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Population structure of brown planthopper (*Nilaparvata lugens,* Hemiptera: Delphacidae) and attack level in endemic area of Padang city, Indonesia

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Abstract

Endemic areas of brown planthopper or BPH (*Nilaparvata lugens* Stal 1854, Hemiptera: Delphacidae) is an area that always provides BPH in each planting season. Kuranji and Nanggalo Sub-districts are two endemic areas in Padang City. The study aimed to determine the population structure of BPH on IR 42 variety in endemic area of Padang City. The study used a survey method by collecting BPH using a modified hand vacuum, collected from 20 samples of IR 42 variety randomly on two fields in each sub-district. The collections were carried out 3 times at 2-week intervals. The research in vegetative phase was began when rice plant was 3 weeks old after planting, while the research in generative phase was began when the rice plant released the first panicle. The results showed that overlapping generations occurred between nymph and adult (brachypteran & macropteran, male and female). The dominance as a whole was nymph (70.7%). Macropteran population was higher than brachypteran. Based on the phase of rice, BPH in generative phase was higher than vegetative meanwhile based on district, BPH in Kuranji was higher than Nanggalo. Attack percentage ranged from 51.6 - 94.1% and attack intensity ranged from 6.01-10.55%.

Keywords: *Nilaparvata lugens*, Nymph, Adult, Attack level, IR 42 variety

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Introduction

Rice (*Oryza sativa* Linnaeus) is a strategic commodity of agriculture and the main food crop in Indonesia. Population increase makes the need for rice increase continuously. According to Irianto (2009), food supply in the next 20 years must be faster than the rate of population growth. It is estimated that by 2020, rice needs will reach 35.97 million tons assuming consumption of 137 kg/ capita. Therefore, the availability of rice has always been a government priority because the lack of rice supply will have an impact on people sustainability.

West Sumatra Province is ranked eighth provinces as a rice producer in Indonesia, including Padang City. There are 3 Sub-districts of Padang City which have the widest area of rice, namely Kuranji with an area of 5,446 ha, Koto Tangah with an area of 3,122 ha and Pauh with an area of 2,516 ha (Central Statistics Agency, 2016). Padang Agriculture Office (2018) stated that there were many problems in optimizing rice production, including attacks by pests and pathogens, such as brown planthopper or BPH (*Nilaparvata lugens* Stal 1854, Hemiptera:

Delphacidae). The BPH attack in Padang City began to be troubled since 2015. In 2015, the BPH attacked 61.7 ha of farmers' land and then in 2016 there was an increase of attacks 3.3 times (201.17 ha) and to be 8.8 times (545.54 ha) in 2017. The BPH took nutrition from stem of rice, and sucked assimilates from the phloem. High population and feeding by a large number of BPH may result in drying of the leaves and wilting of the tillers, called by hopperburn (Huang et al., 2001).

The endemic area is the main source of BPH to maintain its existence and able to support of BPH during planting season. BPH attacks are always high in endemic areas (Romadhon, 2007). Padang Agriculture Office (2018) has classified Kuranji and Nanggalo Sub-districts as BPH endemic areas of Padang City although the attacks continued to spread in nine other districts and attacked various varieties planted by farmers. This study aimed to determine the population structure and attack level of BPH in endemic areas of Padang City.

Material and Methods

The research was conducted from August to December 2017 in the endemic areas of Padang City, namely Kuranji District (0º54'13"S 100º23'03"E; 0º55'55"S 100º24'40"E) and Nanggalo (0º54'13"S 100º23'03"E; 0º54'16"S 100º22'34"E) and Laboratory of Insect Bioecology, Department of Plant Pests and Diseases, Faculty of Agriculture, Universitas Andalas. The study was conducted in survey using purposive sampling method in which the sub-district with the highest attack of BPH and endemic area of Padang City, namely Kuranji and Nanggalo. In each sub-district, one plot of rice field with a sized of 10 m x 20 m was selected.

Conventional rice cultivation was carried out by farmers, including applying synthetic fertilizer of KCl and Urea and planted IR 42 rice variety. In terms of pest control, farmers used synthetic insecticides such as Pimetrozin, Imidacloprid, BPMC, Fipronil, and Carbofuran. Farmers applied insecticide 1 to 3 times each planting season. Farmers mixed two to three types of insecticides for one application. Furthermore, farmers also applied used oil as a pesticide in Nanggalo,

The parameters were BPH abundance (individual/ hill) per stage (nymph and adult), attack percentage and attack intensity. Each parameter was calculated by the formula:

1. $\text{WBC abundance} = \dfrac{\text{WBC population found}}{\text{20 (total of sample)}}$
2. Attack percentage
$$= \frac{\text{number of sample attacked}}{\text{20 (total of sample)}} \text{ x } 100\%$$
3. Attack intensity
$$= \sum \frac{\text{(number of sample attacked x score}}{\text{the highest score x total of sample}} \text{x } 100\%$$

Notes: scoring for BPH attack was based on Baehaki (1985).

BPH collection and observation were conducted in 6 times (3 times in the vegetative phase and 3 times in the generative phase). The collection and observation in the vegetative phase began 3 weeks after planting (wap) with intervals of once two weeks, while in the generative phase began from pregnant/ panicles out. BPH collections were carried out on 20 samples per rice field using modified D-vac vacuum. The samples were different for each observation.

The collected BPH were transferred to bottles that contained 96% alcohol and taken to the laboratory to be sorted and counted. BPH abundance was calculated based on stage, nymph and adult. Adult was distinguished according to sex (male, female) and based on wing type (brachypteran and macropteran).

Results and Discussion

BPH population (individual/hill)

The BPH abundance in endemic area of Padang City was different in each phase of rice and each area. BPH abundance ranged from 3.1 – 16.1 individual/hill. BPH abundance in vegetative phase was lower than generative, the abundance was higher in Kuranji than Nanggalo (Figure 1). That abundance was higher than not endemic area generally. Sianipar et al. (2017) found 2.1 individual/hill and then Sianipar (2018) found 0.6 individual/ hill in rice field, Jawa Barat, Indonesia.

According to Harini et al. (2013), BPH can attack rice in all phases of growth, from nursery to harvest. Baehaki et al. (2001) stated that BPH could attack dryland and wetland rice. The low abundance of BPH in the vegetative phase is natural because BPH is building a new generation to survive on the new field. The high abundance of BPH in Kuranji compared to Nanggalo was assumed to be related to differences in cultivation techniques practiced by farmers. Both sub-districts basically used synthetic insecticides to control the BPH population but with different active ingredients and spraying frequency. Farmers generally spray with pesticides when the population increases and stop when the BPH population appears to be decreasing. According to Dianawati and Sujitno (2015), the main factors that contributed to the increase in the BPH population were influenced by biotic, abiotic and rice cultivation techniques which supported the development of BPH population. Furthermore, fertilizer application to rice increased BPH fitness and starvation tolerance (Lu and Heong, 2009).

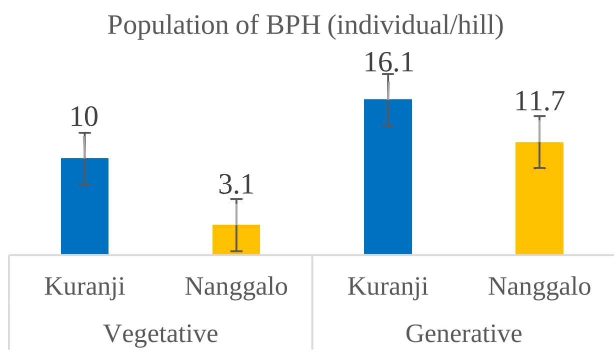


Figure-1: BPH (*Nilaparvata lugens*) abundance in vegetative and generative phases in endemic areas of Padang City (individual/hill).

Overlapping generation occurred in each growth phase and in each study area, where BPH found in nymph and adult stages (brachypteran and macropteran) simultaneously. The abundance of nymph was higher than adult and the abundance of brachypteran was lower than brachypteran (Figure 2). In the vegetative phase, brachypteran abundance was lower than macropteran, and brachypteran was higher in Kuranji than Nanggalo, even it was not found in Nanggalo. The brachypteran abundance in the vegetative phase was higher than generative, with male and female compositions tended to be similar (Table 1).
Overlapping generation is one of the characteristics of the existence of BPH in endemic area (Romadhon, 2007). The brachypteran existance showed feed availability and environmental suitability, while the macroptera existance showed the readiness of BPH to migrate to new habitat (Oktarina, 2009). The macropteran existance is more on older rice than young, and more on semi-damaged rice than healthy (Baehaki and Widiarta, 2010).

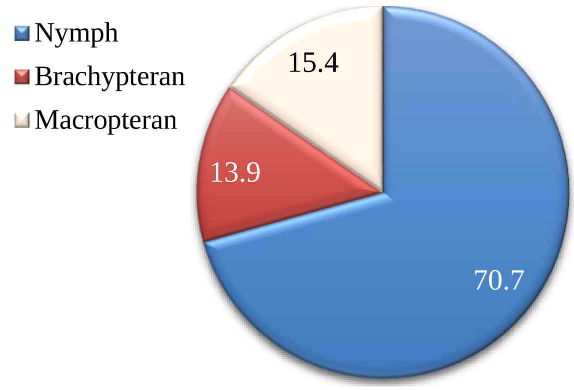


Figure-2: Structure population of BPH (*Nilaparvata lugens*) di endemic area of Padang City (individual/hill).

Table-1: BPH (*Nilaparvata lugens*) abundance in the vegetative and generative phases in endemic area of Padang City (Individual/hill).

BPH stages		Kuranji		Nanggalo	
		Vegetative	Generative	Vegetative	Generative
Nimfa		6.6	11.9	2.3	8.1
Brachypteran	♂	0,8	1.4	0.0	0.8
	♀	0.7	1.4	0.0	0.6
Macropteran	♂	0.9	0.7	0.4	1.1
	♀	1	0.7	0.4	1.1

The BPH that appears from the beginning of planting season will be able to develop one or two generations until harvest. Baehaki and Widiarta (2010) stated that the peaks of the first and second generation emerged at the age of 5-6 wap and 10-11 wap, respectively. In the vegetative phase, the BPH abundance in two sub-districts tended to increase in the third observation. In the generative phase, the BPH abundance in Kuranji decreased while in Nanggalo increased (Figure 3). Fluctuations of BPH abundance were assumed to be influenced by the time, frequency and active ingredients of pesticides used by farmers. The difference in abundance in two sub-districts will have a negative impact on rice cultivation because the condition helps each other with the availability of BPH at all times. Tauruslina (2019) reported there was genetic similarities between BPH population in endemic and non-endemic areas > 50% in West Sumatera.
Prasetyo et al. (2012) stated that the BPH outbreak was possible to happen because of spatial connectivity factor. It could be in the form of transportation and irrigation network correlation in which open area that allows BPH migration and the similarity of grain variety to occur. According to Price (1997), the high

abundance of insect in optimum conditions can cause the insect develop rapidly and become injury economically.

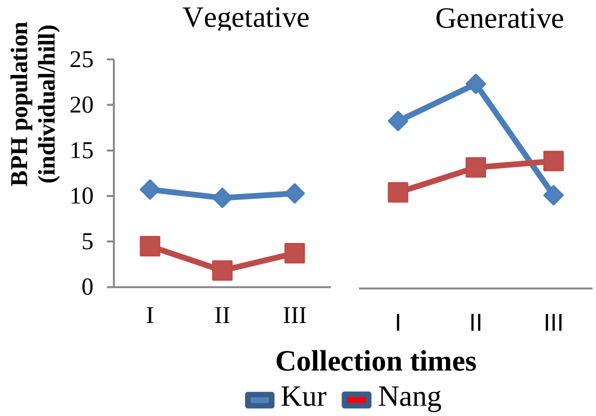


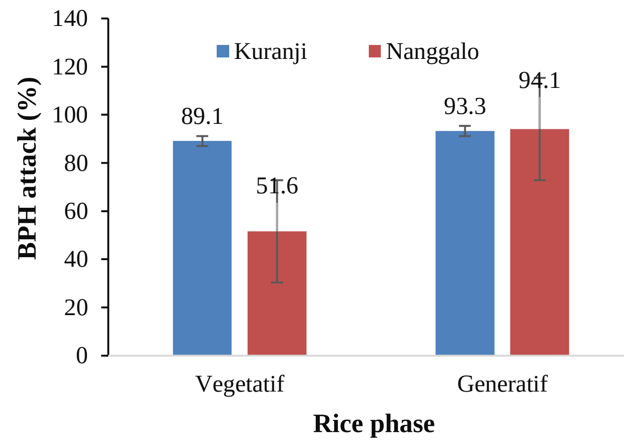
Figure-3: The development of BPH (*Nilaparvata lugens*) abundance in the vegetative and generative phases in endemic areas of Padang City (individual / hill) during 3 observations.

Observation of rice in the vegetative phase was carried out at the age of ± 3 wap at intervals of two weeks and observation of rice in the generative phase starting from pregnant rice / panicle out.

Attack level

The attack percentage in endemic area of Padang City ranged from 51.6 - 94.1%, while the attack intensity was classified as low with a range between 6.01-10.55%. The attack percentage in the vegetative phase (70.3%) was lower than generative (93.7%). The attack in the vegetative phase was higher in Kuranji (89.1%) than Nanggalo (51.6%). In the contrary, the BPH attack in the generative phase was higher in Nanggalo (94.1%) than Kuranji (93.3%). In line with that, the attack intensity in the vegetative phase (8.28%) was lower than generative (10.55%). The attack intensity in the vegetative phase was higher in Kuranji (10.55%) than Nanggalo (6.01%), while in the generative phase was higher in Nanggalo (10.64%) than Kuranji (10.46%) (Figure 4).

The attack percentage of BPH in the vegetative phase was lower when compared to the generative phase. This is due to the BPH abundance that has settled in the rice plantations. After settling, the BPH develop exponentially one or two generations. Olsen et al. (2004) stated that the attack intensity tended to be directly proportional to population abundance. In high population conditions, the attack intensity will also be high. Ahmadi (2011) reported that climatic factor such as temperature, humidity, rainfall gave a different impact to attack level of BPH.



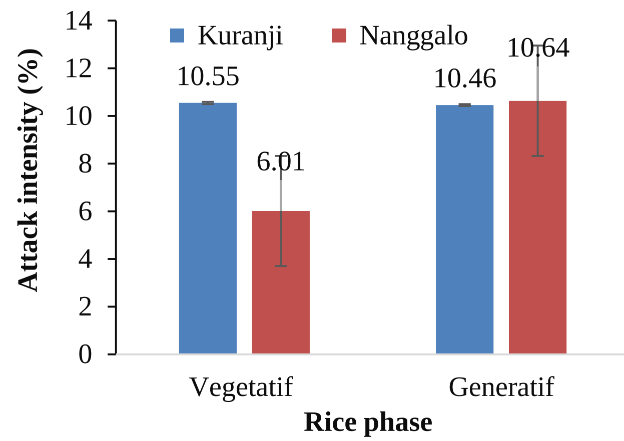


Figure-4: Attack percentage and attack intensity of BPH in vegetative and generative phases in endemic area of Padang City

Conclusion

Overlapping generations occurred between nymph and adult (brachypteran & macropteran). The dominance as a whole was nymph (70.7%), and macropteran population was higher than brachypteran. Based on district, BPH in Kuranji was higher than Nanggalo meanwhile based on the phase of rice, BPH in generative phase was higher than vegetative. Attack percentage ranged from 51.6 - 94.1% and attack intensity ranged from 6.01-10.55%.

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Contribution of Authors

Syahrawati M: Conceived idea, conducted survey, compilation of results, arranged final report and write up of article
Putra OA: Helped in survey, compilation of results, arranged final report
Rusli R: Compilation of results and write up of article
Sulyanti E: Compilation of results and write up of article

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