Economic Loss Potential of Cherry Tomato Pest Attacks based on Light Trap Data in Lembang

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ABSTRACT

Cherry tomato is a high-value horticultural crop in Indonesia, yet its productivity is frequently threatened by pest attacks that may cause economic losses. In many production areas, pest control decisions are still applied preventively without adequate population monitoring, leading to inefficiency and unnecessary production costs. This study aimed to assess the potential economic losses caused by pest attacks on cherry tomato, determine site-specific Economic Injury Level (EIL) and Economic Threshold (ET), and evaluate the economic feasibility of pest control using a Benefit–Cost Ratio (B/C) approach based on light trap data.

The study was conducted from October to November 2025 on a 300 m² cherry tomato field (850 plants) in Cibodas Village, Lembang District, West Java. Pest populations were monitored using light traps over eight observation periods. Economic analysis was performed by integrating yield loss, control costs, EIL, ET, and B/C ratio calculations.

Results showed that a total of 164 insects (such as Spodoptera, Mythimna, Lyriomiza, etc) were recorded, causing cumulative crop damage of only 0.492% and yield loss of 4.92 kg, equivalent to an economic loss of IDR 49,200 per 300 m². The calculated EIL and ET were 32,500 and 26,000 insects per 300 m², respectively. Observed pest populations were far below these thresholds. The B/C ratio of chemical control was 0.0757, indicating that pest control was not economically viable.

The study concludes that, during the early growth stage, pest management through intensive monitoring without chemical intervention is the most rational and economically efficient strategy, supporting Integrated Pest Management principles and sustainable horticultural production.

KEYWORDS

cherry tomato, light trap, economic injury level, economic threshold, benefit–cost ratio

I. INTRODUCTION

Tomato is a high-value horticultural commodity in Indonesia, with national production reaching 1.28 million tons annually [1]. Desa Cibodas, Lembang District, West Java, as one of the major tomato production centers, faces significant economic losses due to attacks by Plant Pests and Diseases (PPD). Previous studies reported yield losses of 35–55%, resulting in economic losses of IDR 15–25 million per hectare [2].

The main challenge faced by farmers is the absence of an effective pest monitoring system. Pest control is commonly conducted in a reactive manner through untimely and excessive insecticide applications, leading to economic inefficiency and environmental risks [3]. Light traps have been widely recognized as an effective tool for monitoring nocturnal insect pests, with studies confirming their accuracy in detecting pest population dynamics [4] [5].

However, the utilization of light trap data for economic analysis in tomato pest management in Desa Cibodas remains limited. Accurate monitoring data are essential for determining the Economic Injury Level (EIL) and Economic Threshold (ET) to support economically sound pest control decisions [6]. Recent studies have demonstrated a strong correlation between light trap catches and actual pest populations, as well as their contribution to improved benefit–cost ratios and reduced insecticide use under Integrated Pest Management (IPM) approaches [7] [8] [9].

Therefore, this study aims to quantify pest population dynamics using light trap data, estimate EIL and ET values, assess potential economic losses, and evaluate the economic feasibility of pest control strategies through Benefit–Cost Ratio analysis, to support efficient, data-driven, and sustainable tomato pest management strategies in Cibodas Village.

II. METHODOLOGY

The study applied a quantitative descriptive research design integrating pest monitoring data with economic analysis. The study was conducted at a single plot and during one growing season to generate site-specific EIL, ET, and BCR estimates under local production conditions, and was conducted from 17 October to 11 November 2025 at the Multi Karya farmer group, led by Dadang Rukmana, located in Cibodas Village, Lembang District, West Bandung Regency, Indonesia. The study site was selected purposively based on three considerations: (1) Lembang is a major tomato production center in West Java, (2) tomato cultivation is conducted continuously by local farmers, and (3) no previous light trap–based pest monitoring study had been conducted in the area.

The study utilized primary and secondary data. Primary data were collected through direct field observation, structured interviews, and questionnaires administered to tomato farmers. Insect populations were monitored using two light trap configurations. The first configuration consisted of a continuously operating purple ultraviolet (UV) lamp with a power output of 0.5 W, operated for 24 h day^{-1}. The second configuration was a time-controlled light trap system, employing a 5 W yellow lamp during daytime and a 5 W white lamp during nighttime, operated from 18:00 to 22:00. The dual-lamp system was designed to account for diurnal and nocturnal insect activity patterns. Light traps were positioned at canopy level and operated uniformly throughout one growing season. Observations focused on pest populations captured using light traps and crop condition during the study period. Interviews and questionnaires were used to obtain data on cultivation practices, pest control measures, production costs, and yield performance. Secondary data were obtained from scientific literature, journals, books, seminar papers, official documents, and statistical data from relevant institutions.

The population in this study consisted of 850 tomato plants cultivated on a 300 m² plot owned by a farmer who is a member of the Multi Karya farmer group. All plants within the selected plot were included as observation units for pest monitoring and economic evaluation.

Key variables observed in this study included: (1) pest population levels based on light trap catches, (2) costs of pest control and production inputs, (3) yield losses due to pest attacks, and (4) economic indicators derived from the Economic Injury Level (EIL), Economic Threshold (ET), and Benefit–Cost Ratio (BCR). Pest population data served as the primary input for determining economic thresholds and control decisions.

Data analysis was conducted using quantitative analytical methods. Collected data were tabulated and analyzed using established economic pest management models. The Economic Injury Level (EIL) was defined as the pest population level at which the economic loss caused by pest damage equals the cost of control. The Economic Threshold (ET) was set at 80% of the EIL and used as an early warning indicator for initiating control actions. The Benefit–Cost Ratio (BCR) was calculated to evaluate the economic feasibility of pest control strategies, where BCR > 1 indicates that control is economically beneficial, while BCR < 1 suggests that control is not recommended. This analytical framework supported decision-making between two management options: allowing pest damage without control or implementing control measures to reduce yield loss and improve economic returns.

III. RESULTS AND DISCUSSION

3.1 Pest Population Dynamics and Economic Losses in Cherry Tomato Cultivation

The results of pest observations conducted on cherry tomato plants at one week after transplanting over eight observation periods within one month indicated that insect populations and crop damage fluctuated over time. A total of 164 insects were recorded within a 300 m² cultivation area during the study period (Table 1).

During the first three observations, pest populations were relatively low (4–14 individuals), resulting in minimal crop damage (<0.06%) and cumulative economic losses of IDR 8,700. A sharp increase in pest population occurred during the fourth observation, reaching 42 individuals, which corresponded to the highest recorded damage (0.084%), yield loss (1.26 kg), and single-observation economic loss (IDR 12,600).

Table 1. Pest population dynamics and economic losses in early growth stage of cherry tomato (300 m²)

Observation	Total insects (insects)	Damage (%)	Yield loss (kg)	Economic loss (IDR)	Cumulative loss (IDR)
1	11	0,022	0,33	3.300	3,300
2	14	0,028	0,42	4.200	7,500
3	4	0,008	0,12	1.200	8,700
4	42	0,084	1,26	12.600	21,300
5	9	0,018	0,27	2.700	24,000
6	30	0,060	0,90	9.000	33,000
7	27	0,054	0,81	8.100	41,100
8	27	0,054	0,81	8.100	49,200
Total	**164**	**0,492**	**4,92**	**49.200**	

Source: Processed primary data (2025)

This population surge was likely influenced by favorable environmental conditions. The fourth observation coincided with the highest rainfall (25.8 mm) and relative humidity (86%) recorded during the month, which are known to enhance pest development. In subsequent observations, pest populations fluctuated between 9 and 30 individuals, with economic losses ranging from IDR 2,700 to IDR 9,000 per observation. Overall, cumulative yield loss reached 4.92 kg, equivalent to a total economic loss of IDR 49,200 [10].

3.2 Economic Injury Level and Threshold Analysis

Based on socio-economic parameters presented in Table 2, the Economic Injury Level (EIL) for cherry tomato cultivation on a 300 m² plot was calculated at 32,500 insects. The EIL represents the pest population level at which economic losses equal control costs; pest control is economically justified only when populations exceed this threshold [11].

The Economic Threshold (ET), defined as 80% of the EIL, was established at 26,000 insects, serving as an early warning level for control intervention [5].

Table 2. Parameters for economic analysis of pest control

Parameter	Value	Unit	Description
Potential yield (Yp)	1,500	kg/300m²	Optimal yield
Market price (P)	10,000	IDR/kg	Average market price
Control cost (C)	650,000	IDR/300 m²	Pesticide + labor
Damage coefficient (d)	0.002	%/insect	2% damage per 1,000 insects
Economic Injury Level (EIL)	32.500	insects	C / (P × d) (Pedigo dan Buntin, 1994)
Economic Threshold (ET)	26.000	insects	80% × EIL

Source: Processed primary data (2025)

Across all eight observations, pest populations remained far below the ET value, with the highest population recorded at only 42 insects. Consequently, based on Integrated Pest Management (IPM) principles, chemical control was not recommended during the study period. All observations resulted in a "monitor" recommendation (Table 3).

Table 3. Pest management recommendations based on ET

Observation	Total insects (ind.)	Damage (%)	Recommendation
1–8	4–42	0.008–0.084	Monitor

Source: Processed primary data (2025)

These findings support the IPM concept which emphasizes that pest control measures should only be taken when pest populations reach economically detrimental levels [12].

3.3 Benefit–Cost Ratio (BCR) Analysis

The economic feasibility of pest control was evaluated using the Benefit–Cost Ratio (BCR) approach [13]. Under the observed pest population and damage levels, the maximum potential economic benefit preserved through chemical control was equivalent to the total estimated yield loss (IDR 49,200), whereas the associated control cost reached IDR 650,000. This substantial imbalance resulted in a BCR value far below unity, clearly indicating that chemical intervention was economically unjustifiable under the prevailing field conditions.

The low BCR value reflects not only the relatively limited magnitude of pest-induced economic loss but also the disproportionally high cost of chemical control relative to the actual damage incurred. From an economic injury perspective, pest population levels during the observation period did not exceed the Economic Injury Level (EIL), meaning that the cost of control was higher than the value of yield losses that could be prevented. Consequently, chemical control applied at this stage represents an inefficient allocation of production inputs.

These findings highlight the critical role of integrating economic thresholds into pest management decision-making. Preventive or calendar-based chemical control, when applied without reference to EIL and ET, may unnecessarily increase production costs and reduce overall farm profitability. In contrast, intensive pest monitoring using light traps provides an early warning system that enables farmers to delay intervention until pest populations approach economically damaging levels.

Therefore, under early growth stage conditions and low-to-moderate pest pressure, light trap–based monitoring without immediate chemical intervention constitutes the most economically rational strategy. This approach supports cost-efficient pest management while minimizing unnecessary pesticide use, thereby improving both economic and ecological sustainability of cherry tomato production systems.

IV. CONCLUSION

4.1 Conclusion

This study directly addressed the research objectives by quantifying economic losses due to pest attacks, determining locally based Economic Injury Level (EIL) and Economic Threshold (ET), and evaluating the economic feasibility of pest control in cherry tomato cultivation in Cibodas Village. The results showed that pest attacks during the early growth stage caused relatively low economic losses, amounting to IDR 49,200 per 300 m², with a total yield loss of 4.92 kg or 0.33% of the potential yield. Thus, pest infestation during the observation period did not result in economically significant damage.

The locally calculated EIL and ET were 32,500 insects per 300 m² and 26,000 insects per 300 m², respectively. Observed pest populations throughout the eight monitoring periods remained far below these thresholds, with the maximum population recorded at only 42 insects. This finding confirms that, under the studied agroecosystem conditions, pest populations did not reach levels requiring control measures based on Integrated Pest Management (IPM) principles.

Furthermore, the Benefit–Cost Ratio (BCR) analysis yielded a value of 0.0757, indicating that chemical pest control during the early growth stage was economically unjustifiable. Control costs substantially exceeded the potential economic benefits. Overall, this study demonstrates that early-stage pest management decisions for cherry tomato in Cibodas Village should rely on local economic thresholds and economic analysis to avoid unnecessary and inefficient chemical control applications.

From a practical perspective, this study contributes empirical evidence supporting the integration of light trap–based monitoring with economic analysis (EIL, ET, and BCR) as a rational decision-making tool for pest management. The findings reinforce the importance of avoiding preventive chemical control when pest populations remain below economic thresholds, thereby improving farm efficiency and reducing unnecessary input costs.

However, this study was limited by its short observation period, single location, and focus on the early growth stage of the crop. Pest dynamics and economic impacts may differ at later growth stages or under different seasonal and environmental conditions.

4.2 Suggestions for Future Studies

This study was conducted at a single location and during one growing season; therefore, the findings should be interpreted within the specific agroecosystem context and may not be directly generalizable to other regions or seasons. Future research is recommended to extend the observation period across multiple crop growth stages and planting seasons, involve larger and more diverse farming locations, and incorporate additional ecological variables such as natural enemy populations and climate dynamics. Integrating digital or automated light trap systems may further enhance the accuracy and applicability of economic threshold–based pest management strategies.

4.3 Policy Implications

Based on the economic analysis, pest management in the study area is recommended to focus solely on monitoring without chemical intervention, as the observed pest populations and damage levels resulted in a BCR value of only 0.075, indicating that chemical control is not economically justified. Continuous monitoring using light traps remains the most rational, efficient, and sustainable strategy under the prevailing conditions.

REFERENCES

[1] Badan Pusat Statistik (BPS), Produksi Tanaman Sayuran, ISSN 2086-4955, Jakarta. Indonesia, 2024.

[2] S. Nurjanah, P. Hidayat, and Dadang, *Economic losses due to major pests in tomato cultivation in West Java, Indonesia*, Journal of Tropical Plant Protection. vol. 8. no. 1. pp. 45–58, 2022.

[3] F. R. Musser and A. M. Shelton, *The economic impact of insecticide resistance in the Colorado potato beetle: A case study of the Michigan potato industry,* Journal of Agricultural and Resource Economics. vol. 28. no. 2. pp. 315–333, 2003.

[4] U. Widyastama et al., Efektivitas berbagai jenis perangkap cahaya untuk monitoring hama sayuran di Lembang. Jurnal Hortikultura Indonesia, vol. 9. no.2. pp. 89–97, 2018.

[5] T. Rahman and A. Rauf, *Determination of economic injury level and economic threshold of major insect pests in tomato cultivation*, Journal of Crop Protection. vol. 8. no. 3. pp. 321–332, 2019.

[6] J. D. Stone and L. P. Pedigo, *Development and economic-injury level of the green cloverworm on soybean in Iowa,* Journal of Economic Entomology. vol. 65, no. 1, pp. 197–201, 1972.

[7] Y. Chen, W. Li, and X. Zhou, *Correlation between light trap catches and actual field population density of tomato fruit borer*, Crop Protection. vol. 158, p. 106017, 2022.

[8] T. H. Nguyen, M. D. Tran, and V. H. Le, *Nationwide implementation of light trap-based pest monitoring system for vegetable production in Vietnam*, Crop Protection. vol. 161, p. 106075, 2022.

[9] X. Wang, Y. Zhang, and Z. Liu, *Integrated benefit–cost analysis of tomato pest management strategies with environmental consideration*, Journal of Cleaner Production. vol. 434, p. 139857, 2024.

[10] Climate-Data.org, Climate data for Lembang, West Java, Indonesia. [Online]. Available: https://id.climate-data.org/asia/indonesia/west-java/lembang974703/t/oktober-10/

[Accessed: Nov. 29, 2025]

[11] L. P. Pedigo and M. E. Rice, *Entomology and Pest Management*. 6th ed. Long Grove, IL, USA: Waveland Press, 2014.

[12] V. M. Stern et al., “The integration of chemical and biological control of the spotted alfalfa aphid,” Hilgardia, vol. 29, no. 2, pp. 81–101, 1959.

[13] J. T. Trumble and B. Alvarado-Rodriguez, “Development and economic evaluation of an IPM program for fresh market tomato production in Mexico,” Journal of Economic Entomology, vol. 86, no. 1, pp. 1–10, 1993.