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Color Lighting Efficiency of Light Emitting Diode Tube to Lure the Adult Coconut Hispine Beetle

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***Abstract*—**The objective of this research was to investigate the efficiency of the light emitting diode (LED) tube in various color lights used to lure the adult coconut hispine beetle. The research was conducted by setting the forward bias on LED tubes, and the next step was to test luminous efficacy and quantity of electricity used to power each LED tube in different color lights. Finally, the researcher examined the efficiency of each color-light LED tube to lure the adult coconut hispine beetle.

The results showed that the ultraviolet LED tubes had the most capacity to allure the adult coconut hispine beetles with the percentage of 82.92, followed by the blue LED tubes with the percentage of 59.76. Whereas the yellow, pink, red and warm white LED tubes had no influence to the adult coconut hispine beetles.

***Keywords*—**Coconut Hispine Beetle, Color Lights, Lighting Efficiency, LED Tubes.

I. Introduction

SAMUT SONGKHAM province is located at the estuary connecting to Mae Klong River to the western Thai Gulf, so there are a myriad of canals and rivers flowing through this province for irrigation. Its total land area comprised of 416.707 square kilometers; most of land is alluvial plain generated from coastal alluvion deposited by the northern rivers [1]. It is obvious that 80% of population in this province is agriculturists. They mostly cultivate significant industrial crops, namely coconuts, lychees, and pomeloes including other agricultural yields such as bananas, kales, rose apples, and limes etc.

Coconut is the highest yield in Samut Songkham. Three types of coconut palms are cultivated in this province, namely Coconut palms, Sugar-coconut palms (used to product coconut sugar), and Aromatic coconut palms in the average plantations around 41,067 Rai, 9,481 Rai, and 4,601 Rai respectively. (A rai is a unit of area, equal to 1,600 square metres). The total plantation of coconut trees in Samut Songkham is 55,149 Rai [2]. The coconut yield raises much higher incomes to the farmers in this province. However, some of coconut farmers have recently encountered outbreak of the adult coconut hispine beetle on coconut palms throughout Samut Songkham and neighboring provinces. This pest attacks coconut palms, especially unopened coconut buds, so the growth of coconut palms has discontinued, and infestations turn the coconut leaves whiten obviously, as shown at the Fig. 1. Consequently, the yield of coconuts has reduced with lower quality.

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Fig. 1 The damaged coconut plantation by the adult coconut hispine beetle

The coconut hispine beetle (Brontispa longissima Gestro), the indigenous pest, which lives in Indonesia, Papua New Guinea, and Malaysia, is one of the most damaging pests for the coconut palms including ornamental palm species in many countries in Asia and the Pacific region. The outbreak of coconut hispine beetle has caused substantial production losses without less product quality; once in the past the coconut palms discolored from green to gray [3]. Adult coconut hispine beetles, around 1 cm long and 2-2.5 mm wide, are flat with yellowish brown thorax and black elytra as shown in Fig. 2. The larvae and the adults feed on leaf tissues of the developing, unopened coconut buds. In the stage of full growth, they become insects of Coleoptera.

Fig. 2 The adult coconut hispine beetles

The coconut palms are attacked by both larvae and adult coconut hispine beetles. These larvae and adults inhabit the growing in unopened coconut leaves or coconut buds where they feed on leaf tissues. Adults are the most serious pests of coconut palms. During day time, the adults stay inactive to light in folded heart leaf and active to fly for very long distance and attack coconut plants at night. When infestations

in coconut palms are severe, the growth of coconut palms discontinues while some may result in death.

Biological control approach is introduced to eliminate the outbreak of the adult coconut hispine beetle by using its enemies: parasitic wasps and *Chelissoches morio*. Nevertheless, there are difficulties to breed parasitic wasps and *Chelissoches morio* enough to complete coconut farmers' demands. In term of chemical control, the use of pesticides is unsustainable and not practicable. This chemical control approach destroys the numbers of parasitic wasps and *Chelissoches morio*, and causes environmental damages. So far, using fluorescent lamp to lure the coconut hispine beetles has been promoted to coconut farmers, but this approach is yet unpopular idea due to the high cost of electricity.

As a result of technological revolution, the light emitting diode or LED tube has been designed and developed in various colored lights such as in red, yellow, green, blue, purple, and white etc. The LED tube also supplies a lower energy level than a fluorescent lamp; therefore, it leads to decrease electric energy and less electricity cost. Accordingly, the research was conducted to study color-lighting efficiency of LED tube utilized to lure the adult coconut hispine beetle in order that findings from this study are expected to be applied to enhance the farmer's capacity to face pest outbreaks.

II. Objectives

To investigate the efficiency on various colored lights of the light emitting diode or LED tube used to lure the adult coconut hispine beetle.

III. Methodology

This research has been designed as an experimental research with the following research steps.

Step 1: To set the forward bias system on LED tubes

The electrical circuit of the forward bias on LED tubes as shown in Fig. 3. Each set of forward bias on a LED tube was comprised of 1 resistor and 3 LED tubes. In this study, 30 sets were needed as shown in Fig. 4 and all sets were connected through series electrical circuit as shown in Fig. 5. Each set, one resistor was place in line, and three LED tubes were placed in the same direction. The connector allowed electrical current to flow in one direction equally.

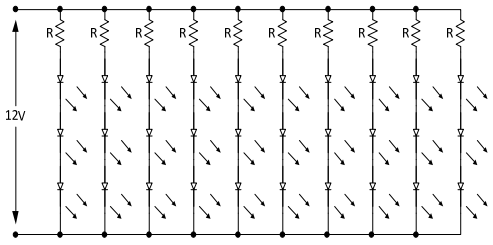

Fig. 3 Circuit of the forward bias on LED tubes

Fig. 4 Thirty sets of forward bias on a LED tube

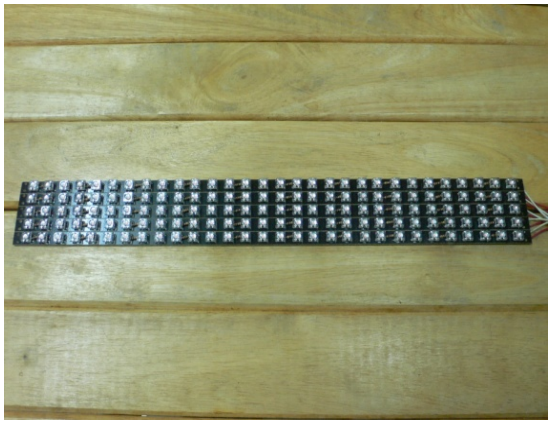

Fig. 5 Experimental set of luminous efficacy of LED tubes

Step 2: To test luminous efficacy and electricity supply

In this step, DIGICON LX-50 Lux Meter was used to measure light intensity of each LED tubes in different colors: blue, yellow, pink, red, warm white, cool white, and ultraviolet. The researcher used this device to measure in the closed and dark area without any interrupting light and placed this device away for 50 cm from LED tubes.

To investigate the quantity of electricity, YUGO YX-360 TR DC Ampmeter was utilized to measure how much electricity used to power LED tubes in each color light as shown in Fig. 6

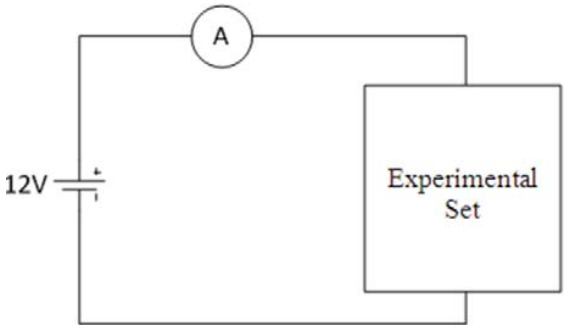

Fig. 6 The direct circuit of DC Ampmeter in Experimental set of luminous efficacy of LED tubes

Step 3: To find out which color light of LED tubes has the highest capacity to lure the adult coconut hispine beetle.

In this step, 82 adult coconut hispine beetles were placed into a clear plastic box, and then put LED tubes in different color light into the box. The researcher observed behavior of these 82 adult coconut hispine beetles, and also counted the number of these beetles attracted by LED tubes in each color light.

IV. Results

According to the experiment, the researcher found as follows:

1. After the researcher had measured luminous efficacy of LED tubes in different color light by using DIGICON LX-50 Lux Meter, it was obvious that there were differences of luminous efficacy as shown in Table I.

TABLE I
LIGHT INTENSITY OF LED TUBES IN DIFFERENT COLOR LIGHTS

Types	Color Light	Light Intensity
LED tube	Blue	1,980
LED tube	Yellow	360
LED tube	Pink	200
LED tube	Red	330
LED tube	Warm White	640
LED tube	Cool White	1,810
LED tube	Ultraviolet	160

LED tubes in blue had the highest light intensity at 1,980 Lux, followed in order by LED tube in cool white at 1,810 Lux whereas ultraviolet LEDs had the lowest intensity at 160 Lux.

2. The researcher used YUGO YX-360 TR DC Ampmeter to measure the quantity of electricity used to power LED tubes. It showed in Table II.

TABLE II
ELECTRICITY SUPPLYING TO LED TUBES IN EACH COLOR LIGHTS

Types	Color Light	Current(mA) Intensity
LED tube	Blue	865
LED tube	Yellow	1,425
LED tube	Pink	1,300
LED tube	Red	1,430
LED tube	Warm White	1,065
LED tube	Cool White	665
LED tube	Ultraviolet	1,100

Red LED tubes used 1,430 mA, the highest level of current used to generate lighting, followed by yellow LED tubes which used 1,425 mA. Conversely, the current in blue LED tubes was 865 mA, and cool white LED tubes used the lowest current at 665 mA.

According to Tables I and II, it was found that LED tubes in blue and cool white are much brighter than LED tubes in other colors, and also these blue and cool white ones consumed lowest electricity current to generate lighting. However, LED tubes in red, yellow, pink, warm white, and ultraviolet generate less lighting, but they used much more electricity to generate light.

3. In the final step, the researcher studied the efficiency of using LED tubes in different color lights to allure 82 adult coconut hispine beetles in the experimental plastic box. When turning on LED tubes in different color lights, the researcher observed the beetles' behavioral responses to different lights. The findings were displayed in Table III.

TABLE III
THE NUMBERS AND THE OBSERVED RESPONSES OF THE ADULT COCONUT HISPINE BEETLES ATTRACTED BY LED TUBES IN DIFFERENT COLOR LIGHTS

Types	Color Light	Numbers	Observed Behaviors
LED tube	Blue	49	Active after 5-10 minutes turning on the light
LED tube	Yellow	-	Inactive, hiding in the leaves
LED tube	Pink	-	Inactive, hiding in the leaves
LED tube	Red	-	Inactive, hiding in the leaves
LED tube	Warm White	-	Inactive, hiding in the leaves
LED tube	Cool White	14	Active after 15-20 minutes turning on the light
LED tube	Ultraviolet	68	Active after 3-5 minutes turning on the light

V. Discussion

It was found that ultraviolet and blue LED tubes had the most capacity to allure the adult coconut hispine beetles with the percentage of 82.92 and 59.76 respectively. The finding is relevant to a previous study conducted by The Forest Entomology Research Center II [4]. They invented lighting lamps to lure insects and moths by using 20 or 40 Watt light bulbs in violet with 315-380 nm wavelengths.

Besides, Pitsamai [5] conducted the study on the efficacy of fluorescent lamps in white, violet, and blue to lure the pest. The researcher suggested that blue light fluorescent lamps should be set up in plantation, for they cost cheaper than the violet fluorescent ones.

Regarding to the behavioral response, the researcher also noticed the responses of these coconut hispine beetles after turned on the LED tubes. These beetles which did not hide themselves under coconut leave were active and flied to the LED lights, while those hiding themselves in unopened coconut buds where the lights could reach moved slowly to go outside the coconut buds, and there was no reaction from some beetles hiding in the dark and no light.

VI. Conclusion

From the study of color lighting efficiency of LED tubes to lure the adult coconut hispine beetle, it can be concluded as follows:

1. The ultraviolet LED tube was highest efficient to lure the adult coconut hispine beetles (68 adult coconut hispine beetles), followed by the blue LED tube (49 adult coconut hispine beetles).
2. The LED tubes in yellow, pink, red and warm white colors had no influence to the adult coconut hispine beetles.
3. The blue LED tube had the highest light intensity, followed by the cool white LED tube whereas the ultraviolet one had the least light intensity.
4. The LED tubes in yellow, pink, red, ultraviolet, and warm white demanded higher electricity current to generate

light whereas the LED tubes in cool white and blue used less electricity current to generate light.

5. The adult coconut hispine beetles which did not hide in the folded coconut buds were active to the blue and ultraviolet LED tubes after the researcher turned on the light. But, in case that the light could not illuminate in some spots, the adult beetles were passive and still hid there.

VII. Suggestions

The suggestions from this research are as follows:

1. This study is an experimental research which has not applied in the real situation yet due to time limitation. In fact, this experimental research was conducted in different period which was not the season of the coconut beetles outbreak. To be effective, the research should be conducted again in coconut plantation which has been attacking by the adult coconut hispine beetles.
2. For the further study, the researcher should design the experimental set of blue and ultraviolet LED tubes to have equal luminous efficacy and light intensity to fluorescent tubes to compare the efficiency between two types of lighting tubes to lure the adult coconut hispine beetles.
3. The findings of this study, including other related researches should be applied to design the electronic device using LED tubes to eliminate the adult coconut hispine beetles, for the LED tube have longer lifetime than the fluorescent tube.

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