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Composition and abundance level of pest mites in jasmine gambier (*Jasminum officinale*) plantation of Purbalingga, Central Java, Indonesia affected by some abiotic factors

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Abstract. *Budianto BH, Sasongko ND. 2022. Composition and abundance level of pest mites in jasmine gambier (*Jasminum officinale*) plantation of Purbalingga, Central Java, Indonesia affected by some abiotic factors. Biodiversitas 23: 5227-5232.* The decline in productivity of gambier jasmine flowers is not only caused by the reduction of gambier jasmine land area but also insect, caterpillar and pest mite attacks. Types of pest mites and their population dynamics are closely related to abiotic factor conditions such as temperature, humidity, rainfall, season, an abundance of predatory mites and types of plant cultivars. The study aimed to determine the types of pest mites and some abiotic factors that affect their abundance in gambier jasmine plants. The research method was a survey with a purposive sampling technique. Sampling locations were in Cipawon village, Bukateja sub-district, Purbalingga district, and Central Java Province, Indonesia. The obtained data were analyzed by analysis of variance at an error rate of 0.05. The types of pest mites that were identified consisted of 8 species, namely *Brevipalpus phoenicis*, *B. californicus*, *B. papayensis*, *B. obovatus*, *Tetranychus urticae*, *T. kanzawai*, *T. cinnabarinus* and *Tyrophagus putrescentiae*. The type of pest mite always found at each sampling point was *B. phoenicis*, with an abundance range of 0.027 to 0.067. The results of the analysis of the variance of pest mite abundance in gambier jasmine plantations showed that abundance of individuals between pest mite species did not significantly differ at all sampling points. Based on multivariate analysis, it was noted that trichome density had the most influence on pest mite abundance with a population model of Y = 0.399 + 0.043a + 0.012b.

Keywords: Abiotic factors, abundance composition, jasmine gambir, pest mites

INTRODUCTION

Jasmine gambir (*Jasminum officinale*) is a perennial plant with a creeping shrub habitus capable of growing in an open area of low and high land (Qur'ania and Sarinah 2018). In Indonesia, the production of jasmine gambier is quite potential for agribusiness industries, as its flowers are used as an important raw material in perfumery (Budianto et al. 2021) to make farmers in some areas like Tegal, Purbalingga and Pemalang, of Central Java, grow this plant massively.

Unfortunately, in the mean times, the quality and total production of jasmine gambier declined greatly because the farmers altered the planting areas of jasmine gambier for other purposes. Moreover, some predators like insect, caterpillar and pest mite are also known to attack this plant in those planting areas, especially during the dry season when the abundance of pest mites increase rapidly because they are more resistant to the increase of temperature, low humidity and the decrease of predatory mites. Goleva and Zebitz (2013) reported that the population dynamics of various types of pest mites are closely related to the conditions of temperature, humidity, rainfall, season, an abundance of predatory mites and types of plant cultivars (Hewitt et al. 2015).

Leite et al. (2022) reported that the gambier jasmine plants require warm and wet environmental conditions such as a temperature of 28-36°C, night 24-30°C during the day and night times a day and so air humidity of 50-80% for growth, unfortunately, the same condition is also favorable for the pest mites. Moreover, low-level of rainfall and humidity are also known to increase the population abundance of various phytophagous mites (Ihsan et al. 2021). Furthermore, Kean et al. (2019) and Leite et al. (2022) suggested that high rainfall is negatively correlated with the population abundance of *Tetranychus urticae,* or vice versa, *T. urticae* is very resistant to a high level of rainfall. The favorable various environmental factors, as described previously, lead to a decrease in this predatory mite drastically, resulting in an increase in various pest mites (Nishida et al. 2005).

Plant cultivars significantly affect the abundance of various pest mites that attack the plants. The differences in population abundance is closely related to the content of flavonoid, phenol and terpenoid compounds (Ahmad-Hosseini et al. 2020) and leaf morphology (Hodson and Lampinen 2019; Weinblum et al. 2021). Nain and Rathee (2017) suggested that the leaf morphology of the okra plant (*Abelmoschus esculentus*), such as lamina thickness, length and density of leaf trichomes, leaf axil and leaf area, greatly affect the abundance of *T. urticae* pest mites. Furthermore, leaf area, lamina thickness, length and density of leaf trichomes, and leaf axil are positively correlated with the survival rate of larval stages, length of time larvae and nymphs of *T. urticae* to live (r: 0.82). Similar results were previously obtained by Di Palma et al. (2020), who found that ecological interactions between plant morphology, phytophagous mites and predatory mites suggest that different types of pests and predator mites can occupy different positions on the same leaf. However, till now, no information has been reported regarding the types of pest mites, abundance and abiotic factors that attack jasmine gambir (*Jasminum officinale*) plants. This study aimed to determine the composition of pest mites and some abiotic factors that affect their abundance in gambier jasmine plants.

MATERIALS AND METHODS

Study area

The current study used the Cipawon village, Bukateja sub-district, on the southern part of Purbalingga regency, Central Java province, Indonesia, as the sampling site. This place was in the latitude coordinate of -7.44056, and the longitude coordinate of 109.45346. The 2800 m^2 gambier jasmine farm was located in a relatively flat area with a low slope and temperature ranging from 28-32ºC with rainfall levels of 2500-3500 mm (Figure 1).

Procedures

Determination of sampling points and sampling method

The purposive sampling technique was conducted in a 2800 m^2 plantation area of gambier jasmine. Sampling points were located in each corner as well as in the center of the gambier jasmine plantation (Figure 2). Each sampling point was taken as many as 3 gambier jasmine plants. The leaves of gambier jasmine were taken as many as 10 pieces from the bottom 5 stalks of the plant. For further analysis, leaves were then brought to the Entomology-Parasitology Laboratory, Faculty of Biology, Universitas Jenderal Soedirman, Purwokerto, Indonesia.

Leaf area measurement

The leaves were measured by the gravimeter method, where leaves were dried in an oven to reach a stable weight, and estimated the area by comparing the fresh ad dry weight (gravimetry). This method was based on the hand drawing of a leaf on a piece of paper before being estimated for its area. The leaf replica on paper was then cut out to determine its weight and area. The leaf area was then estimated based on the ratio of the weight of the leaf replica to the total weight of the paper.

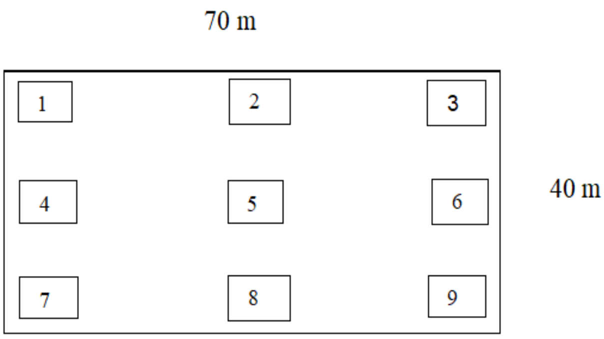

Figure 2. Sampling point (☐) in jasmine gambir (*Jasminum officinale*) plantation in Cipawon village, Bukateja sub-district, Purbalingga district, Central Java, Indonesia

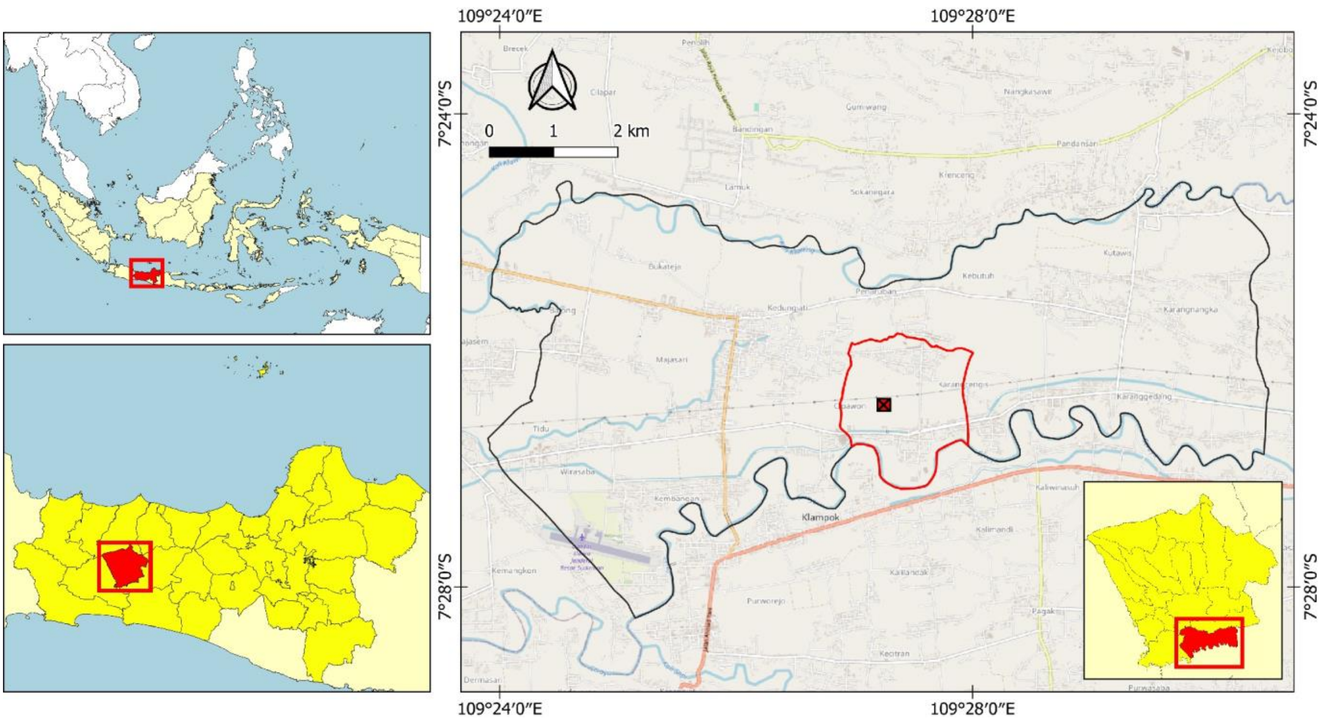

Figure 1. Sampling location (crossed boxes) in Cipawon village, Bukateja sub-district, Purbalingga district, Central Java, Indonesia

Measurement of leaf trichome length and density

Trichomes length and density were measured by dripping the leaf in clear nail polish on the tip and center of each leaf and allowing the nail polish to dry. The small part of the dried nail-polish leaf which carried the trichome was taken for analysis of trichomes length and density using an optilab microscope. The average of trichome density of 5 points on the leaf was calculated.

Leaf axil measurement

The leaf axil was measured using a protractor under the leaf sitting angle at all sampling points.

Temperature and humidity measurement

Temperature and humidity were measured at each sampling point using a thermohygrometer placed at the bottom of the leaf canopy of the gambier jasmine plant.

Determination of pest mite species and their abundance

Jasmine gambier leaves were examined using a stereo microscope at 100x magnification and each type of pest mite obtained was put into a concave glass object that was filled with alcohol before fixation. After fixation, each type of pest mite was transferred to a concave glass object filled with lactophenol solution for the maceration process, following to this, each type of mite was prepared for identification using Hoyer's solution. The types of pest mites were identified using the chaetotaxy method based on the number and distribution of setae on the dorsal part of the mite idiosoma. Furthermore, the body length and width of each type of pest mite data were obtained from observation using an optilab microscope. The abundance of pest mites was measured by recording the number of individuals of each type of pest mite.

Data analysis

The data obtained from the study were analyzed for their abundance by analysis of variance at 0.05 significant error level. Whereas abiotic factors, namely leaf area, trichome length, trichome density, leaf axil, humidity and temperature, which were associated with pest mite abundance, were analyzed by a multivariate logistic regression analysis at the same error level.

RESULTS AND DISCUSSION

Species and abundance of pest mites on jasmine gambir (*Jasminum officinale*) plants

The results showed that 8 species, namely *Brevipalpus phoenicis*, *B. californicus*, *B. papayensis*, *B. obovatus*, *Tetranychus urticae*, *T. kanzawai*, *T. cinnabarinus* and *Tyrophagus putrescentiae* were found in the sampling sites. The abundance of pest mite species is presented in Table 1.

The identification feature of *B. phoenicis* showed it had a body length of 350.59 µm with a flattened body shape and a blackish-red color, and chelicerae, palpus and stylet on the gnathosoma. A scale-like pattern and slits was observed on propodosoma limbs. Hysterosoma had 6 pairs of dorsolateral setae (c3, d3, e3, f3, f2, h2 and h1) but did not have setae f2. The identification results, in accordance with those of Hao et al. (2016) suggested that the body length of *B. phoenicis* ranges from 250 to 350 µm, with blackish-red body color. Laranjeira et al. (2015) reported that there are 291 genus of *Brevipalpus* and *B. phoenicis* that are characterized with a scale-like pattern. In terms of identification, Di Palma et al. (2020) believe that spermatheca-based identification and insemination tracts of female mites have proven to have specific morphological traits that can be useful for taxonomic purposes, can be useful for taxonomic purposes.

The pest mite of *B. phoenicis* belonged to the order Prostigmata, family Tenuipalpidae. This mite was also characterized by a scale-like pattern on propodosoma and slits on the limbs. Moreover, the family is characterized by the presence of a palpus without claws sejugal furrow with a flattened dorsoventral (Castro-Resendiz et al. 2021). *Brevipalpus phoenicis* was found at each sampling point, with the abundance level ranging from 0.027 to 0.067. This shows that *B. phoenicis* spreads evenly throughout the gambier jasmine plantation area, as stated by Laranjeira et al. (2015) that *B. phoenicis* is a cosmopolitan mite.

In contrast to *B. phoenicis*, pest mite *B. californicus* was flat, with a reddish color and a body length of 330.6 µm. The hysterosoma had 7 pairs of dorsolateral setae (c3, d3, e3, f3, f2, h2 and h1) and setae f2. The prodorsum of female mites had a wrinkle in the center with a "V" shaped cuticle. The identification results are parallel with the results of Saccaggi et al. (2017), who reported that the body length of female mites ranges from 228-330 µm and the same characteristics of prodorsum as obtained from the present results.

Hao et al. (2016) suggested that the identification of *Brevipalpus* is advisable to notice the number of dorsal setae, solenidia (omega) on tarsus leg II, and dorsal cuticle patterns so that it can be distinguished between *B. phoenicis*, *B. lewisi* and *B. californicus*. Further, Hao et al. (2016) reported that *B. californicus* has 2 solenidia (omega) which are the same number as *B. phoenicis*, but *B. californicus* has 2 pairs of F setae (f2-3), while *B. phoenicis* only has a pair of F setae (f3). Like *B. phoenicis*, *B. californicus* mites also have the ability to spread evenly in gambier jasmine gardens, with abundances ranging from 0.0022 to 0.107 (Table 1).

The body length of *B. papayensis* pest mite was 410.36 µm longer than the previous two species, with a flattened body and tapered oval and brownish red in color. The propodosoma had a cuticle with a clear areola. The posterior sublateral part of the idiosoma had reticulations forming several large cells, while the anterior direction had reticulations that faded into small or narrow bands, with tarsus II having 2 solenidia. The genital plate had a striped pattern with 2 pairs of genital setae and a pair of genital setae. The results of the present study are in accordance with the results obtained by Akyazi et al. (2017) and Di Palma et al. (2020). Unlike the previous two *Brevipalpus* species, *B. papayensis* was spread more in the central part of the gambier jasmine garden with low abundance (Table 1).

Table 1. Abundance of pest mite species on gambier jasmine plants

Pest mite species	Sampling points								
	1	2	3	4	5	6	7	8	9
Brevipalpus phoenicis	0.067	0.049	0.067	0.065	0.031	0.027	0.038	0.033	0.038
B. californicus	0.107	0.062	0.1	0.053	0.022	0	0	0.036	0
B. papayensis	0	0	0	0	0.033	0	0	0	0.018
B. obovatus	0	0	0.009	0	0	0	0	0	0
Tetranychus kanzawai	0	0	0	0.018	0	0.013	0	0	0
T. urticae	0	0	0	0	0	0	0.011	0.022	0.011
T. cinnabarinus	0.022	0	0	0	0	0.007	0.013	0	0.02
Tyrophagus putrescentiae	0	0	0.002	0	0	0	0	0.004	0

Another *Brevipalpus* species, i.e., *B. obovatus*, belonged to the family Tenuipalpidae. This species had an oval-shaped body with a length of 351.23 µm. The idiosoma had a lateral scallop pattern, with a cuticular line at the upper center of the propodosoma that was faded or indistinct. Tarsus II had 1 solenidia, with 6 pairs of dorsolateral setae on the hysterosoma and cuticle had a wide wrinkle pattern forming the letter "V". The identification results are similar to those reported by Hao et al. (2016) at a very low abundance compared to other *Brevipalpus* sp.

The present study also identified 3 species of the Tetranychidae namely *Tetranychus urticae*, *T. kanzawai* and *T. cinnabarinus*. *T. urticae* mite belonged to the Acariformes order and had a body length of 490.04 µm, size setae, brown or orange in color with 2 black spots on the dorsal area, like a spider. The main taxonomic feature of *T. urticae* was the knob on the aedeagus was small, less than 2 times (about 1.5 times) the width of the aedeagus neck; the dorsal edge of the knob was angled and tip was rounded. The identification results are consistent with those obtained by Weinblum et al. (2021), which stated that this spider mite has 2 black spots on the sides of the body and has a dorsal knob with rounded edges. However, the results showed that the abundance of *T. urticae* was low and only found at the outer edge of the garden, as obtained by Savi et al. (2021). The abundance of *T. urticae* was found to be higher in the leaves under sunlight, as stated by Shibuya et al. (2020), through a low coefficient of variation and correlation coefficient compared to other pest mites.

In contrast with the *T. urticae*, *T. kanzawai* mites had a longer body size that reached up to 510.49 µm, orange in color, and had longer setae than others. Moreover, *T. urticae* had a larger size of the knob on its aedeagus, about 2 times the width of the aedeagus neck; the dorsal edge of the knob was angled, and tip was slightly rounded. *T. kanzawai* had an empodium with 6 proximoventral setae without spurs, tarsus I with 4 tactile setae parallel to the duplex proximal setae. The identification results of this study are, therefore, in accordance with those obtained by Budianto and Munadjat (2012), with low abundance and scattered at the outer edge of the garden exposed to the sunlight near sunset.

The species of genus *Tetranychus* with a smaller body length than the two *Tetranychus* species described previously was *T. cinnabarinus* which had a body length of 310.37 µ only, with dark red color, and with white legs and gnathosoma. Tarsus I had 4 pairs of setae located parallel to the duplex proximal setae. The present results are in accordance with those obtained by Eziah et al. (2017), that *T. cinnabarinus* mites have a dark red body color, white legs and gnathosoma and 4 pairs of setae on tarsus I. They also mentioned that *T. cinnabarinus* is a polyphagous species with high adaptability to be easily found in almost 100 plant species. However, the results of the present study showed that the abundance of this species was lower and could spread evenly in gambier jasmine gardens.

In addition to those two families of Tenuipalpidae and Tetranychidae, the present study also found data from the Acaridae family, whose species was *Tyrophagus putrescentiae*. This mite was characterized with a body length of 340.26 µm, oval in shape, milky white in color and had long setae and 2 spots on the lower dorsal part. *T. putrescentiae* belonged to the Acariformes superorder, order Astigmata and was classified as a cosmopolitan species. The body is milky white, and the legs and chin are slightly brown in color. The left and right sides of the proximal phalanx of the second leg form in a W-like shape, but the proximal phalanx of the first leg form a Y-like shape. These data are in accordance with the results obtained by Fayaz et al. (2016) and it is concluded that this mite is distributed as a cosmopolitan mite.

It was also noticed that besides *B. phoenicis*, *Brevipalpus* mite species were less evenly distributed (Table 1). However, the results of the analysis of the variance of pest mite abundance in gambier jasmine plantations showed that the abundance level of individuals among the pest mite species did not significantly ($P>0.05$) differ at all sampling points (Table 2).

Savi et al. (2021) showed that the abundance of *T. urticae* did not significantly differ in various plants, including hop plants (*Humulus lupulus*). This fact proves that there is no antibiosis against the presence of *T. urticae*, so this pest mite can have a high ability to pass life on various types of plants. The high survival rate of *B. californicus* is also found at low and high altitudes on various types of plants, as reported by Castro-Resendiz et al. (2021).

Abiotic factors affecting pest mite abundance in gambier jasmine (*Jasminum officinale*) plants

The results of measuring 6 abiotic factors, namely leaf area, trichome length, density, leaf axil, temperature and humidity, were then analyzed by bivariate logistic regression first. In bivariate selection, it was found that the length and density of the trichome determined the abundance of pest mite species (Table 3).

Tabel 2. Analysis of variance abundance of pest mite in gambier jasmine plantations

Source of varition	Degree of freedom	Sum of square	Mean of square	Fcalculated	Probability
Between pest mite	8	0.003	0.000	0.516	0.840
Within pest mite	63	0.039	0.001		
Total	71	0.041			

Table 3. Results of bivariate logistic regression analysis of abiotic factors

Abiotic factors	P-value	Conclusion
Leaf area	0.344	Not selected
Trichome length	0.044	Selected
Trichome density	0.012	Selected
Leaf axil	0.538	Not selected
Temperature	0.487	Not selected
Humidity	0.307	Not selected

Table 4. Results of multivariate logistic regression analysis of length and trichome density variables on pest mite abundance

Variable	B	P-value	Odd ratio	95% CL	
				Lower	upper
Trichome length	-1.061	0.043	0.346	0.124	0.966
Trichome density	1.242	0.012	3.461	1.310	9.142

Based on the results of bivariate selection, the present study was analyzed further for multivariate analysis or modeling of trichome length and density on pest mite abundance (Table 4). Results showed that the trichome density had the most influence on pest mite abundance in gambier jasmine plantations (Odd Ratio/OR value of trichome density was 3.461 is greater than the OR value of trichome length). It was also noted that the abundance of pest mites in gambier jasmine plantations had a population model of Y = 0.39 9 + 0.043a + 0.012 b. Sudo and Osakabe (2013) reported that the role of stellate-shaped trichomes from *Viburnum erosum* var. *punctatum* plants protects *Brevipalpus obovatus* eggs from their predatory mite of *Phytoseius nipponicus*. Samia and Yasin (2019) obtained different results from Sudo and Osakabe (2013), namely that the denser the trichomes of various cotton plant varieties, the lower the development, reproduction, and various population parameters of *T. urticae*. These different results may be due to using different pest mite species.

Based on the results, it can be concluded that the abundance of 8 species of pest mites was similar in gambier jasmine plantations, and it was observed that the density of trichomes was the most important factor affecting the abundance of pest mites with the population model Y = 0.399 + 0.043a + 0.012b.

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