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Distribution Pattern and Population Density of *Spodoptera frugiperda* (Lepidoptera: Noctuidae) in Corn Fields in The Tanggunggunung Hills, Tulungagung Regency

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Abstract

Background: *Corn is an important commodity in Tulungagung Regency; however, infestations of Spodoptera frugiperda have caused substantial yield losses, particularly during the vegetative growth stage, with reported damage levels reaching 20–70% depending on infestation intensity. Understanding the population density and spatial distribution of this pest under local agroecosystem conditions is therefore essential for developing effective control strategies. This study aimed to analyze the population density, distribution pattern, and environmental relationships of S. frugiperda on corn plants in the hilly area of Tanggunggunung, Tulungagung Regency*. **Methodology:** *The research was conducted on corn plants aged 15 to 45 days post-planting at two distinct locations: Ngrejo Village (approximately 110 meters above sea level) and Jengglungharjo Village (approximately 145 meters above sea level), each encompassing an area of 25 square meters. A two-dimensional sampling method was employed, utilizing 10 fixed observation plots per field, with observations occurring every three days. The variables observed included pest population density, symptoms of pest attack, and abiotic environmental factors such as temperature and humidity. Distribution patterns were analyzed using the Morisita index and the degree of Morisita (Ip), while the relationships between pest populations and environmental factors were examined through Pearson's correlation analysis.* **Findings:** *The population of S. frugiperda in Ngrejo village exhibited a random distribution pattern (Id= 1.016; Ip= 0.004), whereas in Jengglungharjo village, it demonstrated a tendency towards clustering (Id = 0.211; Ip= 0.456). The density of the pest population showed a strong positive correlation with temperature (r= 0.799 to 0.702) and a negative correlation with humidity (r= −0.661 to −0.423).* **Contribution:** *Microclimatic conditions play a key role in shaping the spatial distribution and population density of S. frugiperda, highlighting the importance of site-specific, ecology-based pest management to improve corn productivity in hilly agroecosystems.*

Keywords: *Corn plants; Distribution pattern; Morisita index; Spodoptera frugiperda*

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INTRODUCTION

The distribution of organisms is the pattern of how an individual or population inhabits an area and interacts with its environment (Mukhlis et al., 2011). These distribution patterns can generally be classified into three categories, namely random, uniform, and clustered. Understanding organism distribution patterns plays an important role in various fields of science, especially ecology and agriculture. In ecology, distribution patterns form the basis for understanding population dynamics, competition, organism behavior, and responses to environmental changes (Begon et al., 2020). Meanwhile, in agriculture, the distribution patterns of organisms, especially pests, form the basis for designing control strategies based on population dynamics and habitat preferences. Thus, accurate knowledge of organism distribution patterns can increase the effectiveness of control and reduce crop damage through an ecology-based approach (Day et al., 2017).

One important organism that has been the subject of global concern in recent years is *Spodoptera frugiperda* (Fall Armyworm/FAW). This invasive pest has spread rapidly from America to Africa, Asia, and Southeast Asia, including Indonesia since 2019 (Midega et al., 2018; Prasanna et al., 2021). FAW attacks on corn crops have been reported to cause severe damage and even crop failure, especially during the vegetative phase, with potential yield losses reaching 20–70% depending on the level of infection (Goergen et al., 2016). Tulungagung Regency, as one of the corn centers in East Java, has also been affected by the increasing incidence of FAW attacks in the last five years. The agroecosystem conditions of the hills, microclimate variations, and farmers' planting patterns are factors that influence the dynamics of the infestation. Previous studies have shown that the distribution of FAW tends to be influenced by environmental conditions such as temperature, humidity, and plant density (Harrison et al., 2019). Studies in China and India have found that FAW tends to spread randomly to in clusters, depending heavily on plant age and microclimate conditions (Sharanabasappa et al., 2020; Wu et al., 2021). Thus, studying the distribution patterns of FAW in local conditions in Indonesia is essential to understand how these distribution characteristics are formed in specific agroecosystems.

Although various studies have been conducted on the distribution of FAW, most have focused on regional scales and macro approaches such as migration patterns and spatial distribution across regions. Limitations in studies at the micro level, such as distribution patterns within a single plot of land using a two-dimensional sampling design, remain a significant research gap. In addition, few studies have integrated distribution pattern analysis using the Morisita index with environmental factors such as temperature and humidity simultaneously. In fact, this combination of approaches can provide a more holistic picture of the ecological determinants of FAW distribution. At the local level, particularly in Tulungagung, there have been few scientific reports describing the distribution patterns of FAW based on plant age, land topography, and altitude variations in hilly areas. Therefore, specific research is needed to fill this gap by combining distribution pattern models, ecological parameters, and microenvironmental characteristics.

This study was conducted to analyze the distribution patterns of *Spodoptera frugiperda* populations on corn crops in the hilly areas of Tanggunggunung Subdistrict, Tulungagung Regency. This study aimed to: (1) analyze the population density of *Spodoptera frugiperda* on maize plants in two villages with different altitude characteristics, (2) determine the distribution pattern of *S. frugiperda* using the Morisita index, and (3) examine the relationship between population density and environmental factors, namely temperature and humidity. The contribution of this study lies in its effort to enrich the understanding of FAW distribution dynamics on a micro scale through a two-dimensional approach that is rarely applied in local studies. In addition, the results of this study are expected to form the basis for technical recommendations in designing ecology-based pest control strategies that are tailored to specific land characteristics, thereby helping to increase corn productivity in hilly areas.

METHOD

Place and Time of Research

This study employed a two-dimensional sampling method, which accounts for two spatial variables, specifically length and width (Utami & Putra, 2020). The observational approach was applied to two corn fields in Tanggunggunung Subdistrict, Tulungagung Regency, namely Ngrejo Village (8°14'31"S, 111°51'39"E) with a monoculture planting system and Jengglungharjo Village (8°16'45"S, 111°52'54"E) with a polyculture planting system, as depicted in Figure 1. Each plot encompassed an area of approximately 25 m², with 10 observation plots arranged based on a fixed-point design to characterize the distribution of the *S. frugiperda* population. Observations were conducted over a one-month period on corn plants (Pioneer 27 variety) aged 15–45 days after planting (DAP), with observation intervals every three days. The design of the observation points is illustrated in Figure 2.

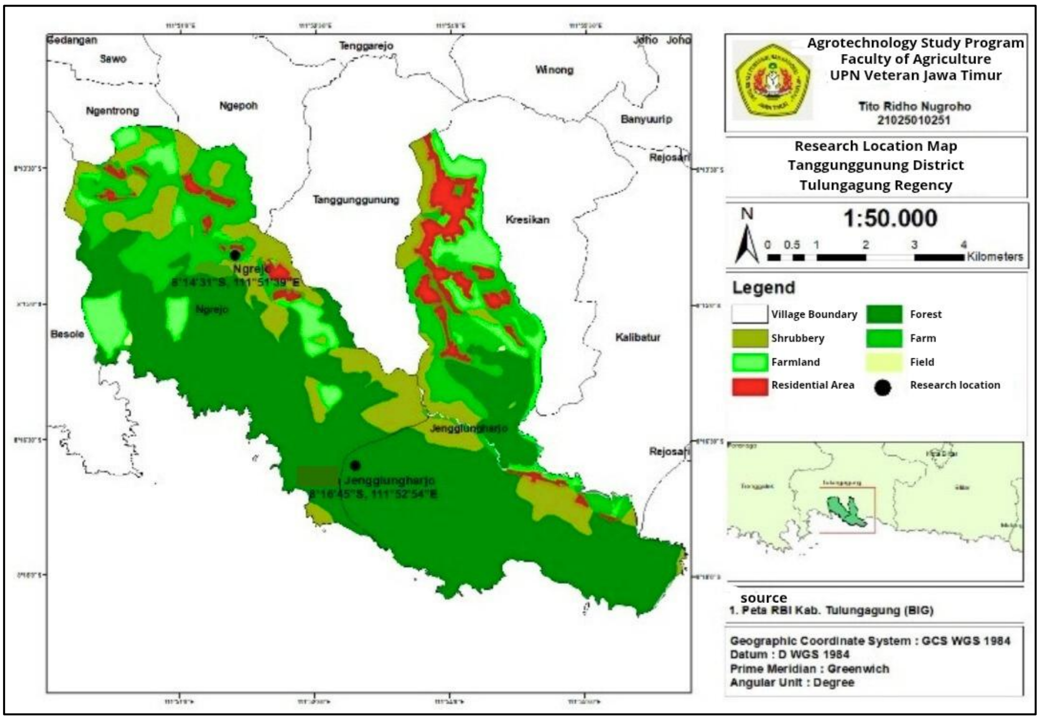

Figure 1. Map of data collection locations in Tanggunggunung Subdistrict

Sample or Participant

Each plot has an area of ±25 m² with 10 observation plots arranged based on a fixed-point design to describe the distribution of the *Spodoptera frugiperda* population. Observations were conducted for one month on corn plants aged 15–45 days after planting (DAP) with observation intervals of every three days. The observation point design is shown in (Figure 2). Each sample plot had 70 plants that were used as a representative sample of the observed land (Magdalena et al., 2015).

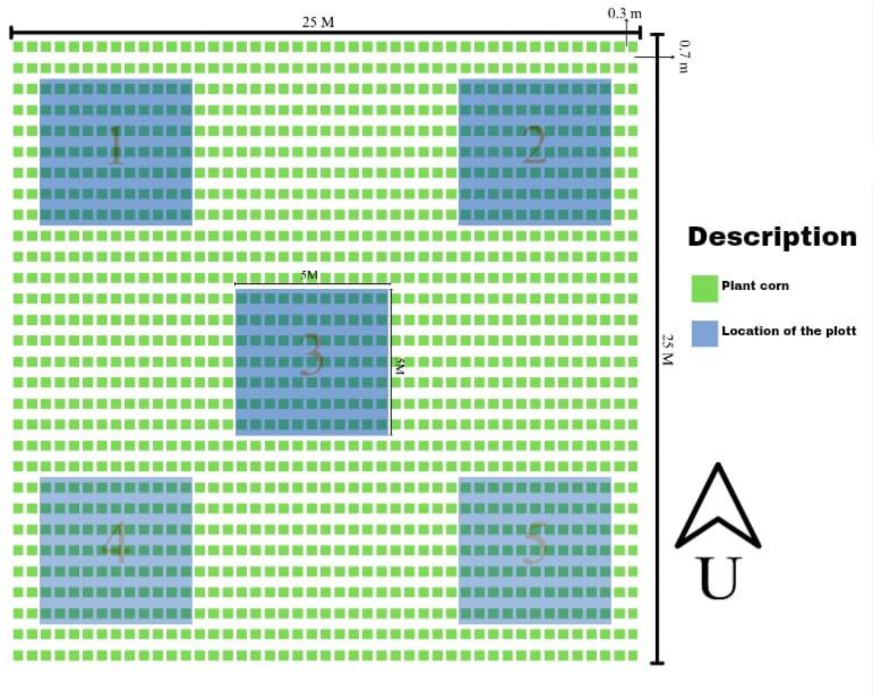

Figure 2. Observation point design on the Ngrejo and Jengglungharjo land

Instrument

The tools used in the study were wooden stakes, tweezers, measuring tape, HTC-1 hygrometer, and a 50 MP f/2.4 camera, observation sheets, *Microsoft Excel* 2019 software, Arc GIS version 10.8 software, SPSS software, SgeMS 64x bit software, writing instruments, collection bottles, 15-day-old corn plants (*Zea mays* L.) planted at a distance of 70 x 30 cm, raffia rope, and observation sheets.

Procedure

The research procedure was carried out through direct observation of two plots with different environmental conditions. Five replicate plots were taken from each plot. Observations were made in the morning for 3 - 4 hours. Each plant in the plot was examined individually to record the number of larvae per plant on the observation sheet. All types of attack symptoms that appeared, such as holes in the leaves, torn leaves, or larval feces in the leaf axils, were recorded on the observation sheet. The criteria for the larvae observed ranged from instar 3-6 (Agustin et al., 2021). The *S. frugiperda* larvae observed had a head with a line resembling an inverted "Y", four large spots on the 8th abdominal segment, and varied in color from pale to brown and light green during the larval stage. This color darkens as *S. frugiperda* pests grow (Triplehorn & Johnson, 2004).

At the same time, temperature and humidity were measured using a thermohygrometer to determine the environmental conditions at the time of observation. This procedure was repeated every three days for one month, in accordance with the 15 – 45 DAP plant growth period, so that data on pest population development and environmental variables could be obtained sequentially. All data collected were systematically recorded in observation sheets and then processed at the data analysis stage.

Morisita Index

Pest population data obtained from each plot were analyzed quantitatively using the Morisita Index (Id) with interpretation at the degree of morisita (Ip) with an interpretation of Ip > 0 as a clustered pattern, Ip = 0 as a random pattern, and Ip < 0 as uniform (Nurlia & Toana, 2023).

$$id = n\frac{\sum x^2 - \sum x}{(\sum x)^2 - \sum x}$$

Description:

Id : Morrisita index
n : number of sampling plots
Σx : number of pests per observation plot
Σx2 : sum of squares per observation plot

The distribution pattern is seen through the calculation of Mu and Mc using the formula (Nurlia & Toana, 2023).

$$Mu = \frac{X^2 0{,}975 - n + \sum xi}{(\sum xi) - 1}, \qquad Mc = \frac{X^2 0{,}025 - n + \sum xi}{(\sum xi) - 1}$$

Description:

Mu	: Uniform distribution ID
Mc	: Group distribution ID
X20.975	: Chi-square value table with degrees of freedom n-1 and confidence interval 97.5%
X20.025	: Chi-square value table with degrees of freedom n-1 and confidence interval 2.5%

The interpretation of the obtained Morisita Index value is as follows (Nurlia & Toana, 2023),

a. if the Id value > 1, and Id > or = Mc, then use formula 1
b. if the Id value > 1, and Id < Mc, then use the second formula
c. if the Id value < 1, and Id > Mu, then use the third formula
d. if the Id value < 1, and Id < Mu, then use the fourth formula.

After all the data has been obtained, the next step is to determine the value of the distribution pattern of the Morisita index (IP). The calculation of the Morisita index (IP) is conducted using the following formula refers to (Nurlia & Toana, 2023):

a. Ip=0.5+0.5($id-Mc$/n$-Mc$) : if Id≥Mc≥1
b. Ip=0.5($id-1$/Mc−1) : if Mc>Id≥1
c. Ip=0.5($id-1$/Mu−1) : if 1>Id>Mu
d. Ip=0.5+0.5($id-M$u/Mu) : if 1>Mu>Id

Correlation between caterpillar presence and the environment

Furthermore, the relationship between pest populations and environmental factors, namely temperature and humidity, was analyzed using Pearson's correlation. This analysis was chosen because it is able to describe the strength and direction of the relationship between variables linearly. The correlation coefficient (r) value was interpreted based on general categories: very weak (0.00–0.25), weak (0.26–0.50), strong (0.51–0.75), and very strong (0.76–1.00) (Hidayanti & Mandalika, 2023).

$$r = \frac{\sum(Xi - \bar{X})(Yi - \bar{Y})}{\sqrt{\sum(Xi - \bar{X})^2 \sum(Yi - \bar{Y})^2}}$$

Description:
Xi = the pest population at the i-th observation
Yi = humidity/temperature at the i-th observation
X‾ = average pest population
Y‾ = average humidity/temperature

Representative results of the calculation will be read as follows (Hidayanti & Mandalika, 2023).:
R = 1 : Perfect positive correlation. When one variable increases, the other variable also increases proportionally.
0 < R < 1 : Positive correlation. When one variable increases, the other variable tends to increase.
R = 0 : No linear relationship. The variables do not influence each other.
−1 < R < 0 : Negative relationship. When one variable increases, the other variable tends to decrease.

Population density

The population density of *Spodoptera frugiperda* was evaluated through direct field observations conducted over ten observation periods. Observations were made by looking at the average per meter of the observation plot. The population density of *Spodoptera frugiperda* was evaluated through direct field observations conducted during ten observation periods. Observations were made by looking at the average per meter on the observation plot. Population density was calculated by adding up all the larvae found in 10 observations and dividing it by the observation area (25 m2). This calculation was carried out on each observation plot (P1-P5) on the Ngrejo and Jengglungharjo land (Samosir et al., 2015).

RESULT AND DISCUSSION

The results of the study found natural attacks by *S. frugiperda* pests on both research plots, with varying attack intensities and numbers of larvae between plots during the observation period. The attack was identified by symptoms of windowing, tears in the leaf blades, and accumulation of frass in the leaf axils, as shown in (Figure 3). The attack was caused by *S. frugiperda*, as mentioned in studies by Mamahit et al., (2022) and Hidayah et al., (2024). Brownish-yellow material deposits, known as frass or caterpillar droppings, are scattered on the leaf surface and concentrated between leaf rolls, indicating the active participation of pest larvae. This damage is visible on young leaves in the middle of the plant, in the form of tears and uneven cuts caused by young and old instar *S. frugiperda* pest larvae. The age of corn plants is one of the factors that affects the level of damage to plants, where this variable correlates with the appearance of damage at both high and low levels (Aditia & Putra, 2025).

Figure 3. *S. frugiperda* Pest Infestation in Both Observation Fields

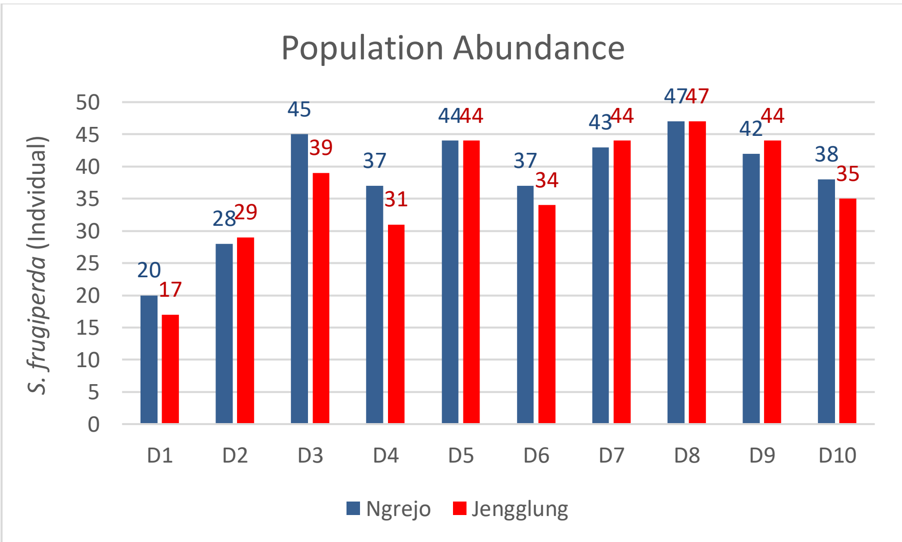

Figure 4. Diagram of *S. frugiperda* Pest Population on Both Observation Plots

The population diagram (Figure 4) shows that the dynamics of *Spodoptera frugiperda* at both observation sites increased consistently over the ten observations. In the early phase (Day 1–Day 3), larval abundance tended to be higher in Ngrejo Village than in Jengglungharjo. Overall, the mean population density in Ngrejo Village was 38.1 ± 8.39 individuals, while Jengglungharjo Village recorded a mean density of 36.4 ± 9.19 individuals. Entering the mid-observation period (Day 4–Day 7), the population in Jengglungharjo showed a faster increase, surpassing Ngrejo at several points. The population peaked on Day 8, where both locations reached their highest values, before experiencing a slight decline in the following observations.

The observed differences (planting patterns, temperature, and humidity) in population dynamics between the two locations indicate the influence of microclimate conditions and specific vegetation characteristics at those locations, which can cause variations in the intensity of *Spodoptera frugiperda* attacks between villages. The difference is also influenced by the quality of the main and secondary host plants in both areas. *Spodoptera frugiperda* pests tend to seek the best quality hosts (Agustin et al., 2021). The presence of companion plants makes the spread of Spodoptera pests more difficult to control (Listyawati et al., 2022). Larvae of *S. frugiperda* utilize their surrounding environment as a means of protection against predation and as a refuge from sunlight during the early instar stages (Trisyono et al., 2019). High vegetation density can create an ideal microenvironment for *S. frugiperda* caterpillars, such as higher humidity and moderate temperatures, which support their survival and reproduction (Lestari et al., 2024).

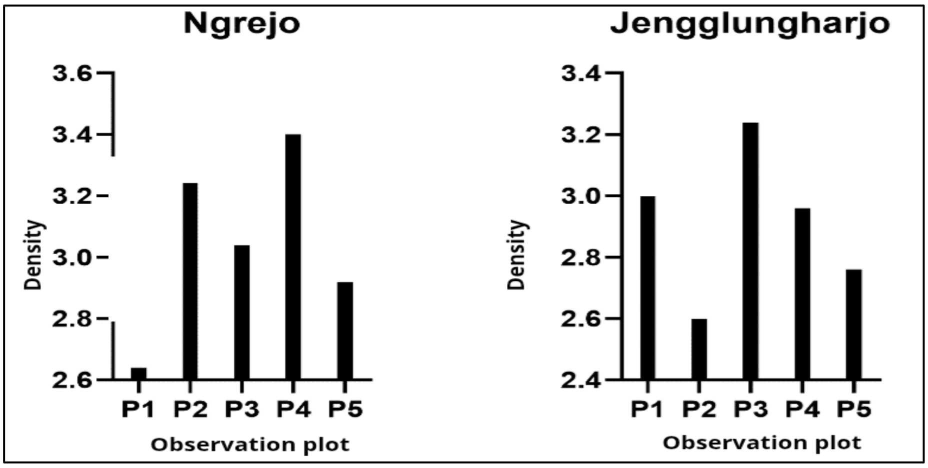

Figure 5. Population Density of *Spodoptera frugiperda*

The results of the observation show that the density of *S. frugiperda* in the Ngrejo and Jengglungharjo areas exhibits different patterns, with variations between plots reflecting the influence of the microhabitat conditions of each location. In Ngrejo, the population was more dynamic, with densities ranging from 2.6 to 3.5 individuals per plant, with the lowest value in plot 1 and plots 2 and 3 having almost uniform plot populations, then the population peaked in plot 4 and declined in plot 5. In contrast, Jengglungharjo showed more static fluctuations, ranging from 2.5 to 3.3 individuals per plant, with plot 2 having fewer individuals, while the highest population was in plot 3, and plots 1, 4, and 5 had almost the same population numbers.

According to Putra et al., (2021), the selection of host plants by females is related to the insects' need to eat, reproduce, and lay eggs. During the larval stage, *S. frugiperda* requires full nutrition to meet the needs of its accelerated metamorphosis cycle. Protein-rich feed can support the efficient synthesis of this hormone (Thamrin et al., 2022). The age of corn plants is one of the factors that influence the level of damage caused by *S. frugiperda* pests, where this variable correlates with the occurrence of damage at both high and low levels (Aditya & Putra, 2025). Diverse landscapes with many types of habitats (including varying vegetation densities) offer more choices of resources and microclimates. This can serve as a buffer against climate variation or environmental disturbances, resulting in more stable populations (Oliver et al., 2010). Although corn is the primary host, S. frugiperda moths can utilize surrounding vegetation as temporary shelter (Aniwanou et al., 2021).

In the Ngrejo area, population density tends to vary because the more favorable environmental conditions, such as suitable temperature and humidity levels and the availability of surrounding vegetation, provide *S. frugiperda* with more hosts to support its metamorphosis process, resulting in a shorter larval cycle for this pest. In contrast, in the Jengglungharjo area, less favorable environmental conditions, including reduced vegetation cover and less stable microclimatic conditions (e.g., fluctuating temperature and humidity), cause *S. frugiperda* to undergo a longer metamorphosis process, resulting in *S. frugiperda* larvae inhabiting corn plants in the area for a longer period of time.

Table 1. Distribution index of *S. frugiperda* pests in Ngrejo and Jengglungharjo fields

Distribution Index	Locations	
	Ngrejo	**Jengglungharjo**
Id (Morisita index)	1.016	0.211
Mu (Id uniform distribution pattern)	0.127	0.134
Mc (Id group distribution pattern)	0.247	0.262
Ip (degree of morisita)	0.004	0.456
Distribution pattern	Random	Cluster

The results of the Morisita Index analysis indicate differences in the distribution patterns of *Spodoptera frugiperda* between the two study locations (Table 1). In Ngrejo Village, the Id value of 1.016 with a low Ip value of 0.004 indicates a random distribution pattern. This pattern is supported by the Mu (0.127) and Mc (0.247) values, which fall within a range that does not indicate either a uniform or clustered distribution. These results reflect relatively homogeneous environmental conditions in Ngrejo Village, characterized by uniform maize growth stages, similar crop structure, and relatively even microclimatic conditions across the field, resulting in a more even spatial distribution of larvae. In contrast, in Jengglungharjo Village, the Id value of 0.211 combined with a higher Ip value of 0.456 indicates a clustered distribution pattern. This tendency toward aggregation is further supported by the Mc value (0.262), which is higher than the Mu value (0.134). Such clustering reflects more heterogeneou. Monoculture corn cultivation can increase attacks by the pest *S. frugiperda* (Arfan et al., 2020).

The results of research by Syafria et al., (2023) state that the use of monoculture planting patterns provides sufficient food availability for *S. frugiperda*. The impact of monoculture planting also reduces the presence of predators. Monoculture systems tend to be more susceptible to pest and disease attacks due to low species diversity and a lack of healthy ecological interactions (Widyastuti et al., 2020). In planting models that differ from polyculture systems, larvae have fewer opportunities to obtain sufficient nutrition. According to Rios et al. (2014), plant diversity causes S. furgiperda pests to cluster because the availability of plants that meet their nutritional needs is limited.

The spread of pests in both locations shows that the condition of other plants in the observation area will change the pattern of pest attacks. The density of vegetation in the area will encourage *S. frugiperda* pests to gather in locations with suitable hosts to meet the nutritional needs of the pest larvae. When food is plentiful, *S. frugiperda* pests will attack all corn plants in the field more evenly. Planting corn using a polyculture system will make it easier to detect pests because their population is concentrated in areas with suitable host conditions.

Table 2. Temperature and Humidity on Tanggunggunung Hills

No	**Ngrejo**			**Jengglungharjo**		
	Number of larvae (Individu)	**Temperature (°C)**	**Humidity (%)**	**Number of larvae (Individu)**	**Temperature (°C)**	**Humidity (%)**
1	20	25.50	94	17	25.5	92
2	28	29.00	86	29	29.1	88
3	45	29.00	85	39	31.3	68
4	37	30.30	74	31	29	86
5	44	31.50	65	44	31.5	74
6	37	28.60	88	34	29	86
7	43	29.30	68	44	28.6	82
8	47	31.10	78	47	31.1	67
9	42	30.20	88	44	30	74
10	38	30.30	65	35	30.2	83

Based on field observations conducted at two sites (found on table 3), a strong positive correlation was observed between temperature and pest population dynamics. At the Ngrejo site, temperature showed a strong positive correlation with pest population ($r = 0.799$) and was statistically significant ($p = 0.006$), indicating that an increase in temperature was consistently followed by an increase in pest activity or abundance under field conditions. Similarly, at the Jengglungharjo site, temperature was also positively correlated with pest population ($r = 0.702$) and statistically significant ($p = 0.037$), although the strength of the relationship was slightly lower compared to Ngrejo.

Table 3. Correlation between pest populations and abiotic environmental factors

Observation Site	Correlation		P- value	
	Temperature	Humidity	Temperature	Humidity
Ngrejo	0.799	-0.661	0.006	0.024
Jengglungharjo	0.702	-0.423	0.037	0.223

Based on field observations conducted at two sites, a strong positive correlation was observed between temperature and pest population dynamics. At the Ngrejo site, temperature showed a strong positive correlation with pest population (r= 0.799) and was statistically significant (p= 0.006), indicating that an increase in temperature was consistently followed by an increase in pest activity or abundance under field conditions. Similarly, at the Jengglungharjo site, temperature was also positively correlated with pest population (r= 0.702) and statistically significant (p= 0.037), although the strength of the relationship was slightly lower compared to Ngrejo.

In contrast, humidity exhibited a negative relationship with pest population at both sites. In Ngrejo, humidity showed a fairly strong negative correlation (r = –0.661) that was statistically significant (p= 0.024), suggesting that higher humidity levels tended to suppress pest presence or activity. However, in Jengglungharjo, although humidity was negatively correlated with pest population (r= –0.423), the relationship was not statistically significant (p= 0.223). This non-significant result may be attributed to the higher vegetation complexity at the Jengglungharjo site, where the presence of more shading and companion vegetation likely moderated microclimatic conditions. Such vegetation cover can buffer fluctuations in ambient humidity, resulting in more stable moisture conditions that reduce the direct influence of humidity on pest population dynamics. Consequently, under these field conditions, humidity may not act as a dominant limiting factor for pest populations in Jengglungharjo compared to Ngrejo, where vegetation structure is more open.

This condition can be explained biologically in that higher temperatures correlate positively with an increase in the population of *S. frugiperda* because temperature plays a role in accelerating the metabolic process and shortening the development phase of insects from eggs to imago, so that larval activity increases as the temperature rises (Ramadhan & Selvy, 2024). Conversely, the negative correlation between humidity and pest populations at both locations indicates that high humidity creates an environment that is less favorable for larvae, both through reduced feeding activity and increased risk of pathogen infection. In addition, changes in weather conditions related to humidity can also affect the dynamics of natural enemies or competing organisms, where increased humidity has the potential to increase the activity of certain biological agents that suppress pest populations (Widhayasa & Suryadarma, 2021).

These correlation findings also show that *S. frugiperda* response to microclimate changes is adaptive and consistent at both research locations. The high temperature correlation values—both in Ngrejo (r= 0.799) and Jengglungharjo (r= 0.702)—indicate that an increase in temperature significantly encourages an increase in larval activity, especially in the early vegetative phase of plants that provide abundant food. This is in line with the characteristics of FAW as a tropical pest that has an optimal temperature range for growth, so that stable temperatures in the warm range tend to strengthen the reproductive capacity and feeding ability of the larvae. Conversely, the fairly strong negative correlation of humidity in Ngrejo (r = –0.661) and moderate correlation in Jengglungharjo (r = –0.423) indicates that a more humid environment can reduce larval survivability, either through an increased risk of pathogen contamination or through the degradation of forage quality due to excessively wet leaf conditions. The difference in correlation strength between the two locations shows that microhabitat variation also shapes pest population dynamics, so that the interaction between temperature and humidity functions as the main regulator of *S. frugiperda* population fluctuations in the field. Abiotic factors through increased activity and population of competitors or natural enemies due to changes in weather conditions (Widhayasa & Suryadarma, 2021).

CONCLUSION

This study concludes that the population dynamics of *Spodoptera frugiperda* in maize fields are primarily driven by site-specific abiotic conditions. Temperature consistently showed a significant positive relationship with pest populations at both Ngrejo and Jengglungharjo, whereas the effect of humidity differed between locations, being significant only in Ngrejo. This indicates that local environmental characteristics, particularly vegetation structure and microclimatic regulation, influence how abiotic factors affect pest populations. The novelty of this study lies in demonstrating that identical abiotic variables can produce different population responses under different field conditions. Therefore, management of *S. frugiperda* should be location-specific, with climate-based monitoring and timely control in more open fields such as Ngrejo, and integrated habitat and population monitoring in more heterogeneous areas like Jengglungharjo.

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REFERENCES

Aditia, A. F., & Putra, I. L. I. (2025). Severity and incidence of *Spodoptera frugiperda* attack on maize plants in Sleman district. *Jurnal Ilmu Pertanian Indonesia (JIPI). 30*(3), 581–590.

Agustin, M., Lestari, R., Hesti, H., Mahani, S., Maharani, E., & Amri, M. Q. (2021). The level of *Spodoptera frugiperda* larvae attacks on maize plants as host plants. *Proceeding of Seminar Nasional Lahan Suboptimal IX on 2021*, 763–770. https://conference.unsri.ac.id/index.php/lahansuboptimal/article/download/2339/1416. Accessed on August 12Th 2025 **[*In Indonesian language*]**

Aniwanou, C. T. S., Sinzogan, A. A. C., Deguenon, J. M., Sikirou, R., Stewart, D. A., & Ahanchede, A. (2021). Bio-efficacy of diatomaceous earth, household soaps, and neem oil against *Spodoptera frugiperda* (Lepidoptera: Noctuidae) larvae in Benin. *Insects, 12*(1), 1–18.

Arfan., Ifall., Jurmadin., Noer, H., & Sumarni. (2020). Population and attack rate *Spodoptera frugiperda* corn plants in Tulo village, Sigi regency. *Jurnal Agroteach, 10*(2), 66-68.

Begon, M., Townsend, C. R., & Harper, J. L. (2020). *Ecology: From individuals to ecosystems.* Fifth Edition. Wiley-Blackwell.

Day, R., Abrahams, P., Bateman, M., Beale, T., Clottey, V., Cock, M., Colmenarez, Y., Corniani, N., Early, R., Godwin, J., Gómez, J., Moreno, P. G., Murphy, S., Oppong-Mensah, B., Phiri, N., Pratt, C., Silvestri, S., & Witt, A. (2017). Fall armyworm: Impacts and implications for Africa. *Outlook on Agriculture*, *46*(3), 197–204.

Goergen, G., Kumar, P. L., Sankung, S. B., Togola, A., & Tamò, M. (2016). First Report of Outbreaks of the Fall Armyworm *Spodoptera frugiperda* (J E Smith) (Lepidoptera, Noctuidae), a New Alien Invasive Pest in West and Central Africa. *PloS One*, *11*(10), e0165632. https://doi.org/10.1371/journal.pone.0165632.

Hidayah, V. U., Surjana, T., & Subagyo, V. N. O. (2024). Biological characteristics and feeding preferences of *Spodoptera frugiperda* (Lepidoptera: Noctuidae) on various types of feed. *Agrica: Journal of Sustainable Dryland Agriculture*, 17(1), 46-57. **[*In Indonesian language*]**

Hidayanti, A. A., & Mandalika, E. N. D. (2023). Pearson correlation analysis of production costs against the land area of salt farmers in Bolo Subdistrict, Bima Regency. *Jurnal Inovasi Pendidikan Dan Sains*, *2*(3), 310–324. **[*In Indonesian language*]**

Harrison, R. D., Thierfelder, C., Baudron, F., Chinwada, P., Midega, C., Schaffner, U., & Van den Berg, J. (2019). Agro-ecological options for fall armyworm (*Spodoptera frugiperda*) management: Providing low-cost, smallholder-friendly solutions in Africa. *Journal of Environmental Management*, 243, 318–330.

Lestari, P., Swibawa1, I., Fitriana, Y., Suharjo, R., Utomo, S. D., & Hartaman, M. (2024). The population dynamics of *Spodoptera frugiperda* after its invasion in Lampung Province, Indonesia. *Jurnal Tropical Plant Pests Diseas, 24*(1), 98-108.

Listyawati, P., S., Wijaya, I., N., Widaningsih, D., Supartha, I., W. (2022). Distribution and adaptability of *Spodoptera frugiperda* (J.E Smith) (Lepidoptera: Noctuidae) to host plants at various altitudes in Bali. *Agrotrop: Journal on Agriculture Science, 12*(1), 110 – 126. **[*In Indonesian language*]**

Lubis, A. A. N., Anwar, R., Soekarno, B. P., Istiaji, B., Sartiami, D., Irmansyah, & Herawati, D. (2020). Corn borer (*Spodoptera frugiperda*) infestation on corn crops in Petir Village, Daramaga Subdistrict, Bogor Regency, and potential control measures using Metarizhium Rileyi. *Jurnal Pusat Inovasi Masyarakat*, *2*(6), 931–939. **[*In Indonesian language*]**

Magdalena, L., Nurkholifah, A. A., & Hatta, M. (2015). Daily test application using web-based systematic random sampling case study: SMKN 1 Bulakamba-Brebes. *Jurnal Digit*, *5*(2), 133–145. **[*In Indonesian language*]**

Mamahit, J. M. E., Pakasi, S., Rompas, J., Paat, F. J. (2022). The potential for controlling *Spodoptera frugiperda* J.E. Smith caterpillars on maize plants using sex pheromones. *Jurnal Agroekoteknologi Terapan, 3*(2), 349-355. **[*In Indonesian language*]**

Midega, C. A. O., Pittchar, J. O., Pickett, J. A., Hailu, G. W., & Khan, Z. R. (2018). A climate-adapted push–pull system effectively controls fall armyworm, *Spodoptera frugiperda* (J.E. Smith), in maize in East Africa. *Crop Protection, 105*, 10–15.

Mukhlis, M., Hadisusanto, S., & Sugianto. (2011). Distribution of organisms in agricultural ecosystems. *Jurnal Agrotek*, *5*(2), 45–52. **[*In Indonesian language*]**

Nurlia, N., & Toana, M. H. (2023). Population density and distribution patterns of cabbage leafworm (*Plutella xylostella* L.) (Lepidoptera: Plutellidae) on cabbage plants in Tanantovea District. *Agrotekbis: E-Jurnal Ilmu Pertanian*, 11(5), 1259–1268. **[*In Indonesian language*]**

Oliver, T., Roy, D. B., Hill, J.K., Brereton, T., & Thomas, C. D. (2010). Heterogeneous landscapes promote population stability. *Ecology Letters*, 13(4), 473-484.

Prasanna, B. M., Huesing, J. E., Eddy, R., & Peschke, V. M. (2021). *Fall Armyworm in Asia: A guide for integrated pest management.* Second edition. CIMMYT.

Putra, I. L. I., & Wulanda, A. (2021). Life cycle of *Spodoptera frugiperda* J.E. Smith with green spinach leaves and green prickly spinach leaves as food in the laboratory. *Bioma: Jurnal Ilmiah Biologi,* 10(2), 201-216. **[*In Indonesian language*]**

Ramadhan, R. A. M., & Isnaeni, S. (2024). Effect of Temperature on Biological Character of *Spodoptera frugiperda* J.E. Smith. *Journal of Plant Protection, 7*(1), 27 - 34.

Rios, E. S., Martins, I. C. F., Noronha, M. P., Silva, J. A., Filho, J. G. S., & Badji, C. A. (2014). Spatial distribution of Spodoptera frugiperda in the wasteland of southern Pernambuco state, Brazil. *Amazon Journal of Agricultural and Environmental Sciences, 57*(3), 297-304.

Samosir, S., Marheni, & Oemry, S. (2015). Preference test of the green stink bug *Nezara viridula* L. (Hemiptera: Pentatomidae) on soybean and long bean plants in the laboratory. *Jurnal Online Agroekoteknologi, 3*(2), 772– 778. **[*In Indonesian language*]**

Sharanabasappa, D., Kalleshwaraswamy, C. M., Asokan, R., Mahadeva Swamy, H. M., Prasad, Y. G., Maruthi, M. S., Pavithra, H. B., Hanchinal, S. G., Navalgatti, T. A., & Shashank, P. R. (2020). Biology of invasive fall armyworm *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) on maize. *Indian Journal of Entomology*, 82(4), 543–548.

Syafria, Reflinaldon, Novri Nelly. (2023). Distribution and Attack Rates of Spodoptera frugiperda on Maize Crops in Sijunjung District, West Sumatra. *Jurnal Proteksi Tanaman (Journal of Plant Protection)*, 7(1), 44 – 54. **[*In Indonesian language*]**

Thamrin, S., Zuliana, N. S., Sjam, S., Melina. (2022). The effect of artificial diet made of soybeans (*Glycine max* L.) on the rearing of *Spodoptera frugiperda* (Lepidoptera:Noctuidae). *Journal of Tropical Plant Pests and Diseases*, *22*(2), 109–115.

Triplehorn, C., Jhonson, N. (2004). *Borror And Delong's Introduction To The Study Of Insects.* 7th Edition. United States of America: Thomson Brook/Cole.

Trisyono, Y.A., Suputa, V.E.F. Aryuwandari, M. Hartaman and Jumari. (2019). Occurrence of heavy infestation by the fall armyworm *Spodoptera Frugiperda*, a new alien invasive pest, in Corn in Lampung Indonesia. *Jurnal Perlindungan Tanaman Indonesia*, 23(1), 156–160.

Utami, I., & Putra, I. L. I. (2020). *Quantitative Ecology: Sampling Methods and Field Data Analysis*. Yogyakarta: K-Media. **[*In Indonesian language*]**

Widhayasa, B., & Suryadarma, E. (2021). The role of weather factors in the attack of Spodoptera frugiperda (Lepidoptera: Noctuidae) caterpillars on corn crops in Berau Regency, East Kalimantan. *Journal of Tropical AgriFood*, *4*(2), 93–98. http://dx.doi.org/10.35941/jatl.4.2.2022.6999.93-98 **[*In Indonesian language*]**

Widyastuti, R., Supriyadi, H., & Yanuwiadi, B. (2020). Soil insect diversity in agroforestry systems. *Jurnal Entomologi Indonesia*, 17(2), 85–92. **[*In Indonesian language*]**

Wu, Q. L., Jiang, Y. Y., Liu, J., & Qiu, L. (2021). Migration and population dynamics of fall armyworm (*Spodoptera frugiperda*) in China: A review. *Journal of Integrative Agriculture*, 20(3), 637–651.

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