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Severity and Incidence of Spodoptera frugiperda Attack on Maize Plants in Sleman District

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ABSTRACT

***Spodoptera frugiperda* (Lepidoptera: Noctuidae) is an invasive pest of maize that has caused damage and economic losses to maize crops in Indonesia. Damage caused by its larvae can be seen from the incidence and level of damage to maize plants, especially in the leaves. This study aimed to analyze the severity and incidence of *S. frugiperda* larvae infestation on maize plants in Sleman Regency. The study was conducted on the vegetative phase of maize plants in Sleman District. Sampling locations were determined using the survey method, and the fields were using the stratified scheme. The maize fields used for sampling were decided by a purposive method. Calculation of incidence and damage level was done using the letter W scouting procedure. Data was analyzed with a correlation test to see the relationship between damage level and *S. frugiperda* incidence in the district. The highest damage level was found in Ngaglik Subdistrict with 51 infested plants with high damage, while the lowest was found in Minggir Subdistrict with 179 infested plants with low damage. The highest incidence rate was found in Seyegan (47.55%), and the lowest in Minggir Subdistrict (11.96%). The conclusion of this study is that *S. frugiperda* infestation has been found in Sleman Regency with low to severe infestation, while the incidence rate is low to moderate.**

Keywords: Maize, occurrence, severity, Sleman, *Spodoptera frugiperda*

INTRODUCTION

Spodoptera frugiperda (fall armyworm, corn armyworm) is an invasive maize pest native to the tropics and subtropics of America (Trisyono *et al*. 2019; Kasoma *et al*. 2021), was discovered attacking maize plants in Indonesia in 2019, notably in West Sumatra Province and West Pasaman Regency (Sartiami 2020). The larvae attacked maize plants' growth points, causing young leaf development failure (Arfan *et al*. 2020) and even plant death (Hutagalung *et al*. 2021). This armyworm has caused damage to maize crops in several locations of Indonesia, including North Sumatra (Hutagalung *et al*. 2021), South Sumatra (Hutasoit *et al*. 2020), West Sumatra (Sartiami 2020), Lampung (Trisyono *et al*. 2019), and West Java (Maharani *et al.* 2019), and North Kalimantan (Waliha *et al.* 2021). Yield losses from this pest attack on maize crops have also been reported in various parts of Indonesia, such as Lampung, where yield losses were around 40% (Suryani *et al*. 2022), Tuban District, East Java (Megasari and Khoiri 2021), Bogor District, West Java (58%), and DI Yogyakarta, particularly in Sleman and Bantul Districts (Nurkomar *et al*. 2021), with the local name of *ulat grayak*. According to Nelly *et al*. (2021), the severity of this pest attack can result in yield losses of 34–38% in the early stages of the maize crop but can reach 100% when management was implemented late.

Aside from attack intensity, *S. frugiperda* attack can be assessed by incidence and damage level (Li *et al*. 2023). They suggested that pest incidence is a proportion of the amount of damage to the sample of plants investigated, whereas degree of damage is a measurement or comparison scale used to quantify the level of harm to a plant surveyed. *S. frugiperda* incidence is defined as the presence of armyworm attacks on agricultural land, which is calculated by expressing the number of damaged leaves as a percentage of the total number of leaves per plant assessed. Siaw *et al*. (2024) investigated the occurrence and damage levels of this pest in Ghana's Ashanti Region. However, no studies on the occurrence and severity of *S. frugiperda* larval infestation on maize have been completed in Indonesia, particularly in the Sleman District. Nurkomar *et al*. (2024) and Putra *et al*. (2021) have previously reported on *S. frugiperda* population dynamics and natural enemies in Sleman Regency. Whereas knowing the incidence and amount of damage allows us to determine the extent of harm caused by *S. frugiperda* attacks on maize plants in a given area. The goal of this study was to determine the frequency and severity of *S. frugiperda* larval attacks on maize plants in Sleman District, Yogyakarta Special Region.

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METHODS

Tools and Materials

The following items were used in this study: an anemometer (Benetech GM816), a plastic clip measuring 20 x 30 cm (Cetik), a digital Lux meter AS 803 (Smart sensor), a thermohygrometer HTC-2 (DR Gray), a micro mica aquarium measuring 10 × 15 cm (Sweet), a watch battery (Maxell), and a wall clock battery (AAA). This study's resources included maize plants (*Zea mays* L.) in Sleman Regency that were still in the vegetative phase.

Determination of Sampling Location

A survey method was used to establish whether maize fields existed in Sleman District. The survey approach involved traveling across Sleman Regency using the Google Maps platform. The stratified technique was used to determine sampling locations in 17 subdistricts of Sleman Regency (Table 1). Three villages were selected from each of the 17 subdistricts. Each village lost one grain field. The corn fields were purposively determined. This study considered the vegetative phase of the maize plant as well as maize fields with maize plants that displayed indications of *S. frugiperda* attack in the form of symmetrical or parallel holes in the leaves. The coordinates of each sampling location were obtained using the Essential GPS app.

Measurements of Abiotic Factors

The study examined abiotic parameters such as air and humidity temperature with a thermohygrometer and light intensity with a lux meter. Abiotic data measurements were taken three times at each sampling point, with repetitions spaced every seven minutes (Putra and Putri 2023).

Calculation of Incidence and Damage Rate

Nonci *et al*. (2019) used a modified 'W' pattern scouting technique to study maize plants. The adjustment was that observations were made using eight diagonal stations, with each station observing up to ten plants in succession (Figure 1). Maize leaves with *S. frugiperda* infestation symptoms, such as bite holes and leaf graze marks, were inspected and recorded to estimate the frequency and severity of larval damage to maize plants.

- **Calculation of Severity**

Damaged leaves on maize plants were observed individually on each plant. Following that, the damaged plants were classified according to their degree of damage. The extent of damage to maize plants was measured by visually analyzing the damage to the leaves using the Davis and Williams (1992) classification (Figure 2). The damage degree on maize plants was determined using Davis and Williams' (1992) categorization (Table 2).

- **Calculation of Incidence**

Damaged maize leaves were counted individually. Following that, the number of damaged leaves was counted to measure the extent of armyworm larval infestation. The total number of leaves on the maize plants was counted to calculate the incidence of larval infection, determined using Yudiarti's (2007) formula as follows:

$$I = a/b \times 100\ \%$$

where:
I = Incidence
a = Total number of damaged leaves
b = Total number of leaves per plant

The level of damage incidence was determined using Yudiarti's (2007) grouping (Table 3) and (Figure 3).

Data Analysis

The correlation test was used to determine the association between damage level and incidence.

RESULTS AND DISCUSSIONS

Damage Level

S. frugiperda infestations in Sleman District, Yogyakarta, caused varying degrees of damage at each research location. The Ngaglik Subdistrict had the most damage, with 51 maize plants destroyed severely. Meanwhile, Minggir Subdistrict had the lowest level of damage, with 179 maize plants injured to a modest degree (Figure 4).

Several factors affected the results, including the age of the corn plant. Maize plant age is one of the elements that contribute to high and low damage to maize plants (Nelly *et al*. 2020). The plants seen in this study were 4–6 weeks old, indicating that they were still in vegetative phase. The age of the observed plants was determined using larvae's preference for feeding maize plants, namely during the vegetative phase (Hendrival 2013). This is consistent with Nelly *et al*. (2020) findings, which indicated that *S. frugiperda* caused more harm to maize plants during the vegetative phase than during the generative phase. Nurkomar *et al*. (2021) discovered significant damage to maize vegetative phase in Yogyakarta Province.

The high degree of damage in Ngaglik Subdistrict was caused by the continual planting of maize plants without crop rotation, which offers ample food for larvae. According to Pramudi (2022), continual maize crop planting increases the population at that area, resulting in significant damage to the plants. This is supported by Syafria (2023), that higher damage rates in areas with continuous maize planting patterns than in areas with rotational maize planting patterns. Most maize plants in Ngaglik Subdistrict had attack damage

Table 1 Coordinates of study locations

Subdistrict	Village	Coordinate
Berbah	Tegaltirto	S07°49.030'E110°25.988'
	Sendangtirto	S07°49.360'E110°26.516'
	Kalitirto	S07°47.313'E110°27.873'
Kalasan	Tamanmartani	S07°44.961'E110°28.267'
	Purwomartani	S07°44.527'E110°28.289'
	Tirtomartani	S07°45.149'E110°27.846'
Prambanan	Bokohrjo	S07°44.756'E110°29.426'
	Sumberharjo	S07°47.427'E110°29.372'
	Madurejo	S07°48.592'E110°29.087'
Ngemplak	Umbulmartani	S07°43.198'E110°25.997'
	Wedomartani	S07°40.620'E110°25.116'
	Bimomartani	S07°42.057'E110°27.474'
Ngaglik	Sukoharjo	S07°43.115'E110°25.419'
	Sinduharjo	S07°42.746'E110°22.477'
	Sardonoharjo	S07°41.291'E110°24.141'
Pakem	Harjobinangun	S07°41.486'E110°24.196'
	Candibinangun	S07°41.210'E110°23.969'
	Purwobinangun	S07°40.003'E110°23.643'
Cangkringan	Wukisari	S07°40.359'E110°26.084'
	Argomulyo	S07°39.424'E110°27.924'
Turi	Bangunkerto	S07°39.442'E110°21.161'
	Girikerto	S07°38.643'E110°23.426'
	Donokerto	S07°39.745'E110°22.091'
Sleman	Trimulyo	S07°40.437'E110°21.620'
	Triharjo	S07°40.507'E110°20.478'
	Tridadi	S07°43.540'E110°21.291'
Moyudan	Sumberahayu	S07°48.189'E110°14.687'
	Sumberagung	S07°46.765'E110°15.134'
	Sumberarum	S07°47.031'E110°13.866'
Godean	Sidomulyo	S07°46.607'E110°17.682'
	Sidoagung	S07°46.366'E110°17.808'
	Sidokarto	S07°47.073'E110°18.160'
Gamping	Balecatur	S07°48.382'E110°17.679'
	Ambarketawang	S07°48.557'E110°18.515'
	Banyuraden	S07°47.544'E110°19.729'
Mlati	Sendang Adi	S07°44.044'E110°21.219'
	Tlogoadi	S07°43.799'E110°20.741'
	Sumberadi	S07°43.657'E110°20.236'
Depok	Condong Catur	S07°44.674'E110°24.314'
	Maguwohajo	S07°45.251'E110°25.031'
Tempel	Margorejo	S07°40.123'E110°19.689'
	Mororejo	S07°40.226'E110°19.040'
	Pondokrejo	S07°39.912'E110°18.866'
Seyegan	Margoagung	S07°41.960'E110°17.927'
	Margomulyo	S07°42.622'E110°18.587'
	Margoadi	S07°43.484'E110°18.450'
Minggir	Sendangmulyo	S07°44.342'E110°14.112'
	Sendangarum	S07°44.905'E110°15.377'
	Sendangagung	S07°43.230'E110°14.286'

levels of 7, 8, and 9, indicating high damage (Figure 5).

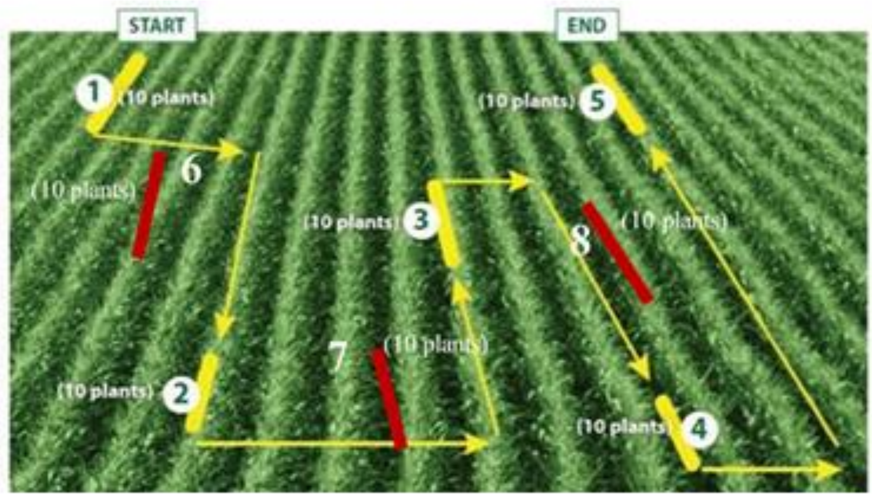

Figure 1 Modified letter W scouting system (Nonci et al. 2019); Red lines were additional observation stations that were modified in this study. Thick yellow lane indicate total plants that observed in the fields and red thin yellow lane indicate observation route or path.

Figure 2 Visual rating scale (scoring system) to determine the level of leaf damage due to *S. frugiperda* larval infestation (Prasanna *et al.* 2018).

levels of 7, 8, and 9, indicating high damage (Figure 5). Denia (2023) mentioned that the more maize plants in each area, the greater the pest harm.

In contrast to Ngaglik Subdistrict, the data from Minggir Subdistrict revealed the highest number of damaged maize plants with modest levels of damage compared to other sites. This is because the area contained m ore rice plants than maize plants. Although rice provides an alternative host plant, *S. frugiperda* prefers corn plants as its primary host (Putra *et al*. 2024; Putri and Putra 20023), This is because maize leaves provide more nutrients for larvae growth than rice leaves (Montezano *et al*. 2018). The larvae caused damage to maize plants in the Minggir Subdistrict at only scores 1, 2, and 3 (Figure 6). This is consistent with the findings of Sharon *et al*. (2020) and Bakry *et al*. (2023), who discovered that the damage caused by *S. frugiperda* larvae attacks on maize plants was

Table 2 Incidence level of *S. frufiperda* attack on maize plants

Incidence level (%)	Remarks
0	No damaged leaves
1–20	Low leaf damage
21–49	Moderate leaf damage
50–100	High leaf damage

Table 3 Severity of *S. frugiperda* larvae attack on maize plants

Severity	Remarks
0	No *S. frugiperda* larvae attack
1–3	Low severity
4–6	Moderate severity
7–9	High severity

Figure 3 Incidence damage of *S. frugiperda* attack on maize plants; (a) Low incidence; (b) Moderate incidence; and (c) High incidence.

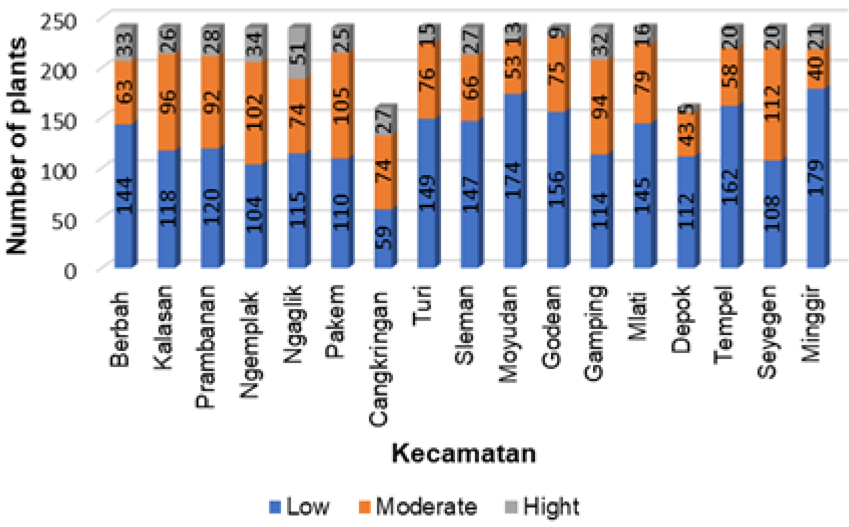

Figure 4 Damage levels of *S. frugiperda* attack on maize crops in Sleman District

minimal when a small number of maize plants were present in a site.

Incidence Percentage

The percentage of *S. frugiperda* infection in Sleman District varied by subdistrict, ranged from 11.96 to 47.55%. The occurrence was highest in maize fields in Seyegen, and lowest in Minggir Subdistrict (Figure 7). The pest harms maize plants by chewing leaves (Putri and Putra 2023). The first instar larvae feed on leaf tissue and leave a clear epidermal layer (Nonci *et al*. 2019), but the second and third instar larvae burrow holes in the leaf and feed on it from the edge to the inside. Late instar larvae can inflict significant damage

Figure 5 High level of damage to maize crops in Ngaglik Subdistrict by *S. frugiperda*; (A) Score 7; (B) Score 8; and (C) Score 9.

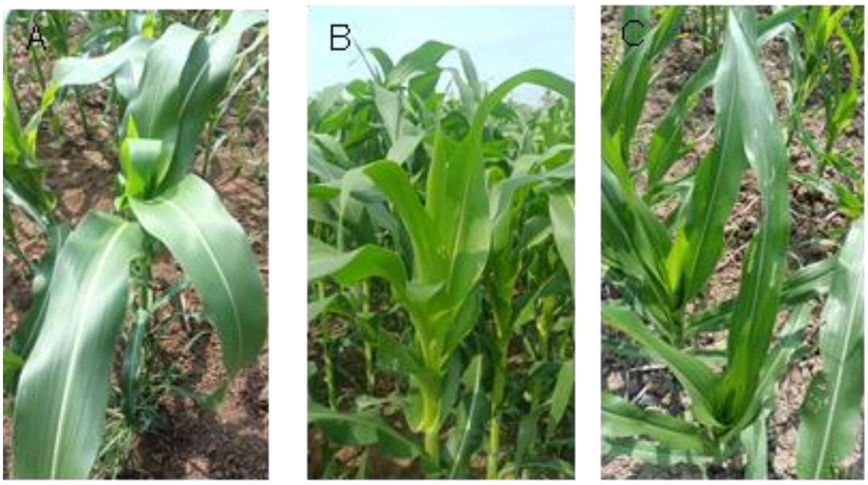

Figure 6 Low level of damage to maize crops in Ngaglik Subdistrict by *S. frugiperda*; (A) Score 1; (B) Score 2; and (C) Score 3.

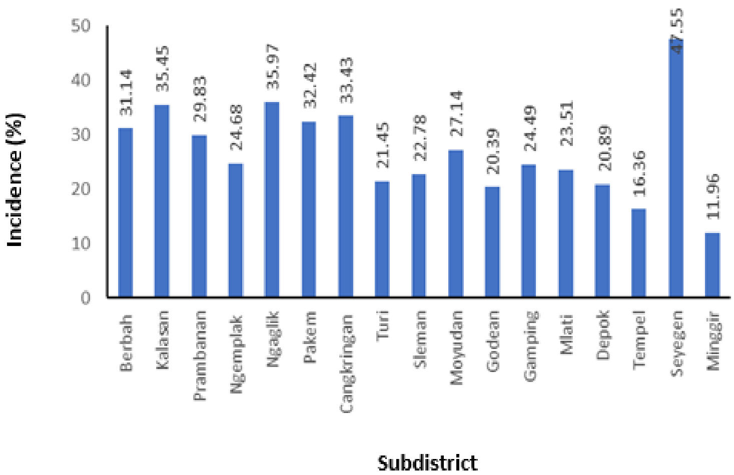

Figure 7 Incidence percentage of *S. frugiperda* attack on maize plants in Sleman District.

to the plant, often leaving just the leaf veins and stalks. Because of their cannibalistic character, larvae in instars 3 to 6 are typically found solely on one plant (Nonci *et al*. 2019). Cristine (2022) reported on the occurrence of *S. frugiperda* on maize plants in the Bali islands. According to the paper, the prevalence in each location can be affected by its population number. Although population size influences the amount of damaged leaves, the damage or incidence rate can be determined disregard to the presence or absence of larvae on maize plants. The larvae prefer plants that are less than 30 days after planting (DAP) to 90 DAPs, which is roughly 1–3 months (Dhar *et al*. 2019). Damage produced by larvae bites or attacks during the vegetative phase of maize will persist or be detected until the plant enters the generative phase (Pratama *et al*. 2020). This is one of the contributing causes to the study's high incidence rate.

The findings revealed that the highest incidence was found in the Seyegan Subdistrict, while the lowest in Minggir Subdistrict. These findings are strongly related to the magnitude of the maize crop in each area. Furthermore, the high occurrence percentage is connected to the planting of maize plants that are not in unison (Liu *et al.* 2020), which results in overlapping maize ages. The overlapping maize age ensures that the pest has always access to food. Thus, the higher the number of host plants, the higher the incidence rate or percentage in a given area (Nonci *et al*. 2019).

The presence of host plants plays a significant role in the invasion and colonization of insects into host plant habitats (Irawan *et al*. 2022). This is consistent with the findings of Masadi *et al*. (2017), who discovered that *S. exigua* colonized onion plants in Kintamani, Bangli, Bali Province. According to Price (1991), herbivorous insects that get food sources in monoculture crops on a continuous and massive scale can maintain their reproduction and survival. According to the findings of previous research, there is a link between the level of damage caused by *S. frugiperda* attacks and the percentage of incidence acquired. Data on the level of damage and the percentage of incidence were then correlated to see if there was a relationship between the two variables. The correlation test findings revealed a relationship between the level of damage and the incidence (Table 4). This means that the higher the level of damage, the higher the frequency at that location, consistent with the findings of Liu *et al*. (2020), who indicated that the extent of damage is directly related to the availability of maize in a place. This reveals that the level of harm corresponds to the percentage of pest attacks in a specific place.

In addition to the elements listed above, there are others that have an impact. Agreeing Supartha *et al*. (2021), one of the elements influencing pest population expansion is extrinsic variables such as climate (abiotic factors). Based on the results of abiotic factor measurements conducted at the study location, it has been determined that the abiotic factors assessed at the research location promote the growth and development of this pest in Sleman Regency (Table 5). It was determined that the measured abiotic variables support the survival of *ulat grayak* in the Sleman District. According to Pu'u and Syatrawati (2022), air temperature and humidity influence the population and growth of *S. frugiperda* life stages, particularly the larval phase. Female larvae can waste energy to generate more eggs in high-temperature environments (Hutasoit *et al*. 2020). In addition, they thrive in hot and humid conditions (Irawan *et al*. 2022). Light intensity can indirectly affect the abundance of individuals of an organism, by influencing the temperature and humidity of the air at the sample site (Faizin and Maghfiroh 2023; Zainuri *et al*. 2023). This is consistent with Pu'u and Syatrawati's (2022) statement that light intensity has an indirect influence on the population dynamics of *S. frugiperda*.

CONCLUSION

Based on the investigation, the following conclusions were reached. *S. frugiperda's* damage to maize plants in Sleman Regency was classified as low, medium, or high. The highest level of damage was found in Ngaglik Subdistrict, while the lowest was in Minggir Subdistrict. Additionally, the highest incidence of infestation in Sleman District was found on maize fields in Seyegan Subdistrict (47.55%), while the lowest was found on maize fields in Minggir Subdistrict (11.96%).

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Table 4 Correlation test between severity and incidence of *S. frugiperda* on maize plants in Sleman District

		Incidence	Low severity	Moderate severity	High severity
Incidence	Correlation coefficient	1.000	–0.433**	0.584**	0.519**
	Sig. (2-tailed)	.	0.001	<0.001	<0.001
	N	51	51	51	51
Low severity	Correlation coefficient	–0.433**	1.000	–0.656**	–0.554**
	Sig. (2-tailed)	0.001	.	<0.001	<0.001
	N	51	51	51	51
Moderate severity	Correlation coefficient	0.584**	–0.656**	1.000	0.407**
	Sig. (2-tailed)	<0.001	<0.001	.	0.003
	N	51	51	51	51
High severity	Correlation coefficient	0.519**	–0.554**	0.407**	1.000
	Sig. (2-tailed)	<0.001	<0.001	0.003	.
	N	51	51	51	51

Remaks: *. Correlation is significant at the 0.05 level (2-tailed) and **. Correlation is significant at the 0.01 level (2-tailed).

Table 5 Abiotic factors measured at sampling locations in Sleman District

Subdistrict	Air temperature (ºC)	Air humidity (%)	Light intensity (Lux)
Berbah	24.99	52.56	5299.00
Kalasan	30.04	34.56	81332.22
Prambanan	26.41	46.00	29027.89
Ngemplak	28.63	43.51	70996.89
Ngaglik	27.19	47.51	25851.89
Pakem	30.53	52.00	60861.11
Cangkringan	23.63	58.00	3010.67
Turi	26.38	48.56	34544.44
Sleman	29.54	39.78	17216.67
Moyudan	25.13	60.89	3504.67
Godean	28.44	50.67	33183.33
Gamping	31.58	45.78	94194.44
Mlati	23.27	54.56	6685.67
Depok	23.87	44.00	51960.00
Tempel	23.70	52.78	4495.11
Seyegan	24.88	50.67	20925.56
Minggir	29.79	35.67	72415.56

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