

Study on Population Abundance of Papaya Mealybug (*Paracoccus marginatus* Williams & Granara de Willink) in the North Minahasa Regency of North Sulawesi Province, Indonesia

William Tairas, Max Tulung, Jantje Pelealu, S.J. Rondonuwu

Abstract— We have conducted a research to study on population and the level of attacks by mealybug (*Paracoccus marginatus*), which damages the papaya plant, in three villages of papaya production centers, namely Dimembe Village, Matungkas and Paslaten in North Minahasa Regency, North Sulawesi Province, and to assess the abundance of populations of *P. marginatus* in the dry season and the rainy season. The samples were taken once in June 2011. Observations on population and attack by *P. marginatus* in the two seasons were made at intervals of one month, starting in April to December 2011 in Dimembe Village where the population of *P. marginatus* was highest.

The results showed that the abundance of populations of *P. marginatus* was found in Dimembe Village ($2,509 \pm 1,732$ individuals/plant), followed by Matungkas Village (1018 ± 745 individuals/tamaman) and Paslaten Village (421 ± 419 people/plant). The level of attack on the leaves in Dimembe, Matungkas, and Paslaten Villages were (48 ± 13) %, (25 ± 10) %, and (11 ± 7) %, respectively; while the level of attacks on fruits in Dimembe, Matungkas and Paslaten Villages were (32 ± 19) %, (9 ± 7) % and (7 ± 6) %, respectively. Population abundance of *P. marginatus* in dry season was 3226 individuals/plant which was higher than in the rainy season, which counted 285 individuals/plant. The total population of *P. marginatus* was positively correlated with the level of attack on the fruit and leaves of papaya plants. In the dry season the attack level on the fruits was 32% and 49% on the leaves; while during the rainy season the attack level was 11% on fruits and 15% on leaves.

Index Terms— *P. marginatus*, mealybug, papaya, abundance population, attack level, North Minahasa, North Sulawesi.

1 INTRODUCTION

PAPAYA mealybug (*Paracoccus marginatus*) is a destructive polifag pest of tropical fruits, vegetables, and ornamental plants [1]. *P. marginatus* is a species originated from Mexico and Central America and was first described by Williams and Granara de Willink in 1992. In 1994 *P. marginatus* became a pest of papaya in 14 countries in the Caribbean region, and in 1998 *P. marginatus* was found in the state of Florida, and in 2001 spread to the state of Illinois [2], then to India in 2007 [3].

In Indonesia *P. marginatus* was first found in papaya plants at the Bogor Botanical Garden, West Java in May and July 2008 [4], and has spread to Bali and Sulawesi islands [5]. Since the beginning of 2009 and the papaya in North Minahasa Manado has been attacked by *P. marginatus* [6]. Interviews with papaya farmers in February 2011 showed that *P. marginatus* has spread and caused damage to the leaves and fruits of papaya in North Minahasa region. So far population abundance and damages to papaya crops caused by *P. marginatus* in North Minahasa Regency has not yet been reported.

Population abundance is the number of individuals per unit area/plant where the number of organisms in a population changes over time as a result of various factors such as birth, death, immigration, and emigration [7], [8]. Abundance of insect populations is also governed by the availability of food resources [9]. Abundance and spread of pest populations in crops is very important to study to reveal various things about ecology. Therefore, a quantitative study on population growth of mealybug (*P. marginatus*) and percentage of attacks need to be carried out, especially when the epidemic. This information is needed to provide the basis for developing a technique that effectively controls *P. marginatus*. Our research was aimed to study the population abundance and attack rates by *P. marginatus* in several papaya production centers, and to analyse *P. marginatus* population abundance in the dry and the rainy seasons in papaya plants in North Minahasa Regency.

2 MATERIALS AND METHODS

Sampling and observation of the abundance of *P. marginatus* were conducted in three temperate tropical papaya producer villages in North Minahasa District, North Sulawesi Province, Indonesia. They are Dimembe Village ($01^{\circ} 30' 29.3''$ N and $124^{\circ} 58' 45.0''$ E), Matungkas Village ($01^{\circ} 28' 12.2''$ N and $124^{\circ} 57' 54.8''$ E), and Paslaten Village ($01^{\circ} 24' 19.2''$ N and $125^{\circ} 00' 10.7''$ E). Geographically, the Matungkas village is situated on about 270 m above sea level (asl) and the Dimembe village on 219 m asl in District of Dimembe, and the Paslaten village seats 274 m asl located in District of Kauditan North Minahasa Regency,

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In our research we studied the mealybug population abundance on the leaves and fruit of papaya plants in the three villages,) calculated the rate of leaf attack by *P. marginatus* in the three villages, and analysed the differences in population abundance of *P. marginatus* in the dry season and the rainy season in the village with the highest population.

Observations were made in the plantations under attacked by *P. marginatus*. Papaya plants were cultivated monoculturely. Observation plots were made by dividing the plantation area of 5000 m² into five plots. Four samples of papaya plant were taken from each plot by purposive sampling. *P. marginatus* infested papaya leaves and fruits were taken and put into plastic bags. Population abundance of *P. marginatus* was measured by counting the number of egg and nymph groups under a stereo microscope.

Percentage of *P. marginatus* on the fruits and leaves was calculated by dividing the number of fruits/leaves attacked by the total number of fruits/leaves in each plant individual by (1);

$$P = \frac{n}{N} \times 100\% \quad (1)$$

with *P* = percentage attack rate, *n* = number of fruits/leaves infected per plant, and *N* = total number of fruits/leaves per plant.

Population abundance of the papaya mealybug (*P. marginatus*) in two different seasons, i.e. the dry season and the rainy season, was calculated every month, from April to December 2011. The results were analyzed using the analysis of variance (ANOVA). If the analysis results indicated that the effect was significance, then further tests were conducted by using the Tukey method at the level of 95%.

3 RESULTS AND DISCUSSION

3.1 Population Comparison of *P. marginatus* Egg and Nymph Groups in Three Villages

Population of egg and nymph groups of *P. marginatus* diversified in all villages. Results of Anova showed that the population number of egg and nymph groups in three studied villages were significantly different (*P* ≤ 0.00) (see Fig. 1).

We found the highest population of eggs and nymphs in Dimembe village (2,509 ± 1,732 individuals/plant and 823 ± 600 groups of eggs/plant), whereas in Paslaten village gave the lowest population, although not significantly different from the population in the Matungkas village. The differences in nymph and egg populations of *P. marginatus* on papaya crops in the three villages were thought to be influenced by differences in climatic factors, plant cultivation method and the presence of natural predators, parasitoids and pathogens. Spacing of the papaya plants in Dimembe village varied from 2 to 3 meters, which was suspected to causing the easier spread of *P. marginatus* onto other papaya plants. One of the characteristics of *P. marginatus* is its first and second instars both have high activity and continuously migrate to another niche for survival. Temperature and humidity also affect pop-

ulations of the insect due to changes in physiology development, migration and dispersal, resulting in a local population explosion [10]. Variations in temperature and humidity in the crop environment (microclimate) occur due to variations in crop conditions are a result of agronomic practices in the cultivation of plants, plant population and fertilization.

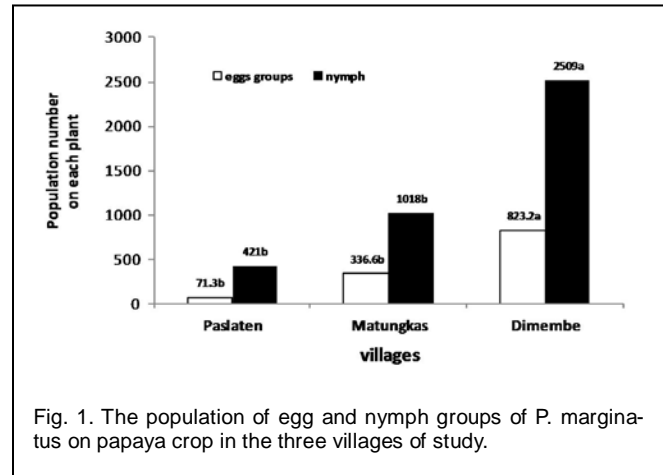


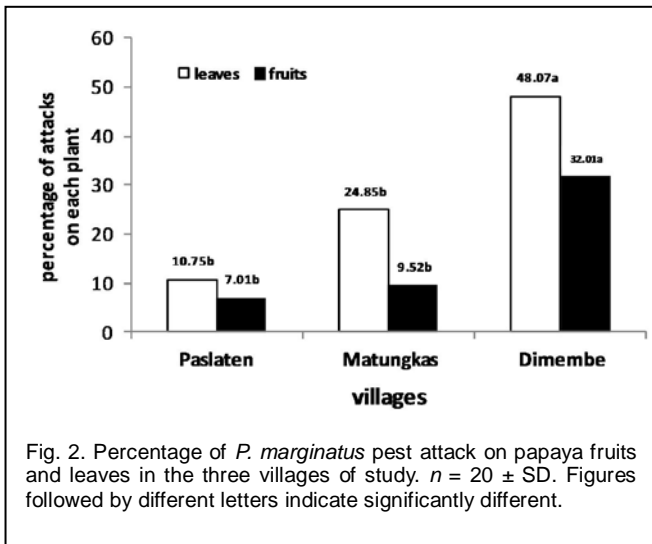
Fig. 1. The population of egg and nymph groups of *P. marginatus* on papaya crop in the three villages of study.

The high plant populations and the dense spacing allow the plants to grow very densely, resulting in microclimate in the plantation with a consequence of high susceptibility to herbivora infestation [11]. Papaya cultivation in Paslaten village is almost the same as in Dimembe village, yet mealybug *Aleorodocus dispersus* outnumbered *P. marginatus*. Low populations of *P. marginatus* in Paslaten village might be resulted from competition in one habitat and the presence of its natural enemies [12].

3.2 Attack Percentage of *P. marginatus* in the Three Villages

Results of the Anova analysis showed differences in presentage levels of mealybug attack on fruits and leaves in the three study areas (*P* ≤ 0.00). The results showed that the average percentage rate of mealybug attack on the fruits and leaves in Dimembe Village was significantly higher (32.01 ± 18.63) % than in Paslaten Village (7.01 ± 5.61) % and Matungkas Village (9.52 ± 6.61) % (see Fig. 2). Similar conditions also occurred where mealybug attack on the leaves was highest in Dimembe Village (48.07 ± 12.87) %. The level of attack in the Matungkas Village was (24.85 ± 10.26) % and Paslaten Village was (10.75 ± 7.25) %.

Population growth led to an increase in the percentage level of attack on the papaya fruits and leaves in all villages of papaya production centers. This suggests that if the population abundance of *P. marginatus* were low, the percentage of attack will itself be reduced, and vice versa. In general, this insect has a high adaptability to environmental conditions of their life. Deployment and density of the population are closely related to local conditions, such as altitude [13] and climatic factors (temperature, humidity, rainfall, light) and biotic factors [9], [14].

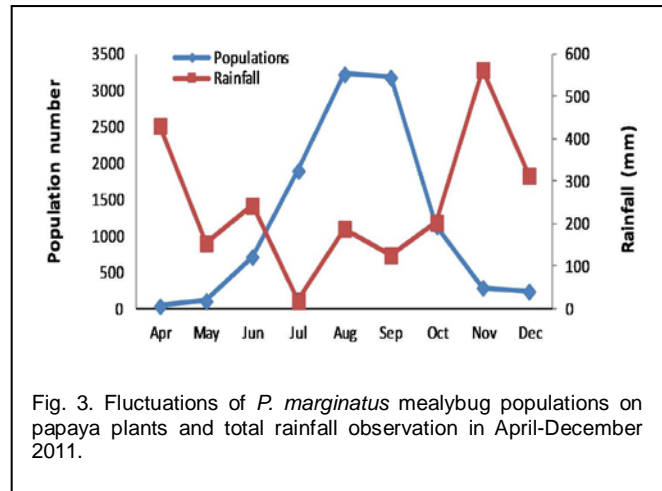


3.3 Population Abundance *P. marginatus* in Dry and Rainy Seasons

Observations on abundance of population of *P. marginatus* in the dry season and the rainy season were carried in Dimembe Village as the village showed the highest mealybug population. The results showed that from April to September the total population significantly grew from 30 individuals/plant in April up to 3,183 individuals/plant in September (Fig. 3) and dropped after then in October-December. This was inline with the condition of rainfall. Changes in population abundance indicate a close relationship between the amount of rainfall and the growth of mealybug populations, where the highest population coincides with dry season [15].

Variation in population abundance of eggs also relates with changes in population of nymphs. When the nymph population increases, so does the egg number; and vice versa. The population of *P. marginatus* reached an average of 3,226 individuals per plant in August when the total rainfall touched 188.5 mm (Fig. 3). Such condition indicates a tight relationship between the population growth rate with the surrounding environment as explained by Painter [16] and Chapman [17]. Mealybug take approximately 2 to 3 months to grow properly when climatic conditions support, such as low rainfall, and food is plenty. In contrast, when the climatic conditions are not suitable, e.g. in rainy season, the mealybug populations decline. Our findings showed a 563.5 mm rainfall and 28-day raining yields a declined population by an average of 285 individuals per plant. The high population in the dry season is a common phenomenon that has long been known on tropical insects [18].

The influence of temperature on the development of insects closely relates to humidity as it could influence the growth and insect activity. During our observation in July to September the average temperature was 32 °C and humidity average of 53.33%, which was an ideal condition for the development of mealybug [15].



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4 CONCLUSION

Papaya mealybug *P. marginatus* has spread in three villages of papaya producers in North Minahasa Regency, North Sulawesi Province. Of the three villages observed, Dimembe Village had the highest population abundance (2,509 ± 1,732 individuals/plant), which was associated with a high rate of attacks on leaves (48.07 ± 12.87) % and the fruits (32.01 ± 18.63)%. Population abundance of *P. marginatus* on papaya plants showed differences in two different seasons. The population was higher in the dry season (an average 3,226 individuals/plant) and lower in the rainy season (an average 285 individuals/plant).

Our study did not take into account the presence of natural enemies of *P. marginatus*. Therefore, it is important to study the population conditions by looking at the influence of the natural enemies.

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