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FULL PAPER

Planthopper population monitoring in Malaysian rice granary as a pre-requisite in releasing new rice varieties

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Abstract

Brown planthopper (BPH) and green leafhopper (GLH) are among the major insect pest in Malaysian rice cultivation. The existence of a high population with a serious infestation of these insects can result in low rice yield for the farmers. The importance of these insect pests is among those taken into account in the development of new rice varieties. Thus, in the assessment of new rice varieties in the field trial plot, BPH and GLH population monitoring activities were carried out at nine selected rice fields for two seasons of rice cultivation. The results showed that there were significant differences between the location of trial plots for BPH and GLH populations in the fields. Seberang Perai, Pulau Pinang had the highest BPH population (mean, 1.37 hoppers) and Pendang, Kedah had the lowest (mean, 0.27 hoppers). The GLH population is the opposite, with Seberang Perai, Pulau Pinang having the lowest population (mean, 0.05 hoppers) and Pendang, Kedah having the highest population (mean, 1.80 hoppers). The insect monitoring conducted in Seberang Perak, Perak for the main season of rice cultivation recorded a high BPH population and exceeded the economic threshold level (ETL). It's almost the same in Sungai Besar, Selangor for the off-season of rice cultivation. In Pendang, Kedah, the GLH population is high and exceeds the economic threshold level (ETL) during the main season of rice cultivation. The presence of BPH and GLH populations varies by location as well as the rice planting season.

1. Introduction

Rice plants continuously encounter biotic stresses, for example, attacks by a diverse range of organisms. Unfortunately, the rice plants cannot move to escape damage. Insects cause injury to plants to secure food either directly or indirectly and almost all parts of the plants like roots, stems, shoots, leaves and fruits can be attacked and damaged by insects (Atwal and Dhaliwal, 2015). Brown planthopper (BPH) and green leafhopper (GLH) are the most economically important pests of rice plants. These planthoppers are a phloem feeder and are largely monophagous on rice. A high population of BPH in an area can result in an outbreak of so-called 'hopperburn' which will cause a high loss of rice yield to farmers. In contrast with GLH where these insects are vectors of the tungro virus disease. The infestation will cause rice plants severe stunting and yellowing which can result in low rice yield (Backus *et al.*, 2005; Dupo and Barrion, 2009).

The importance of these insect pests is among those taken into account in the development of new rice varieties. Besides high-yielding varieties, rice breeders continue to search for ways to improve rice resistance against the BPH and tungro virus disease. In response to the apparent increased virulence of planthopper populations in Asia, many breeders have looked for ways to increase the durability of resistance by opting for stronger genes (genes with marked effects on planthopper fitness) and by pyramiding two or more resistance genes within a single variety (Fujita *et al.*, 2013). From the ecology perspective, besides the stronger genes owned by rice varieties, trial plot locations have to be on consideration in the assessment. Malaysian rice cultivation has different times of planting in different locations. Muda area in north Peninsular Malaysia started planting season from November to February and across the southern area, planting become late. For example, from central Selangor to south Peninsular Malaysia, the rice planting starts in January until April. Meanwhile, in East Coast Malaysia, mid-December until April is the time for planting their rice. Due to this, the movement of insects will be more mobile because the food source is always available around the

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corner.

The assessment should also be done on the factors of some locations that are focal locations for the development of some types of insects. This favourable condition becomes a hot spot area for certain species of insects (Saad *et al.*, 2012). Farmers are concerned about BPH because it has historically been linked to this issue in some hot spot areas. Infestations occurred in hot spots in almost every planting season, and they only varied in intensity from high to low. Sabah is more concerned with tungro virus disease. Rice seeds to be used in this state must be free from the source of viruses and resistant to the vector, GLH. The peninsular is also no exception to this virus attack but not so widespread. In this study, the population of BPH and GLH was assessed at various locations to determine the extent of an area's infestation. This assessment is important so that the rice varieties selected to be launched are able to withstand the infestation of these insect pests without affecting the yield. It is also important in reducing operating costs and in turn, increasing farmers' incomes.

2. Materials and methods

2.1 Materials

The standard operating procedure (SOP) for releasing rice varieties is followed to evaluate the test lines at the trial plot in different locations (MAFI, 2021). Nine locations (Figure 1) in the rice granary area have been selected for the stage of LVT (Local Verification Trial) and tested in two rice growing seasons, the main season and the off season. Five test lines had been chosen, namely MR323, MR324, MR326, MR330, and MR331 with one control variety, MR297 have been tested for this purpose. The agronomic practices were even for all varieties as recommended by Manual Teknologi Penanaman Padi Lestari (Azmi *et al.*, 2008).

Figure 1. LVT trial plot locations.

2.2 Sampling and data analysis

The sampling method for BPH and GLH population monitoring was done by using a tapping board and at least ten plants from each variety were randomly selected for each location. Samplings were done during the rice plant was after flowering stage. Sampling at this stage gave less disturbance to the rice plants. The samples were then identified and recorded before being analysed by using analysis of variance.

3. Results and discussion

Analysis of data from the results of the study shows that there was a significant difference between the location of trial plots for BPH and GLH populations in the fields. Seberang Perai, Pulau Pinang had the highest BPH population (mean, 1.37 hoppers), and Pendang, Kedah had the lowest (mean, 0.27 hoppers). Meanwhile, the GLH population is the opposite with Seberang Perai, Pulau Pinang having the lowest population (mean, 0.05 hoppers) and Pendang, Kedah having the highest (mean, 1.80 hoppers) (Figure 2). On average, both BPH and GLH populations in all locations are below five hoppers,

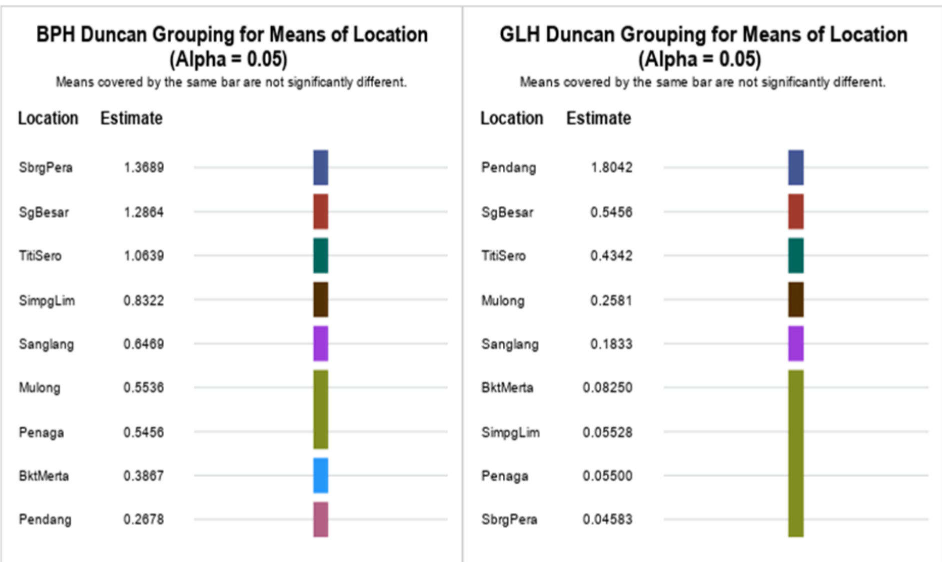

Figure 2. The significant result of BPH and GLH population monitoring between LVT trial plot locations.

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which is their economic threshold level (ETL).

The BPH population collected in Seberang Perak, Perak for the main season of rice cultivation recorded a high BPH population on MR326 and exceeded the ETL. It's almost the same in Sungai Besar, Selangor for the off -season of rice cultivation on MR 330 (Table 1). In the meantime, other locations indicate the BPH population was below ETL. Most of the GLH populations in the trial plot were below 1 hopper except in Pendang, Kedah, where the GLH population is high and exceeds the ETL on MR324, MR330 and MR297 during the main season of rice cultivation (Table 2). The data collected in Penaga during the off season have no GLH population recorded.

According to the data collected, BPH and GLH populations vary depending on the planting season and location. The study area covers rice granary in Peninsular Malaysia and is not restricted to areas that can produce high yields including hot spots that cause pest infestation problems. The hot spot area was not properly documented by the authorities; instead, the agriculture officer and local farmers chose the location. They were aware of the issue because the infestation repeatedly occurs season by season and only differs in the level of infestation, high or low (Safina, 2021). Common control measures can reduce the infestation level, but if the situation arises unexpectedly, the infestation causes a significant loss in rice yield.

Table 1. Mean individual number of BPH at different trial plot locations

Main Season (2019/2020)									
Variety	Sanglang	Penaga	Pendang	Mulong	Sbrg. Perak	Bkt. Mertajam	Sg. Besar	Simpg. Lima	Titi Serong
MR 323	0.89	0.22	0.33	1.33	0.55	1.11	0.22	0.44	0.89
MR 324	0.77	0.00	0.11	0.00	0.11	1.00	0.22	0.44	2.00
MR 326	0.44	0.44	0.89	0.22	11.67	0.11	0.00	0.67	1.22
MR 330	1.00	0.67	0.00	0.11	2.66	0.33	0.33	1.45	3.33
MR 331	1.00	0.33	0.00	0.33	0.55	0.22	0.11	0.00	1.89
MR 297	0.78	0.22	0.11	0.89	0.00	0.33	0.22	0.66	1.56
Off Season (2020)									
Variety	Sanglang	Penaga	Pendang	Mulong	Sbrg. Perak	Bkt. Mertajam	Sg. Besar	Simpg. Lima	Titi Serong
MR 323	0.55	0.44	0.44	2.33	0.00	0.22	1.66	1.11	0.00
MR 324	0.78	0.67	0.44	0.89	0.00	0.11	1.00	0.44	0.89
MR 326	0.11	0.33	0.67	0.11	0.56	0.44	1.67	2.11	0.33
MR 330	0.00	1.55	0.22	0.22	0.11	0.11	6.45	0.33	0.33
MR 331	0.44	0.56	0.00	0.22	0.22	0.22	0.56	1.23	0.00
MR 297	1.00	1.11	0.00	0.00	0.00	0.44	3.00	1.11	0.33

Table 2. Mean individual number of GLH at different trial plot locations

Main Season (2019/2020)									
Variety	Sanglang	Penaga	Pendang	Mulong	Sbrg. Perak	Bkt. Mertajam	Sg. Besar	Simpg. Lima	Titi Serong
MR 323	0.33	0.00	1.00	0.89	0.00	0.00	0.11	0.00	0.44
MR 324	0.22	0.00	7.22	0.44	0.22	0.00	0.44	0.00	1.11
MR 326	0.22	0.00	0.44	0.44	0.00	0.11	0.00	0.00	1.11
MR 330	0.33	0.44	5.78	0.33	0.11	0.00	0.00	0.00	0.22
MR 331	0.22	0.00	0.66	0.11	0.11	0.00	0.00	0.44	0.55
MR 297	0.11	0.22	6.00	0.56	0.00	0.00	0.00	0.11	0.44
Off Season (2020)									
Variety	Sanglang	Penaga	Pendang	Mulong	Sbrg. Perak	Bkt. Mertajam	Sg. Besar	Simpg. Lima	Titi Serong
MR 323	0.11	0.00	0.22	0.33	0.11	0.22	0.33	0.00	0.55
MR 324	0.22	0.00	0.00	0.00	0.00	0.00	1.22	0.00	0.67
MR 326	0.22	0.00	0.11	0.00	0.00	0.22	0.56	0.00	0.00
MR 330	0.00	0.00	0.00	0.00	0.00	0.22	1.33	0.11	0.11
MR 331	0.11	0.00	0.00	0.00	0.00	0.00	2.23	0.00	0.00
MR 297	0.11	0.00	0.22	0.00	0.00	0.22	0.33	0.00	0.00

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Different location positions also lead result in different farming practices and attitudes, which in turn affect different numbers of insect populations. Several farmers use fertilisation techniques and activities that are different from the common or standard practices. Among the activities are fertilising without taking into account the rice crop's proper age or condition, adding or reducing fertiliser at a rate that is different from what is recommended, and adding additional fertiliser without considering the rice crop's need. Various study has shown that adding more nitrogen fertiliser will increase insect pest infestation (Kazushige, 1982; Kulagod *et al.*, 2011; Singh *et al.*, 2019). The nitrogen fertiliser increased the effect of photosynthesis without harming the rice crop. However, it also can increase the infestation level of BPH and GLH due to more succulent tissues produced inside the rice plants. Additionally, the improper use of insecticide can cause differences in insect populations between locations. Plant resistance levels also are reduced with the overuse of insecticides. Insecticide application should be done when the insect population reaches the ETL. However, farmers do not abide by it and allow spraying according to the schedule of habits or the influence of friends, normally five times per season which is very excessive. As a result, the insect becomes resistant and the populations may develop rapidly due to these insecticide abuse activities (Roush and McKenzie, 1987; Fujita *et al.*, 2013; Atwal and Dhaliwal, 2015).

The weather is different from north to south in Peninsular Malaysia. Location-specific variations in temperature and rainfall have an impact on how insects develop. However, no records of weather readings were taken during the study period as there were no weather stations nearby. The temperature has a direct impact on the survival, reproduction and food searching of planthopper. Nevertheless, it is limited until the temperature reaches 33.9°C (Hu *et al.*, 2011). Areas that have high rainfall provide conditions that are very suitable for breeding insects and no migration occurs to other areas. Significant weather changes between high temperatures and heavy rains make insects act aggressively to infest rice crops and develop faster to continue their survival (Hu *et al.*, 2011; Win *et al.*, 2011; Madhuri *et al.*, 2017).

4. Conclusion

The presence of BPH and GLH populations varies by location as well as the rice planting season. The selection of rice varieties to be brought to launching should take into account their suitability and resistance level to BPH and GLH infestation in the rice field. For some areas where the insect population exceeds the ETL, they may require special plant control strategies to maintain the yield and quality of rice. However, other areas need to be monitored continuously before the incident happens.

Conflict of interest

The author strongly confirms that this research was conducted with no conflict of interest.

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