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Research Article

Susceptibility of Two Varieties of Guava (*Psidium guajava* L.) to Pest and Disease Infection in the Sub-District of Tanah Sareal, Bogor

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ABSTRACT

This survey was done in several guava fields around Bogor and found many unhealthy plants infested by various plant pests and diseases. This study aimed to analyze the effect of various guava cultivars on pest and disease intensity on guava in the Sub-District of Tanah Sareal, Bogor. Samples were collected from 20 fields that consisted of 15 samples of Getas Merah and 5 samples of Bangkok Putih cultivars to identify plant pests and diseases. Interviews were done with field owners to obtain information on cultivating practices. Pests found based on morphological identification included plant bugs (Hemiptera: Miridae), locusts (Orthoptera: Acrididae), bagworms (Lepidoptera: Psychidae), Geometrid caterpillars (Lepidoptera: Geometridae), Pyralid caterpillars (Lepidoptera: Pyralidae), scale insects (Hemiptera: Coccidae), planthoppers (Hemiptera: Flatidae), and mealybugs (Hemiptera: Pseudococcidae). Disease and pathogens identified included red rust disease (*Cephaleuros* sp.), anthracnose (*Colletotrichum gloeosporioides*), and fruit cancer (*Pestalotia* sp.). The occurrence of biting-chewing type pests was greater than piercing-sucking type insects, including 33.33% and 34.99%. Red rust disease was the dominant disease found on both guava cultivars consisting of 68.88% and 63.33% of the samples.

Keywords: guava; pest; plant disease

INTRODUCTION

Guava (*Psidium guajava* L.)—also commonly known as *jambu biji*, *jambu kluthuk*, *jambu siki*, or *jambu batu* in Indonesia—are consisted of many varieties, including the following Getas Merah, Sukun Merah, Sukun Farang, Lokal, Pear, and Kristal cultivars (Ochtavia, 2015). Guava can grow in tropical to subtropical regions making it widely cultivated in many areas of Indonesia, especially Java, including Jakarta, West Java, Central Java, Yogyakarta, and East Java.

Guava production has fluctuated over the years. In Indonesia, guava production reached 200,495 ton/year in 2017 and 230,697 ton/year in 2018 (*Badan Pusat Statistik dan Direktorat Jenderal Hortikultura*, 2017). As much as 425,547 quintals of guavas in 2018, was produced in the District of Majalengka (52,684 quintal) and Bogor (50,878 quintal) (*Badan Pusat Statistika*, 2018). Many factors can cause guava production fluctuations, and one of them is pest and plant diseases. Various pests and diseases have been reported to infect guava in Bogor. Guava pests include chewing-type insects, such as various species of Lepidopteran, locusts, fruit fly, and piercing-sucking-type insects, such as Pentatomidae bugs (Faridah, 2011; Eriza, 2015). Diseases that infected plants included anthracnose, *Pestalotiopsis* fruit cancer, red rust, and sooty dew.

Pest and disease damage will affect yield quality and quantity that later decrease economic profits. Pest and disease management often requires high costs and, therefore, become a financial concern. Currently, the cultivation of guava is quite simple. However, pest and disease outbreaks can occur when a commodity is planted in large-scale monoculture fields (Jaya, 2009).

Complete and detailed information on plant pests and diseases of guava is required if guava will later be planted in large monoculture fields (Pena, 1986). This information is also necessary to create management strategies for these pests and diseases. Therefore, this study aimed to analyze the effect of two guava cultivars on pest and disease occurrence in the Sub-District of Tanah Sareal, Bogor.

MATERIALS AND METHODS

Interview

Interviews were done with 20 guava field owners to obtain information on cultivation practices regarding plant spacing and weed management in guava fields in Sukaresmi and Sukadamai Village, Sub-District of Tanah Sareal, Bogor.

Observed Field and Demonstration Plots

Observations were done in the 20 farmer-owned fields and consisted of 15 fields planted with Getas Merah and 5 fields with Bangkok Putih cultivars that were located in the Sukaresmi and Sukadamai Village, Sub-District of Tanah Sareal, Bogor. Field areas of respondent farmers were classified into several categories, consisting of ≤ 0.1 ha of 4 farmers, 0.1 ha $< x \leq 0.5$ ha consisting of 9 farmers, 0.5 ha $< x \leq 1$ ha consisting of 3 farmers, and ≥ 1 ha consisting of 4 farmers. Observations were done on 3 sample trees at each field. Sample plants were done systematically and included plants in a diagonal transect.

Pest and Disease Observation

Observation of pests and diseases of guava were done directly on each plant based on pest and disease damage. Observation of pests and diseases incidence and intensity were done on ones that were considered dominant based on direct observations. On each plant, 4 branches were selected from the 4 directions (north, west, east, and south). On each branch, 4 youngest leaves and 4 older ones were observed for pest and disease until 5 cm from branch base. Observations were done once on branch and leaves. Incidence of pest and disease (KP) were calculated by the followed formula from Cooke (2006):

$$KP = \frac{n}{N} \times 100\%$$

Incidence demonstrated the number of branches infested by pests or diseases (n) compared to the total branches found (N).

Disease intensity was calculated using a formula from Townsend and Heuberger (1963) as cited in Agrios (2005):

$$S = \frac{\sum_{1=1}^{k} n_i \times v_i}{N \times V} \times 100\%$$

S is disease severity; n_i is the number of plant parts infested based on category I; v_i is the score for each category; N is total number of plants observed; and V is the highest score. Scoring of rust disease on guava leaves was determined into several categories (Table 1), while disease severity was determined in Table 2.

Table 1. Determining disease infestation levels (Faridah, 2011)

Score	Infestation category
0	no infestation
1	$0 \leq x \leq 25\%$
2	$25 < x \leq 50\%$
3	$50 < x \leq 75\%$
4	$> 75\%$

Tabel 2. Infestation severity of red rust (Eriza, 2015)

Disease severity (S)	Category
0	Healthy
$0 < n \leq 5$	Very mild
$5 < n \leq 15$	Mild
$15 < n \leq 30$	Moderate
$30 < n \leq 60$	Severe
$n \leq 60$	Highly severe

Sample Collection, Pest and Disease Identification

Insect pest samples were collected and placed into plastic containers, while unhealthy plant parts were placed in plastic containers with newspaper to reduce humidity. Insect samples were then identified in the laboratory using a stereo microscope, especially for smaller insects. Infected plant parts were observed using a compound microscope and pathogens were identified. Identification of insect

pests were done using determination keys from Borror *et al.* (1996) and Kalshoven (1981). Identification of diseases were done by preparing samples and identified using determination keys from Barnett and Hunter (1998); also Watanabe (1994). Identification of pests and diseases were done in Insect Biosystemic Laboratory, Plant Mycology and Plant Clinic, Department of Plant Protection, Faculty of Agriculture, IPB University.

Data Analysis

Interview data were processed using *Microsoft Excel* 2013. Pest occurrences, disease incidence, and intensity were analyzed using SPSS version 20.0 (*Statistical Package for Social Science*) and T-test at α=5%.

RESULTS AND DISCUSSION

General Conditions of Research Location

Sub-District of Tanah Sareal was the largest guava production center in Bogor. This is caused by its suitable soil, high rainfall, and environment that promotes guava growth. Farmers planted Getas Merah, Bangkok Putih, and Kristal cultivars.

Average monthly rainfall in the location during November, December, February, and March were 11.8 mm; 6.8 mm; 18.8 mm; and 11.8 mm, respectively and are categorized into moderate (*Badan Meteorologi Klimatologi dan Geofisika*, 2017). Daily rainfall during observations was light to heavy. According to Utami (2008), guava can grow between 15° to 45°C; young guava plants can die at temperatures between -2.78°C to -2.22°C. Optimum yields are obtained from 23°C to 28°C 1.000 to 2.000 mm/year rainfall. Yearly rainfall at observation locations was suitable for guava resulting in plants producing optimum yield.

Guava Cultivation

As much as 45% of farmers in the Sub-District of Tanah Sareal plant guava on fields with an area between 0.1–0.5 ha (Table 3). Farmers owned both fields with monoculture and mixed cropping. A large proportion of farmers (60%) choose monoculture planting systems, and only 40% of farmers used mixed cropping (Table 4). Farmer plant guava with sweet potato, cassava, jicama, corn, eggplants, taro, papaya, groundnut, and mango.

Table 3. Guava fields owned by farmers

Area category (ha)	Number of farmers	Percentage (%)
≤ 0.1	4	20
$0.1 < x \leq 0.5$	9	45
$0.5 < x \leq 1$	3	15
≥ 1	4	20

Table 4. The cropping pattern of guava farmer respondents

Cropping pattern	Number of farmers	Percentage (%)
Cropping pattern		
Monoculture	12	60
Polyculture/ Mixed cropping	8	40
Weed management		
Manual	10	50
Herbicide	5	25
Manual and Herbicide	5	25

Mixed cropping help control weed besides adding extra products. Farmers that did mixed cropping, manually control weed although less weed grow in the field.

As much as 50% of farmers managed weed manually, 25% of farmers used herbicide, and the rest used both practices (Table 4). Farmers thought that herbicides should not be used as they can affect guava plants and other crops planted in the field. Plant spacing used by farmers varied from 2 × 2; 3×3; 3×5; 4×4; 5×5; 5×6 m. Guava planted at spacing 2×2 m produced less because plant populations were dense and canopies overcovered between two-years-old guava plants. Larger planting space in cultivation have been reported to reduce the intensity of pest and disease damage (Asmaliyah & Rostiwati, 2015).

Pest Guava Plants

Pests found on Getas Merah and Bangkok Putih cultivars were locusts, bagworms, caterpillars, piercing-sucking bugs, mealybugs, scale insects, and planthopper (Figure 1). Pest damage occurrences

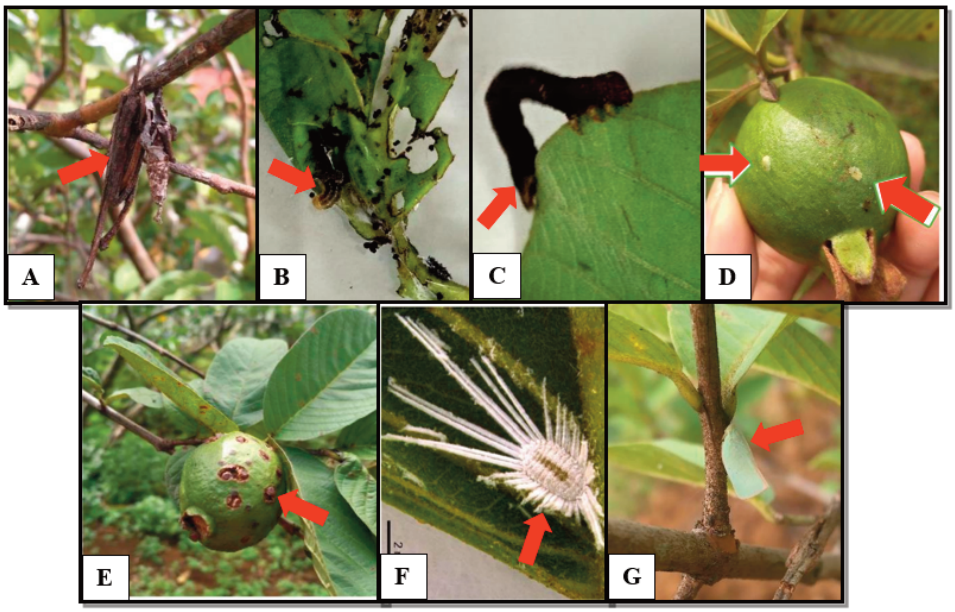

Figure 1. Pest and infestation symptoms on guava in Bogor: bagworm (A), holes on leaves due to tip caterpillars (B), caterpillars (C), scale insect (D), necrotic spot on fruit due to *Helopeltis* sp. (E), mealybug (F), and planthopper (G)

Table 5. The effect of cultivar on pest infestation on guavas in Sub-District of Tanah Sareal, Bogor

Cultivar	n	Pest occurrences (%)	
		Biting-chewing ($\bar{X} \pm$ SE)	Piercing-sucking ($\bar{X} \pm$ SE)
Getas Merah	15	33.33 ± 3.72[a]	30.48 ± 3.79[a]
Bangkok putih	5	34.99 ± 14.76[a]	18.26 ± 4.86[a]

[a] Numbers in the same row followed by the same letter are not significantly different compared to a T-test with $\alpha = 0.05$, $\bar{X}$: mean; SE: standard error; n: the number of observed fields.

between biting-chewing and piercing-sucking insects on both cultivars were not significantly different (Table 5). Occurrences of biting-chewing insects were more frequent on Bangkok Putih than the Getas Merah cultivar. Occurrences of piercing-sucking pests were more frequent on Getas Merah than Bangkok Putih cultivar.

Locust (Orthoptera: Acrididae) found on Bangkok Putih cultivars were identified as *Valanga* sp. This insect will eat young leaves. Locusts were found on vegetative stages, and symptoms found were leaves with holes and only midribs remaining. Most individuals found were also nymphs.

Bagworms (Lepidoptera: Psychidae) eat young leaves, especially the bottom side, causing holes on leaves and drying out. Damage symptoms on leaves are caused by larvae feeding activity that only devour the bottom epidermal of leaf and mesophyll tissue while leaving upper epidermal causing window panning. The remaining epidermal dried out and midrib were the remaining tissue (Emmanuel *et al.,* 2012). Bagworms were found on both guava cultivars. According to Kalshoven (1981), these bagworms are included as Psyichidae family and have various shapes due to each species having specific characteristics and these bag structures being an identifiable feature.

Pyralid caterpillars (Lepidoptera: Pyralidae) damage young leaves and shoot by folding several leaves. Larvae will then feed the inner side of leaves that have been combined, causing damage on leaves and structures to be covered with white silk.

These caterpillars were found on both cultivars. Pyralid caterpillars were the most dominant biting-chewing pest to cause leaf damages. Later symptoms caused by this insect are tissue death (Figure 1B).

Geometrid caterpillars (Lepidoptera: Geometridae) were found on the Getas Merah cultivar. Each caterpillar had different shapes, colors, and sizes. Caterpillars found were 1.5–2 mm in length and 0.2–0.5 mm in width and were black (Figure 1C). Symptoms caused by this pest were holes on leaves due to feeding activities.

Piercing-sucking bugs (*Helopeltis* sp.; Hemiptera: Miridae) were found on Getas Merah cultivars. The insect has a piercing-sucking mouthpart that is used to damage shoots and fruits. These puncture symptoms cause black necrotic symptoms on fruit (Figure 1E). Severe infestation can cause small fruits to turn black, dry out, and fruit drop. Usually, small fruit cannot develop well and will drop, causing a decrease in production. Farmers find that damage due to this insect is devastating if small fruit were not covered in bags.

Hemipteran insects have great feeding activity and movement. This insect can spread *Pestalotia* sp. spore between fields and plants. This bug is commonly associated with fruit cancer. Piercing wounds make parasites easier to infect fruit. Mealybug (Hemiptera: Pseudococcidae) were found on fruit, leaves, and branch of both cultivars (Figure 1F). This insect attacks plant tissue with its piercing-sucking mouthparts. The insect's body is covered with waxy substances that protect this individual from external factors. Mealybugs found were from a different genus, including *Rastrococcus spinosus* and *Ferrisia virgata*. The latter was found most on guava plants.

F. virgata is a polyphagous insect that can reproduce well in tropical conditions and slower in sub-tropical areas. This insect has been reported to be a pest on 203 genera within 77 plant families, especially on fruit, legumes, and spices (Centre for Agriculture and Biosciences International [CABI], 2016a).

According to CABI (2016b), *R. spinosus* has become an important pest on guavas, mango, banana, citrus, *Annona squamosa,* and other crops. Mealybugs suck fluids from fruit or leaves, cover plant surface with its waxy substances, and produce honeydew. *F. virgata* and *R. spinosus* are associated with ants. Ants eat honeydew, causing ants to protect mealybugs from predators and assist mealybugs distribution across fields. Ants are also a nuisance to farmers when harvesting. Dolichoderus ants were often found to have a symbiosis with mealybugs (Saumiati, 2006). Sooty dew causes plant surface to turn black, inhibits sunlight from reaching plants, and hinders photosynthesis.

Scale insects (Hemiptera: Coccidae) were found on the Getas Merah cultivar in small numbers. This insect is green and found on small fruit with a diameter of 2–3.5 cm or 1–1.5 months old after flower bloom (Figure 1D). *Coccus viridis* is a polyphagous insect and is distributed in tropical and subtropical regions.

Planthoppers (Hemiptera: Flatidae) were found on the Getas Merah cultivar. Planthoppers were green whitish (Figure 1G). Imagoes place eggs in groups of 30–80 on the surface of the underside of leaves, petiole, and branch shoot. Eggs are covered with white or beige waxy substances. Eggs were oval with lengths of 0.91–1.09 mm and width of 0.37–0.47 mm, white, and changed into brownish before hatching. Egg stages last 6–7 days. Nymphs are yellowish-white and covered with white waxy substances. Nymphs do not actively move besides jumping when disturbed. Nymph stage last between 42–49 days (*Direktorat Jenderal Perkebunan*, 2012).

Guava Disease

Disease observed on Getas Merah and Bangkok Putih cultivars were red rust (*Cephaleuros* sp.), anthracnose (*Colletotrichum* sp.), and fruit cancer (*Pestalotia* sp.). Red rust was more dominant on both cultivars, but not significantly different based on the T-test (Table 6).

Red rust disease is caused by *Cephaleuros* sp. This alga causes lesions on leaves, flowers, fruit, branches, and stems (Figure 2A). This disease is often called red rust due to the growth of erected talus with yellow to red filaments (Figure 2B). Red rust disease was found on both guava cultivars, and this disease was dominant in both fields. Mean red rust on Getas Merah was 68.88% and Bangkok

Table 6. Disease severity on guava from Sub-District of Tanah Sareal

Disease	Cultivar			
	n	Getas Merah ($\overline{X}$ ± SE)	n	Bangkok Putih ($\overline{X}$ ± SE)
Red rust	15	68.88 ± 5.48[a]	5	63.33 ± 11.96[a]
Anthracnose	15	12.28 ± 3.39[a]	5	5.66 ± 3.92[a]
Fruit cancer	15	13.33 ± 5.81[a]	5	8.09 ± 3.73[a]

[a] Numbers in the same row followed by the same letter are not significantly different compared to a T-test with α = 0.05, $\overline{X}$: mean; SE: standard error; n: the number of observed fields.

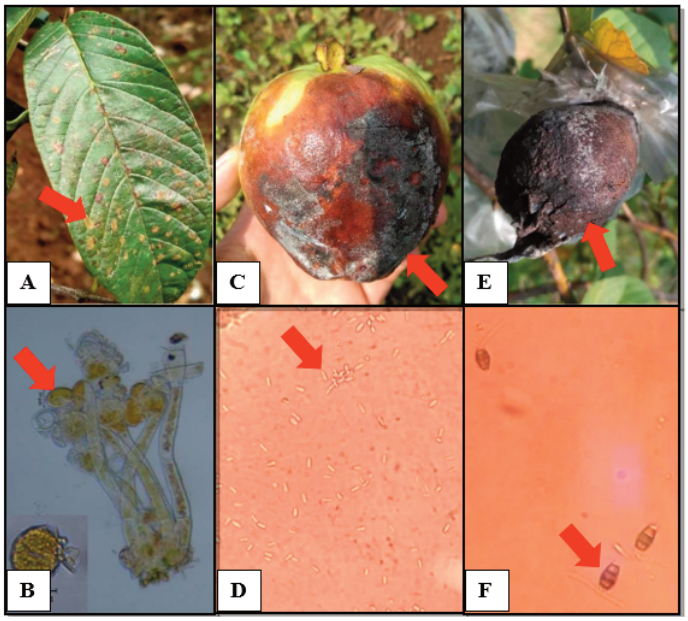

Figure 2. Symptoms and pathogen on guavas from Bogor: *Cephaleuros* sp. leaf spots (A), *Cephaleuros* sp. spore (B), *Colletotrichum* sp. fruit rot (C), *Colletotrichum* sp. conidia (D), *Pestalotia* sp. fruit cancer (E), *Pestalotia* sp. conidia (F)

Putih cultivar was 63.33%, but not significantly different based on the T-test.

Anthracnose was caused by *Colletotrichum* sp. Anthracnose symptoms on guava were necrotic lesions on young fruit that grow to the entire fruit, causing black and rots (Figure 2C). Anthracnose has also been reported to infect dragon fruit in Central Java (Wibowo *et al.*, 2011). *Colletotrichum gloeosporioides* was the species that infected Getas Merah and Bangkok Putih cultivars. *Colletotrichum* has an acervulus body with bulges on the fruit surface. Acervulus form many conidia appearing like ooze. Conidium had no color, consisted of 1 cell, elongated, formed on the edge of conidiophore (Figure 2D). When conidia germinate, it creates partitions. Sprout veins form appressorium before infection. Between conidiophores, there are stiff setae and are dark brown (Semangun, 2000).

Fruit cancer was commonly found on both cultivars, Getas Merah and Bangkok Putih (Figure 2E). The disease was found on plants during their generative stages and was caused by *Pestalotia* sp. According to Wibowo *et al.* (2011), this fungus is a weak pathogen and form many acervuli on the epidermal tissue of wounded plant stems. Conidium had five cells, three brown cells in the middle, and a cell base and tip without color (Figure 2F). Tip cells had three appendices. This fungus is a wound parasite that makes it a pathogen associated with insect feedings, such as *Helopeltis* sp. and infection of other fungi, including *Gloeosporium*, the cause of anthracnose, or *Botryodiplodia*.

CONCLUSION

Farmers' cultivation practices affect the occurrence of pests and diseases. Mixed cropping was able to suppress weed growth and maximize land use compared to monoculture practices. Pests found on guavas in the Sub-District of Tanah Sareal were pierce-sucking bugs, locusts, bagworms, caterpillars, scale insects, leafhoppers, and mealybugs. Diseases found were red rust due to green algae (*Cephaleuros* sp.), anthracnose (*Colletotrichum gloeosporioides*), and fruit cancer (*Pestalotia* sp.). Biting-chewing insects were found more on Bangkok Putih, while pierce-sucking insects were found more on Getas Merah cultivars. Red rust disease was the dominant disease on both cultivars compared to anthracnose and fruit cancer.

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