits. In particular, the grade-1 fruits obtained at Long Xuyen were significantly higher than those at Thoai Son. The F4 fertilizer treatment also showed the maximum rate of good fruits at both testing locations compared with other fertilizer treatments.

Similarly, the tomatillos harvested at Long Xuyen were higher in fruit diameter than those at Thoai Son, and they also had the largest fruit size (32.1 mm) with the F4 fertilizer application. In the fertilizer treatments, tomatillos grown with only chemical fertilizers often have larger fruit diameters than those grown with organic fertilizers. However, for tomatillos grown with a

combination of two types of fertilizers, the fruit diameter was optimal. Although the tomatillo grade-1 fruits had the highest rate, the average fruit diameter in various fertilizer treatments was lower than the standard of a grade-1 fruit (30 mm) (Table 2). These results suggested the larger difference in size among the harvesting phases of tomatillo fruits. Fruits harvested in earlier phases have broad diameters, while fruits harvested in later phases tend to have narrow diameters.

The Brix content of ripe fruits differed nonsignificantly between the two testing locations; however, it varied with different fertilizer treatments. The Brix measured in the experiments ranged from 6.60% to 8.80% (Table 2). These results were consistent with past findings of González-Pérez and Guerrero-Beltrán (2021) and Shamim *et al.* (2022), who also reported similar observations in husk tomato (*P. philadelphica* and *P. ixocarpa*). Tomatillos are non-sweet fruits, and their Brix content (total soluble solids) differed among the different cultivars. The Brix content was 5%–6.89% in green tomatillos, while it was 2.33%–9.23% in purple cultivars (González-Pérez and Guerrero-Beltrán, 2021). In tomatillo fruits, the Brix contents in fertilizer treatments F4 and F3 were the highest and at par, followed by three other fertilizer treatments, F2, F1, and F5, respectively. The results showed tomatillos cultivated with organic fertilizers helped increase the

Table 2. Effect of fertilizers on the quality traits of *Physalis philadelphica*.

Treatments	Grade-1 fruits (%)			Fruit diameter (mm)			Brix content (%)		
	LX	TS	Means (B)	LX	TS	Means (B)	LX	TS	Means (B)
F1	80.3	73.6	77.0e	26.5	23.4	24.9e	8.07	7.76	7.91c
F2	85.7	79.5	82.6d	28.6	25.1	26.9d	8.40	7.89	8.15bc
F3	92.6	86.3	89.5b	30.7	28.5	29.6b	8.47	8.33	8.40ab
F4	95.3	89.5	92.4a	32.1	31.1	31.6a	8.80	8.63	8.72a
F5	90.8	83.6	87.2c	30.3	27.1	28.7c	6.60	7.54	7.07d
Means (A)	88.9a	82.5b		2.96a	27.1b		8.07a	8.03a	
F _A	*			*			ns		
F _B	*			*			*		
F _{A,B}	*			*			ns		
CV (%)	1.21			2.23			3.49		

Notes: F1-F5: Treatments of fertilizer; LX: Long Xuyen location; TS: Thoai Son location; F_A: Probability of fertilizer treatments; F_B: Probability of location treatments; F_{A,B}: Probability of the combination of fertilizer and location treatments; *: Significant at the 0.05 probability level; ns: nonsignificant; The same letter within measured traits indicates nonsignificant difference at $p \leq 0.05$.

sweetness of fruits. In treatments using complete or some part of organic fertilizers, the Brix content was often higher than in the treatments using only inorganic fertilizers. Organic fertilizers and micronutrients play a vital role in improving fruit quality in tomatoes (*S. lycopersicum* L.) (Gao *et al.*, 2023; Yadav *et al.*, 2024).

Spacing and pruning effects on the growth of *P. philadelphica*

In this experiment concerning growth in tomatillo plants, the plant height and stem diameter began to grow considerably after the second week of transplanting, while leaf size grew later in the following weeks (Figure 2). Two weeks after transplanting, plant height was at par in the treatments, whereas it was highest in the treatment S3 (with plant spacing 70 cm × 60 cm). However, six weeks after transplanting, the plant height in treatment S1 was taller than in treatment S2, while the recorded lowest plant height resulted in treatment S3 (Figure 2A). The outcomes showed that plant height tends to increase with closer spacing, which also enhanced the competition for space and light (Alam *et al.*, 2011; Singh *et al.*, 2017).

The traits of stem diameter and leaf size in tomatillo plants two weeks after transplanting did not differ among the plant

spacing treatments. After six weeks of transplanting, the stem diameter increased rapidly, with the largest diameter recorded in the S3 treatment (plant spacing 70 cm × 60 cm) (Figure 2B). Meanwhile, the traits of leaf length and leaf width grew rapidly at nine weeks of transplanting, recording the largest leaf size also in the S3 treatment (Figures 2C, 2D). Thus, the results revealed the wider the plant spacing, the larger the stem diameter and leaf size. The wider the distance between the plants, the less competition, and therefore, the better the plant grows. Xu *et al.* (2023) affirmed that the distance between the plants influenced plant growth and development through more available light, water, and nutrients.

The experimental outcomes disclosed that tomatillo growth parameters in the pruning treatment tended to be higher than in the non-pruning treatment; however, this difference was nonsignificant. Gonzaga *et al.* (2017) reported similar results with pruning and nonpruning treatments in tomatoes (*S. lycopersicum* L.). However, other various studies have suggested that pruning enhanced plant growth because it decreases competition for assimilates and thereby increases the allocation of resources to the stem, leaves, and other plant parts in husk tomatoes (*P. pubescens* L.) (Goda *et al.*, 2014). However, a previous study emphasized that different cultivars and varying pruning times have

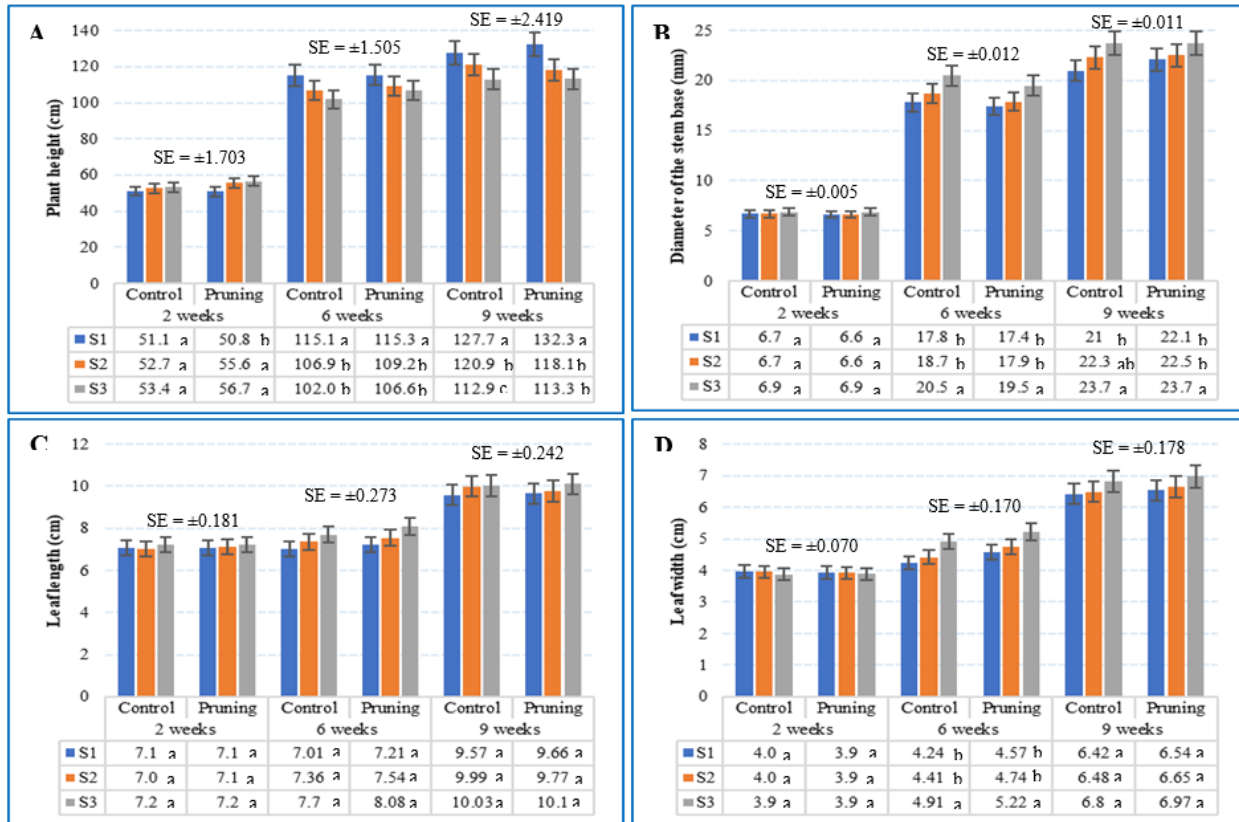


Figure 2. Effect of planting spacing and pruning on (A) plant height, (B) diameter of the stem base, (C) leaf length, and (D) leaf width.

diverse effects on plant growth and development in cherry tomatoes (*S. lycopersicum* L.) (Rao *et al.*, 2022).

Spacing and pruning effects on *P. philadelphica* yield

In tomatillos, the flowers per plant were the maximum in the S2 plant spacing treatment and the least in the S1 treatment. However, the fruits per plant were the highest in the S3 treatment (70 cm × 60 cm planting distance). In treatments, the total fruit weight per plant ranged from 1550.3 to 1848.2 g, and the fruit yield was the highest in the S3 treatment. Fruit yields in S2 and S1 treatments were at par and lower than the same in the S3 treatment by 8.5% and 13.2%, respectively (Table 3). Karpe *et al.* (2024) claimed that optimizing plant

spacing benefits both the yield per unit of cultivation area in tomato crops.

In pruning treatments of tomatillo, the number of flowers, fruits, and total fruit weight per plant were lower than in the non-pruning treatments (control); however, these differences were nonsignificant. D'Angelo *et al.* (2017) reported plants without pruning had more fruit and productivity than in other forms of pruning in *Physalis*. Muhammad and Singh (2007) and Das *et al.* (2025) reported that pruning increased the fruit yield per plant in tomato crops. The results suggested that, although pruning often tends to optimize the photosynthesis, reduce intraspecific competition, and produce higher yields, pruning may not always be beneficial if not properly carried out.

Table 3. Effect of plant spacing and pruning on flowers, fruits, and yield of *Physalis philadelphica*.

Treatments	Flowers plant ⁻¹			Fruits plant ⁻¹			Fruit weight plant ⁻¹ (g)		
	Control	Pruning	Means (B)	Control	Pruning	Means (B)	Control	Pruning	Means (B)
S1	496.8	468.1	482.5c	32.7	29.7	31.2c	1622.6	1550.3	1586.4b
S2	544.1	500.4	522.3a	37.7	36.1	36.9b	1634.9	1708.7	1671.8b
S3	518.5	480.7	499.6b	42.5	40.0	41.3a	1848.2	1808.5	1828.4a
Means (A)	519.8a	483.1a		37.6a	35.2a		1701.9a	1689.2a	
F _A	ns			ns			ns		
F _B	*			*			*		
F _{A,B}	ns			*			ns		
CV (%)	5.03			7.36			4.50		

Notes: S1-S3: Treatments of plant spacing; F_A: Probability of plant spacing treatments; F_B: Probability of pruning treatments; F_{A,B}: Probability of the combination of plant spacing and pruning treatments; *: Significant at the 0.05 probability level; ns: nonsignificant; The same letter within measured traits indicates nonsignificant difference at $p \leq 0.05$.

Table 4. Effect of plant spacing and pruning on the quality traits of *Physalis philadelphica*.

Treatments	Grade-1 fruits (%)			Fruit diameter (mm)			Brix content (%)		
	Control	Pruning	Means (B)	Control	Pruning	Means (B)	Control	Pruning	Means (B)
S1	85.8	91.0	88.4b	34.4	38.5	36.4b	9.09	7.72	8.40a
S2	88.4	95.1	91.8ab	34.9	41.0	38.0b	8.29	8.52	8.41a
S3	91.6	96.5	94.1a	36.5	45.9	41.2a	8.34	8.54	8.44a
Means (A)	88.6a	94.2a		35.3b	41.8a		8.58a	8.62a	
F _A	Ns			*			Ns		
F _B	*			*			Ns		
F _{A,B}	*			*			Ns		
CV (%)	4.13			5.69			9.62		

Notes: S1-S3: Treatments of plant spacing; F_A: Probability of plant spacing treatments; F_B: Probability of pruning treatments; F_{A,B}: Probability of the combination of plant spacing and pruning treatments; *: Significant at the 0.05 probability level; ns: nonsignificant; The same letter within measured traits indicates nonsignificant difference at $p \leq 0.05$.

Spacing and pruning effects on *P. philadelphica* quality

Plant spacing had varied effects on the fruit quality of tomatillos (Table 4). The percentage of grade-1 fruits in treatment S3 was the highest (94.1%) and was more than in treatments S2 and S1 by 2.5% and 6.4%, respectively. Fruit diameter also occurred as the highest in treatment S3, while fruit diameter in treatments S2 and S1 was the same. The Brix content, when measured, had nonsignificant difference in all plant spacing treatments. Pruning also affected fruit quality, and the percentage of grade-1 fruit in the pruned treatment (94.2%) was higher than that in the non-pruning treatment (88.6%); however, a nonsignificant difference was

evident. The fruit diameter of pruned plants was significantly higher than that of control plants by about 17.7%. Still, the Brix content of fruits in pruned and control plants was the same. Past studies revealed shoot pruning has varied effects on fruit quality of husk tomatoes (*P. pubescens* L.) (Goda et al., 2014) and tomatoes (*S. lycopersicum* L.) (Gonzaga et al., 2017).

Fruit quality is an important factor for the commercial value of a crop. The results showed the quality of tomatillos depends on several factors, including plant spacing, pruning techniques, and other management practices. Karpe et al. (2024) reported that high planting density increases competition for resources, leading to reduced fruit size and weight, as well as reduced fruit sweetness in

tomatoes. Pruning plays a vital part in enhancing the fruit size and diameter in tomatoes (Lhamo *et al.*, 2022). Fruits harvested from the pruned plants showed a higher Brix content; however, the difference in Brix content between pruned and control plants was negligible in tomatoes (*L. esculentum* L.) (Hesamil *et al.*, 2012; Alam *et al.*, 2016).

CONCLUSIONS

Fertilizer treatments with a combination of the mineral-organic fertilizer 'Dau Trau HCMK4,' NPK (16-16-8+TE), and urea were an optimal formula for growth and development, fruit yield, and quality traits in tomatillos (*P. philadelphica*) under the farming conditions of An Giang Province, Vietnam. Higher plant spacing optimized the plant height, increased the stem and leaf growth, and improved fruit yield and quality in tomatillos. Plant spacing of 70 cm × 60 cm helped tomatillos grow and develop well, enhancing fruit yield with better quality. The shoot pruning did not have a significant impact on tomatillo's growth and yield-related traits; however, to some extent, pruning increased the fruit diameter and size.

ACKNOWLEDGMENTS

This research received funding support from the Vietnam National University, Ho Chi Minh City (VNU-HCM), under grant number: C2024-16-14.

REFERENCES

- Alam MS, Saha SR, Salam MA, Alam MK (2011). Effect of sowing time and plant spacing on the yield and yield attributes of sweet pepper (*Capsicum annuum*). *Bangladesh J. Agric. Res.* 36: 271-278. <https://doi.org/10.3329/bjar.v36i2.9254>.
- Alam MS, Islam N, Ahmad S, Hossen MI, Islam MR (2016). Effect of different staking methods and stem pruning on yield and quality of summer tomato. *Bangladesh J. Agric. Res.* 41(3): 419-432. <https://doi.org/10.3329/bjar.v41i3.29714>.
- Azeem M, Ahmed R (2011). Foliar application of some essential minerals on tomato (*Lycopersicon esculentum*) plant grown under two different salinity regimes. *Pak. J. Bot.* 43(3): 1513-1520. [https://www.pakbs.org/pjbot/PDFs/43\(3\)/PJ B43\(3\)1513.pdf](https://www.pakbs.org/pjbot/PDFs/43(3)/PJ B43(3)1513.pdf).
- D'angelo JWO, Bastos MC, Cuquel FL (2017). Maintenance pruning in *Physalis* commercial production. *Plant Breed. - Bragantia* 76(2): 214-219. <http://dx.doi.org/10.1590/1678-4499.128>.
- Das DR, Rahman SB, Ehsan GMA, Rahman MA (2025). Growth and yield of tomato as influenced by stem pruning. *J. Environ. Sci. Nat. Resour.* 14(1&2): 31-36. <https://doi.org/10.3329/jesnr.v14i1.81103>.
- Elsayed AYAM, Hassan BAA, Hassanin AA, Zyada HG, Ismail HEM, Aguilera JG (2023). Selection parameters for improvement of yield and quality in tomatillo. *Agric. Sci.* 47: e013722. <http://dx.doi.org/10.1590/1413-7054202347013722>.
- Gao F, Li H, Mu X, Gao H, Zhang Y, Li R, Cao K, Ye L (2023). Effects of organic fertilizer application on tomato yield and quality: A meta-analysis. *Appl. Sci.* 13(4): 2184. <https://doi.org/10.3390/app13042184>.
- García-Mendieta A, Olguín MT, Solache-Ríos M (2012). Biosorption properties of green tomato husk (*Physalis philadelphica* Lam) for iron, manganese and iron-manganese from aqueous systems. *Desalination* 284: 167-174. <https://doi.org/10.1016/j.desal.2011.08.052>.
- Goda Y, El-Rehim A, Mohamed AA, Helaly AA, El-Zeiny OAH (2014). Effect of shoot pruning on growth, yield and fruit quality of husk tomato (*Physalis pubescens* L.). *J. Am. Sci.* 10(1s): 5-10. <https://www.jofamerican science.org/journals/am-sci/am1001s/>.
- Gonzaga NR, Gonzaga Jr. AB, Pepito SLA, Rogers G (2017). Performance of fresh market tomato (*Solanum lycopersicum* L.) lines influenced by pruning. *Ann. Trop. Res.* 39(B): 108-115. <https://doi.org/10.32945/atr39sb8.2017>.
- González-Pérez JE, Guerrero-Beltrán JA (2021). Tomatillo or husk tomato (*Physalis philadelphica* and *Physalis ixocarpa*): A review. *Sci. Hortic.* 288: 110306. <https://doi.org/10.1016/j.scienta.2021.110306>.
- Hernawan D, Jaenudin A, Eviyati R (2023). The effect of doses of cow manure and NPK fertilizer on the growth and yield of purple eggplant (*Solanum melongena* L) cultivars Mustang F1. *J. Agron. Sci.* 1(2): 60-69. <https://doi.org/10.62885/agrosoci.v1i2.108>.
- Hesamil S, Khorami S, Hosseini SS (2012). Effect of shoot pruning and flower thinning on quality and quantity of semi-determinate tomato

- (*Lycopersicon esculentum* Mill.). *Not. Sci. Biol.* 4(1): 108-111. <https://doi.org/10.15835/nsb.4.1.7179>.
- Karangwa A, Ndungutse V, Fashaho A, Habimana S, Manirere JD, Nsengimana V, Mulinga N, Imanishimwe C, Nyagatare G (2023). Influence of organic and inorganic fertilizers on growth and yield of potato (*Solanum tuberosum* L.) in Nyabihu district of Rwandawanda. *Potato J.* 50(2). <https://epubs.icar.org.in/index.php/PotatoJ/article/view/146848>.
- Karpe M, Marcelis LFM, Heuvelink E (2024). Dynamic plant spacing in tomato results in high yields while mitigating the reduction in fruit quality associated with high planting densities. *Front. Plant Sci.* 15: 1386950. <https://doi.org/10.3389/fpls.2024.1386950>.
- Lhamo T, Gyalmo T, Pem T, Bajgai Y (2022). Effect of different pruning systems on yield and quality of tomato grown under greenhouse. *Bhutanese J. Agric.* 5(1): 71-82. <https://doi.org/10.55925/btagr.22.5106>.
- Maldonado E, Pérez-Castorena AL, Garcés C, Martínez M (2011). Philadelphicalactones C and D and other cytotoxic compounds from *Physalis philadelphica*. *Steroids* 76(7): 724-728. <https://doi.org/10.1016/j.steroids.2011.03.018>.
- Muhammad A, Singh A (2007). Yield of tomato as influenced by training and pruning in the Sudan Savanna of Nigeria. *J. Plant Sci.* 2(3): 310-317. <https://doi.org/10.3923/jps.2007.310.317>.
- Peña-Lomelí A, Magaña-Lira N, Gámez-Torres A, Mendoza-Celino FA, Pérez-Grajales M (2017). Manual pollination in two tomatillo (*Physalis ixocarpa* Brot. ex Horm.) varieties under greenhouse conditions. *Rev. Chapingo Ser. Hortic.* 24(1): 41-52. <http://dx.doi.org/10.5154/r.rchsh.2017.02.011>.
- Pretz C, Deanna R (2020). Typification and nomenclatural notes in *Physalis* (*Solanaceae*) from the United States. *Taxon* 69: 170-192. <https://doi.org/10.1002/tax.12159>.
- Rao RL, Singh D, Prasad VM, Antony P (2022). Effect of pruning methods on growth, yield and quality of cherry tomato (*Solanum lycopersicum* var. *cerasiforme*) c.v- Pusa Cherry, Roja Red & Nagamoti under polyhouse condition of Prayagraj. *Int. J. Plant Sci.* 34(23): 749-753. <http://doi.org/10.9734/IJPSS/2022/v34i232485>.
- Santos KS, Passos AR, Silva LCC, Alda S, Tanan TT (2021). Genetic variability of *Physalis ixocarpa* and *P. philadelphica* from physicochemical fruit traits. *Pesq. Agropec. Bras.* 56: e01534. <https://doi.org/10.1590/S1678-3921.pab2021.v56.01534>.
- Shah P, Bora KS (2019). Phytochemical and therapeutic potential of *Physalis* species: A review. *IOSR J. Pharm. Biol. Sci.* 14(4): 34-51. <https://doi.org/10.9790/3008-1404033451>.
- Shamim ASA, Mostarin T, Khatun K, Nahar S, Begum T, Uzzaman MdK, Ahmed A, Imtiaz AA, Rahaman MdA, Samad MdA (2022). Growth and yield of tomatillo as influenced by planting time and macronutrients. *Eur. J. Nutr. Food Saf.* 14(11): 94-105. <https://doi.org/10.9734/EJNFS/2022/v14i111268>.
- Singh H, Sharma P, Kumar P, Dhillon NS (2017). Influence of spacing and pruning on growth characteristics, yield and economics of tomato (*Solanum lycopersicum* L.) grown under protected environment. *Int. J. Curr. Microbiol. Appl. Sci.* 6(9): 1833-1838. <https://doi.org/10.20546/ijcmas.2017.609.226>.
- Solíis-Montero L, Aceves-Chong L, Vega-Polanco M, Vargas-Ponce O (2021). Changes in reproductive traits in *Physalis philadelphica*; An unexpected shift toward self-incompatibility in a domesticated annual fruit crop. *Front. Plant Sci.* 12: 658406. <https://doi.org/10.3389/fpls.2021.658406>.
- Vdovenko SA, Polutin OO, Muliarchuk OI, Hareba OV, Havrys IL (2021). Peculiarities of tomatillo (*Physalis philadelphica*) field production in Ukraine with the use of different elements of technology. *Res. on Crops* 22(1): 116-128. <https://doi.org/10.31830/2348-7542.2021.044>.
- Xu N, Meng L, Tang F, Du S, Xu Y, Kuang S, Lv Y, Song W, Li Y, Qi W, Zhang Y (2023). Plant spacing effects on stem development and secondary growth in *Nicotiana tabacum*. *Agronomy* 13(8): 2142. <https://doi.org/10.3390/agronomy13082142>.
- Yadav D, Topno SE, Bahadur V (2024). Effect of micronutrients on growth, yield and quality of tomato (*Solanum lycopersicum* L.). *Int. J. Res. Agron.* 7(8): 627-633. <https://doi.org/10.33545/2618060X.2024.v7.i8i.1340>.
- Zhang B, Huang W, Li J, Zhao C, Fan S, Wu J, Liu C (2014). Principles, developments and applications of computer vision for external quality inspection of fruits and vegetables: A review. *Food Res. Int.* 62: 326-343. <https://doi.org/10.1016/j.foodres.2014.03.012>.