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The Effect of Light Color Variation in Simple Light Traps on the Number of Fruit Flies (*Bactrocera* sp.)

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ABSTRACT

Fruit flies (Bactrocera sp.) are the most common types of plant pests attacking fruit plants. The pest attacks the fruit in the plantation. The control of fruit flies is quite difficult, which is usually done by using eugenol. Fruit flies are insects that are sensitive to light with wavelengths of 300-650 nm. The light trap is a method commonly used yet it is rarely used to control the fruit flies. This research was conducted to determine the effect of the color variation in light traps on the number of trapped fruit flies. This study used quasi-experimental research methods. The data were analyzed descriptively and continued with one-way ANOVA statistical testing using SPSS 25.0. The results showed that the highest average number of fruit flies was in light traps with the addition of blue lights of 17.22. Post hoc tests showed that blue lights were more effective in attracting flies into light traps.

Keywords: Bactrocera sp.; blue light lamp; fruit flies; light trap; pest control

ABSTRAK

Lalat buah (*Bactrocera* sp.) merupakan jenis hama tanaman yang paling umum menyerang tanaman buah. Hama ini menyerang buah di perkebunan. Pengendalian lalat buah cukup sulit dilakukan, biasanya pengendalian dilakukan dengan menggunakan eugenol. Lalat buah merupakan serangga yang peka terhadap cahaya dengan panjang gelombang 300-650 nm. Penggunaan *Light trap* adalah metode yang sudah sangat umum digunakan namun penggunaannya untuk pengendalian lalat buah masih sangat jarang sehingga penelitian ini dilakukan untuk menguji penggunaan variasi warna lampu pada *Light trap* terhadap jumlah lalat buah yang terperangkap. Penelitian yang dilakukan termasuk dalam eksperimen semu dengan metode penelitian *post test with control group design.* Data di analisis secara deskriptif dan dilanjutkan dengan pengujian statistik menggunakan SPSS 25.0 dengan uji *One-way Anova*. Hasil analisis dengan menggunakan *One-Way Anova* menunjukkan rata-rata jumlah lalat buah paling tinggi adalah pada light trap dengan penambahan lampu biru yakni sebesar 17,22. Uji *post hoc* menunjukkan bahwa lampu biru lebih efektif untuk menarik lalat ke dalam light trap. Penelitian ini diharapkan dapat memberikan Informasi baru mengenai cara pengendalian lalat buah di lapangan.

Kata Kunci: Lalat Buah; Light trap; Lampu cahaya biru; Bactrocera sp.; Pengendalian Hama

INTRODUCTION

Fruit and vegetable commodities have a high prospective to be developed because they have high economic value, even the market demand for these commodities covers the domestic and foreign markets (Sarjan, Yulistiono, & Haryanto, 2010). Indonesia's agricultural land reaches millions of hectares since it is an agricultural country (Mukhlis, 2016). The land is used by farmers to handle the increased demand for fruit and vegetable commodities (Sarjan et al., 2010). The value of Indonesian fruit imports is high (Rofika Rochmawati, 2017). The price of imported fruit and vegetable is more expensive than that of local varieties (Syahfari & Mujiyanto, 2013). This provides opportunities for local varieties of fruit and vegetable to compete on the market. However, the quality of fruits and vegetables must be considered so that opportunities can be realized well (Sarjan et al., 2010).

The low quality of local fruits and vegetables is due to the attack of fruit fly pests (*Bactrocera* sp.) (Siregar & Agus Sutikno, 2015). This type of fly is one of the main pests of horticultural crops, especially fruit plants. More than 100 types of fruit plants are the target of fruit fly attacks. In high populations, the intensity of attacks reaches 100%. Crops that are frequently affected by these pests are oranges, papayas, cantaloupe, mangoes and starfruit as well as rice (Ruswandi, 2017; Susanto et al., 2017; Wulansari et al., 2017). This fruit fly pest attack causes substantial losses reaching 30-60%. The attack on the old fruit causes the fruit to become wet rot due to larvae attack. The attack of fruit fly populations will increase in a cool climate, high humidity and moderate winds. Fruit fly attacks are increasing so that the need for control techniques is highly expected, especially in producing effective, efficient, and environmentally-friendly control techniques (Muryati, Hasyim, & de Kogel, 2007).

Controlling fruit flies is difficult despite a lot of efforts that have been carried out, including mechanical, technical, and biological methods (Patty, 2012). Fruit flies (*Bactrocera* sp.) are one of the pests that belong to the class of insects. One of the characteristics of insects is having an interest in light (Mukhlis, 2016). Fruit flies like dim light compared to dark places (Oktary, Ridhwan, & Armi, 2015). The use of light as an insect trap has traditionally been used for a long time, for example, the use of a petromax lamp to catch larvae (insects), the use of striking colors to capture fruit flies and flies, and the use of ultraviolet to catch mosquitoes (Mukhlis, 2016). Light traps are one of the most common methods for collecting insects (González et al., 2016). Although light traps are commonly called "CDC light traps", various light trap models equipped with incandescent or UV lamps have been developed (Gaglio et al., 2017). Recently, light traps have been modified by replacing incandescent lamps into light-emitting diodes (LEDs) (Gaglio et al., 2018; Müller et al., 2011; Silva et al., 2016). Various types of insects, including fruit flies, can respond to light at wavelengths of 300 - 650 nm with ultraviolet to red color spectrum.

Wavelengths that can be received by insects are varied due to the differences in retinal cells in the insect's eyes (Munandar, Hestiningsih, & Kusariana, 2018). Flies can also sense ultraviolet frequencies in the spectrum of light that are invisible to humans (Prasetya, Yamtana, & Amalia, 2015). Based on various experiments, it can be proven that insects can recognize and distinguish different types of colors. Insects can see ultraviolet light clearly. In general, insects have two sensitivity peaks, namely the blue-green color. This is also reinforced by previous research (González et al., 2016) using a light trap with five light-emitting diodes (LEDs) (white, green, red, blue, ultraviolet) run for 15 consecutive nights. The results showed that a higher number of Culicoides (fies) was trapped in traps with green, blue or ultraviolet (UV) lights compared to red and white LED traps (Gaglio et al., 2017). Differences in the results of these studies lead to the necessity to conduct studies on Light Traps with various lamp colors.

Factors of quality, price, brand, location of purchase, source of information (preference), physical quality, product packaging, and promotion influence consumer behavior to buy fruit. Fruit flies do not only attack plantations but also attack fresh fruit in the market. Many fruit sellers complain that there are fruit flies in the place where they sell the fruits. This is because one fruit fly can attack other fruits, especially if the fruit is papaya and sapodilla because the fruits do not need to be peeled before it can still attract fruit flies (Oktary et al., 2015). Thus, alternative fruit fly control is needed with a simple method and an affordable price. Alternative control of fruit flies in Indonesia that has prospects to be developed is an active ingredient with methyl eugenol (Petrogenol 80 L). However, a further research is still needed (Susanto et al., 2017). The use of light traps can also be used as an alternative in controlling fruit fly pests. Several previous studies applying the Light Trap method to catch flies reported that flies were also trapped in yellow light (Mustikawati, Martini, & Hadi, 2016), and the number of flies trapped was higher in red light traps (Munandar et al., 2018). Meanwhile, the study of Prasetya et al. (2015) showed that flies were trapped in blue light.

Physical-mechanical and physiological control of flies is also commonly carried out by applying glue adhesives and various color stick traps (Ardiansyah et al., 2019). In this research, control was carried out by installing fly adhesive glue by adding TL (tubular lamp) lamps to the traps with color variations according to the wavelength preferred by the flies. The aim of this study was to determine the effect of the light color in a simple light trap and to find the most effective light to be used in this flytrap. The light trap is expected to attract fruit flies to perch since the fly is highly attracted to light.

MATERIALS AND METHOD

Research Site

This research is a quasi-experimental study using a post-test with control group design research method. The population in this study were all fruit flies in the sampling area. The study was conducted in April for 3 days in Sleman Regency, Yogyakarta. The location of this research was in the surrounding of fruit sellers, allowing the existence of fruit flies. The temperature and humidity of the research location were the same and appropriate for the activities of the surrounding population.

Simple Light Trap Design

The tools and materials used in designing simple light traps are easily obtained. The tool used was a TL lamp (Tubular lamp), which was chosen because this type of lamp can emit ultraviolet light preferred by insects including fruit flies. The color of the lamp used was based on the wavelength preferred by the insects including fruit flies, which was at a wavelength of 300-650 nm. In this study, the chosen lamp colors were red, blue, green and white. The white color was chosen because, the previous studies reported that the highest number of flies was trapped in this color compared to other colors, as well as control treatments with no TL (light) lamps. The other tools used were five plastic boxes, flies glue and an electrical socket to turn on the lights. The materials used were several types of fruits such as guava, papaya, banana, and longan, which will be placed in each box with the same amount.

Setting Traps in The Field

The simple Light Trap was designed and made from 5 plastic boxes, consisting of four light trap boxes with TL lamps as a treatment group and one box without lights as a control. TL lights then were installed and fly glue was added to the box and the fruits were put inside in equal quantities. The light trap treatment and control box were placed in the same place at the same temperature and humidity, and the TL (Tubular lamp) lamp was connected to the socket. The exposure was carried out for 8 hours, starting at 21:30 with 9 repetitions both in control and treatment group. The trapped fruit flies were counted directly. Fruit flies have a size of 3-4 mm with brownish-yellow body (some are gray) and red eye. The samples in this study were the fruit flies trapped in light traps. The independent variable in this study was the color of the lamp and the dependent variable was the number of trapped fruit flies. This study referred to the method of previous research conducted by Prasetya et al. (2015) and González et al. (2016) in which the researchers created a varied light color in the traps of flies and mosquitoes in house. The simple light trap designed by the researchers in this study is shown in Figure 2.

Data Analysis

The data obtained were grouped in tables and then analyzed descriptively and continued with statistical tests using the SPSS version 25.0 program. The statistical test began with the data normality test using the Kolmogorov Smirnov test as an initial test. Normal distributed data were then proceeded to the statistical test using one-way ANOVA (5%). A Post Hoc test was performed to determine the most effective light color to trap flies with a significance level of 5%.

RESULTS AND DISCUSSION

Data retrieval was carried out 9 times, showing that light traps with blue lights had a higher number of trapped fruit flies compared to red, green and white lights. An average of 17 fruit flies were trapped in the blue light trap. The fewest trapped fruit flies were found in Light traps without TL lights (control), which were 5 fruit flies in average (Table 1).

The data in Table 1 were tested for normality using SPSS 25.0 then continued to be analyzed using one-way ANOVA. Data normality test was performed using the Kolmogorov-Smirnov Test. Based on the results of normality tests, it can be seen that the data has p = 0.200 (p> 0.05) so that it can be concluded that the data of the number of fruit flies trapped in the light trap both the treatment and control group are normally distributed. One-Way ANOVA was performed to determine differences in variance on each factor. The factors in this study were the color variations of the lamps used in the light trap. Statistical test with one-way ANOVA resulted an average number of flies trapped in the light trap control (without lights) of 4.89, while the average number of flies trapped in the light trap with green, blue, red, and white light was 8.44, 17.22, 11.22, and 9.67, respectively. Based on the test results obtained descriptively, it can be concluded that the highest average number of trapped fruit flies was in light traps with blue light, which was 17.22. The result of ANOVA also showed a significant difference in the average number of fruit flies based on the color variation of the light trap lights, thus, further tests (Post Hoc Test) was carried out. According to the homogeneity test, the Post Hoc test used was the Games-Howell test since the variance of the data was not homogenous.

Table 1. Number of fruit flies (*Bactrocera* sp.) in each light trap

Repetition	Control	Treatments			
	No lamp	Green lamp	Blue lamp	Red lamp	White lamp
1	0	6	11	8	3
2	7	6	12	7	5
3	4	4	16	10	2
4	5	7	12	3	8
5	9	8	13	11	10
6	7	10	20	8	5
7	4	11	25	17	19
8	5	13	23	19	18
9	3	11	23	18	17
Average	5	8	17	11	10
Difference		3	12	6	5

The Games Howell test was performed to determine the treatments giving significantly different effect. The results showed that control group (without light) had significantly different number of trapped fruit flies compared to blue light. Meanwhile, the control group did not show significant difference in the number of trapped fruit flies compared to green, red, and white lights. These results indicate the blue light is more effective in attracting flies into the light trap

Fruit flies trapped in a simple light trap were calculated by looking at the general characteristics of fruit flies. The morphological characteristics of fruit flies that can be observed are brownish yellow and gray body with thin and flat wings, an abdomen with black bands, and a size of 3-4 mm. There were certain types that have red eyes (Indriyanti, Insnaini, & Priyono, 2014) The average number of trapped fruit flies shown by descriptive data showed that the control group (Light trap without light (Figure 1) was the group that had the lowest average number of trapped fruit flies compared to the treatment group (Light trap with light variations (Figure 2). This is because the fly is an insect that has phototrophic properties, which means that the insect is attracted to the color of light so that fruit flies like bright places over the dark places (Oktary et al., 2015). Symptoms that arise because an object reflects light and has the nature of light as well as having different wavelengths are called

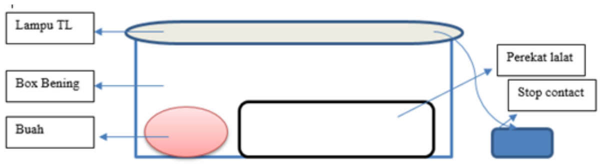

Figure 1. Simple light trap design

Figure 2. The simple light trap (control and treatment)

colors. The colors used in this study ranged from 300 nm to 650 nm, consisting of red, green and blue. This study also used white, although this color does not belong to the wavelength range of 300-650 nm, because it is an object that can reflect all light.

Light traps with blue lights obtained the highest average number of trapped flies. The wavelength of blue color is in the range of 450-495 nm. These results are supported by previous studies, which stated that the highest number of trapped flies was found in blue lights (Prasetya et al., 2015). The sensitivity range of flies' eyes is between 300-650 nm. The blue color has a smaller wavelength than the red and green color. Light trap with the second highest number of trapped flies was the red light. According to previous research, red is included in the wavelength range that can attract insects, included in the range from ultraviolet to red. This is also supported by the research of Munandar, Hestiningsih, and Kusariana (2018) reporting most flieas were attracted by red color.

Light traps with green lights obtained the least results in trapping fruit flies among the colors included in the wavelength range of 300-650 nm. This happened because the green light cannot emit ultraviolet light. Even the green light had fewer trapped fruit flies compared to white. This is in line with the research of Munandar et al. (2018) and Wulandari, Bey, & Tindaon (2014) which showed that flies were still attracted to the color of white light. Light traps without the addition of lights obtained the lowest results in trapping fruit flies. This fact shows that the addition of light colors to the light trap has an effect on increasing the number of trapped fruit flies. The control was still visited by flies even though it did not reflect light at all. A further research on the effect of ultraviolet light showed that Traps with UV lamps trapped more house flies than without UV lamps and open trap types (Puspitarani, Sukendra, & Siwiendrayanti, 2017).

The use of lights in controlling fruit flies is based on the physiological aspects of insects. There are so many types of insects that can detect aphrodisiacs in low doses. In fruit flies, the commonly used aphrodisiac is eugenol. However, the application of light traps in trapping the fruit flies, in particular, is still less optimal. Insects have a high sensitivity to the stimulation of smell, hearing, and vision. Flies are usually attracted by lights due to their sensitive eyesight. The lamp used in the study emits light that has been adjusted to the sensitivity of the visual senses of fruit flies and insects in general, namely in the range of light spectrum of 300-650 nm or the range of purple, blue and green to red color. The Post Hoc Test results showed that light trap with blue lights was the most effective in trapping fruit flies.

In line with the results of Prasetya's study (2015) stating that the sticky trap glue with blue light had the highest number of trapped fruit flies of 14.67. Meanwhile, in this study, the percentage of trapped fruit flies was 16% for green, 33% for blue lights, 22% for red lights, 19% for white lights, and 10% for control groups (Figure 3). Based on these results it can be concluded that the blue light is the most effective color to attract fruit flies. The results of this study also support the reasons why many insect traps on the market have bluish-colored lights.

Some difficulties in this research were controlling fruits, glue thickness, box color and also the smell of glue. However, these things can be over-

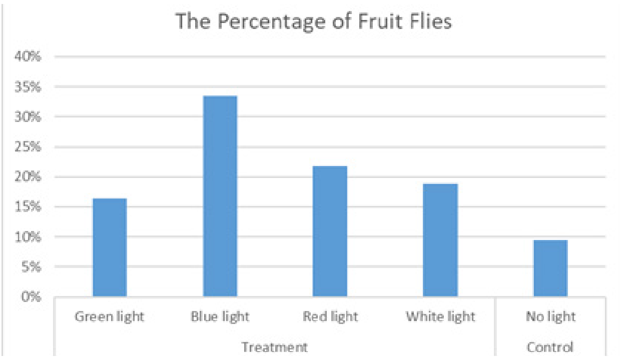

Figure 3. Percentage of number of fruit flies (treatment and control)

come by putting the same amount of fruits in each box. Instant sticky trap glue that has been provided on a paper sheet shape was used because if using manual fly glue, it will be difficult to measure the thickness of each sticky trap glue. Instant glue has the same odor, which is the smell of durian fruit, and white is used to control the color of the box. Simple light traps designed in this study were able to help the community, especially fruit sellers, control fruit flies that perched on the fruits they sell, and maintain the quality of fruit.

CONCLUSION

Green, blue, red and hite light variations influenced the number of trapped fruit flies. The most effective lamp color to be used in light trap application was blue. The difficulties in this research were controlling the fruit, the thickness of the glue, the color of the box, and the smell of the glue. Simple light traps can be used as an alternative for the community, especially fruit sellers to control fruit flies that perch on fruit.

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