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Identification of *Spodoptera frugiperda* J.E. Smith attacks on alternative host plants in Magelang and Klaten Regencies, Central Java

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ABSTRACT

Spodoptera frugiperda is a polyphagous insect whose main host is the maize plant and had attacked 23 families of higher plants other than maize. The purpose of this study was to identify the most frequent and least frequent attacks of *S. frugiperda* on alternative host plants and identify the plants scepies most often used by *S. frugiperda* as an alternative hosts in Magelang and Klaten District. This research was conducted from October 2024 - May 2025. Samples were taken around corn fields in Magelang and Klaten Districts. Each sub-district was taken 3 villages using stratified method. Each village was taken one land around the corn field as a sampling location using purposive method. The criteria for host plants taken were those with *S. frugiperda* infestation in the form of bite marks, larval faeces or egg packages. The results of this study obtained 27 species of alternative host plants consisting of 16 families attacked by *S. frugiperda* in Magelang District and 17 species of plants from 6 families in Klaten District. The most common type of *S. frugiperda* infestation in the two districts was bite marks and the least common type of infestation was dung marks. The conclusion of this study is that *S. frugiperda* infestation has been found on higher plants other than maize in Magelang and Klaten Districts, Central Java.

Key words: alternative host; Klaten District; Magelang District; maize; *S. frugiperda*.

INTRODUCTION

Spodoptera frugiperda (J.E. Smith), or the fall armyworm, is an invasive insect from the tropical regions of the Americas that has spread to various countries, including Indonesia (Lubis *et al*., 2020). The first outbreak of S. frugiperda in Indonesia was discovered in early 2019 in Pasaman Barat Regency, West Sumatra (Supeno *et al*., 2021). The outbreak then spread to nearly all of Indonesia, including: North Sumatra, Lampung, Aceh (Nonci *et al*., 2019), Bandung, Garut, Sumedang (Maharani *et al*., 2019), Yogyakarta (Nurkomar *et al*., 2021), Central Java and East Java (Megasari & Khoiri, 2021; Supeno *et al*., 2021).

S. frugiperda attacks on corn plants are characterized by window panning, which is a condition where the leaves appear transparent due to the loss of the epidermal layer (Nonci *et al*., 2019). Another type is leaf holes or sawdust-like

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marks on the stems or cobs (Ariska, 2021), which are usually caused by instar II and III larvae (Nonci *et al*., 2019). In addition, *S. frugiperda* larvae can also damage corn shoots and young leaves, which are the growing points of the plant, thereby killing the plant (Nonci *et al*., 2019). The presence of egg clusters on plants can also be one of the parameters of *S. frugiperda* infestation (Irawan *et al*., 2022). In addition to corn plants, *S. frugiferda* also attacks around 23 families of higher plants, which are referred to as its alternative hosts (Fadel & Anshary, 2023).

Alternative hosts attacked by *S. frugiperda* in Indonesia include those from the Poaceae, Fabaceae, Solanaceae, Asteraceae, Rosaceae, Chenopidaceae, Brassicaceae, and Cyperaceae families (Suroto *et al*., 2021; Putra *et al*., 2024). The attack of *S. frugiperda* on alternative host plants can be influenced by several factors, one of which is the unavailability of the main host, corn, causing the larvae to move to other plants in the vicinity (Casmuz *et al*., 2017) as well as biological factors such as larval movement (Montezano *et al*., 2018). In addition, according to Suroto *et al*. (2021), spinach, caisin, water spinach, and lelulangan grass have the potential to become alternative hosts for *S. frugiperda*. Several of the plants mentioned above are commodities in districts located in Central Java Province, namely Magelang and Klaten Districts. Besides having the aforementioned commodities that have been used as alternative hosts by *S. frugiperda*, another factor that makes these two districts potentially susceptible to *S. frugiperda* is that their territories directly border the special region of Yogyakarta, where there have been reports of *S. frugiperda* infestations (Nurkomar *et al*., 2021; Putri & Putra, 2023).

Currently, there have been no reports of *S. frugiperda* attacks on alternative host plants in Magelang and Klaten Regencies. Therefore, this study is important to identify alternative host plants other than corn that have been attacked and used by *S. frugiperda* as alternative host plants in both regencies. In addition, this study is expected to be used as an anticipation of *S. frugiperda* attacks on alternative host plants other than maize in Magelang and Klaten Regencies, considering that both regencies have other food and horticultural commodities besides corn. Thus, the objectives of this study are to identify alternative host plants of *S. frugiperda* in Magelang and Klaten Regencies and to analyze the relative frequency of plant species used as alternative hosts by *S. frugiperda*.

MATERIALS AND METHODS

Sampling

Alternative host samples were taken from parts of plants infested with *S. frugiperda*, characterized by bite marks, feces, and egg packets. Samples were collected by hand (hand picking)

Figure 1. Map of sampling locations in Magelang and Klaten Regencies, Central Java, Indonesia.

and documented using a camera. Environmental factors measured included air temperature and humidity using a thermohygrometer, and light intensity using a lux meter, with 3 replicates (Putra *et al*., 2021).

Sample identification

Alternative host plants were identified at the Ecology and Systematics Laboratory, Faculty of Applied Science and Technology, Ahmad Dahlan University. Plant samples that could not be identified directly were documented using a camera. Further identification was carried out using the i-Naturalist and PlantNet applications.

Calculation of relative frequency of host plants

Table 1. Types of host plants found as alternative hosts for *S. frugiperda* in Magelang and Klaten Regencies, Central Java.

No	Family	Species
1.	Amaranthaceae	*Achyranthes aspera* L.
		Amaranthus viridis L.
2.	Araceae	*Syngonium podophyllum* Schott
		Xanthosoma violaceum (L.) Schott
		Xanthosoma sagittifolium (L.) Schott
3.	Asteraceae	*Synedrella nodiflora* (L.) Gaertn
		Galinsoga quadriradiata Ruiz & Pav.
		Erigeron sumatrensis Retz.
		Elephantopus mollis Kunth
4.	Cleomaceae	*Cleome rutidosperma* DC.
5.	Commelinaceae	*Commelina diffusa* Burm. f.
6.	Convolvuloideae	*Ipomoea aquatica* Forssk.
		Ipomoea batatas (L.) Lam.
		Ipomoea triloba L.
7.	Euphorbiaceae	*Manihot esculenta* Crantz
8.	Fabaceae	*Arachis hypogaea* L.
9.	Malvaceae	*Urena lobata* L.
10.	Marantaceae	*Maranta arundinaceae* L.
11.	Muntingiaceae	*Muntingia calabura* L.
12.	Myrteae	*Psidium guajava* L.
13.	Onagraceae	*Ludwigia octovalvis* (Jacq.) P.H.Raven
14.	Poaceae	*Axonopus compressus* (Sw.) P.Beauv
		Bambusa sp.
		Cynodon dactylon (L.) Pers.
		Digitaria sanguinalis (L.) Scop.
		Eleusine indica (L.) Gaertn
		Gigantochloa atter (Hassk.) Kurz
		Imperata cylindrica (L.) Raeusch
		Megathyrsus maximus (Jacq.) B.K.Simon & S.W.L.Jacobs
		Oplismenus undulatifolius (Ard.) P.Beauv.

Frequency calculations were performed to determine the types of alternative host plants most frequently attacked by *S. frugiperda* at the study site. The relative frequency of plants was calculated using the following formula (Utami & Putra, 2020).

$$Fx = \frac{\sum \text{districts where certain crops were found to be attacked by pests}}{\text{total of districts}}$$

$$F\ relative\ (FRx) = \frac{\text{Fx}}{\text{Total of Fx for all districts}} \text{ x } 100\%$$

Table 1. C*ontinued.*

No	Family	Species
14.	Poaceae	*Oryza sativa* L.
		Panicum virgatum L.
		Pennisetum purpureum (Schumach.) Morrone
		Paspalum dilatatum Poir.
		Setaria palmifolia (J. Koeing) Stapf
15.	Sapindaceae	*Dimocarpus longan* Lour.
16.	Solanaceae	*Capsicum frutescens* L.
18.	Zingiberaceae	*Zingiber officinale* Roscoe.

Table 2. Frequency (Fx) and relative frequency (FRx) of alternative host plants used by S. frugiperda in Magelang and Klaten Regencies.

Family	Species	Klaten		Magelang	
		∑Fx	∑FRx (%)	∑Fx	∑FRx (%)
Amaranthaceae	*Achyranthes aspera* L.	0.04	1.49	0	0
	Amaranthus viridis L.	0	0	0.19	5.41
Araceae	*Syngonium podophyllum* Schott.	0	0	0.05	1.35
	Xanthosoma violaceum (L.) Schott.	0	0	0.1	2.7
	Xanthosoma sagittifolium (L.) Schott.	0	0	0.05	1.35
Asteraceae	*Synedrella nodiflora* (L.) Gaertn.	0	0	0.05	1.35
	Galinsoga quadriradiata Ruiz & Pav.	0	0	0.05	1.35
	Erigeron sumatrensis Retz.	0	0	0.05	1.35
	Elephantopus mollis Kunth	0	0	0.05	1.35
Cleomaceae	*Cleome rutidosperma* DC.	0	0	0.05	1.35
Commelinaceae	*Commelina diffusa* Burm. f.	0	0	0.05	1.35
Convolvuloideae	*Ipomoea aquatica* Forssk.	0.04	1.49	0	0
	Ipomoea batatas (L.) Lam.	0.04	1.49	0	0
	Ipomoea triloba L.	0	0	0.05	1.35
Euphorbiaceae	*Manihot esculenta* Crantz	0.12	4.48	0.05	1.35
Fabaceae	*Arachis hypogaea* L.	0.04	1.49	0.1	2.7
Malvaceae	*Urena lobata* L.	0.04	1.49	0	0
Marantaceae	*Maranta arundinaceae* L.	0	0	0.05	1.35
Muntingiaceae	*Muntingia calabura* L.	0	0	0.05	1.35

Data Analysis

The data analysis used in this study is descriptive and inferential analysis. The analysis results are presented in tables and figures.

RESULTS AND DISCUSSIONS

Alternative host plant species utilized by *S. frugiperda*

Based on the research, 38 species from 17 families were identified as alternative hosts for *S.*

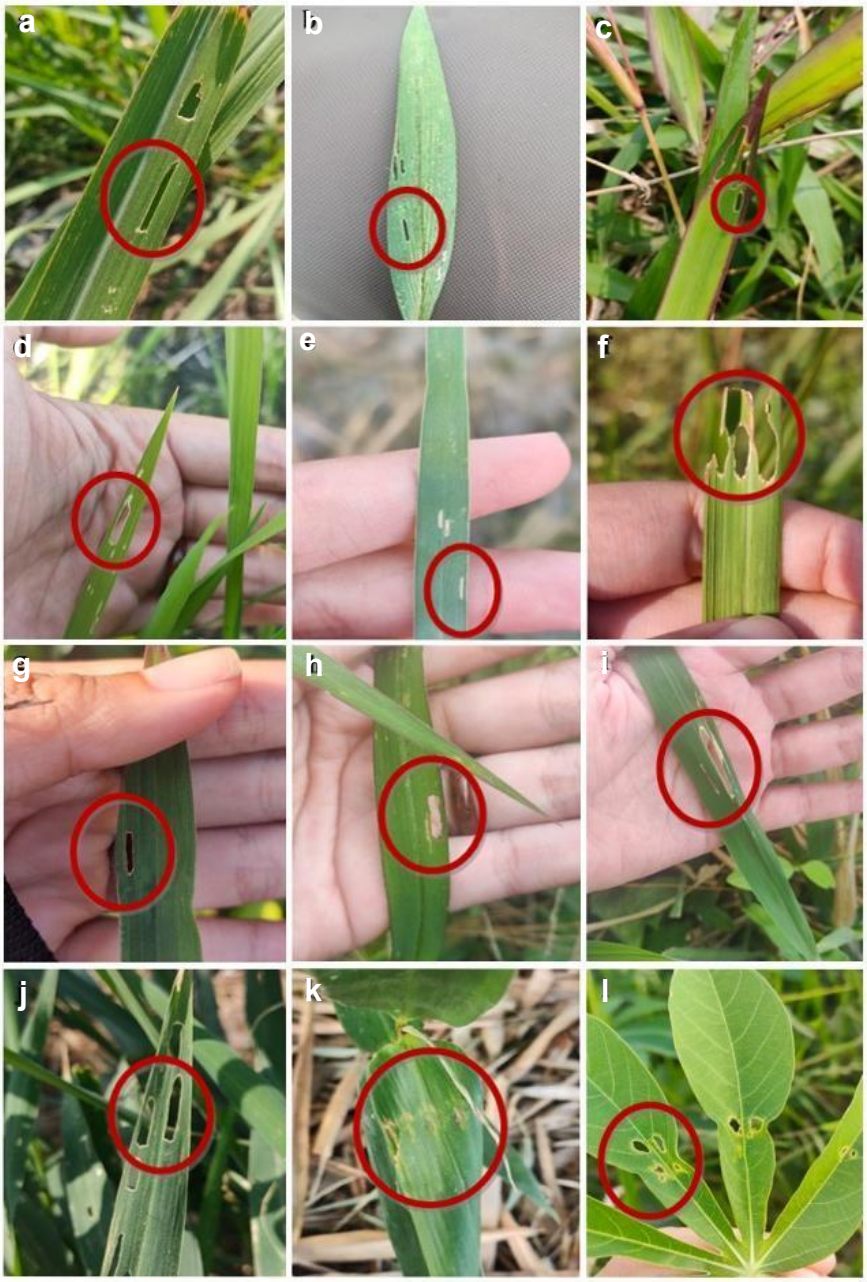

Figure 2. *S. frugiperda* larvae bite marks on alternative host plants in Magelang and Klaten Regencies. (a) species of *P. purpureum*, (b) *S. palmifolia*, (c) *P. dilatatum*, (d) *O. sativa*, (e) *C. dactylon*, (f) *I. cylindrica*, (g) *D. sanguinalis*, (h) *E. indica*, (i) *M. maximus*, (j) *P. virgatum*, (k) *G. atter*, (l) *M. esculenta.*

frugiperda in Magelang and Klaten Regencies. The Poaceae family was the most widely utilized as an alternative host, while the fewest species belonged to 12 different plant families (Table 1).

The Poaceae family, or grasses, is extensively used by *S. frugiperda* as an alternative host because the primary host of *S. frugiperda* is maize, which belongs to the same family and shares similar characteristics. Research by Sinaga (2022) states that grasses and maize share common morphological features, including fibrous root systems, hollow and segmented stems, and leaves with parallel venation.

According to Subiono (2020), *S. frugiperda* exhibits a host plant preference for the Poaceae family because these plants provide the appropriate nutrients to accelerate larval growth. Deden *et al*. (2023) further state that *S. frugiperda* favors the Poaceae family due to its broader leaf structure. These broad leaves are utilized by female *S. frugiperda* moths for oviposition (Setyaputri *et al*., 2023). Furthermore, broad and lush foliage creates a warmer microclimate regarding temperature and humidity, making the plants more attractive to female moths for laying their eggs. This is supported by Umboh *et al*. (2023), who noted that female *S. frugiperda* moths have a specific preference for broad-leaved plants as they provide better protection for the eggs against environmental conditions.

The Poaceae family, or grasses, is widely utilized by *S. frugiperda* as an alternative host

Table 2. Continued.

Family	Species	Klaten		Magelang	
		∑Fx	∑FRx (%)	∑Fx	∑FRx (%)
Muntingiaceae	*Muntingia calabura* L.	0	0	0.05	1.35
Myrteae	*Psidium guajava* L.	0	0	0.05	1.35
Onagraceae	*Ludwigia octovalvis* (Jacq.) P.H.Raven	0	0	0.05	1.35
Poaceae	*Axonopus compressus* (Sw.) P.Beauv	0	0	0.05	1.35
	Bambusa sp.	0	0	0.1	2.7
	Cynodon dactylon (L.) Pers.	0.04	1.49	0	0
	Digitaria sanguinalis (L.) Scop.	0.08	2.99	0.1	2.7
	Eleusine indica (L.) Gaertn	0.08	2.99	0	0
	Gigantochloa atter (Hassk.) Kurz	0.04	1.49	0	0
	Imperata cylindrica (L.) Raeusch	0.46	17.91	0.81	22.97
	Megathyrsus maximus (Jacq.) B.K.Simon & S.W.L.Jacobs	0.12	4.48	0	0
	Oplismenus undulatifolius (Ard.) P.Beauv.	0	0	0.05	1.35
	Oryza sativa L.	0.38	14.93	0.38	10.81
	Panicum virgatum L.	0.04	1.49	0	0
	Pennisetum purpureum (Schumach.) Morrone	0.81	31.34	0.86	24.32
	Paspalum dilatatum Poir.	0.19	7.46	0	0
	Setaria palmifolia (J. Koeing) Stapf	0.04	1.49	0	0
Sapindaceae	*Dimocarpus longan* Lour.	0	0	0.05	1.35
Solanaceae	*Capsicum frutescens* L.	0	0	0.05	1.35
Zingiberaceae	*Zingiber officinale* Roscoe	0	0	0.05	1.35
Total		**2.58**	**100**	**3.52**	**100**

because its primary host, maize, also belongs to the Poaceae family and shares similar characteristics. Research by Sinaga (2022) confirms that grasses and maize share morphological similarities, ranging from fibrous root systems and hollow, segmented stems to leaves with parallel venation.

Furthermore, according to Apriani *et al*. (2021), plants from the Poaceae family have a low average trichome density. Trichome density can influence a plant's level of resistance to insect pest attacks and the feeding process of *S. frugiperda* larvae (Poniman *et al*., 2020). This is consistent with Elisa (2013), who stated that thick and dense leaf trichomes make it difficult for insects—including *S. frugiperda* larvae—to consume leaf tissue. The denser the leaf trichomes, the less likely *S. frugiperda* larvae are to feed on the plant (Prasetya *et al*., 2022). According to Untung (2006) and Sodiq (2009), both the feeding process and pest behavior can be influenced by a plant's trichome density.

Compounds emitted by a plant can also attract insect pests, as one of the ways insects forage is through their sense of smell (olfactory) (Senewe, 2019). Plants from the Poaceae family contain volatile compounds, specifically *cis-3-hexen-1-ol*, commonly known as leaf alcohol, which can attract female *S. frugiperda* moths for oviposition (Guenther, 1990). According to Masriany *et al*. (2020), volatile compounds are used by insect pests as cues to locate their food sources. This is further supported by Nurlinda *et al*. (2022), who stated that one way insects identify host plants is by detecting the volatile compounds evaporated from the plant.

Figure 3. *S. frugiperda* excrement on *P. dilatatum* in Klaten Regency.

Insects will taste plants first to obtain food. If the plant is suitable as a host plant, the insect will settle there, but if it is not suitable, the insect will move on after tasting it. Larvae from the order Lepidoptera will leave tasting marks in the form of bites on plants because these insect larvae have a chewing mouth type (Sodiq, 2009) (Figure 2). A sign that the plant is suitable for use as a host plant is the presence of larval feces (Nonci *et al*., 2019), but if it is not suitable, it will leave only bite marks (Nonci *et al*., 2019). The fecal traces left behind indicate that S. frugiperda larvae can utilize the plant because it has been eaten by the larvae (Girsang *et al*., 2022).

In addition to feeding scars, *S. frugiperda* infestation can also be identified by the presence of frass. The excrement left by *S. frugiperda* larvae has a coarse, sawdust-like appearance (Putra *et al*., 2024). This frass is typically found on the leaf surface (Figure 3) or around the leaf shoots. According to Damayanti *et al*. (2023), besides being on the leaf surface, *S. frugiperda* larval frass can also be found in the growing point areas of the leaves.

Beyond serving as a food source, alternative host plants also function as oviposition sites for *S. frugiperda*. Irawan *et al*. (2022) state that the presence of egg masses on leaves is a definitive sign of *S. frugiperda* infestation. Insects utilize host plants not only for nutrition but also as sites for breeding and egg-laying (Susniahti *et al*., 2017). *S. frugiperda* eggs exhibit distinct characteristics, appearing translucent white or pale green when freshly laid and turning brownish the following day (Hutagalung *et al*., 2021). Furthermore, the eggs are covered in fine hairs (Nonci *et al*., 2019) and are deposited in clusters (Hutagalung *et al*., 2021) (Figure 4).

Figure 4. Eggs of *S. frugiperda* on alternative host plants in Magelang Regency; (a) reed grass (*I. cylindrica*), (b) bamboo (*Bambusa* sp.), and guava (*P. guajava*).

Table 3. Measurable abiotic environmental factors at the sampling location.

Regency	District	Temperature (◦C)	Humidity (%)	Light intensity (Lux)
Magelang	Muntilan	26.97	68.33	187,182
	Ngluwar	29.39	65.89	59,320
	Salam	24.84	78.22	16,701
	Srumbung	26.78	61.00	26,498
	Mungkid	25.33	76.57	19,573
	Mertoyudan	27.42	72.47	22,055
	Borobudur	29.53	55.33	60,771
	Salaman	32.67	44.00	68,003
	Secang	33.06	42.43	78,249
	Grabag	31.67	46.20	46,426
	Sawangan	26.12	69.44	47,427
	Pakis	29.28	59.00	84,481
	Ngablak	26.85	57.11	102,638
	Bandongan	27.31	78.55	101,726
	Windusari	31.93	48.99	105,627
	Kaliangkrik	25.33	43.15	180,597
	Dukun	25.25	73.77	43,482
	Candimulyo	31.82	59.66	154,809
	Kajoran	25.93	56.34	246,300
	Tempuran	27.26	79.89	72,048
	Tegalrejo	33.317	58.44	133,364
	Average	**28.48**	**61.66**	**88,442**

Relative frequency of *S. frugiperda* host plant species

Based on the research findings, the plant species most frequently utilized as alternative hosts belong to the Poaceae family. The alternative host species most commonly found to be infested by *S. frugiperda* across both regencies in this study is *Pennisetum purpureum* (Table 2).

Table 3. Continued.

Regency	District	Temperature (◦C)	Humidity (%)	Light intensity (Lux)
Klaten	Prambanan	26.72	69.10	40,803
	Jogonalan	33.13	51.32	68,871
	Gantiwarno	35.32	36.45	87,014
	Juwiring	28.10	54.00	53,767
	Karangdowo	30.87	40.00	58,322
	Wonosari	27.84	41.00	67,478
	Polanharjo	29.81	38.00	63,528
	Delanggu	32.26	32.33	92,829
	Wedi	29.14	43.78	47,118
	Kalikotes	32.87	31.56	121,063
	Manisrenggo	27.05	45.67	51,657
	Kemalang	29.88	35.45	88,292
	Karangnongko	25.49	48.55	28,376
	Karanganom	28.49	33.67	82,177
	Jatinom	24.77	50.89	13,597
	Tulung	31.68	29.89	112,040
	Bayat	33.36	34.54	77,871
	Cawas	37.43	27.77	68,661
	Pedan	24.82	56.78	28,964
	Trucuk	29.95	37.78	77,852
	Ngawen	26.97	51.00	83,600
	Klaten Utara	31.57	33.11	117,728
	Ceper	28.08	42.56	91,310
	Klaten Tengah	31.03	31.67	112,730
	Klaten Selatan	31.81	34.63	82,594
	Kebonarum	29.94	28.22	111,586
	Prambanan	26.72	69.10	40,803
	Average	**29.94**	**40.76**	**74,224.15**

Based on the research results, the Poaceae family is the family with plants most frequently found to be attacked by S. frugiperda. The plant species most frequently found to be attacked in the Poaceae family was *P. purpureum* (31.34% in Magelang Regency and 24.32% in Klaten Regency). The morphology of *P. purpureum* is similar to corn leaves, which are environmental components that can affect the growth and development of a plant, one of which is temperature and humidity. The air temperature range at the research location where *P. purpureum* was found in both districts was 25-35°C (Table 3). This air temperature can support the optimal growth of *P. purpureum*, which is in accordance with the statement by Islam *et al*. (2023) that *P. purpureum* will grow well at a temperature of 25-40°C. Temperature is one of the abiotic factors that can affect the rate of photosynthesis in plants because photosynthetic activity is influenced by the pressure generated by

temperature (Lupitasari *et al*., 2020). This is reinforced by the statement of Wibawani & Laily (2015), that elephant grass belongs to C4 plants that are resistant to heat stress and have high photosynthetic capacity.

Based on the research results, Poaceae was the plant family most frequently found to be infested by *S. frugiperda*. Within this family, *P. purpureum* was the species most commonly infested (31.34% in Magelang Regency and 24.32% in Klaten Regency). The morphology of *P. purpureum* shares similarities with maize leaves, which are the primary host of *S. frugiperda*. These morphological similarities include fine hairs (trichomes) on the leaf surface and a lanceolate leaf shape (Yunus *et al*., 2019; Muryanto & Putri, 2023). Such morphological resemblances can attract female moths to visit and oviposit, as visual cues like plant shape play a role in helping female moths recognize their host plants (Little *et al*., 2019).

P. purpureum (elephant grass) is a member of the Poaceae family with a nutritional profile comparable to that of maize, the primary host of *S. frugiperda*. The nutritional content of elephant grass consists of 1.15% crude fat, 10.44% crude protein, 33.64% crude fiber, and 88.83% organic matter (Setyaningrum & Ismail, 2018). In comparison, maize contains 13.01% lignin, 27.61% crude fiber, and 6.37% crude protein (Mayasari et al., 2015). This similarity may be a key factor in why this plant was frequently found infested by *S. frugiperda* in this study. According to Putra et al. (2024), the presence of nutrients such as carbohydrates, fats, and proteins is one of the reasons plants are targeted by *S. frugiperda*. This is further supported by Hidayanti & Asri (2019), who state that larvae require nutrients like carbohydrates as the primary energy source for metabolism, while fats and proteins serve as reserve energy.

Abiotic factors also likely contribute to the high prevalence of *P. purpureum* at the research sites. Abiotic factors are environmental components that can influence plant growth and development, including temperature and humidity. The air temperature range at the locations where *P. purpureum* was found in both regencies was 25-35°C (Table 3). These temperatures support optimal growth for *P. purpureum*, which is consistent with the findings of Islam *et al*. (2023), stating that *P. purpureum* thrives at temperatures between 25-40°C. Temperature is a key abiotic factor that can affect the rate of photosynthesis in plants, as photosynthetic activity is influenced by temperature-induced pressure (Lupitasari *et al*., 2020). This is further supported by Wibawani & Laily (2015), who stated that elephant grass is a C4 plant that is resistant to heat stress and possesses a high photosynthetic capacity.

In addition to air temperature and humidity also affects the growth of *P. purpureum*. The humidity measured in this study supports the optimal growth of *P. purpureum*, which ranges from 80-94% (Seseray & Santosa, 2013) with light intensity ranging from >2000 lux (Ainun *et al*., 2022). Based on table 3, it shows that the air humidity and light intensity measured at the research location support the growth and spread of *P. purpureum*. This is reinforced by the statement of Patmawati *et al*. (2023), that elephant grass can grow in extreme conditions, but its growth will be optimal in areas with air humidity ranging from 60 to 70%.

CONCLUSION

Based on the results of the study, it can be concluded that 38 plant species have been found to be used by *S. frugiperda* as alternative hosts in Magelang and Klaten Regencies. The alternative host plant species most frequently attacked by *S. frugiperda* in both regencies is elephant grass (*P. purpureum*).

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