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Implementation of Shallot Pest Trap Model Based on Color Spectrum Using Photovoltaic Energy

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Abstract: East Java is the second center for shallot production in Indonesia, mainly in Probolinggo Regency. Where farmers always complain about shallot crop pests such as leafminer flies, moths, and urethral pests, which will threaten the decrease in shallot production. This study aims to implement a pest-trapping model and determine the effect of the color spectrum on light intensity levels. LED lights on the interest of flying pests of shallot plants, and knowing the effective time of turning on light traps in the shallot rice fields using photovoltaic. The results of this implementation research are pest traps designed with simple and affordable tools for farmers. The color spectrum of LED lights that catch a lot of pests is the LED with the ultraviolet spectrum with the brightest light intensity, then the most effective time to turn on the light trap for onion plant pest traps is 18.00-20.00, where the electrical energy in the pest trap uses photovoltaic.

Keywords: Color Spectrum; LED Lighting; Light Trap; Photovoltaic Energy; Shallot Pests

Introduction

Shallots are one of the superior vegetable communities that have high economic value (Andraini et al., 2021; Askari-Khorasgani & Pessarakli, 2020). The consumption of shallots in Indonesia is currently increasing, in line with the increase in the existing population (Utari et al., 2019). East Java is the second largest shallot production center in Indonesia after Central Java. East Java in 2014 contributed 23.76% to the national shallot production. Shallot production in East Java during the period 2009 – 2016 tends to increase. Probolinggo is the second largest shallot production center in East Java after Nganjuk. Based on BPS data for East Java Province 2017, the average shallot production in Nganjuk Regency during 2009-2016 was 48,766 tons (Astuti et al., 2020; Pranata & Umam, 2015). Shallot cultivation cannot be separated from problems, especially attacks by plant-disturbing organisms (OPT), especially those that occur in Probolinggo Regency. The pests of shallot plants that are considered to be the most damaging to plants are pests in the larval stage (caterpillars), which actively eat shallot plants until they experience crop damage (Anwar, 2021; Capinera, 2020; Rahim et al., 2022).

The main factor that often causes shallot farmers to fail to harvest is the occurrence of pest attacks (Arafah et al., 2022). Onion plant pests have many types, one of which is: (1) moths, moths have the characteristics of yellow spotted front wings which can produce 1000 eggs and when they hatch the caterpillars will eat the leaves and stems of shallots so that the growth of the bulbs becomes disturbed ; (2) orong-orong, an attack by an orong-orong animal causes the shallot plants to die because they damage the roots of the shallot plant; (3) Trips, trips animals have the characteristic of tufted wings with a yellowish white color, attacks of trips animals cause white leaves and then the leaves will die; and (4) the cutting fly, the attack of the cutting fly on shallot plants, which causes shallots to dry and die (Suprayoga et al., 2023). Pests that can attack shallot plants include the orong-orong Gryllotalpa spp. (Orthoptera: Gryllotalpidae), onion caterpillar Spodoptera exigua (Lepidopera: Noctuidae), armyworm Spodoptera litura (Lepidoptera: Noctuidae), leafminer fly Liriomyza chinensis (Diptera: Agromyzidae) and thrips Thrips tabaci (Thysanoptera: Thripidae). While diseases that can infect shallot plants include purple spot

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(Alternaria porri), downy mildew (Peronospora destructor), Cercospora leaf spot (Cercospora duddiae), anthracnose (Colletotrichum gloeosporiodes), Fusarium wilt (Fusarium oxysporum) and nematodes (Dytylenchus dissaci) (Triwidodo & Tanjung, 2020)

In recent years, there has been an increase in the use of alternative energy sources to complement the global energy matrix. However, such sources of global renewable energy generation have impacts and constraints, which impose some limitations. This limitation is important for sustainable energy policy planning and design, demanding special studies to get good performance in system installation, to avoid serious consequences. Renewable energy sources are classified as hydro, solar thermal, solar photovoltaic, wind, marine, geothermal and biomass. These sources use natural resources such as wind, water, solar radiation and heat as the operating principle for their generation. Therefore, the application of renewable energy sources is quite diverse and has been sought by several users (De Castro et al., 2013; Farret & Simões, 2006; Reca et al., 2016).

From the description above, this research will implement a color spectrum-based onion pest trap model using photovoltaic, to help onion farmers, especially in Probolinggo Regency, in eradicating flying pests on shallot plants.

Method

Planning and Observation of Test Sites

Observation planning where the test is carried out to find out whether the place indicates the presence of flying pests on shallot plants and determines the time for data collection (der Heyden et al., 2021; Hammig et al., 2008) while determining the number of variations in the color spectrum of the light that will be used. The LED lights used are RGB LED lights which have 5 color spectrums including, yellow, white, green, blue, and red (Qian et al., 2021; Steigerwald et al., 2002; Yan et al., 2023). Then the next stage will list what materials will be used in designing tools for implementing pest traps. Furthermore, after the tools and materials are complete, the design will be carried out. After the pest traps have been designed, 2 tests are carried out, namely the first test tests the characteristics of the LEDs which are carried out with a luxmeter measuring instrument, and the second test is carried out with the TCS3200 color sensor. In the final stage, field testing was carried out in which data collection was carried out on how effective the tools used were for pest control in shallot plants.

In the field testing of photovoltaic-based pest traps it was carried out for 2 days. Due to the data collection process that was carried out for 3 days, therefore each variation was carried out for 2 days of data collection, during the data collection process data every day starting at 18.00-24.00 with intervals of data collection every two hours.

Tools and materials

As for implementing pest traps on red onion plants based on a color spectrum using photovoltaic, it includes several materials and tools needed.

Table 1. Implementation Needs

Material and tool	Function
Iron	Iron measuring 1" with a length of 1100 mm, as a light trap pole
Plate	Dishes made from melamine serve to hold soapy water/oil and fly traps for pests on shallot plants
LED light	refracts the LED light and protects the LED from water
LED control boxes	Box kontrol berfungsi untuk sistem kontrol tingkat intensitas led yang dilakukan pada pengujian
LED hpl	The HPL LED consists of 5 color variations with 1 watt each as a test for shallot pest traps
Cable ties	Makes it easier to dismantle pest traps
Cat	paint pest traps
Iron glue	attached to the LED dop on the dish
Soap water	the liquid used in the light trap
Photovoltaics	Turn on the LED light on the pest trap

Furthermore, after the tools and materials for making pest traps are complete, the tool design is carried out, which can be seen in Figure 1. In Figure 1 it can be shown that the total length of the iron is 1100 mm, and divided by 300 mm for support on the ground, with a panel box size of 150 mm and using a 3 watt DC LED lamp, using 5 Wp for photovoltaic.

The basic photovoltaic unit is called a solar cell, which together in groups form a photovoltaic panel, the interconnected elements that make up the electricity generator of a photovoltaic installation. The panels convert radiation into electrical energy with a photovoltaic effect. Such a phenomenon is possible because the panels are composed of semiconductor materials with certain properties. Its electricity production is the photovoltaic effect based on the direct or indirect conversion of sunlight. Direct sunlight is essential for the generation of photovoltaic energy after an indirect approach does not result in ideal performance for the system. Therefore, the panel must be able to capture the maximum amount of solar radiation during the day (Chang, 2009; Tang & Wu, 2004). Figure 1 shows a schematic system for photovoltaic energy in shallot pest traps.

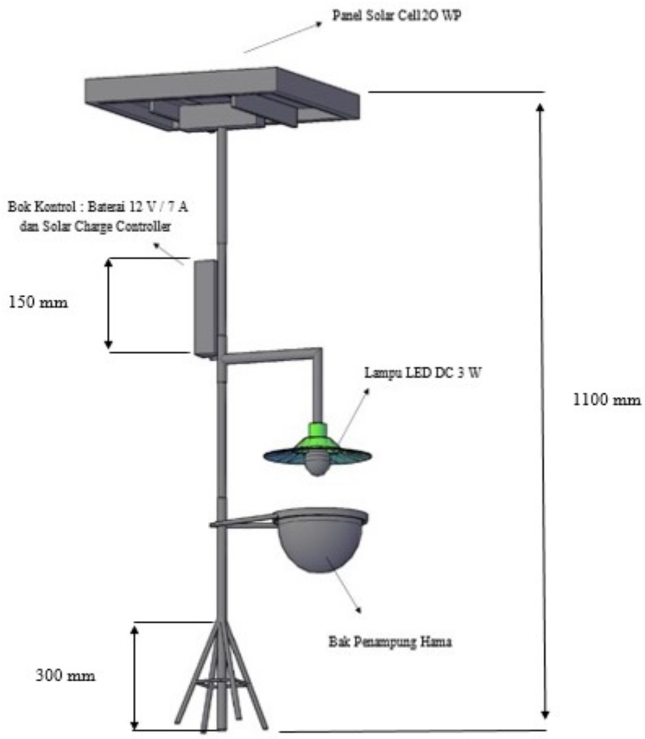

Figure 1. Pest Trap Design

Because the conversion of solar energy into electrical energy is done by converting radiation into electrical energy, the higher the beam of sunlight on the panel, the greater the power generated by the photovoltaic system. There are several methods used to increase energy production, such as solar trackers, which provide better performance compared to fixed angles due to the amount of direct radiation on the panels (Kalogirou, 1996; Yao et al., 2014).

Design a Pest Trap Model Series Using Photovoltaic

At the design stage of this pest trap model series requires some equipment that must be assembled including RGB sensor circuitry, light trap circuitry and photovoltaic assembly in implementing it.

The implementation of pest traps requires a series of tools so that the system can function properly (Preti et al., 2021). The equipment needed to make the system is one SHIYOKU 50WP solar panel to charge the battery, one STEC 10 ampere charge controller to control the incoming current from the panel to the battery and control the current going out from the battery to the load, the battery used VRLA VOZ 10Ah as storage power, the circuit can be seen in Figure 2.

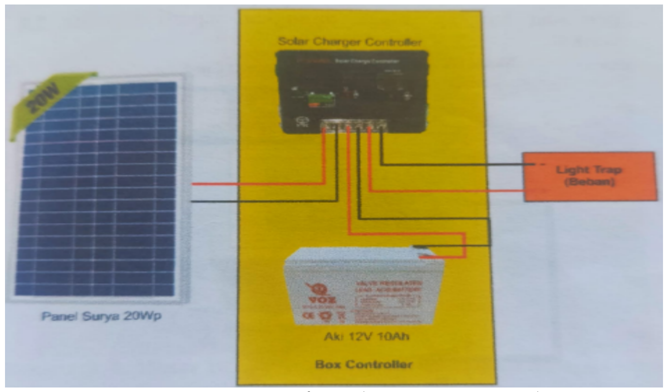

Figure 2. Series of Implementation Tools

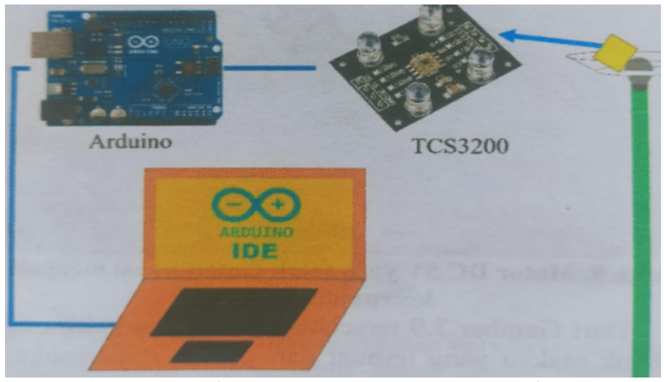

Figure 3. Arrange the RGB LED spectrum using the TCS3200 color sensor

In Figure 3. The materials needed are one light trap, TCS3200 color sensor, Arduino, laptop, DC 12V power supply and LED control system. After the materials are complete and assembled, the TCS3200 sensor is calibrated using a 6000K 1 watt white HPL LED. The TCS3200 sensor is to determine each voltage based on the RGB value for variations in the light intensity of the 1 watt RGB HPL LED (Martínez-Ciro et al., 2019), so as to produce colors that match the predetermined variations.

Result and Discussion

LED Characteristics Test Results

The results of the LED characteristic test on the onion pest trap tool, which was carried out using a Luxmeter measuring instrument. Based on the results of the Luxmeter measurements, the data is presented in Table 2.

From Table 2 it can be seen the characteristic results for the RGB LED when the red color is controlled at a voltage of 1.9 volts, resulting in a red spectrum value of 170, a green spectrum of 0, a blue spectrum of 0, and a brightness level of 1.48 lux. Likewise for variations in intensity and other colors. The intensity column in the table shows the brightness level of each color produced, where intensity 1 shows the dimmest light and intensity 4 produces the brightest light.

Table 2. Results of LED characteristics using a Luxmeter

Color	Intensity	Voltage			Current	Luxmeter
		R	G	B	(Ampere)	(Lux)
Red	1	1.90	0	0	0.027	1.48
	2	2.05	0	0	0.065	2.09
	3	2.35	0	0	0.146	6.97
	4	2.50	0	0	0.190	11.01
White	1	0	3.00	0	0.067	7.31
	2	0	3.15	0	0.097	10.47
	3	0	3.35	0	0.135	17.97
	4	0	3.50	0	0.217	21.85
Blue	1	0	0	2.70	0.029	0.05
	2	0	0	2.80	0.045	0.21
	3	0	0	2.97	0.075	0.51
	4	0	0	3.11	0.089	0.67
Green	1	0	2.60	0	0.043	5.40
	2	0	2.70	0	0.066	8.28
	3	0	2.87	0	0.099	9.44
	4	0	3.00	0	0.13	14.67
Yellow	1	1.90	2.60	0	0.055	7.45
	2	2.05	2.70	0	0.11	10.75
	3	2.35	2.87	0	0.201	18.35
	4	2.50	3	0	0.248	21.21

Implementation Test Results

In testing the implementation in the field for pest traps, there were two types of data collection, namely the effect of the color spectrum on the attractiveness of flying pests to pest traps, and wind speed.

Effect of Color Spectrum on Onion Fly Pest Traps

Variation 1

The results obtained from data collection within one day can be seen in Table 3. Table 3 shows that on the first day the color spectrum that most pests like the most is blue with 9 pests, followed by green with 8 pests and so on for different color variations. From table 4.3 it can be seen that the most preferred color spectrum for pests is blue, followed by green and yellow. The difference in the number of pests found on the first day is very significant, which is due to the wind speed factor.

Variation 2

In data collection, variation 2 uses 4 different color spectrums from variation 1, namely RGB white, pink, blue, and ultraviolet. The results obtained in the data collection are.

It was found in Table 4 that the 2nd variation on the second day of the spectrum which was favored by the most pests was the ultraviolet color with the arrangement of the number of rows of 4, and so on for different color variations. The color spectrum favored by shallot plant pests is ultraviolet, blue, and pink.

Table 3. Results of Implementation of Variation Data for the First Day

Color	Time									Amount
	18.00-20.00			20.00-22.00			22.00-24.00			
	A	B	C	A	B	C	A	B	C	
Red	0	0	0	0	0	0	0	0	0	0
White	0	0	0	0	0	0	0	0	0	0
Blue	5	1	0	3	0	0	0	0	0	9
Green	1	2	0	1	2	0	2	0	0	8
Yellow	1	1	0	1	1	0	1	0	0	5

Table 4. Results of the Implementation of the Second 2-Day Variation Data

Color	Time									Amount
	18.00-20.00			20.00-22.00			22.00-24.00			
	A	B	C	A	B	C	A	B	C	
White RGB	1	1	0	0	0	0	0	0	0	2
Pink	1	1	0	1	0	0	0	0	0	3
Blue	1	1	0	1	0	0	0	0	0	3
Ultraviolet	1	2	0	1	1	0	0	0	0	5

Information :
A = Leafminer Flies
B = Moth Pest

C = Urethral Pest

Conclusion

The implementation of the color spectrum-based onion pest trap model using solar cells, it can be concluded that the pest trap model uses light traps that use simple materials, and uses photovoltaic energy to ease the burden on shallot farmers, especially in Probolinggo Regency. And the color spectrum used uses LED lights of different colors, which attract pests the most and are trapped by using blue and ultraviolet colors with the brightest light intensity. And the optimal time to turn on the light trap is 18.00-20.00, at which time the most flying pests.

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Author Contribution

The first author's contribution to the research is the mentor in the process of designing tools and data collection, the second author's contribution in this research is guiding the writing, and the third author's contribution is designing, writing, and data collection.

Funding

In this research for funding is done independently.

Conflict of Interest

The interest in this research is to implement the tool, and as a graduation requirement for the third author.

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