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Production trial on eggplant, *Solanum melongena* L. varieties utilized by farmers in Arayat, Pampanga, Philippines

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Abstract

Background and Objective: Eggplant, *Solanum melongena* L., has received major attention in improving agricultural production. Several varieties of the crop have been developed, and a number are still being studied to make the crop adaptive to the changing climatic and environmental conditions. The study was conducted to determine the growth and yield performance of different eggplant varieties utilized by vegetable farmers in Arayat, Pampanga.

Methodology: The experiment was laid out in a randomized complete block design (RCBD), with three replications and three varieties, namely Calixto F1, Long Purple F1, and Warhawk F1, representing the treatments.

Main Results: Results of the study showed significant differences among varieties tested in terms of plant height at 30 (P = 0.006) and 60 (P = 0.005) days after transplanting (DAT), days to flowering (P = 0.023), polar diameter (P = 0.016), equatorial diameter (P = 0.040), numbers of marketable (P = 0.001) and non-marketable fruits (P = 0.022), weight of marketable (0.010) and non-marketable fruits (P = 0.048), and computed yield (kg/ha; P = 0.011). The variety Calixto F1 showed the best growth and yield performance as it gave the tallest plant height at 30 DAT (43.23 ± 0.92 cm), took the shorter length of days to flowering (31.67 ± 0.33 days), widest equatorial fruit size (10.40 ± 0.23 cm), heaviest fruit yield per plant (212.31 ± 9.46 g), heaviest weight of marketable fruit (6,939.19 ± 282.68 g), and highest computed yield (2,541.83 ± 103.55 kg/ha).

Conclusions: The current study recommends that Calixto F1 may be the most appropriate eggplant variety to be planted in the area, as it showed superior performance on various growth and yield parameters. However, other factors may still be taken into consideration when selecting varieties to be utilized.

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INTRODUCTION

Eggplant (*Solanum melongena* L.) is one of the world's most important vegetables. It is one of the most inexpensive and popular vegetable crops grown and consumed in Asia. It is considered a staple in countries in South and Southeast Asia and is widely used in many cuisines (Dala-Paula *et al*., 2021). In the Philippines, eggplant or *talong* is the number one vegetable in terms of production area, with an average of 21,225 hectares planted every year. The top five eggplant-producing areas in the country are Ilocos, Central Luzon, Cagayan Valley, CALABARZON, and the Bicol region (Gerpacio and Aquino, 2014). Resource-poor farmers in many provinces grow eggplant and depend on it for their livelihood (Parreño-de Guzman *et al*., 2015). Its production accounts for more than 30% of the total volume of production of the most important vegetables in the country (Philippine Statistics Authority, 2014). While there are numerous varieties of eggplant already available in the Philippines, local farmers continue to look for improved cultivars that are superior in terms of their growth, productivity, disease resistance, and transportability (Panergayo *et al*., 2008).

Unlike previous experiments in the region which focused on the development and assessment of genetically modified (Bt) eggplant lines for resistance to eggplant fruit and shoot borer, this study presents a novel varietal trial specifically designed to test the following available varieties in Arayat, Pampanga, Philippines: Calixto F1 (a high-yielding variety that produces long and slim fruits). These are also said to be resistant to bacterial wilt: Long Purple F1, which produces dark purple fruits with glossy skin, pale white flesh, and few seeds; and Warhawk F1, a fast-growing, prolific, high-yielding hybrid that produces long purple eggplants resistant to diseases. By focusing on these varieties, the study offers practical insight for farmers who mainly rely on seeds as their primary option. It is hypothesized that the three varieties used in the experiment will exhibit significant variations in agronomic performance under the conditions of Arayat, Pampanga. The hybrid varieties utilized were expected to specifically show differences in their growth characteristics, such as plant height, flowering time, fruit quality parameters (size and weight of marketable and non-marketable produce), and overall yield performance. The results of this trial will provide farmers with evidence-based recommendations to optimize their yield, ultimately improving their income and thereby supporting sustainable eggplant production in the region.

MATERIALS AND METHODS

The study was conducted in Barangay Telapayong, Arayat, Pampanga, Philippines (15°11'04" N 120°39'47" E) from January to April 2022 (Figure 1). The experimental area is situated within a vegetable farm, where corn, rice, and other vegetables are planted in rotation throughout the year.

Experimental Design

The experiment was laid out using a randomized complete block design (RCBD), composed of three treatments that represented different eggplant varieties, namely Calixto F1, Long Purple F1, and Warhawk F1. To ensure uniform plant density, proper randomization, and effective control of field variability following the standard practices in eggplant field trials, each plot (2.80 m × 2.80 m) consisted of forty plants with a 70 cm distance between rows and a 40 cm distance between hills. The plots were arranged in three blocks, wherein each treatment appears once per block. A one-meter distance between plots and blocks was employed for ease of access and to minimize border effects.

Soil Sampling

Using a shovel, one kilogram of soil sample was collected from ten different sites in the experimental area at a depth of 20–30 cm. These were air-dried, pulverized, and properly mixed. The samples were submitted to the Regional Soil Laboratory of the Department of Agriculture, Regional Office No. III, San Fernando, Pampanga, for soil analysis. Soil analysis indicated a pH of 4.81 and 1.32% organic matter, determined using the Walkley-Black method. The soil contained 7.59 ppm phosphorus and 0.63 cmol/kg potassium.

Land Preparation

An approximately 108 m^2 area was allotted as the experimental area. It was plowed at a depth of 15–20 cm and harrowed twice alternately at one-week intervals.

Seedling Preparation and Transplanting

The seedling tray method was used to prepare the seedlings. The sowing medium was prepared by thoroughly mixing one part of vermicompost, one part of cocopeat soil, and one part of garden soil. Two seeds were sown in each hole at 0.5 cm. The seeds were covered with fine soil and sprinkled with water to boost germination. Transplanting was done 30 days after sowing when three to four true leaves were observed. The seedlings were transplanted at a 70 cm distance between rows and 40 cm distance between hills.

Figure 1 Location of the experimental site (15°11’04” N 120°39’47” E)

Fertilizer Application and Irrigation

Fertilizers were applied uniformly among all treatments to eliminate the confusing effects of different nutrients supplied, thus allowing direct comparison of the varieties' inherent traits. While this approach may have limited the prediction of specific nutritional requirements of each variety, it provides a standardized baseline for growth and yield performance evaluation of the crops under certain environmental conditions.

Urea (46-0-0), which is commonly used by farmers due to its high nitrogen content (Akter *et al*., 2022; Bautista *et al*., 2024), and fully decomposed chicken dung were applied into the furrows during the transplanting time. Chicken dung was applied at a rate of 1 kg/plot, while urea was applied at a rate of 70.56 g/plot at 3 and 9 weeks after transplanting, following the recommended rate of 90 kg/ha based on soil analysis. On the other hand, a water pump was used to irrigate the field late in the afternoon when necessary.

Harvesting

Harvesting of fruits was done at 60 days after transplanting (DAT). It was done early in the morning. The experiment has been limited to ten harvest primings done every four days to avoid over-maturity of fruits. The damaged fruits were removed from the harvest and sorted according to market standards. Fruits were packed in 10 kg/plastic bags. The bags were pricked for ventilation. Marketable fruits are those without blemishes, insect damage, and cracks.

Data Analysis

One-way analysis of variance (ANOVA) was used to compare treatments in a randomized complete block design. After which, a post-hoc analysis was done using the least significant difference (LSD) test to determine significant differences among treatment means ($P < 0.05$).

RESULTS AND DISCUSSION

Plant Height

As indicated in Table 1, at 30 DAT, the plant heights of eggplant varieties of Calixto F1 and Long Purple F1 were statistically similar to each other, recording taller plant heights than those of Warhawk F1. However, at 60 DAT, the three varieties used exhibited statistically incomparable plant heights. The tallest plants were noted on Long Purple F1 (113.13 ± 2.49 cm), followed by Warhawk F1 (104.47 ± 0.75 cm) and Calixto F1 (95.23 ± 2.89 cm). This implies that differences in height of different plant varieties may be quite observable at 30 DAT ($P = 0.006$) but not at 60 DAT ($P = 0.005$) when plants have fully matured. These significant results corroborate the study of Sharath *et al*. (2023), which indicates significant plant height differences among different varieties of a single crop. In addition, plant height is considered one of the most important factors in varietal development as it affects the overall biomass of the crop, thus affecting its yield (Miao *et al*., 2024). Sarker *et al*. (2011) also reported that plant heights may have varietal effects. Hence, differences are seen among treatments, although they are exposed to similar environmental conditions. Abney and Russo (1997) and Kumar Yadav *et al*. (2024) described a positive correlation between plant height and average fruit yield of eggplants, indicating higher yields obtained among taller plants. Although several experiments account for the positive relationship between plant height and yield, there are still other factors that may affect the complex relationship of the two, such as specific fertilizer combinations (Suge *et al*., 2011; Akshay *et al*., 2018).

Days to Flowering

The results shown in Table 2 indicate the number of days to flowering of the different eggplant varieties. There were significant differences in the number of days to flowering of eggplant ($P = 0.023$).

Long Purple F1 took the longest number of days to flowering (33.67 ± 0.33 days), while Calixto F1 (31.67 ± 0.33 days) and Warhawk F1 (32.33 ± 0.33 days) took shorter days to flowering. The latter two varieties took a statistically similar number of days to flowering, which may imply that different eggplant varieties exhibit different numbers of days to flowering, which significantly impacts their overall growth and development (Umezinwa *et al*., 2021). Aside from genotype differences, this may be a result of environmental influences (Adamczewska-Sowińska *et al*., 2016; Koundinya *et al*., 2017). The results obtained underscore the importance of selecting varieties to optimize planting schedules, which may be useful for farmers seeking shorter cropping cycles, thus allowing better income opportunities.

Table 1 Average plant height at 30 and 60 days after transplanting (DAT) of different eggplant varieties

Varieties	Plant height at 30 DAT (cm)	Plant height at 60 DAT (cm)
V_1 - Calixto F1	43.23 ± 0.92^a	95.23 ± 2.89^c
V_2 - Long Purple F1	40.03 ± 0.71^a	113.13 ± 2.49^a
V_3 - Warhawk F1	31.07 ± 1.43^b	104.47 ± 0.75^b
P-value	0.006	0.005

Note: Means within the same column followed by different superscript letters (a, b, c) are significantly different (P < 0.05), according to the least significant difference test. Values are expressed as mean ± standard deviation.

Table 2 Average number of days to flowering of different eggplant varieties

Varieties	Days to flowering
V_1 - Calixto F1	31.67 ± 0.33^b
V_2 - Long Purple F1	33.67 ± 0.33^a
V_3 - Warhawk F1	32.33 ± 0.33^b
P-value	0.023

Note: Means within the same column followed by different superscript letters (a, b) are significantly different (P < 0.05), according to the least significant difference test. Values are expressed as mean ± standard deviation.

Polar and Equatorial Fruit Size

Table 3 presents the average polar and equatorial diameters of eggplant produced by different eggplant varieties. Significant differences are noted in the polar (P = 0.016) and equatorial (P = 0.040) diameters of fruits produced. It is noted that the polar diameters of fruits produced by varieties Calixto F1 (24.34 ± 0.74 cm) and Warhawk F1 (25.10 ± 0.53 cm) are comparable with each other and are statistically different from the polar diameter of fruits produced by variety Long Purple F1 (29.16 ± 0.67 cm). Although varieties Long Purple F1 and Warhawk F1 produced fruits with statistically similar equatorial diameters, these are lower than the equatorial diameters of fruits produced by Calixto F1. Additionally, this demonstrates that various eggplant cultivars have genotypic traits that differ phenotypically manifested on their polar and equatorial diameters, supporting the findings of Damnjanović *et al*. (2022), who found that these two characteristics also yielded significant results. Similar to other phenotypic characters, the polar and equatorial fruit sizes are influenced by a combination of genetic, agricultural, and environmental factors (Akhtar, 2015). The differences in fruit size reflect genotypic variations that may influence market preferences.

Table 3 Average polar and equatorial diameter of eggplant produced by different eggplant varieties

Varieties	Polar diameter (cm)	Equatorial diameter (cm)
V_1 - Calixto F1	24.34 ± 0.74[b]	10.40 ± 0.23[a]
V_2 - Long Purple F1	29.16 ± 0.67[a]	9.50 ± 0.23[b]
V_3 - Warhawk F1	25.10 ± 0.53[b]	9.59 ± 0.06[b]
P-value	0.016	0.040

Note: Means within the same column followed by different superscript letters (a, b) are significantly different (P < 0.05), according to the least significant difference test. Values are expressed as mean ± standard deviation.

Fruit Yield Per Plant (g)

While Calixto F1 produced the highest average fruit yield per plant (212.31 g), results suggest that no variety is better than the other (Table 4), which, however, contradicts the results obtained by Quamruzzaman *et al*. (2019), which showed significant differences among varieties tested. Insignificant results obtained in this study may be attributed to the equal amounts of fertilizers applied on the different varieties, as these plants may have different fertilizer requirements as part of their varietal characteristic (Suge *et al*., 2011).

Number of Marketable and Non-Marketable Fruits

Marketable fruits are defined as those free from insect pest infestation, pathogenic infection, and other forms of physical defects; otherwise, fruits are classified as non-marketable (Keinath, 2024). Significant differences were observed in the number of marketable (P = 0.001) and non-marketable fruits (P = 0.022) produced by the three varieties (Table 5). The number of marketable fruits obtained from varieties Warhawk F1 (105.00 ± 1.00), Calixto F1 (88.33 ± 4.64), and Long Purple F1 (55.00 ± 2.00) was found to be significantly different from one another. Regarding the number of non-marketable fruits, varieties Calixto F1 (12.33 ± 1.20) and Warhawk F1 (11.33 ± 0.33) gave comparable results, which are significantly different from the variety Long Purple F1 (7.33 ± 0.33). Results obtained are in line with the reports of Rashid *et al*. (2015) and Isah *et al*. (2022). Their studies concluded that genetically different varieties perform differently in the field, as evidenced by the quality of fruits they can produce. The result is also supported by the findings of Bogoev and Kostadinox (2011) and Yeshiwas *et al*. (2016), who observed that different varieties perform differently in the field, as evidenced by their produce. This result further suggests that not all varieties may be planted in an area if a farmer aims at achieving optimum yield with minimum intervention.

Table 4 Average fruit yield per plant produced by different eggplant varieties

Varieties	Fruit yield per plant (g)
V_1 - Calixto F1	212.31 ± 9.46
V_2 - Long Purple F1	194.83 ± 6.02
V_3 - Warhawk F1	184.50 ± 2.08
P-value	0.142

Note: Values are expressed as mean ± standard deviation.

Table 5 Average number of marketable and non-marketable fruits produced by different varieties of eggplant

Varieties	Number of marketable fruits	Number of non-marketable fruits
V_1 - Calixto F1	88.33 ± 4.64[b]	12.33 ± 1.20[a]
V_2 - Long Purple F1	55.00 ± 2.00[c]	7.33 ± 0.33[b]
V_3 - Warhawk F1	105.00 ± 1.00[a]	11.33 ± 0.33[a]
P-value	0.001	0.022

Note: Means within the same column followed by different superscript letters (a, b, c) are significantly different ($P < 0.05$), according to the least significant difference test. Values are expressed as mean ± standard deviation.

Weight of Marketable and Non-Marketable Fruits

Table 6 shows the average weight of marketable and non-marketable fruits produced by different varieties of eggplant. There were significant differences exhibited by different eggplant varieties in terms of the weight of marketable ($P = 0.010$) and non-marketable fruits ($P = 0.048$) they produced (Figure 2). It may be observed that varieties Calixto F1 (6,939.19 ± 282.68 g) and Warhawk F1 (6,763.39 ± 220.56 g) produced the heaviest marketable fruits with statistically comparable means, leaving variety Long Purple F1 (4,967.76 ± 119.65 g) incomparable with the two since it produced the lowest weight of marketable fruits. Nevertheless, although Calixto F1 gave the heaviest mean marketable fruit weight, it also gave the heaviest weight of non-marketable fruits (803.87 ± 82.58 g). It is then found statistically different from the weight of non-marketable fruits obtained from varieties Warhawk F1 (593.57 ± 26.20 g) and Long Purple F1 (539.29 ± 52.46 g), with significantly similar results. Evidently, the varieties that produced a higher number of fruits in terms of both marketable and non-marketable also produced heavier marketable and non-marketable fruits.

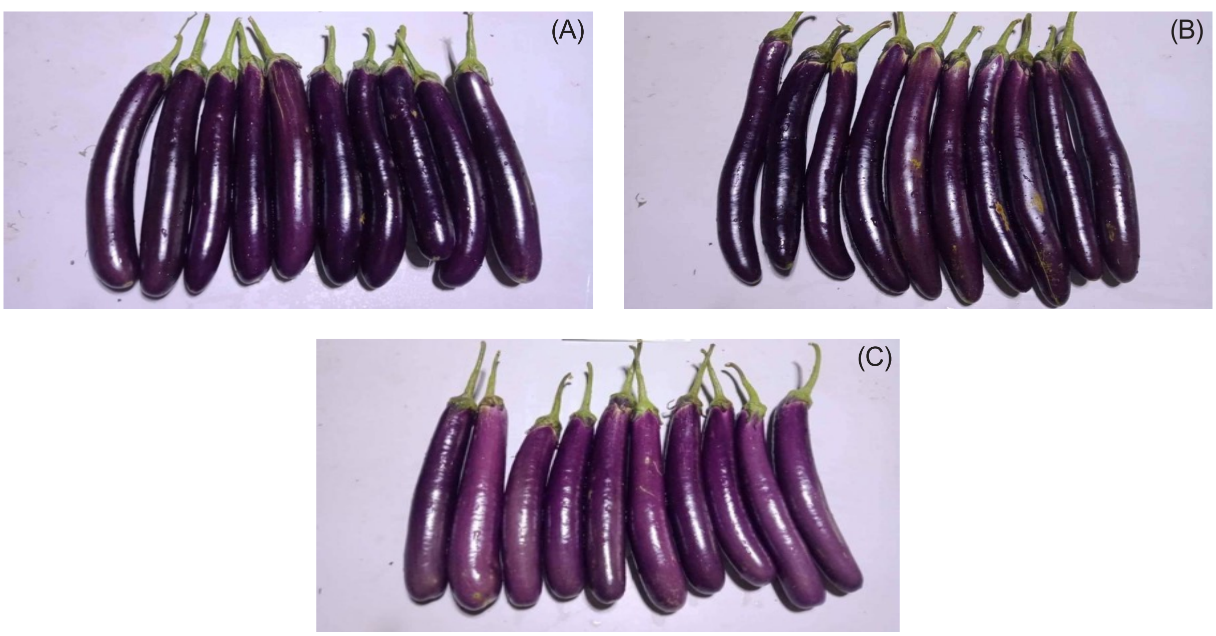

Figure 2 Marketable fruits produced by Calixto F1 (A), Long Purple F1 (B), and Warhawk F1 (C)

Computed Yield Per Hectare

Table 7 shows the average computed yield of eggplant produced from different eggplant varieties. Significant differences among means (P = 0.011) were noted. Variety Calixto F1 (2,541.83 ± 103.55 kg/ha) produced the highest computed yield, which was not significantly different from that of Warhawk F1 (2,480.73 ± 78.97 kg/ha). Variety Long Purple F1 (1,861.88 ± 44.61 kg/ha), however, gave the lowest computed yield per hectare, making it incomparable with the other two varieties. Despite the lack of a significant difference in yield per plant, the overall performance of Calixto F1 and Warhawk F1 may be due to factors influencing the total harvestable yield, such as better flower and fruit set, fruit retention, and the variety's adaptation to local environmental conditions.

These results suggest the importance of carefully scrutinizing the varieties for optimal eggplant production in a certain area. Each of the varieties tested has inherent genotypes, which may influence their growth and development, including their overall productivity (Gotame *et al*., 2020; Uddin *et al*., 2021). It is noted that the soil in the experimental area was acidic (pH 4.81), which may have likely influenced the varietal performance differently, as varieties may exhibit varying tolerance to soil acidity and associated nutrient availability limitations. In terms of pests and diseases, there was minimal pest pressure, which may be attributed to the optimal growing season and inherent resistance of the varieties used. This corroborates with Ebert (2017) and Alam and Salimullah (2021), who reported that the adaptability of the varieties in various environmental conditions, such as water availability and nutrient uptake, and resistance to pests and diseases, may also be noted. In addition, agronomic practices such as planting distances, fertilization, and irrigation may have improved the performance of one variety while limiting the other (Rodríguez-Burruezo *et al*., 2008; Mat Sulaiman *et al*., 2020).

Table 6 Average weight of marketable and non-marketable fruits produced by different varieties of eggplant

Varieties	Weight of marketable fruit (g)	Weight of non-marketable fruit (g)
V_1 - Calixto F1	6,939.19 ± 282.68^a	803.87 ± 82.58^a
V_2 - Long Purple F1	4,967.76 ± 119.65^b	539.29 ± 52.46^b
V_3 - Warhawk F1	6,763.39 ± 220.56^a	593.57 ± 26.20^b
P-value	0.010	0.048

Note: Means within the same column followed by different superscript letters (a, b) are significantly different (P < 0.05), according to the least significant difference test. Values are expressed as mean ± standard deviation.

Table 7 Average computed yield produced from different eggplant varieties

Varieties	Computed yield (kg/ha)
V_1 - Calixto F1	2,541.83 ± 103.55^a
V_2 - Long Purple F1	1,861.88 ± 44.61^b
V_3 - Warhawk F1	2,480.73 ± 78.97^a
P-value	0.011

Note: Means within the same column followed by different superscript letters (a, b) are significantly different (P < 0.05), according to the least significant difference test. Values are expressed as mean ± standard deviation.

CONCLUSIONS

The study recognizes that the varietal characteristics of crops planted may significantly impact crop production and income of local farmers, acknowledging the importance of adapting good crop choices in the local context. Results obtained demonstrated that varietal selection can influence several important agronomic parameters, such that different eggplant varieties exhibited significant differences in terms of plant height at 30 and 60 DAT, days to flowering, number of marketable fruits, polar and equatorial fruit size, weight of marketable and non-marketable fruits, and computed yield (kg/ha). Although no significant differences were noted in the average fruit yield per plant among the three varieties tested, variety Calixto F1 showed superior growth and yield performance. Hence, this variety stood out as the top performer across multiple parameters. This result is consistent with findings from other studies conducted in Central Luzon and similar environments in the Philippines, where hybrid varieties have outperformed open-pollinated types, and in some cases, other hybrids in both yield and marketable fruit quality. More so, the fruits produced by Calixto F1 were more appealing and often preferred in the market as they produce dark violet fruits with very green calyx, which enhances their market appeal.

Based on these results, it is recommended that local farmers consider adopting Calixto F1 for improved productivity, marketability, and income. However, suitable agronomic practices should be employed. It should be noted that the experiment was conducted utilizing uniform management practices, which may have affected the varying responses of each variety. Hence, future research should focus on tailoring specific crop production strategies for each variety to optimize growth and productivity.

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