International Journal of Entomology Research
ISSN: 2455-4758; Impact Factor: RJIF 5.24
www.entomologyjournals.com
Volume 2; Issue 4; July 2017; Page No. 79-85

# Relationship of predators flight and rice pests that caught on the light trap of mercury (ML-160 Watt) BSE-G3 model and light trap of solar cell (CFL-20 Watt)

*1 Baehaki SE, 2 Eko Hari Iswanto, 3 Dede Munawar

1 Entomological Society of Indonesia, Bandung Branch, Faculty of Agriculture, Padjadjaran University, Bandung-Sumedang street Km21-Jatinangor, West Java-Indonesia

2 Indonesian Center for Rice Research (ICRR). Jl. Raya No.9, Sukamandi, Subang, West Java, Indonesia

**Abstract**

Light traps can be used for monitoring of rice pests, although in the other hand is suspected to reduce the predators population from many rice areas. The research was carried out at the Sukamandi Research Station of Indonesian Center for Rice Research (ICRR) in 2013 to study the effect of the power capacity of light trap of mercury (ML-160 watt) BSE-G3 model and solar cell (CFL-20 watt) and measured the relationship of predators and rice pests that caught in the light trap. The results showed that rice pests caught on the light trap of mercury (ML-160 watt) BSE-G3 model was higher than rice pests caught on the light trap of solar cell (CFL-20 watt). The light traps reduce of rice pests population, but do not reduce population of predators and do not disturb to predators performance. The flight of *P. fuscipes* positively correlated to flight of rice pests that caught on both light trap of mercury (ML-160 watt) BSE-G3 model and on the light trap of solar cell (CFL-20 watt) with low coefficient determination adjusted 0.3471 and 0.4592 respectively. The flight of *Coccinella* sp positively correlated to flight of rice pests on the light trap of mercury and light trap of solar cell with a low coefficient determination adjusted 0.4189 and 0.3978 respectively. The flight of *O. nigrofasciata* did not determined by the flight of rice pests because the coefficient determination was negative.

**Keywords:** correlation, light trap, predators, rice crop, rice pests

## 1. Introduction

Light trap is a tool for attracting insects that reliably capture immigrant and emigrants insects used as non-chemical insects pest control. In the other hand the pests caught on the trap to be used in an early warning system of some type, to estimate number of pests in the rice crop and to determine the economic threshold [1]. (Baehaki, 2013) [2] showed the light trap data to determine a new economic threshold (ET) of rice stem borer, whereas decision making control of insecticides is done on 4 days after the moth caught in the light trap, because after 4 days since the moth landing, that eggs mass were laid to begin to hatch. In the old ET to borer control base on 5% dead heart or 9% white head were very detrimental, because borer control is done at the time of yield already lost. The YSB attack at vegetative stage will be yield losses amount 31.68 kg grain/ha for every increase of 1% dead heart and YSB attack at generative stage will be yield losses about 1% for every 1% increase of white head in short-lived rice varieties or 0.8% yield losses for every 1% increase of white head in long-lived rice varieties [2]. Monitoring of pests by light trap useful for planning a nursery and planting time that could begin in 15 days after the peak pests flight on the unimodal (one peak) or on the 15 days after the second peak pests flights on the bimodal (two peaks) catches pests curve.

The use of electric light traps with incandescent lamps of 25 watts at the Indonesian Center for Rice Research (ICRR) has been done since 1970, continued in 2008 using electric light trap model BSE-G3 with a mercury lamp 160 watt and in 2010 coupled with the use of electric lights traps knock down model BSE-G4. Likewise, the light traps to pest monitoring have been widely used in China [3], Japan [4], and Brazil [5].

Many models of light trap both equipment and types of lamp lights used to catch pests. Types of lamp lights that attractive pests were used standard incandescent bulbs, fluorescent lamp (tubular lamp) with different wavelengths of color, especially the color type UV (ultra violet), ML (mercury lamp), CFL (compact fluorescent lamp) or LED (light emitting diode). The Light trap with light of different wavelengths can attract a large number of species of insects pests and non-pests. Each different species will respond to the spectrum of visible and invisible light.

Insects flight toward lights on throughout the night or only at certain hours only. The light trap of mercury has maximal ability followed by a black light trap (ultra violet-A with a wavelength of 400-315 nm) and UV light traps (ultra violet-C with a wavelength of 280-100 nm). The total caught of different orders of the mercury light trap, a black light, and UV were 48.13, 41.78 and 10.09% respectively [6]. Baehaki *et al*. 2016 [7] reported that light trap of mercury (ML-160 watt) BSE-G3, BSE-G4, and BSE-Giant models were higher capture of pests compared to the light trap of solar cell (CFL-20 Watt). Further more Baehaki *et al*. (2016) [7] reported the rice pests that caught on the light trap with higher power capacity at 160 watt and light intensity at 3150 lm were higher than in the lower power capacity at 20 watt and low light intensity between 1200-1250 lm.

Flights of predators suspected to follow the pest flights of the rice areas which are viewed as a weakness of light trap. Based on these issues, the aims this study to measure the effect of the light power capacity as the appeal of flights pests and predators. On the other hand to study the relationship between predators and pests of rice that caught on the both models light trap of mercury (ML-160 watt) BSE-G3 model and solar cell (CFL-20 watt).

## 2. Materials and Methods

The research relationship of predators flight and rice pests that caught on the light trap of mercury (ML-160 watt) BSE-G3 model and light trap of solar cell (CFL-20 watt) was conducted in Sukamandi Research Station of Indonesian Center for Rice Research (ICRR), from January to December 2013. The light trap of mercury (ML-160 watt) BSE-G3 model placed on the Road 8 and the light trap solar cell (CFL-20 watt) installed 400 m toward the East of the mercury light trap. All light trap installed at 150 cm height from the ground. Light trap mercury (ML-160 watt) BSE-G3 model turned on manually, whereas light trap solar cell (CFL-20 watt) lights up automatically when the environment was dark. The duration light are for 10-12 hours starting from 18.00 pm. In this research station was planted various rice varieties and lines, given varying doses of fertilizer, planted with the legowo 2: 1 system and in row with various spacing.

### 2.1 Relationship of predator's flights and rice pests that caught on the light trap of mercury (ML-160 watt) model BSE-G3

Light traps of mercury (ML-160 watt) BSE-G3 model is a electric light trap equipped with mercury lamp ML160 W, funnel pests collector with the upper and lower part are 60 and 7 cm in diameter respectively, the cylinder bag pests collector with 31 cm in diameter and 80 cm in height, the rectangular roof to protect the lamp and pests caught especially from rain water. Description of ML160W (Mercury Lamp, Philips) colored cool daylight white light, luminance of 3150 lm, the voltage of 220-230 V, and the power capacity is 160 Watts [7]. Pests were collected in the morning from bag of pests collector of electric light trap and was sprayed by Baygon to kill pests that still alive. All dead pests transferred into a plastic tray for processed further.

### 2.2 Relationship of predator's flights and rice pests that caught on light trap of solar cell (CFL-20 watt)

Light trap of solar cell (CFL-20 watt) is equipped compact fluorescent lamp (CFL) bulbs, container box for collecting pests with a solution of soapy water. Description of CFL bulbs is cool daylight in color, luminance of 1200 lm, long life rays for 10 hours, the voltage of 220-240 VAC, and the power capacity is 20 Watt. On the solar cell light trap, pests was collected from container box [7]. Baygon used to kill pest is still alive, and all dead pests transferred into a plastic tray to processed as follows:

The catch insects of the both light trap separated and identified on the orders, families and species of pests or natural enemies calculated the number pests and predators of each species. Data of pests and predators inserted into an excel program for cumulative every 10 days (dasarian), and then the number of predators to be correlated with the major pests that caught in the light trap. The relationship indicated by multiple regression equation between predator as the dependent variable (Y) and pests as the independent variable (X) as follows

$$Y_1 = a_1 + b_1 X_1 + b_2 X_2 + b_3 X_3 + \text{----------} + b_n X_n$$

Where: $Y_1$ = predator$_1$, $X_1$…..$X_n$ = pest$_1$ ….. pest$_n$, = slope, $b_1$…….$b_n$ = coefficient regression

The $R^2$ as coefficient of determination is measured to determine how well the regression line approximates the real data points. Likewise calculated adjusted coefficient determination (Adj. $R^2$) is a calibration or alignment of $R^2$.

The coefficient of determination adjusted (Adj. $R^2$) is a calibration or alignment of $R^2$. Differences of $R^2$ and adjusted $R^2$ value lies on correction factor (degrees of freedom). $R^2$ does not have a correction factor so that if the independent variables continue to be added, will cause the value of $R^2$ continue to grow. Adjusted $R^2$ have a correction factor, so the addition of independent variables does not necessarily increase value of $R^2$, therefore adjusted $R^2$ much more useful measure of how well a multiple regression equation fits to the sample data than $R^2$ [8, 9].

## 3. Results and Discussion

The main pests that caught on the light trap were brown plant hopper (Nilaparvata lugens), yellow stem borer (Scirpophaga incertulas), pink stem borer (Sesamia inferences), leaf folder (Cnaphalocrosis medinalis), and black bug (Scotinophara coarctata). Other pests caught in low number were mole cricket (Gryllotalpa Africana) and stink bug (*Leptocorisa oratorius*). Predator caught on the light trap were *P. fuscipes*, *O. nigrofasciata*, and *Coccinella* sp..

Pests caught on the light trap of mercury (ML-160 watt) BSE-G3 model more higher and significantly different than pests that caught on the light trap of solar cell (CFL-20 watt), except leaf folder. Predators caught on the light trap of mercury more higher and significantly different than the predator s caught on the light trap of solar cell, except *Coccinella* sp (Table 1).

**Table 1:** Kind of rice pests and predators caught on the light traps mercury (ML-160 watt) BSE-G3 model and solar cell (CFL-20 watt). Sukamandi, 2013

| Rice Pests and predators | Pests and Predators caught on the light trap | | | |
|---|---|---|---|---|
| | Mercury BSE-G3 | Solar cell CFL | Mercury BSE-G3 (%) | Solar cell CFL (%) |
| Yellow stem borer (YSB) | 5199.4* | 1103.0 | 8.30 | 9.45 |
| Pink stem borer (PSB) | 26.0* | 18.6 | 0.04 | 0.16 |
| Leaf folder (LF) | 50.0 | 91.0* | 0.08 | 0.78 |
| Black bug (BB) | 54277.9* | 9691.4 | 86.74 | 83.08 |
| Brown plant hopper (BPH) | 2439.6* | 496.7 | 3.90 | 4.26 |
| Mole cricket (MC) | 43.0* | 3.3 | 0.07 | 0.03 |
| Stink bug (SB) | 5.3* | 3.0 | 0.01 | 0.03 |
| *Coccinella* sp | 11.7 | 16.8* | 0.02 | 0.14 |

| | | | | |
|---|---|---|---|---|
| *Ophionea nigrofasciata* | 23.1* | 15.8 | 0.04 | 0.14 |
| *Paederus fuscipes* | 498.8* | 225.3 | 0.80 | 1.93 |
| Spiders | 0 | 0 | 0 | 0 |
| Total | 62574.8 | 11665.0 | 100 | 100 |

*The values in one row between mercury and CFL significant different on t-test$_{0.05}$.

From the total catches on the light trap of mercury (ML-160 watt) BSE-G3 model showed that about 99.14% were pests and only 0.86% were predators divided into *Coccinella* sp, *O. nigrofasciata*, and *P. fuscipes* of 0.02; 0.04 and 0.80% respectively. Light trap of solar cell (CFL-20 watt) had attracted pests about 97.79% and only of 2.21% were predators divided into *Coccinella* sp, *O. nigrofasciata*, and *P. fuscipes* of 0.14; 0.14 and 1.93% respectively. The rice pests that caught on the light trap almost equal to Baehaki *et al*. (2016) [7] that reported that the major pest of rice was attracted to light from Order Lepidoptera (yellow stem borer, pink stem borer, leaf folder), Orthoptera (mole cricket), Hemiptera-sub Order Heteroptera (black bug and stink bug), Hemiptera- sub Order Auchenorrhyncha (brown plant hopper and green leafhopper), and Coleoptera (lady beetle, ground beetle, rove beetle).

### 3.1 Relationship of predators flights and rice pests that caught on the light trap of mercury (ML-160 watt) model BSE-G3

Relationship between flights of *P. fuscipes* with BPH which caught on the light trap of mercury (ML-160 watt) models BSE-G3 was positive correlation, but was not significantly different because coefficient correlation (0.3140) more smaller than r-tabel$_{0.5, db=34}$ = 0.329 and the probability (0.0621) greater than Prob. <0.05 (Table 2).

Relationship between flights *P. fuscipes* with yellow stem borer, pink stem borer, leaf folder, black bug which caught on the light trap of mercury were significantly different, as indicated by the coefficient correlation were 0.3795; 0.4770; 0.4422; and 0.3298 respectively greater than r-tabel$_{0.5, db = 34}$ = 0.329, likewise the all probability more smaller than Prob. <0.05 (Table 2).

Multiple regression equation between flights *P. fuscipes* (Pf) with major pest of brown planthopper =BPH, yellow stem borer =YSB, pink stem borer = PSB, leaf folder =LF, and black bug =BB were:

$Y_{Pf}$ = 47.11442 + 0.01615 BPH – 0.03995 YSB +10.01831 PSB + 5.39681 LF + 0.00165 BB
$R^2$ = 0.4404 and adj. $R^2$ = 0.3471

The equation shows the coefficient determination $R^2$ = 0.4404 with the multiple correlation of 0.6636, however Adj. $R^2$ (adjusted $R^2$) = 0.3471. This shows that the number of *P. fuscipes* caught on the light trap only 34.71% were explained by abundance of the brown planthopper, yellow stem borer, pink stem borer, leaf folder and black bug that caught on the light trap of mercury (ML-160 watt) BSE-G3 models.

Relationship between *O. nigrofasciata* with brown planthopper, yellow stem borer, pink stem borer, leaf folder and black bug did not significantly different, because the coefficient correlation more smaller than r-tabel$_{0.5, db =34}$ = 0.329 and the probability was greater of Prob. <0.05. This indicates that the predator that caught on the light trap did not caused of many rice pests that fly caught by the light trap of mercury (ML-160 watt) models BSE-G3 (Table 2)

**Table 2:** Partial correlation coefficient between predators and pests caught on the light traps mercury (ML-160 watt) BSE-G3 model. Sukamandi, 2013

| Rice Pests | Predators | | |
|---|---|---|---|
| | **P. fuscipes** | **O. nigrofasciata** | **Coccinella sp** |
| Brown plant hopper (BPH) | 0.3140<br>0.0621 | 0.1739<br>0.3104 | 0.5727*<br>0.0003 |
| Yellow stem borer (YSB) | 0.3795*<br>0.0224 | 0.1883<br>0.2713 | 0.2982<br>0.0773 |
| Pink stem borer (PSB) | 0.4770*<br>0.0033 | 0.1359<br>0.4292 | 0.4516*<br>0.0057 |
| Leaf folder (LF) | 0.4422*<br>0.0069 | 0.0818<br>0.6350 | 0.2742<br>0.1056 |
| Black bug (BB) | 0.3298*<br>0.0495 | 0.2806<br>0.0973 | 0.0150<br>0.9306 |

Remarks: values in one column: the top is the correlation coefficient, * significantly different when greater than $r_{0.5,\ df = 34}$ = 0.329 and $r_{0.1,\ df = 34}$ = 0.424. The lower part is a probability value. * Correlation coefficients were significantly different when the value is smaller than the probability Prob. <0.05.

Multiple regression equation between flights *O. nigrofasciata* (On) with major pest of brown plant hopper =BPH, yellow stem borer =YSB, pink stem borer = PSB, leaf folder =LF, and black bug =BB were:

$Y_{On}$ =13.37778 + 0.00044 BPH+ 0.00144 YSB -0.01915 PSB -0.10079 LF + 0.00012 BB
$R^2$ = 0.1188 and adj. $R^2$ = -0.0281

The equation shows the coefficient determination was very low, amount of $R^2$ = 0.1188, even the coefficient determination adj. $R^2$ was negative value (-0.0281).

The flights of *Coccinella* sp. positively correlated and significantly different with brown plant hopper and pink stem borer that caught on the light trap of mercury with a correlation value more greater than r-tabel$_{0.5,\ db =34}$ = 0.329, and the probability was smaller than Prob. <0.05. The relationship between *Coccinella* sp. with yellow stem borer, leaf folder and black bug insignificantly different from r-tabel$_{0.5, db=34}$ = 0.329 with probability greater than Prob. <0.05 (Table 2).

Multiple regression equation between flight of *Coccinella* sp (Coc.) with major pest of brown planthopper =BPH, yellow stem borer =YSB, pink stem borer = PSB, leaf folder =LF, and black bug =BB were:

$Y_{Coc.}$ = -1.71534 + 0.00221 BPH - 0.00314 YSB + 0.57995 PSB + 0.24122 LF + 0.00001 BB
$R^2$ = 0.5019 and adj. $R^2$ = 0.4189

The coefficient of determination $R^2$ = 0.5019 with a value adj. $R^2$ = 0.4189 showed the number of *Coccinella* sp. that caught on the light traps only 41.89% were explained by abundance of the brown planthopper, yellow stem borer, pink stem borer, leaf folder and black bug. When the black bug pest that low correlates eliminated from the equation above, then the equation becomes as follows:

$Y_{Coc.}$ = -1.22788 + 0.00221 BPH -0.00312 YSB + 0.57597 PSB + 0.24007 LF
$R^2$ = 0.5009 and adj. $R^2$ = 0.4365

The equation shows the coefficient determination $R^2$ = 0.5009 with adj. $R^2$ = 0.4365 a slight increase from the equation originally, therefore *Coccinella* sp that caught on the light trap about 43.65% were explained by the abundance of the brown planthopper, yellow stem borer, pink stem borer and leaf folder.

### 3.2 Relationship of Predators flights and rice pests that caught on light trap of solar cell (CFL-20 watt)

Relationship flights of *P. fuscipes* with brown plant hopper, yellow stem borer, pink stem borer, and leaf folder that caught on the light trap solar cell (CFL-20 watt) are positively correlated, but insignificant different with correlation value more smaller than r-tabel$_{0.5,\ db\ =\ 21}$ = 0.413 and the probability more greater than Prob. <0.05 (Table 3). Relationship flights of *P. fuscipes* with black bug about 0.4375 significantly different from r-tabel$_{0.5,\ db=21}$ = 0.413 with probability (0.0368) is smaller than Prob. <0.05.

**Table 3:** Partial correlation coefficient between predators and pests caught on the light traps solar cell CFL-20 watt). Sukamandi, 2013

| Rice Pests | Predators | | |
|---|---|---|---|
| | **P. fuscipes** | **O. nigrofasciata** | **Coccinella sp** |
| Brown planthopper (BPH) | 0.0180<br>0.9347 | 0.0592<br>0.7884 | 0.0358<br>0.8709 |
| Yellow stem borer (YSB) | 0.3864<br>0.0685 | 0.1109<br>0.6144 | 0.5446*<br>0.0072 |
| Pink stem borer (PSB) | 0.0402<br>0.8554 | 0.1697<br>0.4387 | 0.1171<br>0.5944 |
| Leaf folder (LF) | 0.1158<br>0.5987 | 0.1479<br>0.5005 | 0.6567*<br>0.0007 |
| Black bug (BB) | 0.4375*<br>0.0368 | 0.0182<br>0.9342 | -0.2274<br>0.2967 |

Remarks: values in one column: the top is the correlation coefficient, * significantly different when greater than $r_{0.5,db=21}$ = 0.413 and $r_{0.1,bd=21}$ = 0.526. The lower part is a probability value. * Correlation coefficients were significantly different when the value is smaller than the probability Prob. <0.05.

Multiple regression equation between flights *P. fuscipes* (Pf) with major pest of brown planthopper =BPH, yellow stem borer =YSB, pink stem borer = PSB, leaf folder =LF, and black bug =BB were:

$Y_{Pf}$ = 244.84679 + 0.03031 BPH + 0.12465YSB + 1.18167 PSB -2.81617 LF + 0.00641BB
$R^2$ = 0.5821 and adj. $R^2$ = 0.4592

The equation shows the coefficient determination $R^2$ = 0.5821 with the correlation of 0.7629, however adj. $R^2$ = 0.4592. This indicates that the *P. fuscipes* flights only 45.92% were explained by the abundance of rice pests that caught in the light traps solar cell (CFL-20 watts).

Flights *O. nigrofasciata* to the brown plant hopper, yellow stem borer, pink stem borer, leaf folder and black bug caught on the light trap solar cell (CFL-20 watts) insignificant correlation because the coefficient correlation was smaller than r-tabel$_{05,\ db=21}$ = 0.413 and the probability was greater than Prob. <0.05 (Table 3).

Multiple regression equation between flights *O. nigrofasciata* (On) with major pest of brown plant hopper =BPH, yellow stem borer =YSB, pink stem borer = PSB, leaf folder =LF, and black bug =BB were:

$Y_{On}$ =17.91850+ 0.00158 BPH -0.00021 YSB + 0.60878 PSB -0.15002 LF -0.00004 BB
$R^2$ = 0.0621 and adj. $R^2$ = -0.2138

The equation shows the coefficient determination was very low, amounting to $R^2$ = 0.0621 with negative coefficient determination of adj. $R^2$ = -0.2138.

Relationship between *Coccinella* sp. with brown plant hopper, pink stem borer, and black bug that caught on the light trap solar cell (CFL-20 watts) insignificantly different with coefficient correlation more smaller than r-tabel$_{0.5,\ db=21}$ = 0.413 and the probability more greater than Prob. <0.05 (Table 3). The relationship between *Coccinella* sp. with yellow stem borer and leaf folder that caught on the light trap solar cell (CFL-20 watt) significantly different, because the coefficient correlation more greater than r-tabel$_{0.5,\ db=21}$ = 0.413 with probability more smaller than Prob. <0.05 (Table 3).

Multiple regression equation between flights *Coccinella* sp. (Coc.) with major pest of brown planthopper =BPH, yellow stem borer =YSB, pink stem borer = PSB, leaf folder =LF, and black bug =BB were:

$Y_{Coc}$ = 3.00750 -0.00233 BPH+ 0.00205 YSB + 0.09756 PSB + 0.13180 LF -0.00011 BB
$R^2$ = 0.5347 and adj. $R^2$ = 0.3978

The equation shows the coefficient determination $R^2$ = 0.5347 with the correlation of 0.7312, but the coefficient determination adj. $R^2$ in low values was 0.3978. This indicates that the number of *Coccinella* sp. that caught on the light traps amount 39.78% was explained by abundance of rice pests on the light traps solar cell (CFL-20 watts). When the pests of BPH, pink stem borer, and black bug that low correlates were eliminated from the equation above, then the equation becomes as follows:

$Y_{Coc}$ = 2.79027 + 0.00209 YSB + 0.12892 LF
$R^2$ = 0.4794 and adj. $R^2$ = 0.4273

The equation shows the coefficient determination $R^2$ = 0.4794 and adj. R2 = 0.4273 higher than the originally equation. Therefore the *Coccinella* sp. flight was explained 42.73% due to the abundance of yellow stem borer and leaf folder that caught in the light trap solar cell (CFL-20 watt).

Flights predators of rice pest as signaled richness, and sustainable population dynamics of natural enemies as pest control in rice crops. Sharma and Bisen (2013) [10] reported the light trap determined status of beneficial insects as bio control agents (predatory species), their occurrence, activity and distribution in ecosystem which is very important in planning the IPM programme for different crops with a view to conserve the bio control agents. On the other hand pests flight that caught on the light trap signaled the performance of pest control did not gone well, causing pests development in rice plants rapidly forming to several generations and fly as migrant pests.

The caught pests in the light traps mercury (ML-160 watt) BSE-G3 model more higher and significantly different to the catches pests of light trap solar cell (CFL-20 watt), except leaf folder pest. Predators that caught on mercury lamp more higher and significantly different from the predator were caught by CFL lamp, except *Coccinella* sp. It shows that size of the capacity and kinds of light had different ability attracted pests and predators. The mercury light was more efficient for Lepidoptera, Hemiptera, Hymenoptera, Odonata, and Diptera and black light was more efficient for Coleoptera, Orthoptera, Isoptera, and Dictyoptera [6].

Pests caught on the light trap mercury (ML-160 watt) models BSE-G3 and light trap solar cell (CFL-20 watt) reaches 99.14 and 97.79% respectively, while the 3 predators *Coccinella* sp, *O. nigrofasciata*, and *P. fuscipes* only 0.86% on light trap mercury (ML-160 watt) models BSE-G3 and 2.21% on light trap solar cell (CFL-20 watt). This showed that the light trap very good to reduce rice pests, but do not reduce populations of predators and also do not disrupt the performance of the predators. On the other hand spiders did not caught at all by light trap and even never caught since 1970.

Predators flights and rice pests were caught in light traps as a closeness cue of the statistical relationship one to another. Relationship of *P. fuscipes* flights and rice pests that caught on the light trap mercury lamp (ML-160 watt) models BSE-G3 has a coefficient determination adj. $R^2$ of 0.3471. The *P. fuscipes* flights about 34.71% following the flight of the brown planthopper, yellow stem borer, pink stem borer, f leaf folder and black bug, while as many as of 65.29% were explained by the other biotic and abiotic factors (color light, weather and moonlight).

*P. fuscipes* flights that caught in the light trap solar cell (CFL-20 watt) amounting to 45.92% following the flights of brown planthopper, yellow stem borer, pink stem borer, leaf folder and black bug, while as many as 54.08% again the flights *P. fuscipes* were explained by the other biotic and abiotic factors as described above. Lima *et al*. (2015) [11] reported that *Paederus* beetles were attracted to incandescent, fluorescent, and black light lamps as light sources, but the black light was the most attractive source and the lowest catches were captured at full moon. *Paederus* beetles were attracted to a black light source hourly from 18.00 to 06.00 hours, and the true environmental condition responsible for *Paederus* beetles seasonal pattern and daily night dispersal were the annual moisture and drought cycles and the diurnal maximum temperatures [12]. The Flights of predator is also determined by the population of prey that fly. The flight of *Coenosia attenuate* individuals was affected by environmental factors and was increased in response to increases in temperature, the number of prey flights, and conspecific density [13].

The coefficient determination adjusted of *O. nigrofasciata* in relationship with the major rice pests were negative, both on the light trap mercury (ML-160 watt) models BSE-G3 and solar cell (CFL-20 watts). This indicates that flight of *O. nigrofasciata* nothing did not determined by pest of rice, but determined by abiotic factors such as which have been mentioned above.

The flights of *Coccinella* sp. on light trap mercury (ML-160 watt) BSE-G3 models only 43.65% were explained by flights of brown planthopper, yellow stem borer, pink stem borer and leaf folder, while as many as 56.35% again were determined by the other factors. In light trap solar cell (CFL-20 watt) the flights of *Coccinella* sp. as much 42.73% were explained by the presence of yellow stem borer and leaf folder, while as many 57.27% again determined by the other factors and even the movement of the wind. The abiotic factors influence to flight of pests and predators as Møller (2013) [14] reported that abundance of flying insects decreased strongly with increasing wind speed during summer. Jeffries *et al*. (2013) [15] reported that Ladybirds are therefore potentially able to travel 18 km in a ‘‘typical’’ high-altitude flight, but up to 120 km if flying at higher altitudes, indicating a high capacity for long-distance dispersal. There were strong seasonal trends in ladybird abundance, with peaks corresponding to the highest temperatures of mid-summer, and warm air temperature was the key driver of ladybird flight. On the other hand Sharma and Bisen (2013) [10] reported that natural enemies *Coccinella* sp. of the family Coccinellidae interested to 15 watt ultra violet lamp. Likewise two predators coccinellids (*Harmonia axyridis* and *Propylea japonica)* and three chrysopids (*Chrysopidae* spp.) were the most abundant predatory insects in the catches and selected as the representatives of predatory insects [3].

The moon light influences to flights of both pests and predators. In a high proportion of moonlight is polarized, flight activity increases but when there is a low level of polarization, as at a full moon, flight activity decreases [16]**.** Under the sunny days, the moonlight will reduce the trap quantity and the full moon and new moon respectively has the greatest and least influence, therefore the further studies are necessary to clarify the cause of the minimum catch during the full moon [17].

The relationship between predators and rice pests that caught on the light trap is causal relationship for most predator-pest, while the others not causality. The presence of predators caught on light trap associated with the pests caught on the device, although the relationship is insignificant [18]. Pest-predator relationship is viewed as prey and predator entanglement to woven in food chain relationships. The relationship between predator *O. nigrofasciata, P. fuscipes* and *Coccinella* sp. with brown plant hopper can be viewed as causal relationship, because those predators prey on imago brown plant hopper, but the relationship *O. nigrofasciata, P. fuscipes* and *Coccinella* sp with imago stem borer, leaf roler, and black bug difficult to understand. This is due to the beetle Coccinella and Carabidae (*O. nigrofasciata*) preys to newly hatched larvae of stem borer and Coccinelid preys to eggs of leaf roller [19]. Coccinellid, *Micraspis crosea* as a common predator preys to brown planthopper and also consumed more eggs leaf folder than a common rice field coccinellid, *Synharmonia octomaculata*. Staphylinid, *P. fuscipes* attacking newly hatched stem borer larva in the field (Latter, 1955 in [19]). The red ants, *Selenopsis geminate* (Fab.), Coccinelid beetle, *Micraspis crosea* (Mulsant), black and brown crickets, *Metioche vittaticollis* (Stal.) and *Anaxxipha longipennis* (Serville) attacked black bug eggs, but spiders preyed on black bug eggs, nymphs, and adults [20].

Relationships that are not in the form causal effect can be explained by the charming character of the parasitoid *Telenomus rowani* that always go with the yellow stem borer. The main parasitoid of yellow stem borer is *T. Rowani* is known to disperse by phoresy: the adult wasps can be found clinging to the body of the female moth and using the moth for transport. Immediately after oviposition the wasps leave the moth to attack the eggs masses [21]. In here was not a causal relationship, since parasitoid attached not attack the imago yellow stem borer, but just wait for the target laid eggs as borers. Therefore, the relationship is not causal imago pest-predators to be seen whether a predatory instincts to follow the movements of adult in order to prey offspring of yellow stem borer or there are the other things that are unknown.

The above discussion as a whole show that the use of light traps mercury (ML-160 watt) models BSE-G3 and light trap solar cell (CFL-20 watts) is very effective for monitoring insect pests, even the light trap mercury (ML-160 watt) models BSE-G3 can reduce pests as non-chemical mechanical control in agricultural areas with a low cost can be practiced at the farm level. Thus the light trap has benefits as a tool of IPM compared with other control technologies. Light trap with ultra violet and LED lamps are also effective and profitable for farmers when control as it helps in reducing the use of pesticides [22], The solar light trap model will be very much effective for the control of different insect pests of all crops without any use of chemical pesticides in the agricultural fields in near future. Government and other non- government organisations may also utilise this useful IPM tool for successful implementation of green revolution technology in the crop field for providing necessary safeguard to the nature [23]. Information of light trap use as integrated pest management tool is a new innovation that needs to be applied at the farm level, incorporating measurable rules.

## 4 Conclusions

The pests caught on the light trap mercury (ML-160 watt) BSE-G3 model morehigher and significantly different than pests caught on the light trap solar cell (CFL-20 watt). The proportion of pests caught on light traps of mercury (ML-160 watt) models BSE-G3 and light trap solar cell (CFL-20 watt) reached 99.14 and 97.79% respectively, while the 3 predator *Coccinella* sp, *O. nigrofasciata* and *P. fuscipes* only 0.86% on the light trap mercury and 2.21% on the light trap solar cell. The light trap had reduced rice pests, but did not reduced populations of predators and did not disrupted to the predators performance.

The flight of *P. fuscipes* positively correlated to flight of rice pests caught on the light trap of mercury (ML-160 watt) BSE-G3 model and on the light trap of solar cell (CFL-20 watt) with a low coefficient determination adjusted 0.3471 and 0.4592 respectively. The flight of *Coccinella* sp positively correlated to flight of rice pests on the light trap of mercury and light trap of solar cell with a low coefficient determination adjusted 0.4189 and 0= 0.3978 respectively. The flights of *O. nigrofasciata* did not correlated to the flight of rice pests because the coefficient determination adjusted were negative. The flights of predators signaled a richness and sustainable population dynamics of natural enemies as pest control in rice crops. On the other hand the flight pests that caught on the light trap signaled the performance of pest control did not gone well, causing pests development in rice plants rapidly forming to several generations and fly as migrant pests.

## 6. Acknowledgements

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## 7. References

1. Baehaki SE. Strategi fundamental pengendalian hama wereng batang coklat dalam pengamanan produksi padi nasional (Fundamental strategy of controlling brown planthopper in securing national rice production). Pengembangan Inovasi Pertanian. 2011; 4(1):63-75.
2. Baehaki SE. Hama penggerek batang padi dan teknologi pengendalian (Rice stem borer and its control techniques). IPTEK Tanaman Pangan. 2013; 8(1):1-14.
3. Ma G, Ma CS. Differences in the nocturnal flight activity of insect pests and beneficial predatory insects recorded by light traps: Possible use of a beneficial-friendly trapping strategy for controlling insect pests. European Journal of Entomology. 2012; 109:395-401.
4. Endo N, Wakakuwa M, Arikawa K, Hironaka M. Spectral preference in a free-flying condition of the southern green stink bug, *Nezara viridula* (Heteroptera: Pentatomidae). Japanese Journal of Applied Entomology and Zoology. 2014; 58:23–28.
5. Oliveira AC, Veloso VR, Barros RG, Fernandes PM, Souza ER. Capture of *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) with light trap in tomato crop. Pesquisa Agropecuária Tropical (Pesq. Agropec. Trop. [in Portuguese, English abstr.] 2008; 38:153-157.
6. Ramamurthy VV, Akhtar MS, Patankar NV, Menon P, Kumar R, Singh SK, *et al.* Efficiency of different light sources in light traps in monitoring insect diversity. Munis Entomology and Zoology. 2010; 5(1):109-114.
7. Baehaki SE, Iswanto EH, Munawar D, Sumaryono N. Light traps abilities of mercury (ML-160 Watt) BSE models and light traps of solar cell (CFL-20 Watt) to capture of pests in the rice field. American Journal of Engineering Research (AJER). 2016; 5(11):138-144.
8. Nursiyono JA. Kriteria Model Statistik yang Baik. http://www. Kompasiana. com/jokoade/kriteria -model -statistik-yang-baik_54f6ad0da33311c55c8b45fa, 2014.
9. Anderson A. How to Calculate the Adjusted Coefficient of Determination. http://www.dummies.com/education/math/business-statistics/how-to-calculate-the-adjusted-coefficient-of-determination, 2017.
10. Sharma AK, Bisen UK. Taxonomic documentation of insect pest fauna of vegetable ecosystem collected in light trap. International Journal of Environmental Science: Development and Monitoring (IJESDM). 2013; 4(3):4-11.
11. Lima DCB, Costa AAV, Silva FS. Abundance and night hourly dispersal of the vesicating beetles of the genus *Paederus* (Coleoptera: Staphylinidae) attracted to fluorescent, incandescent, and black light sources in the Brazilian Savanna. Journnal of Medical Entomology. 2015; 2(1):50-55.
12. Silva FS, Lobo SEPD, Lima DCB, Brito JM, Costa-Neta BM. The influence of weather and lunar phases on the flight activity of *Paederus* rove beetles (Coleoptera: Staphylinidae). Environmental Entomology. 2015; 44(3):874-879.
13. Bonsignore CP. Environmental factors affecting the behavior of *Coenosia attenuata*, a predator of *Trialeurodes vaporariorum* in tomato greenhouses. Entomologia Experimentalis et Applicata, 2016; 158(1):87-96.

14. Møller AP. Long-term trends in wind speed, insect abundance and ecology of an insectivorous bird. Ecosphere. 2013; 4(1):1-11.
15. Jeffries DL, Chapman J, Roy HE, Humphries S, Harrington R, Brown PMJ, *et al.* Characteristics and drivers of high-altitude ladybird flight: insights from vertical-looking entomological radar. Plos one, DOI: 10.1371/journal. pone.0082278. 2013; 8(12):1-12.
16. Nowinszky L, Pusk´as J. Light trap catch of the harmful moths depending of moonlight in North Carolina and Nebraska States of USA. International Scholarly Research Network (ISRN) Zoology, doi:10.5402/2012/238591. 2012; 6.
17. Reddy LHV, Reddy VAK, Hemanth S, Durga Prasad PJ. Modeling and optimization of solar light trap for reducing and controlling the pest population. International Journal of Engineering Technology, Management and Applied Sciences. 2015; 3(4):224-234.
18. Baehaki SE, Rustiati T, Iswanto EH, Sumaryono N. Pengaruh faktor meteorologi terhadap penerbangan hama padi tertangkap pada lampu perangkap merkuri dan CFL (The influence of meteorological factors on the rice pests flight that catched in the light traps of mercury lamp and CFL). Agrotrop. 2015; 5(2):122138.
19. Ooi PAC, Shepard BM. Predators and parasitoids on rice insect pests. In E.A. Heinrichs. 1994. Biology and management on rice insects. International Rice Research, 1994; 585-612.
20. Batay-an EH, Torrena PS, Estoy AB. Biological studies on rice black bug *Scotinophara coarctata* (Fabicus) in Cotabato, Mindanao, Philippines. In: Ravindra C. Joshi, Alberto T. barrion, and Leocadio S. Sebastian. Rice black bugs: Taxonomy, Ecology, and Management of Invasive species. Philrice, 2007; 339-359.
21. Kalshoven LGE. The Pests of Rice In Indonesia. Revised by Van der Lanan. PT. Ichtiar Baru-Van Hoeve Jakarta, 1980; 701.
22. Thangalakshmi S, Ramanujan R. Electronic trapping and monitoring of insect pests troubling agricultural fields. International Journal of Emerging Engineering Research and Technology. 2015; 3(8):206-213.
23. Bera PK. Development of a new solar light trap model and its utilization as IPM tool in agriculture. Journal of Emerging Technologies and Innovative Research (JETIR). 2015; 2(3):549-554.