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Design of Fruit Fly Trap ApelB Using a Microcontroller and Sensor System Powered by Solar Photovoltaic

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ABSTRACT

Indonesia's vast horticultural land faces serious threats from Bactrocera fruit fly infestations, a type of fruit fly in the Tephritidae family that causes rotting plants, reducing the quality of plantation and agricultural products, and even crop failure. The purpose of this study was to design a fruit fly (Bactrocera) trap ApelB version 1.1, using the Cockcroft-Walten Circuit, Methyl Eugenol, PIR HC-SR501 sensor, Arduino Uno ATmega328P, powered by electricity from a Solar Power Plant/System (PLTS) with a panel capacity of 10 Wp, Solar Charge Controller 10 A and a 14.8 V 2.5 Ah battery. The ApelB version 1.1 test method on agricultural land for 24 hours used methyl eugenol to attract fruit flies to enter the trap. Electricity from the PLTS functions to eradicate fruit flies that land on the electric net trap. The findings of ApelB version 1.1 successfully attracted, detected through sensors, and eradicated fruit flies with electric shocks. The capture rate was 80% in lab tests, while corn and chili field trials caught an average of 148–150 fruit flies. ApelB version 1.1 can suppress attacks and fruit fly populations, with a PLTS system and energy storage battery. This tool is guaranteed to operate 24 hours automatically.

1. INTRODUCTION

The development of citrus plantations in Indonesia has been rapidly growing, primarily driven by increasing demand from consumers (Andrini *et al*., 2021). Indonesian citrus fruits are well known for their fresh and sweet taste. Other fruits with high potential in Indonesia include bananas, rambutans, and pineapples. These fruits are in high demand in both domestic and international markets. In addition to their strong export potential, fruit plantations in Indonesia also offer significant economic benefits (Fonsah *et al*., 2008; Junaidi & Jannah, 2020).

The main issue is that fruit flies (*Bactrocera*) can transmit diseases to healthy fruits, thereby affecting both the quality and quantity of the harvest (Sarangi *et al*., 2024). Fruit flies insert their eggs into the fruit by inserting their ovipositor, and the larvae develop inside. The damage caused by this pest causes fruit to drop before reaching the desired ripeness, thus reducing both the quality and quantity of production (Hasyim *et al*., 2006). As a result, farmers suffer economic losses due to fruit fly infestations. Symptoms of fruit fly attacks are observed across various fruit vegetables and are typically characterized by visible signs such as black spots on the surface. The affected produce often becomes watery and rotten, with the presence of active, white-colored larvae that may be seen moving or occasionally jumping (Saputra *et al*., 2023). Due of its practicality and effectiveness, farmers most frequently use insecticides to control insect pests. However, the widespread use of chemical pesticides poses health and environmental hazards, including toxicity, pollution, and contamination, which highlights the need for better substitutes (Madduri *et al*., 2025).

Research on fruit fly management to prevent disruption of fruit development has been conducted by several scholars. For instance, Reddy *et al*. (2020) reviewed various control methods, including the Sterile Insect Technique (SIT), the

Male Annihilation Technique (MAT), and others (Reddy *et al*., 2020). Susanto *et al*. (2023) investigated the effectiveness of different trap heights in controlling fruit fly populations (Susanto *et al*., 2023). Rahayu *et al*. (2023) conducted a study on fruit fly traps utilizing electromagnetic waves (Rahayu *et al*., 2023), and Lello *et al*. (2023) conducted a review on the development and application of automated devices for fruit fly detection (Lello *et al*., 2023). Inhibiting insect activity and lowering pest numbers is the main goal of any trapping method (Madduri *et al*., 2025). Fruit fly trap working with microcontroller and sensor system powered by solar photovoltaic (PV) is attractive method in controlling fruit flies. Fruit fly trapping using this technology offers numerous environmental, economic, and practical benefits as an eco-friendly and cost-effective method of pest management, especially in agricultural sector.

The use of solar energy in pest trap designs is gaining increasing attention. For example, Ilham *et al*. (2018) successfully designed an insect trap using a 12V - 7Ah battery powered by a 10Wp - 12V solar panel. Pradana *et al*. (2020) concluded that implementing solar-powered traps in orange field successfully caught twice as many pests compared to conventional methods. Prasojo *et al*. (2024) also reported that solar powered pest trap effectively caught 40 to 80 moths per day, drastically lowering pest numbers and decreasing costs for pest controlling due to fewer chemical pesticides use.

Solar PV powered traps are a sustainable alternative controlling pests compared to chemical pesticides, which can contaminate soil and water and harm beneficial non-target species like bees and butterflies. This method helps preserve local biodiversity and promotes a healthier ecosystem. It is also cost-effective solution. While there is an initial investment, solar-powered traps require minimal maintenance and negligible operational costs because they run on free, renewable solar energy (Sumarwan, 2021). This results in long-term savings on repeated pesticide purchases and labor costs. This technology also energy independence. Utilizing solar panels makes the traps self-sufficient and ideal for use in remote agricultural areas with limited or no access to an electrical grid (Mohapatra, 2024). By effectively controlling fruit fly populations, these traps protect crops from damage, leading to healthier plants, higher yields, and improved fruit quality. The absence of harmful chemicals in the trapping process minimizes health risks for farm workers and consumers to pesticide residues. Therefore, solar PV powered insect traps are an excellent component of an Integrated Pest Management strategy, complementing other methods like biological control and helping to reduce the overall need for chemical interventions. This trapping equipment can also be designed with automatic day-night sensors, turning on at dusk and off at dawn, which ensures continuous, reliable operation without manual intervention (Madduri *et al*., 2025). Incorporating these traps helps prevent pests from developing resistance to chemical pesticides, a common issue with the overuse of traditional methods. The use of solar power benefits the environment by reducing CO_2 emissions, supporting efforts to slow down global warming and mitigate climate change (Alatas, 2024). The use of solar PV will also contribute to the national policy on the energy mix targets 31% from NRE by 2050 (Alatas *et al*., 2020).

Based on these potentials and challenges, the objective of this research is to design fruit fly trap ApelB using a microcontroller and sensor system powered by solar PV. The result is expected to assist farmers in managing fruit fly pests effectively, as well as to maximize productivity in plantation and agricultural outputs, thereby supporting the realization of food and energy self-sufficiency.

2. RESEARCH MATERIALS AND METHODS

This study employs an experimental approach aimed at designing, constructing, and testing the performance of a microcontroller-based fruit fly pest trap powered by a solar panel as the electricity supply. The research method consists of several main stages: planning, designing, and testing. The planning phase involves a theoretical approach to characterize the fruit fly pest, which is the subject of this study.

2.1. Fruit Fly (*Bactrocera dorsalis*)

Fruit flies are often found near ripe or rotting fruit because the females usually lay their eggs on the fruit's surface. When the eggs hatch, the larvae go inside the fruit and feed on the decaying parts. After the larval stage, they turn into pupae and later become adult flies. Their life cycle takes about 10 to 12 days. Fruit flies consist of several species, including *Bactrocera albistrigata*, *B. beckerae*, *B. calumniata*, *B. caudata*, *B. cucurbitae*, *B. limbifera*, *B. papayae*, *B. philippinensis*, *B. umbrosa*, and *B. badius*, each of which exhibits distinct key characteristics (Sarjan *et al*., 2010).

Bactrocera, or fruit fly pests, are fly species that develop by using ripe fruits as a medium for laying eggs. Studies on citrus plants in North Sumatra have shown that fruit fly activity follows a daily pattern, with peak activity occurring between 10:00 AM and 12:00 PM in the morning, and between 12:00 PM and 2:00 PM in the afternoon, as indicated by the number of fruit flies trapped during these periods (Manurung *et al*., 2012). Fruit flies are also more active during the daytime, particularly between 11:00 AM and 1:00 PM (Yuantika *et al*., 2021).

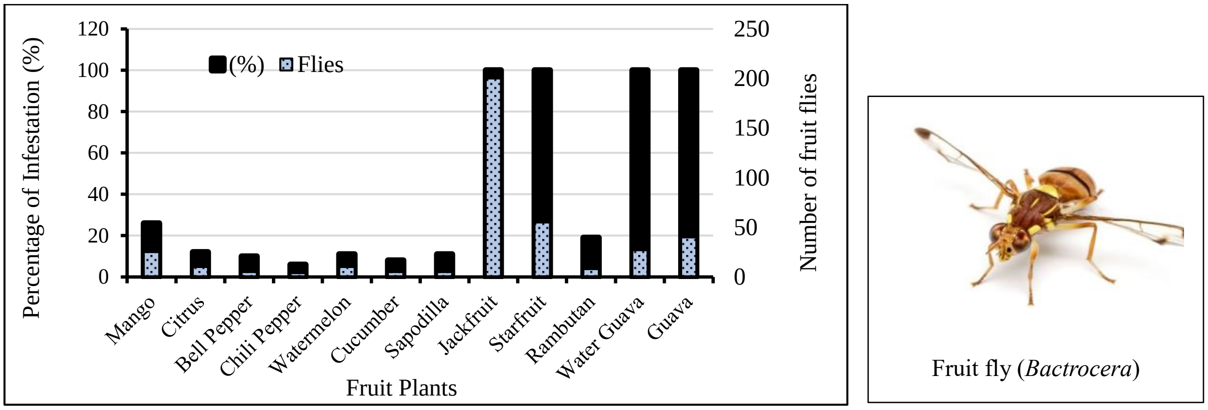


Figure 1. (a) Percentage of fruit fly infestation on fruits, and (b) Fruit fly (*Bactrocera*)

The percentage of fruit fly infestation on fruits varies greatly depending on the population of fruit fly species present in a given area. A study by (Astriyani *et al*., 2016) identified several fruit fly species, including *Bactrocera papayae* Drew & Hancock, *Bactrocera carambolae* Drew & Hancock, *Bactrocera umbrosa* Fabricius, *Bactrocera cucurbitae* Coquillett, and *Bactrocera albistrigata* de Meijere (Diptera: Tephritidae). The infestation percentages on various fruit plants were reported as follows: jackfruit (100%), starfruit (100%), guava (100%), water guava (100%), mango (26%), rambutan (19%), citrus (12%), watermelon (11%), sapodilla (11%), bell pepper (10%), cucumber (8%), and chili pepper (6%). According to the studies by Liu & Yeh (1982) and Chen *et al*. (2006), as cited in (Manurung *et al*., 2012), fruit flies have a body length of approximately 5 mm and a wingspan of about 10 mm. The thermal threshold for their body temperature is around 18 °C.

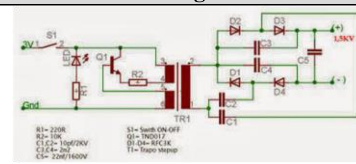
2.2. Fruit Fly Trap (ApelB)

In the initial stage, a system requirements analysis was conducted, including the identification of the specifications for the fruit fly pest trap. The component specifications used are listed in Table 1. The passive infrared (PIR) sensor used in this study is the HC-SR501. Although the HC-SR501 PIR sensor is originally designed for human-scale motion detection, Hahn *et al*. (2023) demonstrated its effectiveness in detecting small insects when integrated into a fruit fly trap. The sensor was positioned near the trap entrance and successfully triggered motion detection and image capture upon fruit fly entry (Hahn *et al*., 2023). This empirical finding supports the feasibility of using the HC-SR501 for detecting fruit flies approximately 5 mm in size, particularly under controlled configurations that amplify infrared motion signatures. In our study, we adapted the sensor by deliberately narrowing its detection range to around 4-5 cm, far shorter than its typical 3-10 meter range for larger animals to enhance its sensitivity to small insect movements at close proximity. This modification not only improved its performance for fruit fly detection but was also guided by economic considerations, aiming to produce a low-cost solution accessible to smallholder farmers. Field testing confirmed the practicality of this design, with the trap system achieving a consistent and satisfactory capture rate.

By understanding the specifications of the components for the fruit fly pest trap device, the next step is to determine the solar power system (PV) components by considering the activity pattern of fruit flies, which occurs from 6:00 AM to 6:00 PM, while the solar panel's effective energy production is between 10:00 AM and 2:00 PM (4 hours) (Sudarmono *et al*., 2020). Based on the reference, the required backup energy for 8 hours is as follows:

$$E\ required = 3.8286\ W \times 8\ h = 30.6288\ Wh \quad (1)$$

Table 1. Component specifications of the fruit fly trap device

No	Component	Power Requirements (P)	Images
1	Cockcroft-walton circuit	3.5 Watt	
2	Sensor passive infrared receiver (PIR) HC-SR501	0.325 Watt	
3	Arduino Uno microcontroller with an ATmega328P	0.0036 Watt	
	Total	3.8286 Watt	

The required backup energy of 30.6288 Wh is provided by a battery, as detailed in the subsequent experimental setup. Battery specifications: lithium-ion, 9.25 Wh, with an efficiency rate of 95%. Therefore, four batteries are required to adequately supply the electrical power:

$$E\ Battery = 9.25\ Wh \times 4 = 37\ Wh \times (95\%) = 33.3\ Wh \quad (2)$$

With the load on the fruit fly device is 3.8286 Wh, and the required battery storage capacity is 37 Wh, resulting in a total load of 40.8286 Wh. Considering the solar panel's effective energy production time of 4 h, the solar panel requirements were calculated according to Equation (3). With a power load of 10.20715 W, for ease of calculation in determining the solar panel requirements, the value will be rounded to 10 W, corresponding to one solar panel.

$$P\ solar\ panel = \frac{40.8286\ Wh}{4\ h} = 10.20715\ W \quad (3)$$

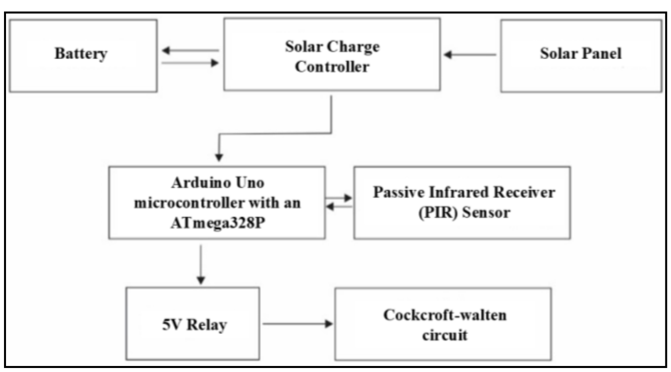
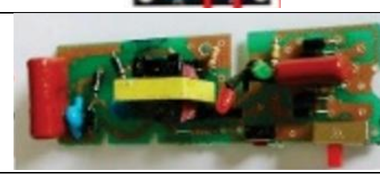


Figure 2. Planning of the fruit fly trap system

2.3. System Design

The planning phase takes into account the function of each component to be used and the working process of the fruit fly trap device powered by a solar panel as its electrical energy source. Figure 2 illustrates steps in the design of fruit fly trap ApelB version 1.1. Table 2 compiled components, their images and function required to assemble fruit fly trap device

Table 2. A series of components, their functions, and device images

No	Components	Functions	Images
1	Solar panel	Converting solar energy into electrical energy	
2	Solar Charge Controller (SCC)	An electrical energy controller that manages the flow of power from the solar panel to the battery and the load	
3	Battery	Energy storage of the power produced by the panel	
4	Arduino Uno microcontroller with an ATmega328P	Controls and sends commands to the circuit	
5	Relay	Automatic controller switch	
6	Cockcroft-walten circuit	Increasing voltage from low voltage to high voltage	

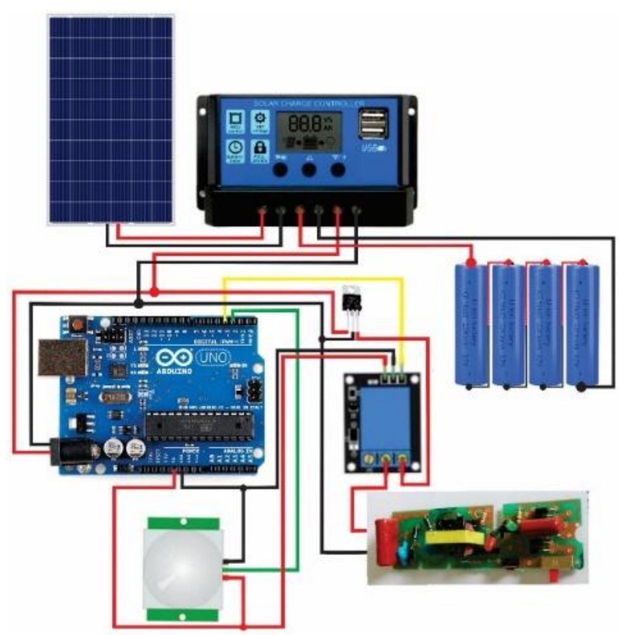


Figure 3. Wiring diagram for ApelB Version 1.1

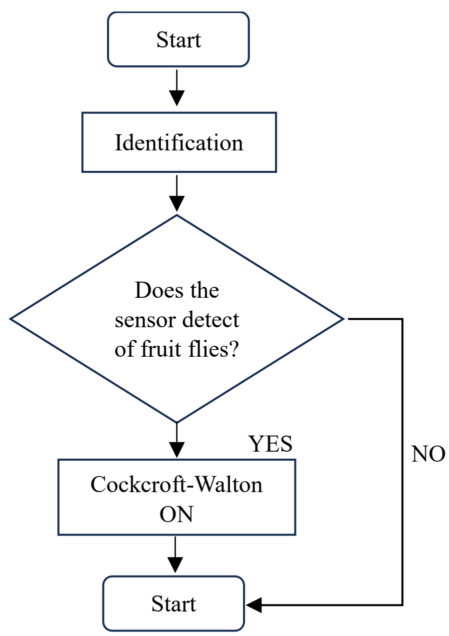


Figure 4. Programming flowchart

device. Electrical system planning for the pest trap device requires a wiring diagram to facilitate the wiring and installation process during the design phase. The wiring diagram is created based on the pest trap system design. An additional component, a 5 V IC regulator, is used to convert voltage from 12 V to 5 V to supply power to the relay. Figure 3 illustrates the wiring diagram for ApelB version 1.1.

2.4. Software Planning

The software planning for the controller utilizes a development platform called Arduino IDE, which employs the C programming language. The overall programming must align with the defined flowchart, as illustrated in Figure 4.

2.5. Fruit Fly Trap (ApelB) Design

The structural design (Figure 5) in this study was created using SketchUp design software, which can be utilized for planning the design of microcontroller-based solar power plant (Putra *et al*., 2019). The support leg has a height of 3.2 cm, the main support pole is 60 cm tall, the trap structure has a height of 15 cm, and the connecting rod from the trap structure to the panel measures 5 cm. The panel box is 30 cm high, the panel mounting is 1 cm, and the solar panel has a thickness of 1.7 cm, resulting in a total height of 115.9 cm.

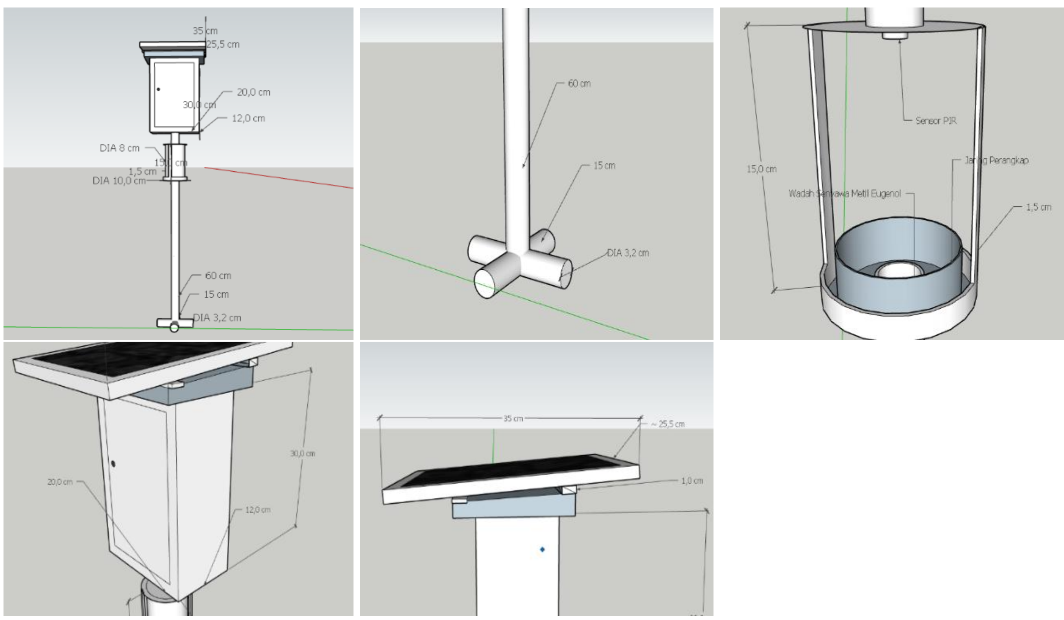


Figure 5. Fruit fly trap design in detail: (a) Front view; (b) Support structure; (c) Trap net; (d) Panel box; (e) Solar Panel

The trap net details include an outer catcher measuring 10 cm in diameter and 15 cm in length, which functions as a collection chamber for dead fruit flies. The net used has a diameter of 8 cm and a length of 15 cm, and consists of a double-layer mesh. The panel box used has a height of 30 cm, a width of 20 cm, and a thickness of 12 cm. The solar panel used measures 35 cm in length and 25.5 cm in width. It is mounted with 1 cm thick bolts on the supports, which are then bolted to the roof of the panel box. Figure 6 shows research steps including planning, construction, testing (laboratory scale and field testing), and drawing conclusions, as illustrated in.

3. RESULTS AND DISCUSSION

3.1. Results of the Fruit Fly Pest Trap (ApelB)

The results of the fruit fly trap frame based on a microcontroller and powered by a solar panel can be seen in Figure 7. The overall frame height is 115.9 cm, with leg lengths of 15 cm, a pole height of 60 cm, a trap diameter of 10 cm, and

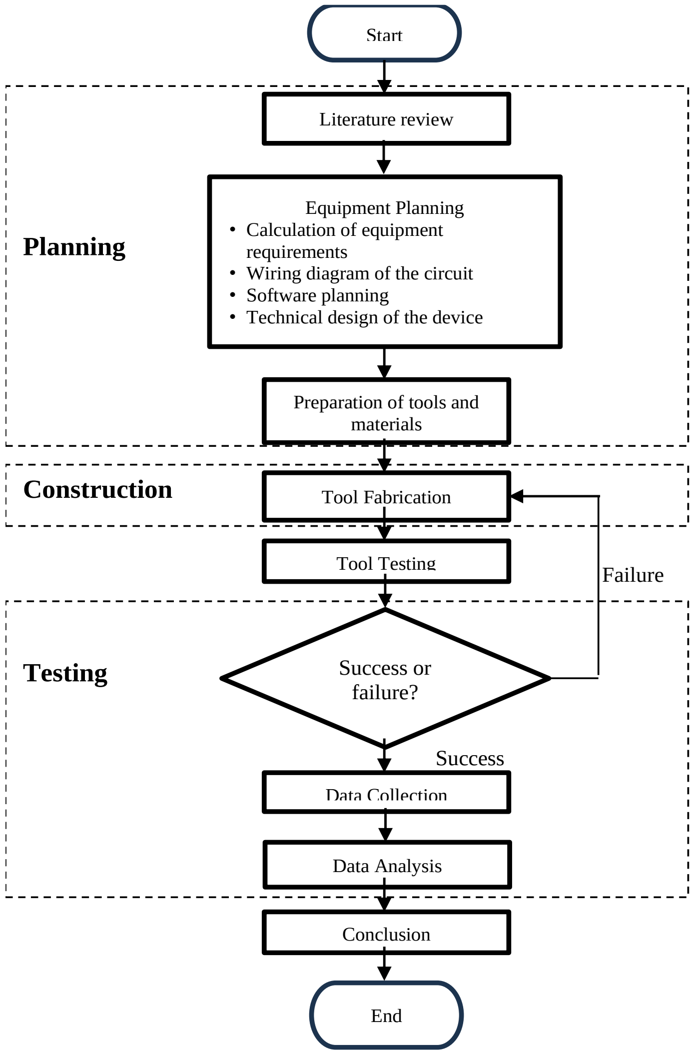


Figure 5. Research Flowchart

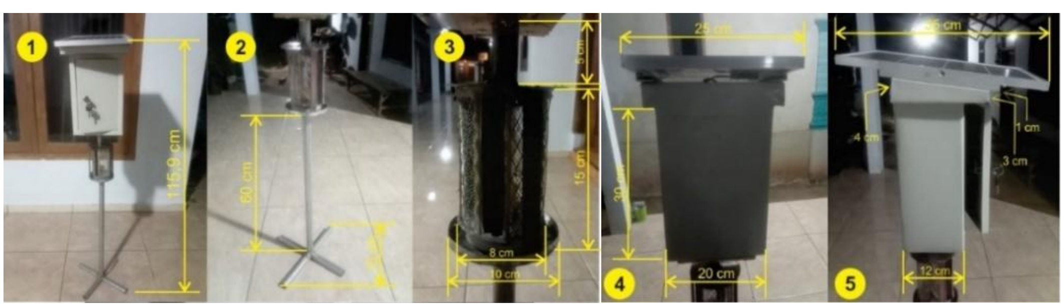


Figure 6. Frame for microcontroller-based fruit fly trap

a net diameter of 8 cm. There is also a 2 cm chamber for collecting dead flies. The connector between the trap and the panel box measures 5 cm. The box dimensions are 30 cm (height) × 20 cm (width) × 12 cm (thickness), and the solar panel measures 25 × 35 cm.

The electrical system fabrication results of the fruit fly pest device, adjusted according to the wiring diagram shown in Figure 8, consist of several components, including a 10 WP solar panel, a 10 A solar charge controller (SCC), a battery,

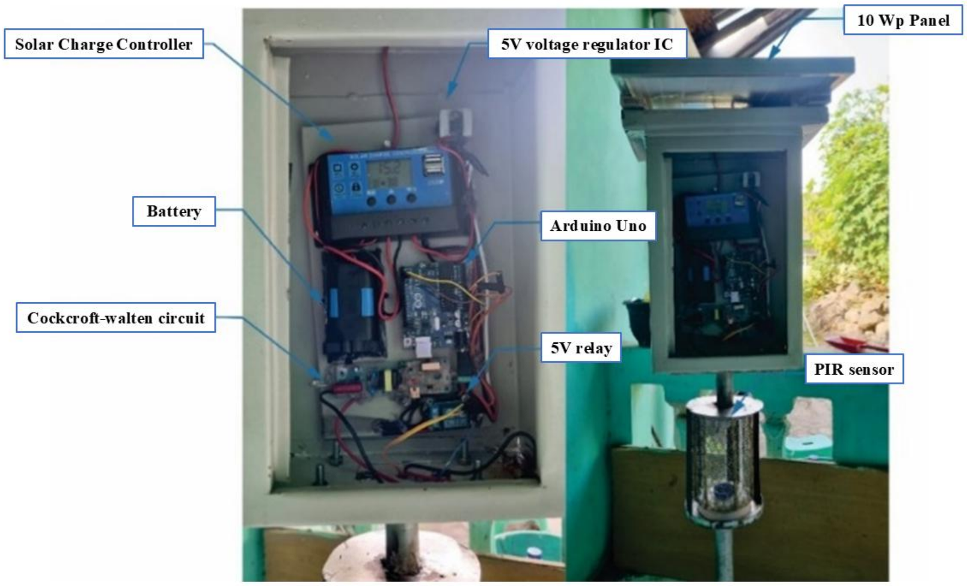


Figure 7. Electrical components of the fruit fly pest trap ApelB Version 1.1

an Arduino Uno, a 5 V relay, a Cockcroft-Walton circuit, a PIR sensor, and a 5 V IC regulator. The IC regulator serves to step down the voltage from the SCC output to match the 5 V relay circuit, ensuring the stability and longevity of the relay circuit and the Cockcroft-Walton circuit for long-term operation.

The software programming results for the fruit fly pest trap were developed to control and issue commands to the Arduino Uno. The PIR sensor output is connected to pin 2, and the relay input is connected to pin 3. The program activates the relay for 15 seconds upon each detection of a fruit fly or movement by the PIR sensor.

3.2. Implementation of ApelB Version 1.1 Using Solar PV

The implementation of ApelB consists of the preparation, operational, and result analysis stages, as outlined in Table 3, which outlines the sequential workflow of the ApelB system from device preparation and activation of each electronic component, to the operational process where fruit flies are attracted and electrocuted, and finally to the analysis stage where system performance and captured insect counts are evaluated. This table is intended to provide a clear and structured overview of how ApelB operates in the field. Testing of the solar power generation system was conducted to prevent malfunctions and short circuits, ensuring the device operates properly. It was observed that the battery voltage was detected at 15.2 V on the SCC monitor, as shown in Figure 7. Measurement of solar PV was conducted to verify the power output of the generator, including the solar panel output, the SCC output to the battery, and the SCC output to the load. The measurement results of solar panel output, SCC output to the battery, and SCC output to the load are presented in Table 4.

Table 3. Implementation stages of ApelB

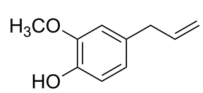
Preparation stages	Operational stages	Result analysis stages
• Preparation of ApelB Version 1.1 Device at the designated corn and chili field locations. • PV: On • Solar Charge Controller (SCC): On • Battery Charging Process: On • Arduino Uno microcontroller with an ATmega328P: On • Automatic Switch Sensor Relay: On	Application of methyl eugenol  The fruit flies attracted to methyl eugenol are electrocuted on the trapping net, resulting in their death	Performance analysis of the ApelB system and calculation of the number of fruit flies electrocuted according to the observation duration

Table 4. Measurement of solar panel output, SCC output to the battery, and SCC output to the load

No	Time (h)	Panel Output		SCC Output		Battery Output	
		Voltage (V)	Current (I)	Voltage (V)	Current (I)	Voltage (V)	Current (I)
1	10.00	14.0 V	0.44 A	14.1 V	0.10 A	14.0 V	0.30 A
2	10.30	13.8 V	0.44 A	13.9 V	0.10 A	13.8 V	0.30 A
3	11.00	12.2 V	0.70 A	11.4 V	0.10 A	11.8 V	0.10 A
4	11.30	13.9 V	0.50 A	14.0 V	0.10 A	13.9 V	0.36 A
5	12.00	13.4 V	0.50 A	13.5 V	0.13 A	13.4 V	0.35 A
6	12.30	12.7 V	0.50 A	12.7 V	0.10 A	12.6 V	0.36 A
7	13.00	13.8 V	0.41 A	13.9 V	0.10 A	13.8 V	0.27 A
8	13.30	13.8 V	0.32 A	13.9 V	0.16 A	13.8 V	0.15 A
9	14.00	13.7 V	0.38 A	13.7 V	0.10 A	13.7 V	0.24 A
10	14.30	12.9 V	0.35 A	13.0 V	0.10 A	12.9 V	0.21 A
11	15.00	12.8 V	0.30 A	12.8 V	0.10 A	12.8 V	0.15 A
Average		13.36 V	0.38 A	13.35 V	0.108 A	13.31 V	0.24 A

The average output voltage of the solar panel was 13.3 V with a current of 0.38 A. The SCC output voltage to the battery was 13.35 V with a current of 0.108 A, while the SCC output voltage to the load was 13.3 V with a current of 0.24 A, resulting in a power output of:

- Panel power (P) = Voltage (V) x Current (I) = 13.36 V x 0.38 A = 5.07 Watt
- Battery power (P) = Voltage (V) x Current (I) = 13.35 V x 0.108 A = 1.44 Watt
- Power to the load (P) = Voltage (V) x Current (I) = 13.31 V x 0.24 A = 3.19 Watt

With an average electrical power output from the 10 Watts panel of 5.07 Watts and a load of 3.19 Watts for one hour, the 10 Wp solar power generator is capable of operating the pest trap device while providing 1.44 Watts for charging the battery backup.

3.3. ApelB Testing Results

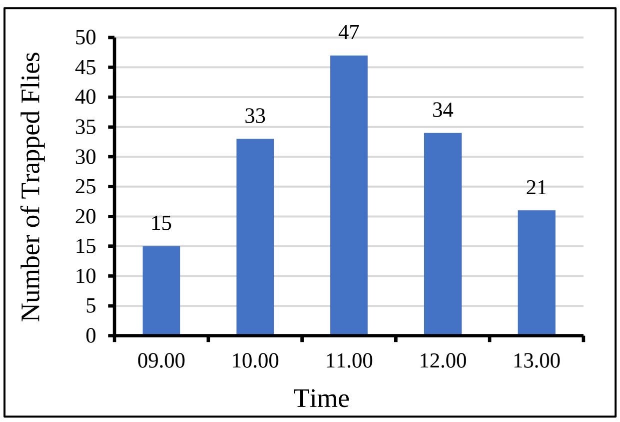
Initial testing was conducted on a laboratory scale within a 3 x 3 meters room using live fruit fly samples collected from the field. The testing lasted for 5 hours, from 08:00 to 13:00 WIB, with data recorded hourly. The tests used sample groups of 10 fruit flies (Table 5) and 20 fruit flies (Table 6). The device demonstrated an effectiveness, measured in terms of mortality rate, of 80% for the 10-fly sample and 85% for the 20-fly sample during the laboratory-scale testing. Field testing (Figure 9) of the microcontroller-based fruit fly trap device powered by a solar panel was conducted in Ponjanan Timur Village, Batu Mar-Mar District, Pamekasan Regency, during May when the area was in the corn and chili planting season. The testing was carried out from 08:00 to 13:00 Western Indonesia Time (WIB).

Figure 9. Field testing of fruit fly trap equipment in the cornfield (top) and chili plantation (bottom)

Table 5. Laboratory-scale testing with a sample of 10 fruit flies

Time	**Number of dead fruit flies**	
	10 samples of fruit flies	**20 samples of fruit flies**
09.00-10.00	2	3
10.00-11.00	3	5
11.00-12.00	2	7
12.00-13.00	1	2
Total	8	17

Based on the direct field test results, on the first day of testing, May 25, 2024, from 08:00 to 13:00 WIB in the cornfield, the device successfully captured 150 fruit flies (Figure 10a). Testing on the second day, May 26, 2024, from 08:00 to 13:00 WIB in the chili plantation, successfully captured 148 fruit flies (Figure 10b). The data indicate that the highest capture rate occurred between 09:00 and 13:00 WIB, which aligns with previous observations by Manurung *et al*. 2012. Prior to field deployment, the device underwent laboratory testing and demonstrated reliable performance in detecting and capturing fruit flies. A subsequent two-day field trial was conducted to evaluate the initial functionality and sensitivity of the system under real-world conditions. The nearly identical capture rates over both days approximately 148-150 flies per day, indicated the trap's consistent effectiveness in attracting and capturing targets. Although the duration of the trial was relatively short, the device was monitored on an hourly basis, allowing for accurate assessment of its real-time performance. Additionally, the device incorporates methyl eugenol as a lure, which selectively attracts male fruit flies (Shelly *et al*., 2004; Wee *et al*., 2018). Upon entry, the flies are eliminated by an electric shock mechanism. This selective targeting of males disrupts the mating cycle and contributes to a gradual reduction in the overall population, thereby mitigating fruit damage caused by infestations.



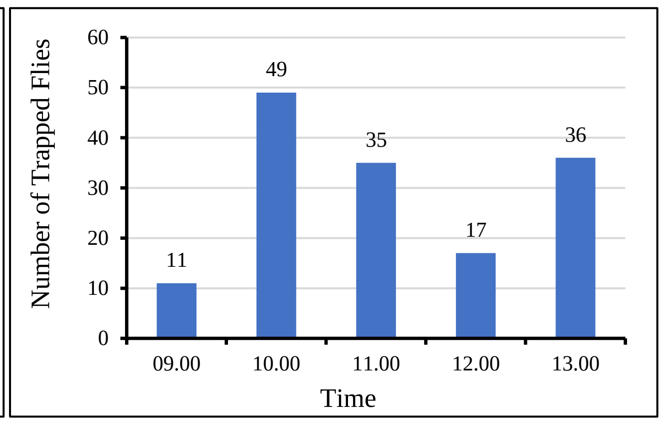


Figure 8. Number of trapped flies during field testing: (a) Cornfield, (b) Chili field

The integration of PIR sensor technology with an Arduino Uno microcontroller and a Cockcroft-Walton circuit generates an electric current flowing through the trap's wires. This current causes fruit flies that land on the wires to be electrocuted and die (Rohpandi *et al*., 2023). These findings reinforce the results of the ApelB Version 1.1 system based on PLTS, which has been proven effective and successful in capturing fruit flies.

4. CONCLUSION

The design of a microcontroller-based fruit fly pest trap utilizing solar panels as its power supply was successfully developed. The device frame was constructed from steel pipes, and a panel box measuring 20 x 30 x 12 cm was used to house the components. The main components employed included a 10 Wp solar panel, 10 A solar charge controller (SCC), battery, Arduino Uno microcontroller with an ATmega328P, 5 V relay, Cockcroft-Walton circuit, Passive Infrared Receiver (PIR) sensor HC-SR, 5 V IC regulator, and the 5 V relay along with the Cockcroft-Walton circuit.

The use of an off-grid solar power system is more efficient for application in fields or plantations, with an average electricity production of 5.07 watts and a load requirement of 3.19 watts. The solar charge controller (SCC) output to the battery is 1.44 watts, which enables the solar power system to operate the fruit fly pest trap effectively. Additionally, the off-grid solar power system offers greater efficiency since it does not rely on energy supply from the public electrical grid and is portable, allowing easy relocation.

The fruit fly pest trap is effective in reducing the population and infestation of fruit flies by disrupting their life cycle. Male fruit flies attracted to the scent of methyl eugenol compound are killed by an electric current, preventing them from fertilizing the eggs laid by females, thus inhibiting egg hatching.

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REFERENCES

Alatas, M. (2024). *Sistem & Teknologi PLTS pembangkit Listrik Tenaga Surya Rooftop*. Penerbit Tahta Media.

Alatas, M., Budiastuti, M.T.S., Gunawan, T., Setyono, P., Burlakovs, J., & Yandri, E. (2020). The identification of micro-hydro power plants potential in irrigation areas based on unmanned air vehicle (UAV) image processing. *E3S Web of Conferences, **190***, 00024. https://doi.org/10.1051/e3sconf/202019000024

Astriyani, N.K., Supartha, I.W., & Sudiarta, P. (2016). Kelimpahan populasi dan persentase serangan lalat buah yang menyerang tanaman buah-buahan di Bali. *Sustainable Agriculture Research, **5***(1), 19–27.

Budiyati, E., Andrini, A., Martasari, C., & Zamzami, L. (2021). *Teknologi inovatif jeruk sehat nusantara: Klasifikasi dan sebaran jeruk nusantara*. Bogor: IPB Press

Fonsah, E.G., Roshetko, J.M., Budidarsono, S., Tukan, J.C., Nugraha, E., & Manurung, G.S. (2008). The fruits and vegetables industry in Indonesia: Production and limited access to market. *Journal of Food Distribution Research, **39***, 62–66.

Hahn, F., Valle, S., Rendón, R., Oyorzabal, O., & Astudillo, A. (2023). Mango fruit fly trap detection using different wireless communications. *Agronomy, **13***, 1736. https://doi.org/10.3390/agronomy13071736

Hasyim, A., Muryati, M., & de Kogel, W.J. (2006). Efektivitas model dan ketinggian perangkap dalam menangkap hama lalat buah jantan, *Bactrocera* spp. *Jurnal Hortikultura*, ***16***(4), 314-320.

Ilham, H.A., Syahta, R., Anggara, F., & Jamaluddin, J. (2018). Alat perangkap hama serangga padi sawah menggunakan cahaya dari tenaga surya. *Journal of Applied Agricultural Science and Technology*, ***2***(1), 11-19.

Junaidi, E., & Jannah, M. (2020). Dynamics of economic growth in agriculture sector and farmer's term of trade in Indonesia. *Journal of Applied Economics in Developing Countries, **5***, 82–94.

Lello, F., Dida, M., Mkiramweni, M., Matiko, J., Akol, R., Nsabagwa, M., & Katumba, A. (2023). Fruit fly automatic detection and monitoring techniques: A review. *Smart Agricultural Technology, **5***, 100294. https://doi.org/10.1016/j.atech.2023.100294

Madduri, K., Hiremath, S., Lokesh, J., Chiniwar, D.S., & Shrishail, M.H. (2025). Environment-friendly experimental solar-powered UV light pest trapping mechanism for open agricultural fields. *Environment Research Communication*, *7*, 035002. https://doi.org/10.1088/2515-7620/adb8a5

Manurung, B., Prastowo, P., & Tarigan, E.E. (2012). Pola aktivitas harian dan dinamika populasi lalat buah *Bactrocera dorsalis* complex pada pertanaman jeruk di dataran tinggi Kabupaten Karo Provinsi Sumatera Utara. *Jurnal Hama dan Penyakit Tumbuhan Tropika, **12(2)***, 103–110. https://doi.org/10.23960/j.hptt.212103-110

Mohapatra, D.S. (2024). Solar 24 X 7 insect trap: A greener pest management device. *NRRI Technology Bulettin*, ***206***, 4 pages.

Pradana, Y.R.A., Wulandari, R., Bintara, R.D., Aminnudin, A., & Prasetya, R.D. (2022). Implementasi teknologi perangkap hama bertenaga surya dan mesin pemeras jeruk di Kebun Petik Jeruk Garum, Kabupaten Blitar. *Jurnal Pengabdian Pendidikan dan Teknologi (JP2T)*, 3(1), 67-75.

Putra, G.M.D., Lailatun, H.I., Sabani, R., & Setiawati, D.A. (2019). Sistem otomasi photovoltaic pada pembangkit listrik tenaga surya (PLTS) berbasis mikrokontroler Arduino skala lab. *Jurnal Teknik Pertanian Lampung, **8***, 130–138. https://doi.org/10.23960/jtep-l.v8i2.130-138

Rahayu, S.U., Nasruddin, Susilawati, Sianturi, H.A., Faturrahman, & Manurung, J.G. (2023). Construction of ultrasonic fruit fly repellent device in orange orchard. *Journal of Phys ics: Conference Series, **2421**(1)*, 012030. https://doi.org/10.1088/1742-6596/2421/1/012030

Reddy, K.V., Devi, Y.K., & Komala, G. (2020). Management strategies for fruit flies in fruit crops – A review. *Journal of Emerging Technologies and Innovative Research, 7(12)*, 1472–1480.

Rohpandi, D., Mufizar, T., Mulyani, E.D.S., Hidayatuloh, A.T., Hidayat, C.R., & Tistianingsih, S. (2023). Perangkap lalat buah di kebun berbasis mikrokontroler. *SISITI, **12**(1)*, 1–10.

Saputra, H.M., Nanda, T.D., Apriyadi, R., Henri, & Setiawan, F. (2023). Keanekaragaman hama lalat buah pada tanaman sayuran buah di Kabupaten Bangka dan kunci identifikasinya. *Jurnal Agrotek Tropika, **11**(4)*, 705–716. https://doi.org/10.23960/jat.v11i4.6480

Sarangi, S., Mohapatra, S.D., Pandi, G.P.P., Bhavana, P., Sahoo, S., Pradhan, P.P., & Dash, S.S. (2025). Menace of fruit flies and its eco-friendly management practices using several modern techniques. In *Proceedings of Recent Advances in Agricultural Sciences*, 120–135. Blue Rose Publishers. https://doi.org/10.54083/978-81-947739-1-7-9

Sarjan, M., Yulistiono, H., & Haryanto, H. (2010). Kelimpahan dan komposisi spesies lalat buah pada lahan kering di Kabupaten Lombok Barat. *Jurnal Crop Agro, **3**(2)*, 109–118. https://cropagro.unram.ac.id/index.php/caj/article/view/70

Shelly, T.E., Pahio, E., & Edu, J. (2004). Synergistic and inhibitory interactions between methyl eugenol and cue lure influence trap catch of male fruit flies, *Bactrocera dorsalis* (Hendel) and *B. cucurbitae* (Diptera: Tephritidae). *Florida Entomologist, **87**(4)*, 481–486. http://dx.doi.org/10.1653/0015-4040(2004)087[0481:SAIIBM]2.0.CO;2

Sudarmono, S., Waluyo, J., & Wilopo, W. (2020). Perancangan pembangkit listrik tenaga surya (PLTS) pembasmi serangga pada tanaman bawang merah di Kabupaten Brebes. *Journal of Appropriate Technology for Community Service, **1**(1)*, 39–47. https://doi.org/10.20885/jattec.vol1.iss1.art6

Sumarwan, S. (2021). Perangkap hama tenaga surya. Jurnal Riset Daerah, ***XXI***(1), 3822-3832.

Susanto, A., Tohidin, Sunarto, T., Sinaga, L.V., Nugroho, A., Basuki, M., Djaya, L., & Fadillah, A. (2023). Effect of trap height level on the capture of fruit fly (*Bactrocera* spp.) on crystal guava field. *IOP Conference Series: Earth and Environmental Science, **1208**(1)*, 012004. http://dx.doi.org/10.1088/1755-1315/1208/1/012004

Wee, S.L., Abdul Munir, M.Z., & Hee, A.K.W. (2018). Attraction and consumption of methyl eugenol by male *Bactrocera umbrosa* Fabricius (Diptera: Tephritidae) promotes conspecific sexual communication and mating performance. *Bulletin of Entomological Research, **108**(1)*, 116–124. https://doi.org/10.1017/s0007485317000554

Yuantika, I., Rachmawati, J., & Sopyan, T. (2021). Perbedaan waktu aktivitas lalat buah terhadap atraktan ekstrak daun kemangi (*Ocimum americana* L.) di kebun mangga Kabupaten Majalengka. *Penata Laksana, **9**(2)*, 41. http://dx.doi.org/10.25157/jpb.v9i2.6301