Abundance, Attack Intensity, and Distribution of *Spodoptera frugiperda* J.E. Smith in Kulon Progo, Yogyakarta

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ABSTRACT

Spodoptera frugiperda is an invasive corn pest from America and has entered Indonesia, including Kulon Progo. However, the abundance, attack intensity, and distribution of *S. frugiperda* have never been reported from Kulon Progo. This study aimed to analyze the abundance, attack intensity, and distribution of *S. frugiperda* larvae in Kulon Progo. This research was conducted from January to March 2023. Sampling locations were determined using the purposive sampling method. The egg packages and larvae of *S. frugiperda* found were counted to determine the abundance of *S. frugiperda*. The intensity of *S. frugiperda* infestation was calculated using the letter W scouting method. The results showed that 24 *S. frugiperda* egg packages were obtained in Kulon Progo, and the abundance of *S. frugiperda* was 0.01 individuals per plant. The attack intensity of *S. frugiperda* in Kulon Progo reached 4.97%, with the highest attack intensity in Nanggulan (8%) and the lowest in Wates (1.5%). The larvae of *S. frugiperda* are distributed in four sub-districts in Kulon Progo. This study concluded that the attack intensity of *S. frugiperda* in Kulon Progo was included in the mild category.

Keywords: Fall army worm; Kulon Progo; Larva; Pest; Scouting

INTRODUCTION

Fall armyworm *Spodoptera frugiperda* (Lepidoptera: Noctuidae) is an invasive pest from America and has spread to various countries (Sharanabasappa et al., 2018; Pratama et al., 2020), including Indonesia (Nonci et al., 2019). *Spodoptera frugiperda* can attack various plants, including food crops (Simanjuntak et al., 2022), horticulture (Irawan et al., 2022), and plantations (Arsi et al., 2021). Corn is one of the food crops reported to be attacked by *S. frugiperda* (Maharani et al., 2019).

Spodoptera frugiperda attacks corn plants from the vegetative to the generative phase (O Awata et al., 2019), with the highest damage occurring in the vegetative phase (Trisyono et al., 2019). The larvae of this pest attack the growing point of corn plants, resulting in the failure of young leaf formation (Maharani et al., 2019). The leaves of corn plants infested by *S. frugiperda* are characterized by holes left by larvae (Novita et al., 2021) and larval feces (Arfan et al., 2020). *Spodoptera*

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frugiperda has been reported to cause corn yield losses of 8.3 - 20.6 million tons/year or US$ 2.5 - 6.2 billion per year in Africa and Europe (FAO & CABI, 2019). Yield losses in corn crops due to *S. frugiperda* infestation have been reported in various countries, such as Brazil (34 %), Zimbabwe (11.57 %) (Baudron et al., 2019), Kenya (>30 %) (De Groote et al., 2020), and India (33 %) (Balla et al., 2019). Megasari and Khoiri (2021) also reported Indonesia's highest corn yield loss due to *S. frugiperda* infestation reaching 40% in Tuban District, East Java.

Provinces in Indonesia that have reported *S. frugiperda* infestation on corn plants include Lampung (Trisyono et al., 2019), West Java (Maharani et al., 2019; Sartiami et al., 2020), Banten and West Sumatra (Sartiami et al., 2020), East Kalimantan (Subiono, 2020), and East Java (Megasari & Khoiri, 2021). In addition, Nurkomar et al. (2021) also reported the presence of *S. frugiperda* in Bantul and Sleman, Special Region of Yogyakarta, with larval densities ranging from 0 - 1 larva per plant. However, the population and attack intensity of *S. frugiperda* infestation have not been reported from Kulon Progo, Yogyakarta. The Department of Agriculture and Food Security of Yogyakarta has reported *S. frugiperda* infestation in several areas in Kulon Progo, including Temon, Wates, Panjatan, Pengasih, and Sentolo (DPKP DIY, 2019). Therefore, this research was conducted as an initial population database to prevent the *S. frugiperda* population explosion in Kulon Progo, Yogyakarta.

MATERIALS AND METHODS

Determination of Sampling Locations and *S. frugiperda* Sampling

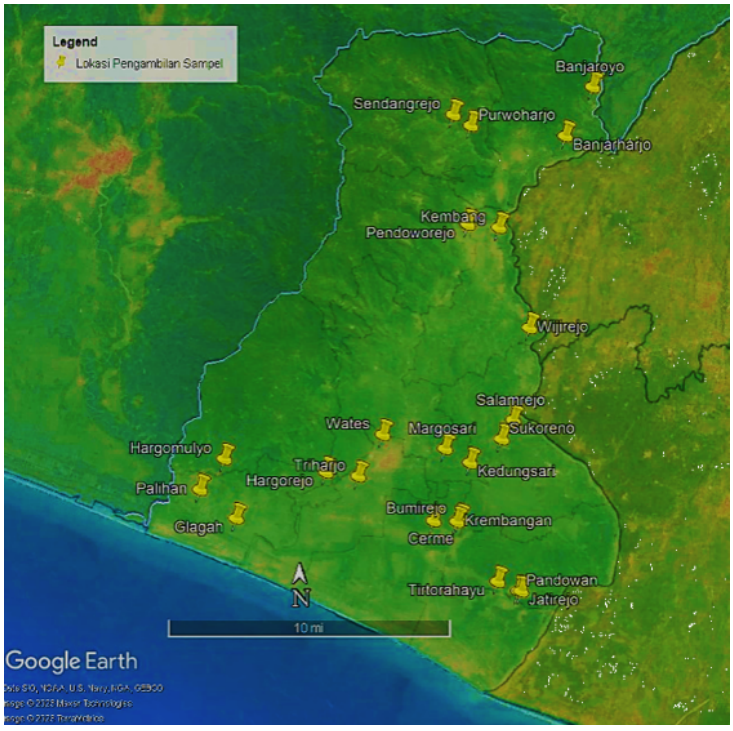

Figure 1. Sampling location map in Kulon Progo

The research was conducted in Kulon Progo, Yogyakarta, from January to June 2023. The number of *S. frugiperda* eggs was determined at Ahmad Dahlan University's Ecology and Systematics Research Laboratory, part of the Biology Study Program. This study used a purposive sampling

method to determine the sampling location. In each sub-district in Kulon Progo, two villages that meet the research criteria were selected. The villages chosen were the villages that had a corn field with at least 50 corn plants that showed symptoms of *S. fugiperda* attack. The coordinate points of the selected corn fields were recorded using GPS essential (Figure 1). Samples of *S. frugiperda* larvae were collected directly. The obtained samples were put into plastic to be counted and identified.

The Calculation of Attack Intensity of *S. frugiperda*

The scouting method of the letter W was used to calculate the attack intensity of *S. frugiperda*. Plants exhibiting signs of an attack by *S. frugiperda* were tallied and documented. The calculation of attack intensity was calculated using the formula according to Megasari & Khoiri (2021), namely:

$$P = \frac{n}{N} x\ 100\% \quad (1)$$

P = attack intensity
n = number of plants that attacked
N = total of plants that counted in the sampling location

After calculating the attack intensity, the intensity value was grouped according to Pratama et al. (2020) (Table 1).

Table 1. Attack intensity category of *S. frugiperda* in corn plant (Pratama et al., 2020)

Skala	Percentage (%)	Criteria
0	0	No attack
1	0 < x < 25	Light
2	25 < x < 50	Medium
3	50 < x < 75	Heavy
4	x ≥ 75	Extremely heavy

Making a Distribution Map of *S. frugiperda*

The application that was used to create the attack intensity map was ArcGIS. The administrative map of district and sub-district boundaries in Kulon Progo Regency was downloaded, and then the administrative map was put into the software. The sub-district boundary layers were Right-clicked, the attribute table was entered, and fields were added to add data on the attack intensity of *S. frugiperda*. The properties option on the sub-district boundary layers was right-clicked, symbology was clicked, and quantities were chosen to set the appropriate value and class. Then, layers were right-clicked, and the table was checked to display the name of each sub-district. Digitization was organized by clicking on the insert to add the map title, cardinal directions, numerical and pictorial scale, legend, and netline. Last, the map was saved as .jpeg or .jpg by clicking on the export map file.

Data Analysis

This study employed both descriptive and inferential data analysis. The variations in *S. frugiperda* abundance in Kulon Progo were explained using descriptive analysis. Inferential analysis was used to calculate the percentage of *S. frugiperda* attack intensity on corn plants in Kulon Progo.

RESULTS AND DISCUSSION

Abundance of *S. frugiperda* on Corn Plant in Kulon Progo

Based on the results of this research, a total of 24 *S. frugiperda* egg packages were obtained in Kulon Progo. The number of eggs obtained was 2103 eggs. The total abundance of *S. frugiperda* was 0.01 individuals per plant, consisting of five 2nd instar larvae and seven 3rd instar larvae (Table 2).

Table 2. Abundance of *S. frugiperda* individuals attacking corn plants in Kulon Progo

Subdistrict	Number of eggs	Number of *S. frugiperda* larvae per plant
Sentolo	337.5	0
Galur	0	0
Pengasih	0	2.5
Wates	121	0
Kalibawang	0	1.5
Nanggulan	145.5	1
Girimulyo	0	0
Lendah	0	0.5
Panjatan	0	0
Temon	368	0
Kokap	79.5	0
Samigaluh	0	0.5

The results of the research found that the abundance of *S. frugiperda* larvae obtained was less than the number of egg packages. This is because the *S. frugiperda* individuals obtained were generally from 2nd and 3rd instar larvae, cannibals (Pebrianti et al., 2021). Due to this cannibal nature, only one to two 2nd or 3rd instar larvae were found on one corn plant (Bakry et al., 2023). According to the research of Prasetya et al. (2022) and Nonci et al. (2019), the cannibalism of *S. frugiperda* larvae causes only one to two 2nd and 3rd instar larvae to be found on one corn plant. Meanwhile, the sampling time in this study also affected the abundance of *S. frugiperda* larvae (Widhayasa & Suryadarma, 2021). This research was conducted during the rainy season, from December 2022 to March 2023. This seasonal condition is thought to affect the abundance of *S. frugiperda* larvae because they are washed to the ground (Caniço et al., 2020). In addition, rainwater entering the base of the corn plant can cause 3rd instar larvae to drown in their burrows (Maharani et al., 2019). At the time of sampling, many of the corn plants in Kulon Progo had entered the generative phase. Due to the generative phase, the number of *S. frugiperda* larvae decreased (Zeni et al., 2021). This is consistent with the study by Jaramillo et al. (2019), who discovered a tiny population of *S. frugiperda* in corn plants during their generative phase.

In contrast, the number of *S. frugiperda* egg packages found at the sampling location was larger than the abundance of individuals, which was 24 egg packages. According to Prasetya et al. (2022), females of *S. frugiperda* imago tend to lay eggs on corn plants that have entered the generative phase. In addition to the phase preference of corn plants, *S. frugiperda* females are attracted by compounds released by corn plants when entering the generative phase (Listyawati et al., 2021). These compounds are phenol compounds, one of which is vanillic acid, which is an attractive compound for *S. frugiperda* females to lay their eggs on corn plants (Anisa et al., 2023).

Table 3. Abiotic factors measured in each district in Kulon Progo

Subdistrict	Abiotic factors		
	Air temperature (°C)	Air humidity (%)	Light intensity (Lux)
Sentolo	35.71	51.83	79003.33
Galur	28.53	84.83	763516.67
Pengasih	33.66	58.50	73478.33
Wates	34.54	60.83	88240.00
Kalibawang	32.88	71.33	278266.67
Nanggulan	35.63	45.17	80965
Girimulyo	29.20	77	21583.33
Lendah	31.88	86.33	37933.33
Panjatan	32.44	85.17	36120.83
Temon	33.03	66.83	63715.00
Kokap	34.27	74.67	40393.33
Samigaluh	30.18	76.33	25498.33

Table 4. Correlation between the number of *S. frugiperda* eggs and abiotic factors

			Number of Eggs	Air Temperature	Air Humidity	Light Intensity
Spearman's rho	Number of Eggs	Correlation Coefficient	1.000	.537**	-.663**	.073
		Sig (2-tailed)	.	.008	.001	.740
		N	23	23	23	23
	Air Temperature	Correlation Coefficient	.537**	1.000	-.776**	.156
		Sig (2-tailed)	.008	.	.000	.477
		N	23	23	23	23
	Air Humidity	Correlation Coefficient	-.663**	-.776**	1.000	-.178
		Sig (2-tailed)	.001	.000	.	.415
		N	23	23	23	23
	Light Intensity	Correlation Coefficient	.073	.156	-.178	1.000
		Sig (2-tailed)	.740	.477	.415	.
		N	23	23	23	23

Note: ** Correlation is significant at the 0.01 level (2-tailed)

According to Table 2, the number of eggs and the number of S. frugiperda larvae obtained were different in each sub-district. For example, in Sentolo, Wates, Nanggulan, Temon, and Kokap sub-districts, corn plants were already in the generative phase at the time of sampling. This caused only *S. frugiperda* eggs to be found in those sub-districts. Meanwhile, in Pengasih, Kalibawang, Nanggulan, Lendah, and Samigaluh subdistricts, only *S. frugiperda* larvae were found. This is because the corn plants were still in the vegetative phase at the time of sampling. In addition to these plant phase factors, the number of *S. frugiperda* eggs and larvae is also influenced by abiotic factors, such as air temperature, air humidity, and light intensity (Table 3).

The correlation test results show that the number of eggs is correlated with air temperature and air humidity, while there is no correlation with light intensity (Table 4). Based on the test results, the higher the air temperature, the higher the number of eggs, while the high air humidity will reduce the number of eggs.

Table 5. Correlation between the number of *S. frugiperda* larvae and abiotic factors

			Number of Individual Larva	Air Temperature	Air Humidity	Light Intensity
Spearman's rho	Number of Individual Larva	Correlation Coefficient	1.000	.179	-.306	.221
		Sig (2-tailed)	.	.414	.156	.310
		N	23	23	23	23
	Air Temperature	Correlation Coefficient	.179	1.000	-.776**	.156
		Sig (2-tailed)	.414	.	.000	.477
		N	23	23	23	23
	Air Humidity	Correlation Coefficient	-.306	-.776**	1.000	-.178
		Sig (2-tailed)	.156	.000	.	.415
		N	23	23	23	23
	Light Intensity	Correlation Coefficient	.221	.156	-.178	1.000
		Sig (2-tailed)	.310	.477	.415	.
		N	23	23	23	23

Note: ** Correlation is significant at the 0.01 level (2-tailed)

In contrast to the number of *S. frugiperda* larvae, the correlation test (Table 5) shows that the number of individuals of *S. frugiperda* larvae correlates with air temperature, humidity, and light intensity. Accordingly, high air temperature will also affect the number of *S. frugiperda* larvae, and high air humidity will also reduce the number of *S. frugiperda* larvae.

Attack Intensity of *S. frugiperda* in Corn Plants in Kulon Progo

This study also calculated the attack intensity level of S. frugiperda on corn plants in Kulon Progo. Based on this research, it is known that in 12 sub-districts in Kulon Progo, S. frugiperda attacks have been found. The attack intensity of S. frugiperda in Kulon Progo reached 4.97 %, classified as mild (Figure 2). Seasonal sampling-related issues were one of the factors that affected the result of this research. The sampling was done during the rainy season. Caniço et al. (2020) reported that S. frugiperda attacked a larger proportion of corn plants during the dry season than during the rainy season.

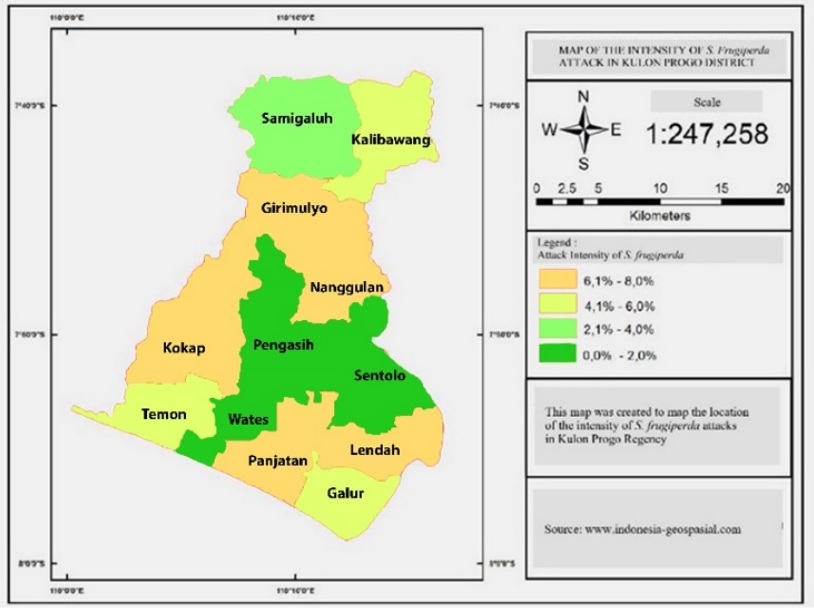

Figure 2. Map of attack distribution of S. frugiperda in Kulon Progo

Table 6. Attack intensity of *S. frugiperda* in Kulon Progo

Subdistrict	Attack Intensity (%)
Sentolo	1.85
Galur	5.14
Pengasih	1.88
Wates	1.5
Kalibawang	5.76
Nanggulan	8
Girimulyo	7.37
Lendah	6.82
Panjatan	6.33
Temon	4.48
Kokap	7.08
Samigaluh	3.79

Based on the results of the research conducted, the highest intensity of attack was found in Nanggulan (8 %), and the second highest was in Girimulyo (7.37 %) (Table 6). The intensity of the attack in Nanggulan could be caused by the fact that planting is not simultaneous. The lowest attack intensity was found in Wates (1.5 %). The low intensity of attack in Wates was influenced by the phase of the corn plant and the presence of alternative host plants (Uge et al., 2021). According to Trisyono et al. (2019), as the age of the plant increases, the level of damage to corn plants caused by S. frugiperda will decrease. Moreover, alternative host plants around corn fields can reduce the attack intensity of S. frugiperda (Wahyudin et al., 2018). This is in accordance with the statement of Asfiya et al. (2020), reporting that intercropping corn plants with several types of plants from the Fabaceae Family can reduce the level of S. frugiperda attack on corn plants.

CONCLUSION

The abundance of larvae on corn plants in Kulon Progo Regency was 12 individuals, consisting of five 2nd instar larvae and seven 3rd instar larvae. The attack intensity of *S. frugiperda* on corn plants in Kulon Progo Regency was 4.97 %, which is classified as low. *Spodoptera frugiperda* larvae in Kulon Progo Regency were found in four sub-districts, namely Kalibawang, Nanggulan, Pengasih, and Lendah.

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AUTHORS CONTRIBUTIONS

ILIP designed and conceived the experiments. ILIP and WHS conducted the experiment. ILIP, WHS, and YH contributed to the preparation of samples and interpretation of the results. The manuscript was primarily composed by WHS. All authors provided critical feedback and contributed to developing the research, analysis, and manuscript.

COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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