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Original Research Article

Evaluation of Light Trap System in Monitoring of Rice Pests, Brown Planthopper (*Nilaparvata lugens*)

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Abstract: Brown Planthopper (Nilaparvata lugens) is a major rice pest insect in Malaysia. Series of the outbreak has been recorded in 1991, 1909, 2011, and 2015 which caused heavy yield losses. The light trap is now commonly used to monitor the pest population to predict the outbreak. The population sampling was conducted based on the crop stage at a specific sampling point and area. It has been done manually through field observations using netting, sweeping, board tapping, or survey patrol. Those methods are laborious and time-consuming. Malaysia Agriculture Research and Development Institute (MARDI) has developed an early warning system for brown planthopper monitoring consisting of modular light traps and a weather database to provide earlier forecasts and more effective outbreak prediction. However, there is not much information about how effective the light trap operated in the open field to draw and trap the insects. The light trap's efficiency depends on a few factors like the trap design, type of light source, duration, and sampling time; all affect the trap's effectiveness. A 30W Compact fluorescence light (CFL) has been selected and used to build four operated light traps and placed at the appropriate selected location. Sampling works were conducted twice a week for three hours per night throughout the planting season (15 weeks). Comparative statistical analysis was conducted to evaluate the effectiveness of the light trap compared to the aerial netting method. The results showed that the difference is statistically significant between light trap and aerial netting with a value of 0.0167 at $p < 0.05$. Therefore, brown planthopper population monitoring is more effectively done using the new design light trap.

Keywords: brown planthopper; population sampling; light trap monitoring; netting method; pest monitoring

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1. Introduction

Global food demand has increased due to the increase in world population, which is expected to be 8.27 billion in 2030. On the other side, an estimated population may increase to 4.95 billion people in Asia by 2030 (United Nation, Department of Economic and Social Affairs, Population Division, 2015). About half of the world's population choose rice as their staple food daily, with Asian countries as the primary consumption and production area (Muthayya *et al*., 2014). It requires the global rice production to be 800 million tonnes/year in 2025 (IRRI, 2000). The supply and demand of rice are positively related to trends, issues, and changes in Asia rice production sectors that are crucial for the global rice industry (Kubo & Purevdoj, 2004).

Brown Planthopper (BPH), also scientifically known as *Nilaparvata lugens*, is one of the major pests in rice, which caused severe damage to the rice crop. The BPH population could multiply up to four generations from planting until harvest and may cause the hopper burn effect to occur as early as 60 days after sowing (Hirao, 1979). In Malaysia, outbreak incidence has been recorded back in 1967, which impacts more than 5000 hectares and caused ~~a~~ severe yield loss of up to US$ 1 million. The outbreak incidence repeated a series of years later. It also impacted a few other countries in Asia, Indonesia, the Philippines, Japan, Taiwan, and India. The total losses of BPH in Asia was estimated at almost US$300 million, excluding the expenses for the control and management of outbreak (Dyck and Thomas, 1979). According to the socio-economic research report for paddy production, the yield losses due to hopper burn is 16.7% or RM1200 / hectares (ha) (Rosnani, 2015).

Therefore, monitoring of BPH in rice cultivation is essential and avoids loss of yield. However, continuous monitoring and extensive usage of labor to cover a vast planted area were required. Currently, BPH monitoring was carried out three to four times a season (Otoniel *et al*., 2012), yet this will not accurately picture BPH population level and pattern throughout the rice planting season. Therefore, the light trap was used to assess the population pattern and migration of the BPH. There are various types of light trap designs that have been developed for trapping nocturnal insects. Each of these light traps comes with various features that influence their effectiveness, depending on the type of insect being targeted (Altaf *et al*., 2016). However, there is not much information about how effective the light trap operated in the open field, especially in Malaysia, compared to current monitoring methods, which were manually done using netting, sweeping, board tapping, or survey patrol. In this study, light traps' ability to determine patterns and levels of BPH populations, mainly migratory and adult BPH, will be evaluated.

2. Materials and Methods

2.1 Study Site

This study has been carried out at Batu 17, Sungai Limau Yan, Kedah, in the northern part of Malaysia. This site was selected due to its condition and is known as one of the hotspot areas for BPH. The sampling area's criteria should be far from the external light source to avoid light source contamination and maintain singular and controlled lighting from the light trap installed inside the paddy field. Then, the traps are fitted and placed at the appropriate predetermined location covering an area of 300 hectares of paddy fields.

Figure 1. Location of light trap and study area

2.2 Sampling and Experiment Design

A modular light trap that MARDI has developed was used in this study. The light traps are ideal for monitoring migratory insects and predicting hopper burn events (Hirao, 1979, Crummay & Atkinson, 1997). The device is equipped with a solar system and a control timer, which facilitates selecting sampling locations according to our needs and requirements. The light trap has a filter layer with a specific hole size that prevents large insects from being trapped compared to BPH. A transparent adhesive plastic size A3 was used for sampling activities to obtain an adequate sample that is easy to process. The light trap is set to operate for three hours a day, starting from 7 pm to 10 pm.

Figure 2. BPH sample on A3 size adhesive plastic was taken using a light trap

We have selected aerial netting as another trapping method, which is suitable for comparison in this experiment. This method can trap BPH at the early seedling stage (immigration period of the BPH) compared to other typically ineffective methods. There are no-tillers produce, and seedlings were still very short (Badrulhadza *et al*., 2013). A net trap is mounted on a steel pole at three levels of height, 5, 10, and 15 meters, and the samples were collected on the same day as the light trap sampling. Trap sampling is carried out as early as 0 days after sowing (DAS) to 112 DAS. The samples from both light trap and aerial netting were collected twice a week on Monday and Thursday and brought back for identification and manually count by the lab's expertise. The collected sample's quality and integrity are less than a week before processing, or else the processed data contained an error.

3. Results

Figures 3 and 4 show the mean numbers of BPH trapped using the light trap and aerial netting method. Both graphs showed the BPH population's fluctuation throughout planting season from 0 DAS until 112 DAS.

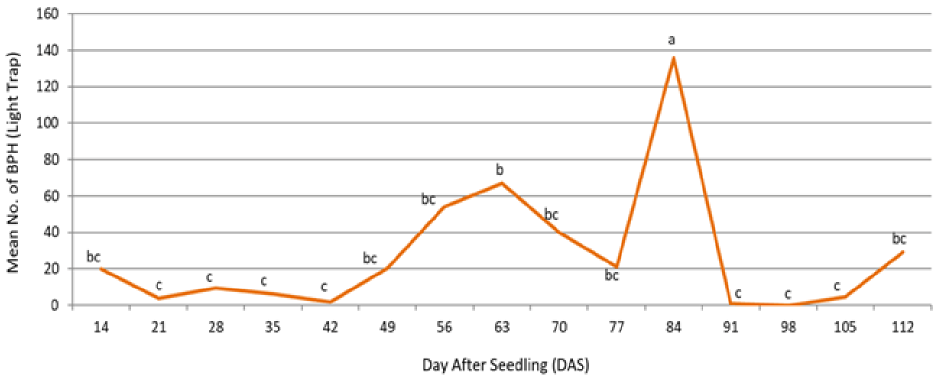

Figure 3. Brown planthopper population captured using a light trap

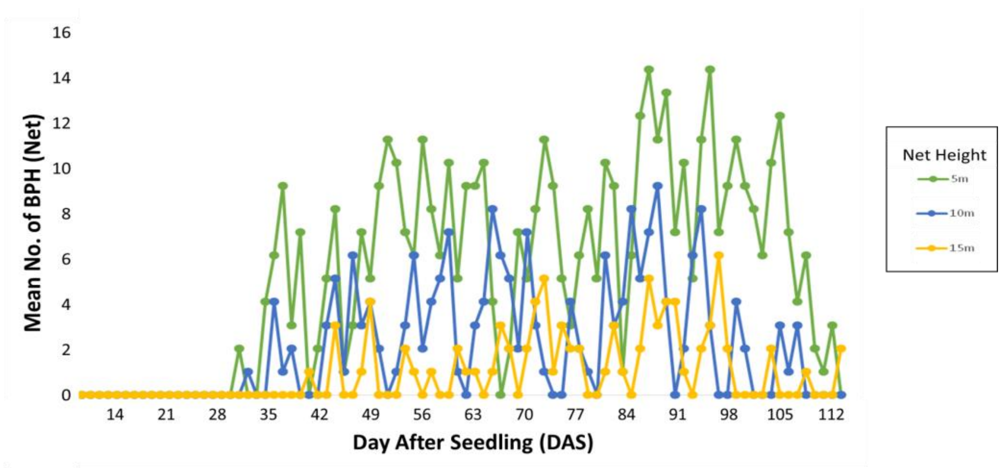

Figure 4. Brown planthopper population captured using aerial netting

Figures 3 and 4 show that the presence of BPH can be detected as early as 14 DAS using a light trap, while the aerial net detects BPH only two weeks later on the 28 DAS. The graph also shows that the number of insects before 40 days is low, less than 20. It might be due to the abundance of natural enemies controlling the BPH population at the early crop stage. On the other hand, second and third generations have been developed after 40DAS.

During this experiment, farmers in the surrounding of the study area had carried out pest control activities. Insecticides have been applied three times throughout the season at 55DAS, 70DAS, and 85 DAS. It reflects in both graphs above as there is a significant drop in BPH after 84 DAS, where farmers implement insecticide application to control the BPH.

The results from the trapping method indicated that the number of BPH trapped in the light trap (mean=27.61) demonstrated significantly higher than the aerial netting (mean=3.75), t (15) = t 2.54, p<0.05 (Figure 5).

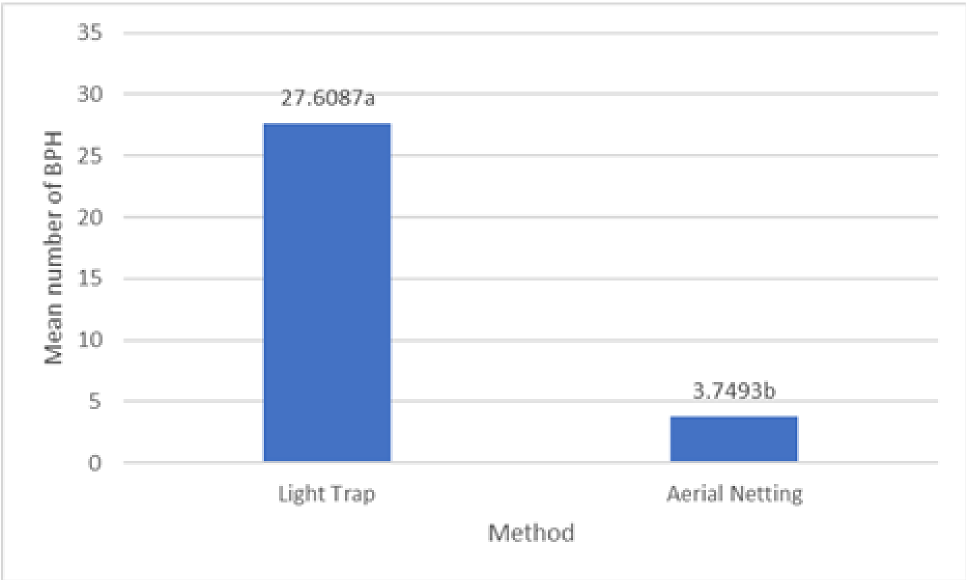

Figure 5. Comparison number of BPH between light trap and aerial netting

4. Discussions

The changes in BPH population growth could be seen over the plant growth stage. BPH's complete life cycle is between 25-29 days and varies between the species (Wada & Nik, 1992). As a result, BPH population growth is expected to increase at 60 DAS (reproductive stage) and 85 DAS (ripening stage). It is crucial to know the BPH population's level at the reproductive and ripening stages since both determine the crop yield. It is noticeable that there is quite a big difference in the number of BPH between light trapping and aerial netting method, which is almost ten times higher using the light trap. It may be due to the light trap's better coverage area, which could attract and trapped winged adult BPH from a distance due to the light attraction.

The use of light traps is seen to be much better in detecting the presence of migratory BPH at the early stages of the crop. With early detection of immigrant density, the BPH population growth rate and the risk of outbreak events could be successfully predicted for the late crop stage (Badrulhadza *et al*., 2013). It would also help with a better insecticide application schedule plan, where there is a possibility of preventing excessive pesticide application and avoiding waste of operating costs.

5. Conclusions

Pest monitoring has become crucial in agriculture protection. Improvement and development of new technology in pest monitoring are needed in line with rice farming technology advances. Current pest monitoring methods are laborious and require a high cost to cater to large paddy cultivation areas. With a frequency of 15 to 30 days between sampling time, the conventional method cannot give us an actual field population pattern and presence of insect migration.

Based on this study, there is a strong correlation between the two trapping methods in giving the population pattern of BPH. However, the use of a light trap provides us better actual population of BPH in the field. The findings suggested that light trap provides more reliable and accurate information in predicting the risk and potential crop damage. It could be useful to develop a risk assessment model in monitoring the BPH population for further research work, especially in early warning system technology. Thus, a light trap is recommended to forecast and better pest control management and be applied in Malaysia's paddy cultivation area.

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