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RESEARCH PAPER

Bemisia tabaci (Hemiptera: Aleyrodidae): evaluation of leaf trichome density based resistance on several soybean varieties

Fitrah Murgianto[1], Purnama Hidayat[2], & Hermanu Triwidodo[2]

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ABSTRACT

The whitefly *Bemisia tabaci* (Gennadius) is one of the important soybean pests which can reduce production up to 80 %. Soybean defense mechanism against *B. tabaci* is affected by the physical characteristics of the leaf surface, e.g. leaf thickness, density of trichomes, and sticky glandular trichomes. The objective of this research was to investigate *B. tabaci* population – trichome density relationship on ten soybean varieties. The experiment was carried out in Ngale Station, Ngawi District, East Java. The tested soybean varieties were Anjasmoro, Demas 1, Dena 1, Dering 1, Devon, Detam 3, Dewah, Gema, Grayak 1, and Wilis. The experiment was done by completely randomized design with three replications. Observation on the whitefly population was conducted weekly from 2 until 10 weeks after planting on 23 sample plants in each plot. The result showed that Devon was the variety with the highest population levels of *B. tabaci,* 10.89 (eggs), 14.48 (nymphs) individuals per leaf, respectively. The population of *B. tabaci* was affected by trichomes density. Devon was the highest density of trichomes (613.7 hairs per cm^2). The density of trichomes and the number of whitefly eggs and nymphs relationship were significant (R2= 0,78 (egg) and 0.84 (nymph), n= 10, α= 1 %, F Value= 0.00157, respectively).

Key words: Antixenosis, *Bemisia tabaci,* population dynamic, defense mechanism

INTRODUCTION

The whitefly *Bemisia tabaci* is one of the main pests of soybeans. Yield losses due to this pest attack can reach 80% even in severe attacks that can cause crop failure. The damage caused by this pest attack is in the form of curly leaves, producing honeydew which is a growth medium for sooty mold, and inhibition of plant growth (Sharma et al., 2014). In addition to causing direct damage, this pest can also act as a vector for transmitting viruses that cause disease in soybean plants. According to Jones (2003) that the whitefly *B. tabaci* was able to transmit 111 virus species to various plants. Several diseases caused by viruses and transmitted by *B. tabaci* on soybeans are: (1) *Cowpea mild mottle virus* (CPMMV), (2) *Bean golden mosaic virus* (BGMV), (3) *Cotton leaf crumple virus* (CLCrV), (4) *Horsegram yellow mosaic virus* (HgYMC), (5) *Leonurus mosaic virus* (LeMV), (6) *Mungbean yellow mosaic India virus* (MYMIV), (7) *Sida golden mosaic virus (*SiGMV), (8) *Soybean crinkle leaf virus* (SCLV), and (9) *Soybean golden mosaic virus* (SoyGMV) (Jones, 2003). Symptoms caused by viruses attacks on soybeans transmitted by *B. tabaci* can be in the form of dry plant leaves, shrinking, yellowish color, stunted plants, and unformed pods (Marwoto & Inayati, 2011). One of the efforts to control *B. tabaci* can be done through an integrated pest management approach (IPM) by using superior soybean varieties that are resistant to this pest attack.

Until 2014, the government of the Republic of Indonesia, in this case, the Ministry of Agriculture, has released around 70 varieties of superior soybeans to farmers (Ministry of Agriculture, 2015). These superior soybean varieties have the advantage of high yields and resistance to abiotic stresses such as drought. However, until now in Indonesia, there are no superior soybean varieties that have been reported to be resistant to *B. tabaci* attack. Therefore, it is necessary to evaluate the resistance of soybean varieties' cultivation against these pest attacks by observing the population of *B. tabaci* in each soybean variety being tested.

The resistance of plants to *B. tabaci* attack is related to their morphological characters. The morphological characters of these plants can influence *B. tabaci* not to lay eggs or suck liquid of soybean leaf. These morphological characteristics such density and arrangement of leaf vascular bundles, leaf

Corresponding author:
Purnama Hidayat (phidayat@apps.ipb.ac.id)

[1]Research and Development Bumitama Gunajaya Agro, Central Kalimantan, Indonesia 74353
[2]Department of Plant Protection, Faculty of Agriculture, Bogor Agricultural University, Jl. Kamper, IPB Dramaga Campus, Bogor, Indonesia 16680

thickness, and leaf color (Chu et al., 1995). Plants have morphological structures like waxes, trichomes, and latices to make feeding more difficult for the insects (Fürstenberg-Hägg et al., 2013). Information on plant defense mechanisms is very important for plant breeders to produce superior soybean varieties that are resistant to *B. tabaci* attacks. Planting a resistant variety is one of the methods to control the pest population with environmentally friendly (Sulistyo, 2016). The use of chemicals insecticide poses serious harm to human health and resistance in these insects to insecticides (Yousaf et al., 2018). This study was conducted to determine the effect of leaf trichome density on the number of eggs and nymphs infested with *B. tabaci* in 10 soybean varieties.

MATERIALS AND METHODS

Research Site. The research was conducted at the Ngale Experimental Station, Paron District, Ngawi Regency, East Java Province. The varieties used in this study were Anjasmoro, Demas 1, Dena 1, Dering 1, Devon, Detam 3, Dewah, Gema, Grayak 1, and Wilis.

Population Dynamics of *B. tabaci.* The method used in observing the population dynamics of the whitefly *B. tabaci* was direct sampling at the egg and nymph stages. Population calculations were carried out by taking sample plants from all soybeans planted at a distance of 40 × 20 cm. One experimental unit contains 1000 soybean plants. Each experimental unit determined the number of sample plants as much as 3% of the total plant population or the equivalent of 23 sample plants without border plants.

Leaf sampling method was carried out randomly to observe eggs and nymphs of *B. tabaci* from each sample plant by taking plant leaves from the 1st branch when the soybean was 2 weeks after planting (WAP), the 2nd branch when the soybean was 3–5 WAP, and 2nd and 4th branching when soybeans were 6–10 WAP. The leaves are put in a plastic bag and observed under a stereo microscope. Observation of population dynamics of *B. tabaci* was carried out every week starting from soybeans aged 2–10 WAP and associated with plant age in each variety.

Research Design. The research experiment used a Completely Randomized Design (CRD) with three replication. The experimental plot area used is 7000 m^2. The experimental unit measuring 20 × 4 m is surrounded by a barrier to minimize bias on the experimental unit from the outside environment. Each level and replication was determined randomly in the experimental plot.

Trichome Density. The calculation of trichome density was carried out on 10 soybean varieties to determine the preference for laying eggs of *B. tabaci* in the ten varieties used. Sample plants are determined at 1% of the total plant population without border plants. In each sample plant, one young leaf is taken in good condition without any symptoms of attack from pests. All trichomes were counted on leaves that had been cut to an area of 1 cm^2 under a stereomicroscope.

Data Analysis. Data analysis of the population of eggs and nymphs of *B. tabaci* on 10 soybean varieties was carried out using ANOVA. Varieties of treatment data were analyzed for variance and if it had a significant different, it was further tested with Duncan Multiple Range Test (DMRT) with = 5% using SAS 9.1 software. Regression analysis was carried out to see the effect of leaf trichome density on the number of eggs and nymphs infested with *B. tabaci.*

RESULTS AND DISCUSSION

The Population of *B. tabaci* on 10 Soybean Varieties. Populations of *B. tabaci* were found in the plants since soybeans were 2 WAP and increased until the plant was 7 WAP at the egg phase (Figure 1), while the nymph phase was 8 WAP (Figure 2). The increase in population that occurs was caused by abiotic factors such as temperature and low rainfall. The average temperature as long soybeans aged 2–7 WAP was 32.19 ºC. *B. tabaci* grows optimally at a temperature of 32.5 ºC (Bonato et al., 2007). Eggs hatch faster at 32.5 ºC (5 days) compared to 16.7 ºC (22.5 days). The life cycle from egg to imago varied from 65.1 days at 14.9 ºC to 16.6 days at 30 ºC (Butler et al., 1983). *B. tabaci* also grows optimally in the dry season with low rainfall. The average rainfall for soybeans aged 2–7 WAP was 3.12 mm.

The decline in the population of *B. tabaci* starting from soybeans aged 8–10 WAP was caused by biotic factors in the form of yellowing of soybean leaves before harvest. The yellowing of soybean leaves resulted in reduced nutrient content for the development of *B. tabaci*. Abiotic factors in the form of high rainfall also affected the decline in the population of *B. tabaci.* The average rainfall at the age of 8 to 10 WAP was 15.95 mm. Arif et al. (2006) reported that rainfall was negatively correlated with the population of *B. tabaci*.

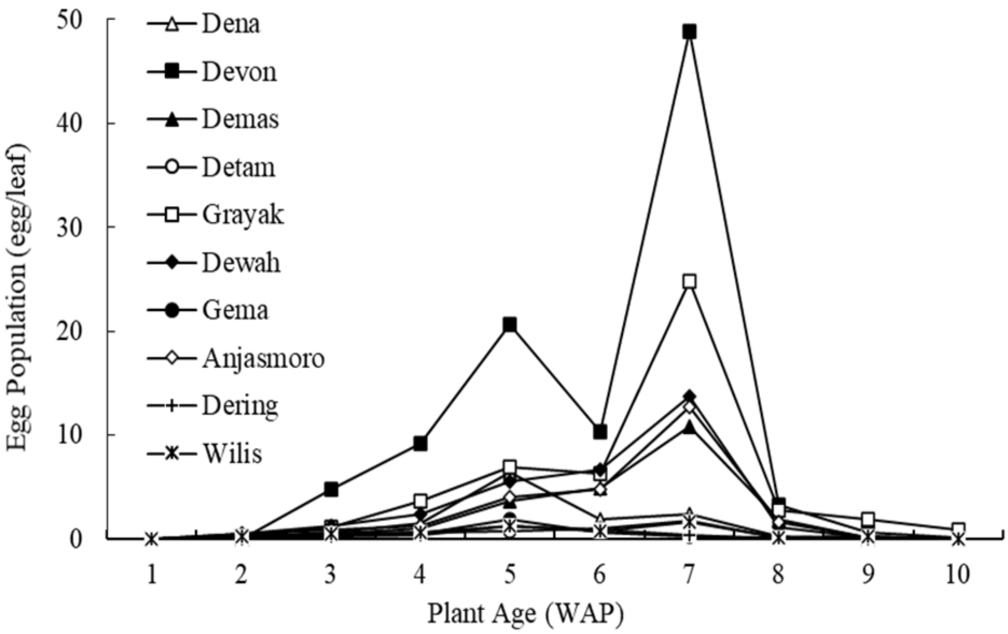

Figure 1. The population development of *B. tabaci* eggs per leaf in 10 soybean varieties. WAP= Weeks after planting

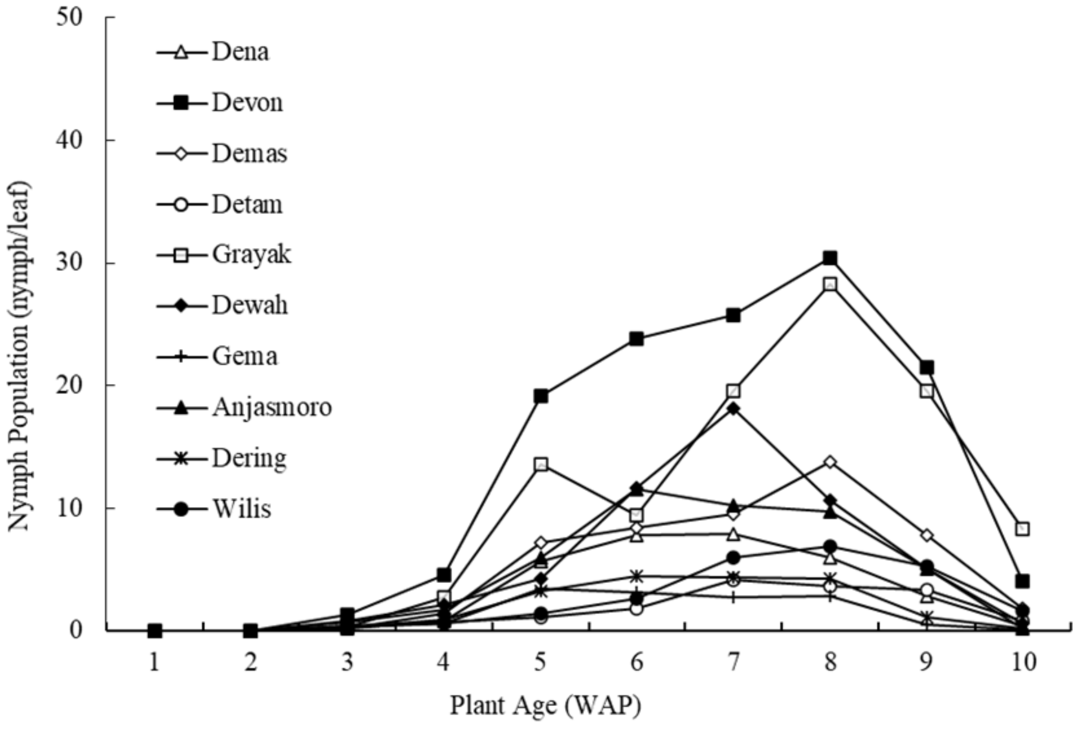

Figure 2. The population development of *B. tabaci* nymph per leaf in 10 soybean varieties. WAP= Weeks after planting

Effect of Leaf Trichoma Density on *Bemisia tabaci* Infestation. Population levels of eggs and nymphs of *B. tabaci* varied in the varieties tested. The soybean varieties that significantly showed the highest population levels in the egg and nymph stages were the Devon variety (Table 1). This indicated that the Devon variety was a variety that is susceptible to *B. tabaci* attack. The high population of *B. tabaci* in the Devon variety was caused by the morphological character of the variety in the form of a high density of trichomes on the underside of the leaves. Dalin et al. (2008) reported that leaf trichomes could influence insect oviposition and feeding behavior in various herbivorous insects. Trichomes, a hair like-like structure on various parts of a plant, are one of the morphological characteristics that can affect pest behavior that infestation plants such as oviposition and feeding behavior (Faiz et al., 2021). According to Mansaray & Sundufu (2009) that *B. tabaci* preferred soybeans as the main host compared to long beans because soybeans had denser trichomes, especially on the leaf surface. Silverleaf whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae), has shown a positive relationship between its population number and oviposition preference with a higher number of trichomes (Lutfi et al., 2019). Devon was the variety that has the highest density of trichomes calculated on a leaf area of 1 cm^2 (Table 1). The number of trichomes had a very significant effect on the number of eggs and nymphs infested with *B. tabaci* (R2= 0.78 (eggs) and 0.84 (nymphs), n= 10, α = 1%, F Value= 0.00157) (Figure 3).

The denser the trichomes on the soybean leaves, the higher the number of eggs and nymphs of *B. tabaci* laid. The density of trichomes is thought to play a role in protecting eggs and nymphs of *B. tabaci* from natural enemy attacks. The more the number of trichomes, the more difficult it will be for natural enemies to reach the eggs or nymphs because they are blocked by the density of the trichomes. The efficiency of whitefly's natural enemies in finding prey will be more effective if the number of trichomes on the leaf surface is reduced (Hua et al., 1987). Heinz & Zalom

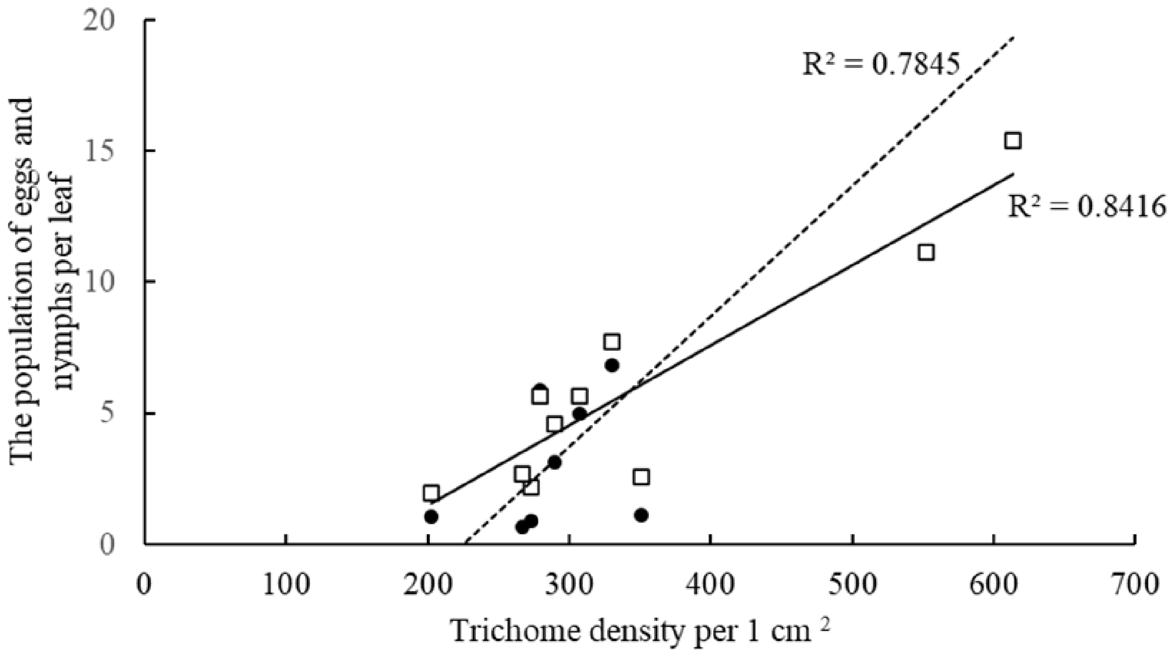

Figure 3. Corelation of Trichome density with number of eggs and nymphs infested with *B. tabaci.*

Table 1. Average trichome density of 10 soybean varieties, population of whitefly eggs and nymphs *B. tabaci* (2–10 WAP)

Varieties	Trichome (1 cm^2)	Average (individual per leaf)	
		Egg	Nymph
Devon	613.70 ± 89.40 a	10.89 ± 9.79 a	14.48 ± 8.36 a
Grayak 1	552.60 ± 40.50 a	5.46 ± 0.78 ab	11.34 ± 1.29 ab
Wilis	351.30 ± 40.60 b	0.63 ± 0.35 b	2.76 ± 1.25 c
Dewah	330.50 ± 58.20 bc	3.47 ± 2.91 b	5.91 ± 3.65 bc
Demas 1	307.10 ± 52.40 bc	2.59 ± 2.49 b	5.58 ± 3.66 bc
Dena 1	290.00 ± 66.60 bc	1.49 ± 0.92 b	3.51 ± 1.22 c
Anjasmoro	279.50 ± 70.70 bc	2.89 ± 2.22 b	5.03 ± 3.53 c
Gema	273.00 ± 44.00 bc	0.48 ± 0.33 b	1.53 ± 0.73 c
Dering 1	267.10 ± 98.80 bc	0.38 ± 0.03 b	2.11 ± 0.21 c
Detam 3	202.70 ± 48.80 c	0.62 ± 0.15 b	1.79 ± 0.62 c

Numbers in the same column followed by different letters show a significant difference in Duncan's multiple-distance test (DMRT) = 5%.

(1995) also reported that tomato cultivars with dense trichome densities were more favorable in egg laying than tomato cultivars with lower trichome densities. Eggplant cultivars having lower trichome densities recorded lower numbers of whitefly adults and eggs than other cultivars (Hasanuzzaman et al., 2016).

Anjasmoro, Dena 1, Dering 1, Detam 3, Gema, and Wilis varieties had better defense mechanisms against *B. tabaci* attacks than other varieties. These varieties have a low level of trichome density (Table 1), so from the aspect of the host plant, it does not meet the ideal conditions for laying eggs of this insect. This can be seen from the low population level of *B. tabaci* in these varieties. The low density of trichomes on soybean leaves can be a character of soybean plant resistance to *B. tabaci* (Hendrival et al., 2013).

Information about *B. tabaci* preferences in egg-laying can be the basis for producing superior soybean varieties that are resistant to *B. tabaci* attack. This is very important information for plant breeding experts to produce superior soybean varieties with high yield potential and low trichome density on the leaf surface. The use of resistant varieties is one of the principles of the IPM technique. The use of resistant varieties is the most effective control technique for controlling *B. tabaci* (Russel, 1978).

CONCLUSION

The density of trichomes affected the number of eggs and nymphs of the whitefly *B. tabaci* on soybean leaves. The higher the density of the trichomes, the greater the number of eggs and nymphs of *B. tabaci.* The Devon variety was the variety with the highest *B. tabaci* infestation of all soybean varieties tested. The varieties Anjasmoro, Dena 1, Dering 1, Detam 3, Gema, and Wilis were the varieties with the lowest *B. tabaci* infestation among the 10 varieties tested because they had low trichome density.

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AUTHORS' CONTRIBUTIONS

FM, PH, and HT considered and planned the experiment. I collected data on the population of Bemisia tabaci and plant damage. I performed analysis and interpreted the plant damage and weather data. PH and HT prepared the manuscript. The authors provided responses and comments on the research flow, data analysis, and interpretation as well as the shape of the manuscript. All the authors have read and approved the final manuscript.

COMPETING INTERESTS

All the authors declare there are no competing interest regarding this publication.

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