Diversity and morpho-agronomic characters of eggplant (Solanum sp) distributed in Palangka Raya Central Kalimantan

Hastin Ernawati Nur Chusnul Chotimah*[1], Syahrudin[2], Wahyu Widyawati[3], Yusi Indriani[4], Kambang Vetrani Asie[5], Sri Endang Agustina Rahayuningsih[6]
[1,2,3,4,5,6]Program Study of Agrotechnology, Faculty of Agriculture, University of Palangka Raya
Jl. Yos. Sudarso Palangka Raya 73111 Kalimantan Tengah
email : hastinwindarto@agr.upr.ac.id

Abstract

The eggplant species are currently at risk of extinction due to various factors such as land conversion into plantation areas and transmigration settlements in Palangka Raya. It is essential to conduct a thorough analysis of eggplant vegetation to address this urgent matter. Consequently, the research aimed to determine the diversity of eggplants, their distribution, as well as their morpho-agronomic characters. Field experiments were carried out in each district of Palangka Raya for 7 months. The methods used were survey, exploration, and interview with the key informant. Plant characterization refers to the descriptors for eggplant (IBPGR, 1990). The observed variables were the morphological characterization of eggplant, agronomy, and the distribution of eggplant in Palangka Raya. Results showed that it is found three species of eggplants, namely *Solanum melongena* (ungu, gelatik, telur, apel hijau eggplant cultivars), *Solanum torvum*, and *Solanum ferox*. There was variation in the morpho-agronomic characters of eggplant found.

Introduction

Indonesia possesses a tropical climate and a diverse range of flora and fauna. The tropical forests are home to more than 30,000 species of plants, which accounts for over 12% of the world's 250,00 species (Grubben et al., 1994). Solanaceae, a family of flowering plants with enclosed seeds, is an example of a diverse range of flora in Indonesia (Cambell, 2003). Solanum is the largest and most abundant genus in the angiosperm group, comprising about 1,500 species in the Solanaceae family. Jennifer and James (2007) noted that Solanum is commonly found in tropical regions with moderate temperatures. Nine Solanum species are found in Egyptian flora, including *S. coagulans, S. elaeagnifolium, S. forskalii, S. incanum, S. nigrum, S. schimperianum, S. sinaicum, S. villosum* and *S. virginianum* (Hepper, 2002). The Solanum genus has garnered significant attention from taxonomists due to its intricate nature, resulting in a lack of clarity regarding species diversity and eco-geographical distribution (Bello et al.,

2013). Solanum has been classified into seven subgenera, each of which comprises numerous sections and series. Leptostemonum is one of these subgenera, which has been further subdivided into various sections and species (Fawzi and Habeeb, 2016).

The Solanum has a high level of diversity, comprising approximately 450 species. This plant is widespread, with its primary center of diversity located in South America and secondary centers in Australia and Africa. The distribution of spiny eggplants native to Africa and Madagascar encompasses 76 species, while 20 species are native to Asia, and 80-140 species are present in Australia (Bean, 2004). Brazil serves as a major center of eggplant diversity, with the subgenus Leptostemonum containing approximately 24% of the world's species and displaying high levels of endemism, with approximately 58 endemic species that account for around 13% of the total species in the subgenus. There are around 455 eggplant plants in Brazil that have been assigned specific names, of which 345 are synonyms (Fatima, 2007).

An inventory of the Solanum was conducted in 12 provinces of Indonesia. Balitbangtan, 2018) reported 372 accessions, including 12 Solanum species in the Leptostemonum subgenus. Gathering information about eggplant species diversity requires the identification and characterization of Solanum species. Furthermore, Palangka Raya's genetic resources will be enhanced. Identification and characterization are carried out through plant morphology observation, which is the most straightforward and efficient method for determining the diversity of plant species (Maskromo & Miftahorrachman, 2007).

The diversity of eggplant is facing the threat of extinction due to widespread land conversion into plantation areas and transmigration settlements. This issue is further compounded by the occurrence of forest and peatland fires during almost every dry season. In light of the diminishing wild plant vegetation, particularly the Solanum genus in Palangka Raya, there is an urgent need to investigate eggplant vegetation analysis. The research on eggplant diversity and vegetation analysis aims to provide fundamental information about the diversity and distribution of dominance, which is critical for exploring natural resource wealth and conserving germplasm in Palangka Raya.

Materials and Methods

A field experiment was conducted in each district of Palangka Raya, Central Kalimantan (Figure 1) for 7 months (August 2019-February 2020). This research was conducted using survey and exploration methods in all districts of Palangka Raya including Pahandut, Sebangau, Jekan Raya, Rakumpit, and Bukit Batu. Sampling was carried out purposively according to the presence of Solanum as well as information from key informants in each exploration area. Key informants are community leaders and local people as well as a farmer who use and cultivate eggplant plants around them to meet their daily needs. Plant characterization refers to the Descriptors for eggplant (IBPGR, 1990). The observed variables were the morphological characterization of eggplant, agronomy (flowering time, harvest time, number of fruits per plant, soil type), and the distribution of eggplant in Palangka Raya.

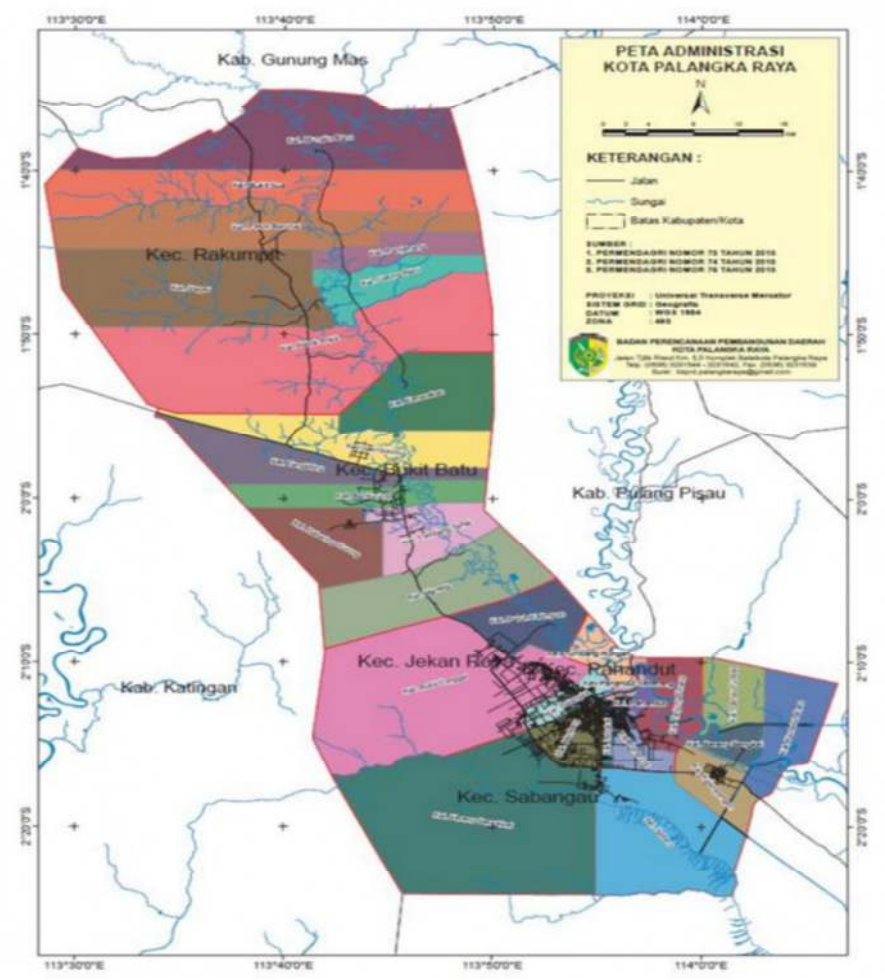

Figure 1. Maps of Palangka Raya

Data analysis

Data obtained are presented and managed in the form of figures and tabulations, and then explained narratively.

Results and Discussions

Study site description

Eggplant sampling locations were determined based on the consideration that the area should be able to adequately represent the diversity and abundance of eggplant populations in Palangka Raya. The specific locations chosen are listed in table 1 below.

Table 1. Sampling locations

No	District Bukit Batu	District Jekan raya	District Pahandut	District Rakumpit	District Sebangau
1	Sub-district Banturung	Sub-district Menteng	Sub-district Pahandut	Sub-district Bukit Batu	Sub-district Kereng Bangkirai
2	Sub-district Tangkiling	Sub-district Palangka	Sub-district Pahandut Seberang	Sub-district Pager	Sub-district Kalampangan
3			Sub-district Panarung		
4			Sub-district Tumbang Rungan		

Palangka Raya is situated at $113^{0}30'$- $114^{0}07'$ East Longitude and $1^{0}35'$-$2^{0}24'$ South Latitude, covering an area of 2,853.12 square kilometers. The city's terrain is predominantly flat and hilly with a slope of less than 40%. The soil types in Palangka Raya are distributed according to the topographical conditions. In the southern part of the city, peat soil and alluvial soil with poor drainage conditions are the predominant soil types, whereas the north is dominated by red-yellow podzolic soils, podzol, and alluvial. The riverside areas are mainly covered by alluvial soil that originates from river sediments. Based on its location, Palangka Raya is bordered by Pulang Pisau Regency to the east and south, Katingan Regency to the west, and Gunung Mas Regency to the north. The average temperature range in Palangka Raya was between 26.7°C to 28.1°C. The month of May had the highest average temperature at 28.1°C, while January had the lowest at 26.7°C. The average maximum air humidity in 2019 was 97.7, whereas the minimum average air

humidity was 46.6. The city experienced 158 rainy days spread out throughout the year in 2019.

Species availability

Various types of eggplants that are distributed within Palangka Raya are presented in table 2.

Table 2. The distribution of various types of eggplant in each district of Palangka Raya

District	Species/cultivar
Pahandut	*S. melongena* (ungu, gelatik, telur eggplant), *S. ferox*, *S. Torvum*
Sebangau	*S. melongena* (ungu, gelatik, telur eggplant), *S.torvum*, *S. ferox.*
Jekan Raya	*S. melongena* (ungu, gelatik, telur, apel hijau eggplant), *S.torvum*, *S. ferox*,
Bukit Batu	*S. melongena* (ungu, gelatik, telur eggplant), *S.torvum*
Rakumpit	*S. melongena* (ungu, gelatik, telur eggplant), *S.torvum*

The results of observations and interviews conducted in 12 sub-districts in five districts in Palangka Raya City revealed that there was a diversity of eggplant. The survey discovered four species of eggplant, namely *Solanum melongena* L, *Solanum torvum* (pipit eggplant/vernacular name), and *Solanum ferox* (rimbang/vernacular name), with four variations of the *S. melongena*. The four cultivars of *S. melongena* were identified in the field, including ungu, gelatik, apel hijau, and telur eggplant (Table 2). Solanum melongena L. is a brief-lived annual plant that can readily thrive in environments with high rainfall and temperatures. It is recognized as one of the plants that can produce high yields in wet and hot environments (Hanson et al., 2006). Although it is a self-pollinating plant, under certain circumstances, it may cross-pollinate with a percentage ranging from 20% to 48% (Choudhary and Gaur, 2009). Figure 2 depicts the phenotype of each species and accession.

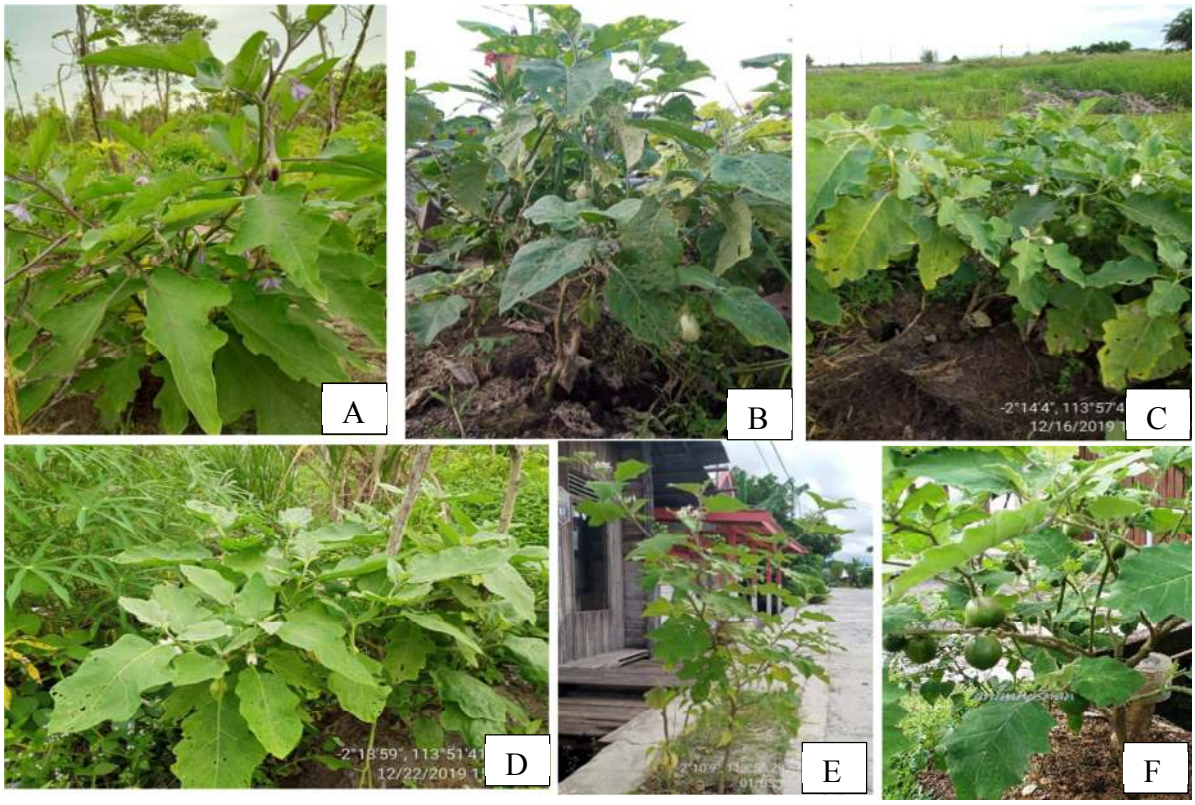

Figure 2. a. Ungu eggplant; b. Telur eggplant; c. Gelatik eggplant; d. Apel hijau eggplant; e. *S. torvum*; f. *S. ferox*

In Palangka Raya, the primary species of eggplant is grown and cultivated in *S. melongena*. Farmers cultivate *S. melongena* extensively, particularly in areas such as Sebangau and Bukit Batu districts. According to the farmers, the four types of *S. melongena* have a high tolerance to the peat soils that dominate most of the city and are also in high demand in the market. S. melongena, a type of eggplant, is extensively cultivated in Palangka Raya. It is commonly grown in the form of plantations, intercropped with other plants, and as a garden plant for self-sufficiency, as it is frequently used as a food source. While some farmers grow *S. ferox*, it was discovered during the research that many of the plants were damaged and died due to the stagnant environmental conditions. Additionally, wild varieties such as *S. ferox* and *S. torvum* were also observed in the area.

S. torvum is a plant with hairy parts, including its leaves, and it thrives in areas with sufficient sunlight and moderate humidity. It can grow up to 2-5 meters in height, with sharp thorns, white compound flowers that have five hairy petals, and tapered leaves that are around 27-30 cm long. This plant has a taproot and is not

typically cultivated, but its fruit is used as a food source. It is originally from the Antilles archipelago and can be found in Indonesia, particularly in Sumatra and Java, where it grows in spread-out conditions that receive moderate sunlight and are not overly wet. *S. torvum* Swartz belongs to the Solanum family and is categorized in the Torva section of the subgenus Leptostemonum. It goes by multiple vernacular names such as pipit eggplant, takokak, cepokak, rimbang and others. The immature fruit is widely used as a vegetable and is also believed to reduce high blood pressure (Balitbangtan, 2018). *S. ferox* is categorized in the Lasiocarpa section of the subgenus Leptostemonum. It is known by various names in Indonesia, such as terung bulu, terung asam, rimbang, terung monyet, and more. *S. ferox* is used both as a seasoning and for medicinal purposes. The fruit is frequently used as a vegetable, a complementary ingredient in dishes, and as a remedy for coughs, whereas the root is utilized as a medication for scabies (Balitbangtan, 2018).

Cultivation

To grow eggplant successfully, it is needed to cultivate in sandy loam soil that is rich in organic matter, and that is well-drained and aerated. The pH of the soil should fall within the range of 6.8 to 7.3, and the plant should receive plenty of direct sunlight. Eggplant is typically grown in low-lying areas that are no more than 100 meters above sea level. The best daytime temperatures for eggplant growth fall between 22 and 30 ºC, while natural temperatures range from 18 to 24 ºC. Unlike chilies and tomatoes, eggplant is less susceptible to drought, but it can be negatively impacted by flooding (Rubatzki and Yamaguchi, 1999). For this reason, eggplants are not usually grown in areas that are prone to flooding during the rainy season in Palangka Raya.

To begin eggplant cultivation in Palangka Raya, it is necessary to start with a nursery. Hybrid seeds are typically used for this purpose. Following this, land preparation is undertaken, which includes applying basic fertilizer, preparing the soil, and installing mulch in particularly dry areas. Preparing the land before planting is a crucial step, as it ensures that the eggplant plants will grow well and produce high-quality yields. Planting of eggplants in Palangka Raya typically takes place 25 days after sowing the seeds, at which point the seeds have reached a height of approximately 7.5 cm. After planting, maintenance is crucial and involves providing adequate water and nutrients,

including follow-up fertilization. Watering is typically carried out twice a day, in the morning and evening, for the first week after planting. To avoid damaging the plant's root system, it is also possible to install pillars early on. The first round of fertilization is given to 21-day-old plants and includes ZA fertilizer (2.5-3 grams/plant), SP-36 (2.5-3 grams/plant), and KCL (1-1.5 grams/plant), with the fertilizers being applied at the edge of the plant, 10 cm away from the stem base. The second fertilization takes place when the plants are 50 days old and involves NPK Mutiara fertilizer 16:16:16 at a dose of 8-10 grams/plant. The last fertilization takes place at harvest time and involves NPK Mutiara fertilizer 16:16:16 at a different dose of 10-12 grams/plant. To manage pests and diseases, it is important to conduct routine spraying of pesticides at concentrations recommended for the specific pest or disease. The spraying interval should be adjusted according to the intensity of the attack and environmental conditions, as noted by (Hadiatna, 2010).

Propagation of *S.torvum* can be done by separating the tillers from the roots or using seeds. The recommended spacing between plants is 70 x 80 cm, and they should be given mature manure or fertilizers such as Urea and TSP to maintain healthy growth. *S. torvum* is resistant to wilt and can be harvested for its fruit after around 3-4 months of planting, with the first fruits typically being almost old (Sirait, 2009). *S. ferox* is commonly cultivated in community yards and used as a border plant in Palangka Raya. However, according to Hasan and Jansen (1993), it can also grow naturally in areas that meet its growth requirements. *S. ferox* can thrive in lowlands up to 1,200 asl with well-draining soil that contains organic matter, and a desired soil pH of 5-6 (Kuling, 2011). *S. ferox* reproduces through seeds obtained from ripe fruit, which can germinate in just one to two weeks. Flowering typically starts three to four months after planting, and the process is aided by bees during hot and humid weather in the morning. The fruit starts to form two to three months after flowering and can be picked when it turns yellow. Green fruit can also be harvested two to four weeks after flowering. Plants usually remain productive for about a year, according to Hasan and Jansen (1993).

Assessing the morphological and agronomic properties of plants through characterization can yield valuable insights into their potential traits (Wardiana, 2007). Morphological

characterization is the most precise technique for determining agronomic traits and plant taxonomic classification (Li et al. 2009). It can be employed to identify redundant germplasm collections, evaluate genetic diversity, and investigate the relationship between morphology and vital agronomic characteristics (CIAT, 1993; Rimoldi et al., 2010; Talebi et al., 2008). The process of characterization generates data that provides details on the features of morphological characters (e.g., flower color, leaf shape) and agronomic traits (e.g., age of harvest, plant height, yield, etc.). Tables 3 and 4 show the morpho-agronomic characters of eggplant observed in Palangka Raya.

Table 3. Morphological characters of eggplant observed in Palangka Raya

No.	Characters	*S. melongena*				*S. torvum*	*S. ferox*
		Ungu eggplant	Telur eggplant	Gelatik eggplant	Apel hijau eggplant		
1	Cotyledon color	Green	Green	Green	Green	Green	Green
2	Growth type	*Upright*	*Intermediate*	*Intermediate*	*Intermediate*	*Upright*	*Upright*
3	Blade length	Long (24.8 -26 cm)	Short (9-9.8 cm)	Medium (11.3-11.6 cm)	Long (20.6-22.6 cm)	Medium (14.6-19.2 cm)	Panjang (26.4-32.4 cm)
4	Blade width	Width (15-16.2cm)	Medium (5.9-6.4 cm)	Medium (8.2-8.8 cm)	Width (13.2-15.7 cm)	Width (15.8-16.2 cm)	Width (31.1-32.0 cm)
5	Leaf blade indentation	*Strong*	*Intermediate*	*Intermediate*	*Intermediate*	*Strong*	*Strong*
6	Leaf tip angle	*Acute*	*Obtuse*	*Intermediate*	*Intermediate*	*Acute*	Acute
7	Thorns leaf number	None	None	None	None	Few (2)	Medium (6-7)
8	Flower petal color	Bright purple	Bright purple	White	White	White	White
9	Fruit length	Very long (>20cm)	Medium long (4-4.9cm)	Medium long (3-4.1cm)	Long (9.1-9.5cm)	Very short (<1cm)	Long (6.5-9.1cm)
10	Fruit diameter	Big (7cm)	Big (2.7-3.6)	Big (4.4cm)	Big (9.2cm)	Small (1.3-1.5cm)	Big (6.2-9.1cm)
11	Fruit ratio	*Three times as long broad*	*Slightl longer than broad*	*As long as broad*	*Slightl longer than broad*	*Broader than long*	*As long as broad*
12	Fruit curve	Indented	None	None	None	None	None
13	Fruit cross section	Many lines	Some lines	Many lines	Many lines	Rounded, no line	Many lines

14	Fruit shape	On ¼ to the end of the fruit	On ½ to the end of the fruit	On ½ to the end of the fruit	On ¾ to the end of fruit	On ½ to the end of the fruit	On ½ to the end of the fruit
15	Fruit tip shape	*Rounded*	*Rounded*	*Depressed*	*Depressed*	*Rounded*	*Rounded*
16	Fruit color in mature Fruit color sold in market	Purple and blackish purple	White	Green	Greenish white	Green	Green and deep yellow
17	Distribution of fruit color at commercial ripeness	*Mottled*	*Uniform*	*Uniform*	*Uniform*	*Uniform*	*Mottled*
18	Fruit physiological ripe color	Blackish purple	Orange yellow	Deep yellow	Deep yellow	Deep green	Deep yellow
19	Flesh density	Medium	Medium	Medium	Medium	Medium	Medium
20	Calyx relative length of buah	Short	Medium	Short	Medium	Short	Short
21	Thorn calyx of buah	None	None	None	None	None	None
22	Fruit position	Horizontal	Horizontal	Horizontal	Horizontal	Vertical	Horizontal
23	Seed number per fruit	Many	Many	Many	Some	Many	Many
24	Seed color	Yellow	Yellow	Yellow	Yellow	Pale yellow	Yellow
25	Seed size (diameter)	Medium (~3mm)	Medium (~3mm)	Medium (~3mm)	Medium (~3mm)-	Small (<2mm)	Medium (~3mm)
26	100 seed weight (g)	0.21	0.20	0.19	0.19	0.17	0.20

Table 4. Agronomic characters of eggplant

Characters	*S. melongena*				*S. torvum*	*S. ferox*
	Ungu eggplant	Telur eggplant	Gelatik eggplant	Apel hijau eggplant		
Flowering time (dap)	53-55	55-57	56-58	58-60	50-52	70-72
Harvesting time (dap)	65	66	86	95	74	130
Soil type	Peat soils, red-yellow podzolic, podzol, alluvial	Peat soils, red-yellow podzolic, podzol, alluvial	Peat soils, podzolic, alluvial	Peat soils, alluvial	Peat soils, red-yellow podzolic, podzol, alluvial	Peat soils, podzolic, alluvial

According to table 3, there are observable differences in the shape, size, and color of various plant parts among the six types of eggplant discovered in Palangka Raya. However, all types of eggplant share the same green cotyledon color. Out of the six types, two distinct growth types were identified, namely upright and medium growth. The upright growth type was observed in ungu eggplant, *S. torvum*, telur eggplant, and *S. ferox*. Meanwhile, the medium growth type was observed in telur, gelatik, and apel hijau eggplant. Eggplants are characterized by their indeterminate growth type and typically grow to a height of between 0.5 and 2.5 cm. They have a robust taproot and large, single alternate leaves. The plant produces perfect flowers that grow opposite the leaves, rather than in the leaf axils, as noted by (Rubatzki and Yamaguchi, 1999).

The fastest flowering and harvesting time are achieved by Ungu eggplant, conversely, the slowest by *S.ferox* (Table 4). According to Faidah et al., (2020), the importance of pollinators cannot be overstated in the process of flower pollination. Among the various types of bees, the buzzing bee can accelerate the flowering process.

Conclusions

The findings indicated the existence of three species of eggplant which include *S. melongena* (ungu, telur, gelatik, apel hijau varieties), *S. torvum*, and *S. ferox*. Moreover, there is a discrepancy observed in the morphology and agronomy characteristics of the eggplants identified.

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