PEST INSECTS IN CASSAVA PLANTATIONS INTERCROP WITH DIFFERENT PLANTS AT GUNUNGKIDUL, YOGYAKARTA, INDONESIA

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ABSTRACT

Cassava is one of the most widely cultivated food crops. One of the cassava production center is located in Gunungkidul, Yogyakarta, Indonesia. Due to the limited information on pests associated with cassava, especially in Gunungkidul, this study was conducted to investigate the diversity of insect pests in cassava plantations in this location. The study was carried out in three locations i.e., Bedoyo, Karangasem, and Kenteng Village. Insect sampling was performed in three areas within each location as many as four times. Each area consisted of five sampling plots. In total, there were 9 areas and 45 sampling plots. Insect sampling was conducted using yellow pan traps and sweeping net. A total of 23500 individuals of insect pests collected in 8 orders, 47 families, and 95 species. The most common orders were Hemiptera (31 species), Coleoptera (25 species), Diptera (13 species), Lepidoptera (11 species), and Orthoptera (10 species). Other species such as Isoptera (1 species), Thysanoptera (2 species), and non-insects Acari (2 species). The diversity of insect pests and the number of individuals (abundance) of insect pests differ between locations. Nonmetric multidimensional scale analysis shows that there are differences in the composition of insect pest species between locations. The highest diversity of pest species was found in Bedoyo Village. The most common species was also observed in Bedoyo compared to other location caused by the high population of whitefly (*Bemisia tabaci*) and mealybug (*Ferrisia virgata*, *Paracoccus marginatus*, and *Pseudococcus jackbeardsleyi*).

Keywords: *Ferrisia virgata*, Hemiptera, *Paracoccus marginatus*, pest diversity, *Pseudococcus jackbeardsleyi.*

ABSTRAK

Ubi kayu merupakan tanaman makanan yang paling banyak diusahakan. Salah satu pusat pengeluaran ubi kayu terletak di Gunungkidul, Yogyakarta, Indonesia. Oleh kerana maklumat yang terhad mengenai perosak ke atas ubi kayu, terutama di Gunungkidul, kajian ini dilakukan untuk mengkaji kepelbagaian serangga perosak di ladang ubi kayu dari lokasi ini. Kajian ini dilakukan di tiga lokasi iaitu di Bedoyo, Karangasem dan Desa Kenteng. Pensampelan serangga dilakukan di tiga kawasan di setiap lokasi sebanyak empat kali. Setiap kawasan terdiri daripada lima plot persampelan. Secara keseluruhan, terdapat sembilan kawasan dan 45 plot persampelan. Pengambilan sampel serangga dilakukan dengan menggunakan perangkap dulang kuning dan jaring sauk. Sebanyak 23500 individu perosak serangga dikumpulkan dalam lapan order, 47 famili, dan 95 spesies. Order yang paling banyak dijumpai adalah Hemiptera (31 spesies), Coleoptera (25 spesies), Diptera (13 spesies), Lepidoptera (11 spesies) dan Orthoptera (10 spesies). Spesies lain seperti Isoptera (1 spesies), Thysanoptera (2 spesies) dan Acari (bukan serangga) (2 spesies). Kepelbagaian serangga perosak dan bilangan individu serangga perosak berbeza antara lokasi. Analisis skala multidimensi bukan metrik menunjukkan bahawa terdapat perbezaan komposisi spesies perosak serangga antara lokasi. Kepelbagaian spesies perosak tertinggi terdapat di Desa Bedoyo. Spesies yang paling kerap ditemui di Bedoyo berbanding lokasi lain yang disebabkan oleh populasi lalat putih (*Bemisia tabaci*) yang tinggi dan *mealybug* (*Ferrisia virgata, Paracoccus marginatus* dan *Pseudococcus jackbeardsleyi*).

Kata kunci: *Ferrisia virgata*, Hemiptera, *Paracoccus marginatus*, kepelbagaian perosak, *Pseudococcus jackbeardsleyi.*

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is one of the main staple foods for millions of people living in the tropics, such as Africa, South America, and Asia (McCallum et al. 2017). Cassava is estimated to be consumed by around 800 million people worldwide (Howeler et al. 2013). Besides being consumed as food, cassava is also widely used for the production of starch on an industrial scale, animal feed, and bioethanol (Ceballos 2012; Maziya-Dixon et al. 2007). This plant is known as a plant that has a high environmental stress tolerance so that its cultivation can be carried out even on marginal lands that contain poor nutrient. This condition often becomes the main obstacle in the cultivation of most other plants. However, cassava is considered suitable to be cultivated by farmers who lack sufficient resources (Ceballos et al. 2011; Hershey et al. 2012; Jarvis et al. 2012).

Cassava is known as a plant that tends to be free from environmental disturbance both of biotic and abiotic factors, because the impact of biotic factors is only less than 5% (Henry & Gottret 1996). However, invasive insect pest attacks have begun to appear and are disturbing in recent years (Graziosi et al. 2016). These pests are partly not native pests to cassava itself. Furthermore, these pests, whose population explosion was reported previously, are now classified as endemic pests. Among the various pests that attack cassava plantations, mealybugs (*Phenacoccus manihoti* Matile-Ferrero) (Hemiptera: Pseudococcidae) are new pests in several Southeast Asia regions that can lead to crop loss (Parsa et al. 2012).

The increasing incidence of pest attacks on cassava plants requires an update of information, especially on pest diversity. However, information on the pest diversity in cassava plantation is still limited, and there have been no reports on the pest diversity in cassava plantation in Gunungkidul, as the central of cassava production in Yogyakarta. Therefore, this research was conducted to investigate the diversity of cassava insect pests at three different locations. The research results obtained were expected to be used as baseline data and references in developing pest management strategies in cassava production.

MATERIALS AND METHODS

Sampling Location

The study was conducted in cassava plantation located in Ponjong District, Gunungkidul, Yogyakarta, Indonesia. Sampling was carried out in three villages i.e., Bedoyo, Karangasem, and Kenteng Village. These locations were chosen based on the availability of cassava plants and the land conditions as presented in Table 1. Three sampling areas were determined within each village. Each sampling area consisted of 5 plots (Figure 1) with 5 sample plants within each plot. In total, there were three villages, 9 areas, 45 plots, and 225 plants as sampling units.

Table 1. Description of land condition in each research location

Location	Area	Intercrop with	Surrounding plants*
Bedoyo	1	Peanut and corn	a, b, c, d, f, g, h, i, j, k, m
	2	Peanut and corn	a, c, d, g, j, k, l
	3	Peanut	a, b, c, e, g, j, l, n
Karangasem	4	Peanut and corn	a, b, c, g, j, o
	5	Peanut, corn, chili, and long bean	a, b, e, g, j, l, p
	6	Peanut, corn, and long bean	a, b, c, g, j, l, m
Kenteng	7	Peanut, corn, chili, and long bean	a, b, c, g, j, l, m, n
	8	Peanut, corn, and long bean	a, b, c, e, g, n, q, r, s
	9	Peanut, corn, chili, and long bean	a, b, g, j, t, u

*a. elephant grass, b. river tamarind, c. teak, d. mahogany, e. banana, f. mango, g. Chinese albizzia, h. acacia, i. gliricidia, j. pigeon pea, k. laran, l. coconut, m. banana, n. papaya, o. hummingbird tree, p. bitter bean, q. jack fruit, r. bamboo, s. banyan tree, t. rain tree, u. jack bean

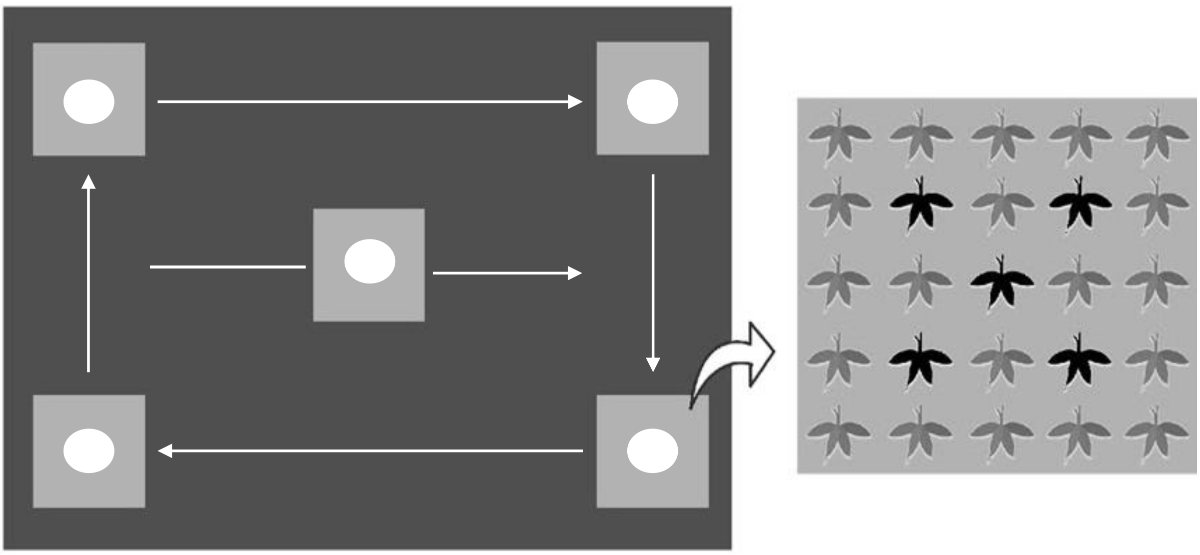

Figure 1. Plot design for sampling purpose in an area. The black square represents an area, the grey square represents a plot, circle: yellow pan trap, arrow: sweeping net track, grey cassava: plants in a plot, black cassava: sample plants

Insect Sampling

Insect samples were collected either directly or indirectly during four times observation. The direct collection was done by taking insects found in sample plants, while the indirect collection was done using traps such as insect nets and yellow pan traps. Insect collection with nets was done by swinging insect nets along the path between plots (Figure 1). The yellow pan traps used in one plot consisted of 5 traps scattered in each direction and the middle of the plot (Figure 1). The yellow pan traps were placed for 24 hours. The insects obtained were then taken to a laboratory for sorting and identified.

Species Identification

Insect samples was grouped to the order, family and genera level using some literature such as Borror et al. (1989) and Kalshoven (1981). Insect samples were then identified based on their morphological character under stereo microscope Nikon SMZ18 (Nikon Corp, Japan) to the species level. Damaged insect samples were identified to morphospecies level. For mealybugs, identification is performed using Miller et al. (2014). All identified insect samples were confirmed by a taxonomist at the Biological Research Laboratory, Universitas Ahmad Dahlan, Yogyakarta, Indonesia.

Data Analysis

The different of number of species and the different in abundance of each insect pest species were analyzed using Generalized Linear Model analysis between time observations. The diversity indices such as Shannon-Wienner index (H), Evenness index (E), and Simpson index (D) was used to see the diversity of pest in research location. Too analyze the effect of research locations against the composition of insect pest species was also analyzed using Analysis of Similarity (ANOSIM) and non-metric multidimensional scaling (NMDS) graph based on Bray-Curtis dissimilarity index (Magurran 2013) using R Statistic ver. 3.5.2 (R Core Team, 2013) with vegan package.

RESULTS

The pest insects collected in this study comprised 95 species of 23500 individuals (Table 2, supplementary file). The number of species found was not different between locations (df = 2, F = 0.268, P = 0.767). However, there were strong significant differences observed in Shannon-Wienner index (H’) (df = 2, F = 5.705, P = 0.00972), Evenness index (E) (df = 2, F = 5.632, P = 0.0102) and Simpson index (D) (df = 2, F = 5.177, P = 0.0139) of species between locations (Table 2). Karangasem had higher species diversity and evenness compared to Bedoyo and Kenteng. Meanwhile, the dominance of species was higher in Bedoyo compared to other locations.

Table 2. Species richness and species diversity of pest in each location

Location	Area	S	N	H'	E	D
Bedoyo	1	39	4135	1.67	0.46	0.76
	2	44	5995	1.20	0.32	0.58
	3	45	2237	1.76	0.46	0.73
Subtotal		67	12367			
Karangasem	4	44	1443	1.68	0.44	0.69
	5	43	638	2.08	0.55	0.69
	6	44	1189	1.51	0.40	0.55
Subtotal		68	3270			
Kenteng	7	46	2086	1.21	0.32	0.54
	8	42	3487	0.88	0.24	0.36
	9	39	2290	1.43	0.39	0.66
Subtotal		66	7863			
Total		95	23500			

S: Number of species, N: species abundance, H': Shannon-Wienner index, E: Evenness index, D: Simpson index

Analysis of similarity (ANOSIM) results showed that the structure of pest species composition was significantly different between areas (ANOSIM Statistics R = 0.679, P = 0.006). Differences in pest species composition can be seen from the NMDS locations between points for each location that are located far apart and not overlapping (Figure 2).

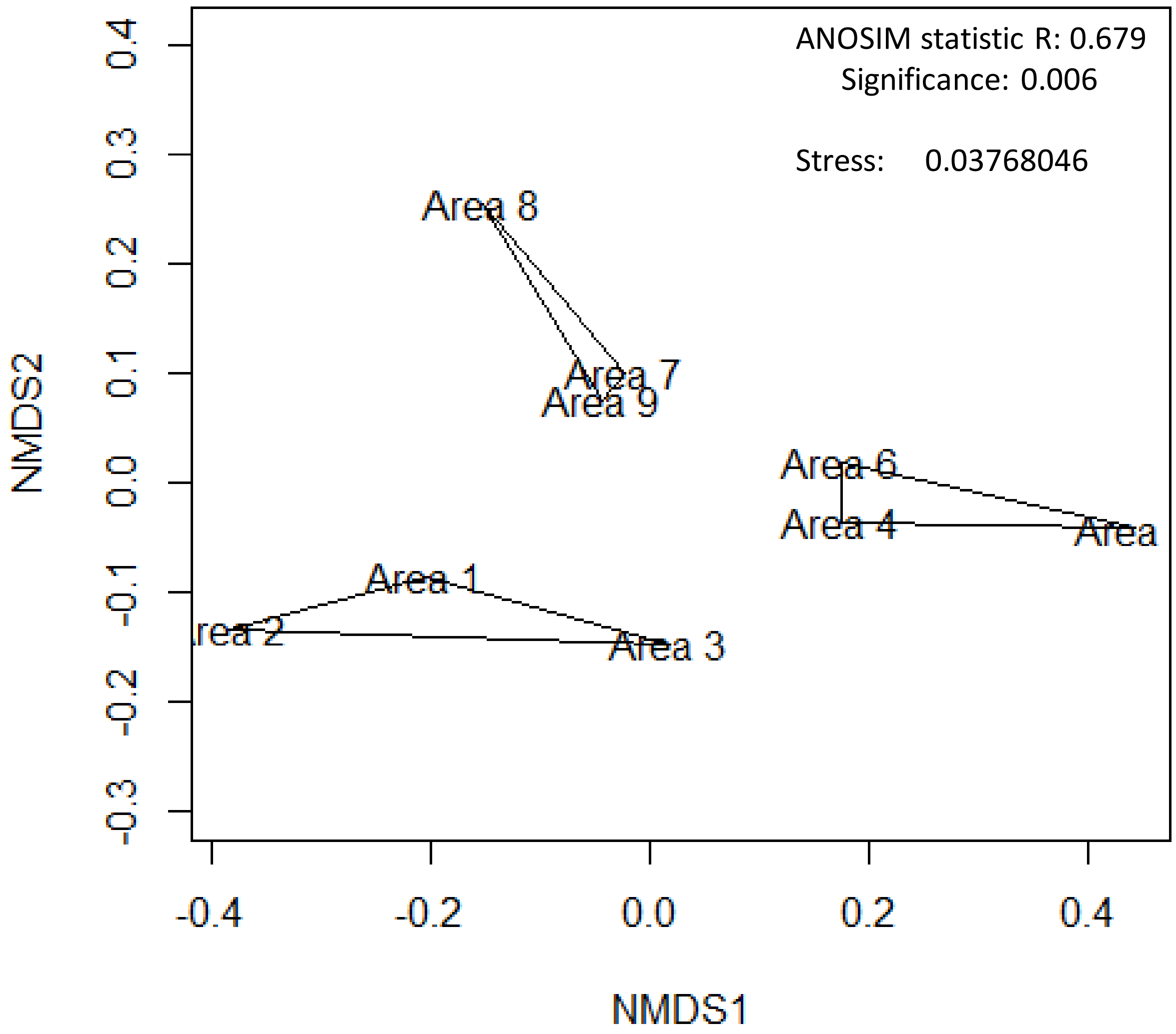

Figure 2. Nonmetric multidimensional scaling (NMDS) of composition of pest insect species between locations based on Bray-Curtis's dissimilarity index

Based on the pest abundance, the number of pests found was significantly different between locations (df = 2, F = 10.603, P = 0.000546). The highest number of pests was found in Bedoyo, Kenteng, and Karangasem respectively. In Bedoyo, the highest abundance was found in area 2. The highest abundance in Karangasem was found in area 4. Meanwhile, the highest abundance in Kenteng was found in area 8. Based on the pest order, Hemiptera is the pest insect with the highest abundance in each area (Figure 3). Pseudococcidae and Aleyrodidae families are families with the highest abundance compared to other Hemiptera families. These two families were found throughout the study area. Besides Hemiptera, Acari was also found in high abundance. However, this order was not always found in each area of the study (Figure 3).

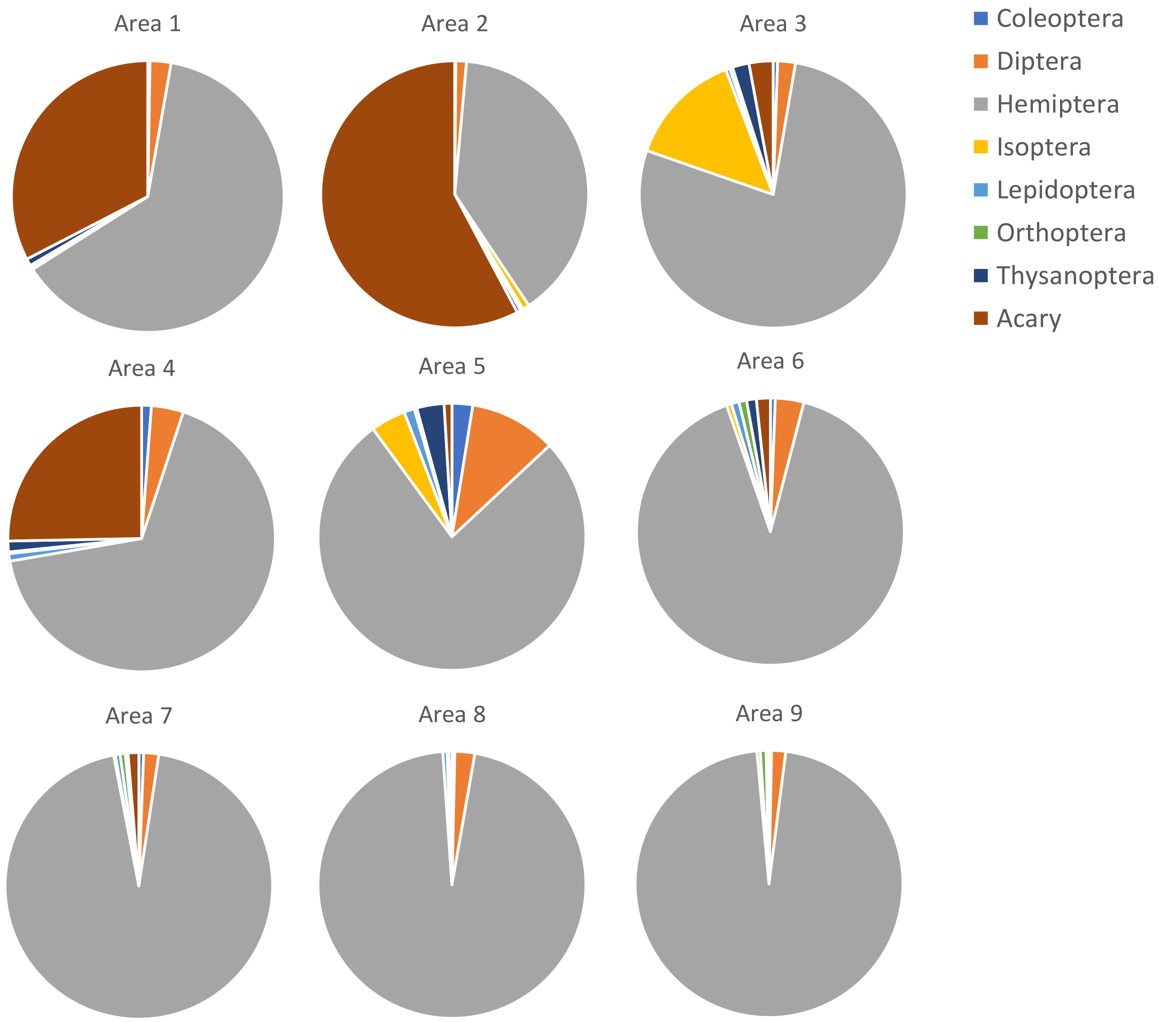

Figure 3. Proportion of pest insect order found from each area

In addition to abundance, the number of species of Hemiptera found was also higher than the pest species from other orders (31/95). Mealybugs and whiteflies were the most common pest species found in Bedoyo, Karangasem, and Kenteng. The most common mealybugs found were *Paracoccus marginatus*, *Psedococcus jackbeardsleyi* and *Ferrisia virgita*. *P. jackbeardsleyi* and *F. virgita* were most commonly found in Bedoyo. Meanwhile, *P. marginatus* was most commonly found in Kenteng (Figure 4). Other hemipterans were found in notably fewer quantities than whitefly and mealybugs. Meanwhile, the highest number of whitefly, *Bemisia tabaci* was found in Kenteng, Bedoyo, and Karangasem respectively.

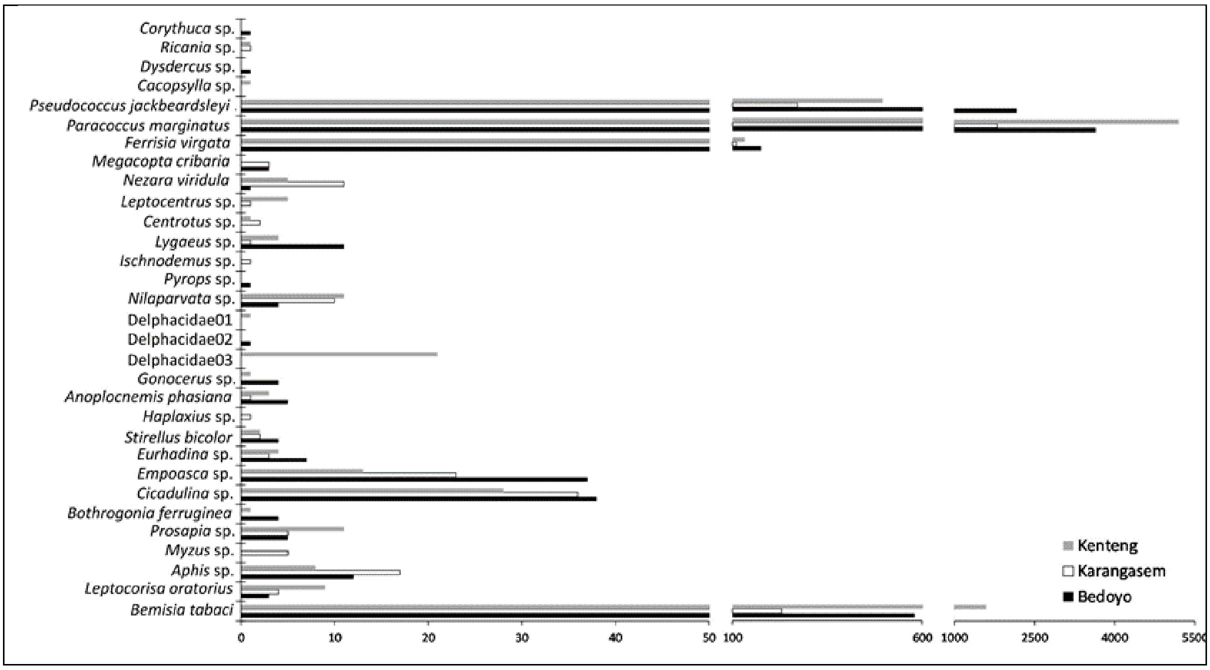

Figure 4. The abundance of hemipteran pest insect species

DISCUSSION

There have been no reports on biodiversity of pests in cassava plantation, especially in Gunungkidul as a cassava production center in Yogyakarta. So far, the diversity of insects, both as pests and natural enemies, in cassava plants has been reported in Banyuwangi (Nurmasari 2015), Ende East Nusa Tenggara and Lombok (Mawaddah et al. 2018).

The results showed that there was no significant difference in the number of species between locations. However, there was a significant difference in insect pest diversity and insect pest abundance between locations. The abundance of individual insect pests found was significantly different between areas. For example, the lowest abundance of pests was found in Karangasem area 5. This area is located close to limestone mining. This condition might be the cause of the lower abundance of insect pests in this area compared to other areas, which are incidentally located around agricultural land. The same result was found in the study of Saputra and Maryana (2017) who reported that the diversity of Hymenoptera insects in post-mining land ecosystems was lower than the diversity of Hymenoptera insects in agricultural ecosystems.

The difference in diversity and abundance of pests between locations in this study proves that insect pests are active organisms whose distribution is influenced by biotic and abiotic conditions so that their existence can be different in a certain area and time (Noyes 1989). Pests of certain plants in an area may not be found or may not become pests for the same crop in other areas (Hill 2008). This is due to environmental conditions such as landscape structure which influences the diversity of pests. Under certain landscape conditions, the number and type of insect species can be different. Pest diversity is typically higher in complex landscapes than in simpler landscapes (Marino & Landis 1996; Plećaš et al. 2014). However, landscape conditions do not always affect insect diversity (Lizmah et al. 2019; Ulina et al. 2019).

The difference in diversity and abundance of individuals between locations has implications on the differences in the composition of pest species found. Hemiptera was found with the highest number of species and abundance in which it is an order of insects consisting of scale insects such as planthoppers (borer). Those insects have the characteristic of being able to reproduce in a fast time with high fecundity (Ahmad et al. 2014; Mastoi et al. 2014; Wardani et al. 2014). This may explain why the abundance of Hemiptera was higher than that of other orders. The pest species of Hemiptera that were always found in all areas were *Bemisia tabaci*, *Ferrisia virgata*, *Pseudococcus jackbeardsleyi*, and *Paracoccus marginatus*. The high abundance of these pest species might occur because there were other host plants in some research areas. Mango and papaya are host plant of mealybugs (Chellappan et al. 2013), while peanuts can be host plant for whiteflies (Bayhan et al. 2006).

The mealybug species found in this study are pest species that have been found for a long time in Indonesia, and some are relatively new in Indonesia. *P. jackbeardsleyi* is a pest that was first discovered in 2004 (Williams 2004), and *P. marginatus* was first discovered in Bogor in 2008 (Muniappan et al. 2008). Meanwhile, *F. virgata* has been reported for a long time in Indonesia (Kalshoven 1981), Malaysia and Singapore (Sartiami, Watson, Roff, & Idris, 2017). The new *Ferrisia* species was found by 2020 in Bengkulu, Indonesia that is *Ferrisa dasylirii* (Zarkani et al. 2020). Another mealybug reported to attack cassava is *Phenacoccus manihoti*. This pest is an invasive pest species from America that was first reported to be found in Asia in 2009 (Parsa et al. 2012). *Phenacoccus manihoti* is the most harmful mealybug. This pest is reported to have spread throughout Java, including Yogyakarta (Abduchalek & Rauf 2017). However, *P. manihoti* was not found in this study. Although this is the first scientific report on mealybug attack in Gunungkidul, the attack of this pest species has been reported in recent years by the farmers.

CONCLUSION

This current study shows that the diversity of pest insect and its abundance differ between locations, so also the composition of insect pest species itself. The highest diversity of pest insect species comprises of hemipterans. A high species dominance was caused by the high population of whiteflies (*B. tabaci*) and mealybug (*F. virgata*, *P. marginatus*, and *P. jackbeardsleyi)*. Population differences between the three types of mealybugs found in each location need to be studied further to understand the population dynamics of mealybug and their interactions with natural enemies that can be used for biological control program. Furthermore, the results then are expected to be useful information that can be used to support an environmentally friendly and sustainable pest control programs.

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