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Field Population Abundance of Leafhopper (Homoptera: Cicadelidae) and Planthopper (Homoptera: Delphacidae) as Affected by Rice Growth Stages

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Abstract. The leafhopper (Homoptera: Delphacidae) and planthopper (Homoptera: Cicadelidae) are considered as important rice pest in Asia including Malaysia. As phloem-feeders, they can cause loss to rice growth development and their population abundance is thought to be influenced by rice growth stages. This study was conducted to examine the population of Delphacidae and Cicadelidae between different rice growth stages, i.e. before and after rice planting periods. Monthly sampling was conducted in three sites in Kuala Selangor at before planting, vegetative, reproductive, maturing stages and post-harvest period using sweeping net and light traps. Population abundance of Delphacidae and Cicadelidae were found to be significantly different and positively correlated with different rice growth stages ($p<0.05$). Delphacidae was most abundance during maturing stages, while the abundance of Cicadelidae peaked during reproductive stage of rice growth. Differences in temporal abundance of the population of these two homopterans indicated adaptive feeding strategy to reduce food competition.

Keywords: Planthopper, leafhopper, Kuala Selangor, Malaysia, rice growth stages.

INTRODUCTION

Rice planthopper (Homoptera: Delphacidae) and leafhoppers (Homoptera: Cicadelidae) remain as important rice pests in rice granary areas especially in Malaysia [1]. Rice planthoppers comprises of brown planthoper (*Nilaparvata lugens)* and white backed planthoppers (*Sagotellaa furcifera)*, while leafhopper comprises of zig-zag leahopper (*Recilia dorsalis*) and green leafhopper (*Nephotettix* spp). These species responsible for losses in the rice fields in Asia including Malaysia. Population of leafhoppers and planthoppers in rice field are influenced by many factors from ecological and biological features to their control practices [2]. One of the factors that affects the population of leaf and plant hoppers is rice physiology. Previous studies have shown that population abundance of plant hopper and leafhopper changes significantly during different rice development stages. This was due to physiological changes in rice plant from early tillering, maximum tillering and entering into milking stages which are crucial in rice development [3]. Leaf- and plant-hoppers attack rice plants by sucking the phloem sap rich in sucrose, potassium and amino acids [4]. The objective of this study is to compare the changes in population abundance of Delphacidae and Cicadelidae affected by the rice growing stages. This information is important for the control of these pests as each of them may response differently to any control method employed.

MATERIALS AND METHODS

Study Area

The study was carried out in rice field located in Kuala Selangor and Sabak Bernam in Selangor state, Malaysia. The rice fields are situated in a flat land and were used as agricultural land for rice farming. The area are well known as a rice field area that producing high yields, and applying heavy usage of chemical insecticides and fertilizers. The area has high rainfall levels which similar to most parts of the country.

Sawah Sempadan lies between 3°28’17.82”N latitude and 101°13’0.4.28”E longitude. For Sungai Burong rice fields, it is lies on 3° 30’04.02’N latitude and 101_o7’34o81’ E longitude. While for Sekichan rice field lies on

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3°30'36.28'N latitude and 101°07'57.74" E longitude. All areas were cultivated with paddy field more than 25 years and have proper irrigation system that was controlled by Department of Agriculture officer. Research sites were cultivated with MR 219 breed that have moderate tolerant to diseases endemic and have average life span between 110 to 120 days before harvesting periods.

Sampling Procedures

Sampling was performed each monthly between December 2011 until June 2012 using light traps and sweeping nets based on the rice growth stages, namely vegetative, reproductive and maturing stages as well as pre- and post-harvest periods. For lights trapping, sampling was conducted using mercury light traps and white plain sheet from 1900 - 2200 hours. Sweep nets were used to capture flying insects in the rice field. Sweeping process was done in the rice fields from 0800 - 1100 hours. All specimens collected were killed by ethyl acetate fume. Samples were then preserved in alcohol 70% before further identification. Sampled insects were sorted to their morpho-species under stereo microscope (Stemi 2000, Carl Zeiss). Identification was family level using published keys [5] and by comparing with type specimen in Centre of Insects Systematics (CIS), Universiti Kebangsaan Malaysia (UKM).

Data Analysis

Number of individuals was used to calculate relative abundance of Delphacidae and Cicadelidae within each family as follows: (number of individual belonging to a given family)/ total number of specimen collected) x 100%. Abundance pattern of Delphacidae and Cicadelidae between rice growths stage were determined based on percentages. Regression analysis was performed to determine correlation between the number of hoppers and the growing stages of rice using SPSS 19 (IBM).

RESULTS

There was a significant difference in the mean number of delphacid with growth stages ($F = 45.35$, $df = 4,14$, $P<0.05$). The mean number of delphacid was significantly higher during maturing stages than during other rice growing stages (FIGURE 1 (a)). The abundance of Delphacid was lowest at the pre-planting stage and did not differ significantly during vegetative stage ($P>0.05$). However, the mean abundance of delphacid per growth stage during the pre-planting was significantly lower than that of reproductive, maturing and post-harvest stages ($P < 0.05$).

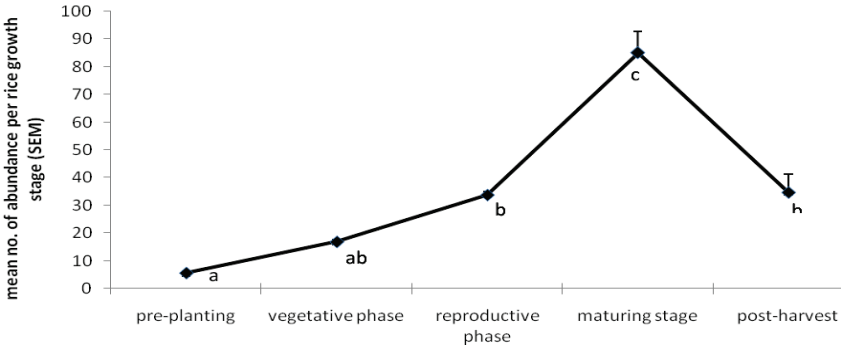
The trend showed by cicadelid was somewhat different from that of delphacid (FIGURE 1 (b)). The mean number of cicadelid was also differed significantly among rice growing stages ($F = 33.20$, $df = 4,14$, $P<0.05$). However, the cicadelids were significantly more abundant during reproductive stage than during other growing stages (FIGURE 1 (b)) ($P<0.05$). Interestingly, the abundance of cicadelid was very low during the maturing stage, in contrast to the delphalid, and that was not significantly different with that pre-planting and vegetative stages but significantly differed with post-harvest stages.

In general both hoppers are significantly more abundant in mid-growing stages with lowest during early stage but the trend of delphacid and cicadelid population abundance somewhat different in mid-growing stages (FIGURE 1). The cicadelids peaked first during reproductive stage followed by delphacid during mature growing stage. Spherman Rho correlation analysis showed that there are significant correlations between the number of Delphacidae and Cicadelidae per rice growth stages ($P<0.05$). Abundance of Delphacidae between rice growth stages have moderate correlation coefficient ($r^2 = 0.66$). Thus, weak correlations ($r^2 = 0.33$) was found between abundance of Cicadelidae between rice growth stages. Both Delphacidae and Cicadelidae have positive correlation to their growth stages.

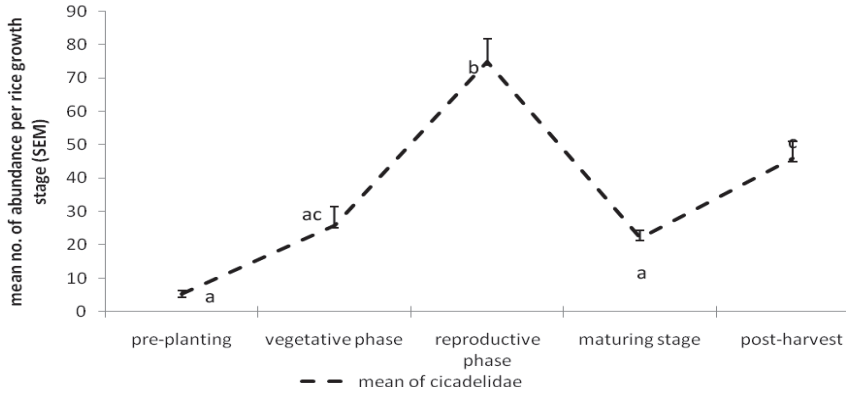
DISCUSSION

Our results showed that the abundance of leaf hoppers and plant hopper are varied between rice growth stages despite the fact that both families are phloem feeders. Both leaf hopper and plant hoppers exhibited population development where it reaches peak and then declined towards post-harvest period. The differences in the abundance of hoppers during separate growing stage of rice indicate that there is a temporal niche between the two hopper

species. This probably due to avoidance for food competition and/or probably predation. This results were similar to Zhong-xian et al. [6] that showed that the population of brown planthopper is increased during reproductive stage until it reached to maximum level at milking stages (early maturing stage). While for Cicadelidae, study have showed that



(a)



(b)

FIGURE 1. (a) Mean number of Delphacidae per rice growth stages. (b) Mean number of Cicadelidae per rice growth stages. Mean not sharing same letter are significantly different (P<0.05) between them.

their population abundance increase with rice growth [6] which are similar in case. As food availability increases during rice growth, the population and abundance of leafhopper and planthopper increase to maximum number and declined thereafter due to decreasing in food condition and physical parameters in rice field [7].

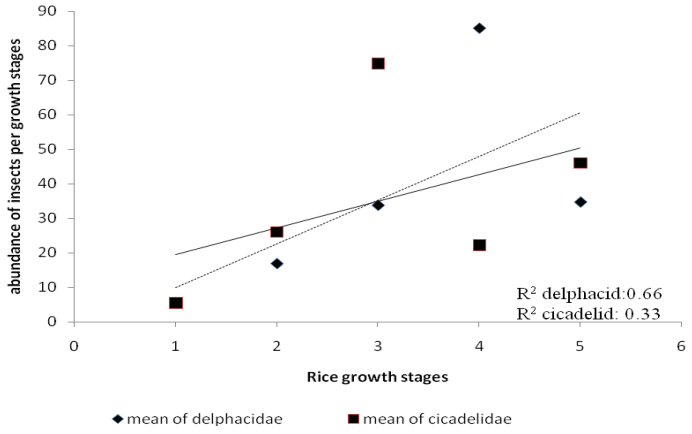


FIGURE 2. Relationship of mean abundance of delphacid (- - -) and cicadelid (----) per rice growth stages between rice growth stages. Number in x-axis represent 1-preplanting period, 2-vegetative period, 3-reproductive period, 4-maturing period and 5-post-harvest period.

Other factors that may contribute to the variation were the farmers' practice in applying nitrogen fertilizer during late reproductive stages until early maturing stages. The population of planthopper increased significantly when the nitrogen level in soil increased [6-8]. Other factors are hoppers' feeding area. As basal root area increased, the areas will be occupied by the planthoppers and leafhopper as they are phloem feeders. This explained the increased of pest throughout the vegetative stages until the reproductive stages [8]. Thus, the rice physiology that undergoes growth development had affected the growth of Delphacidae and Cicadelidae [9].

Nevertheless, abundance of Cicadelidae during sampling showed that they were correlated however the reason is not well understood. It may be due to the population of Cicadelidae was suppress by certain factors such as predator population, nitrogen contain in the soil and regular pesticides spraying in the research site [10]. These results is hope to able to forecast the population of Delphacidae and Cicadelidae in relation to rice growth stages and to estimate the resurgence of pests.

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