Research Article

Potential of various trap crops for the control of *Bemisia tabaci* on chilli pepper

Potensi berbagai tanaman perangkap untuk pengendalian Bemisia tabaci pada tanaman cabai

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Abstract: The whitefly *Bemisia tabaci* is an important pest of chilli peppers and a vector insect that causes yellow leaf disease. This study aimed to compare the whitefly population and the intensity of its attacks on chilli production in plots with or without trap crops. This study used eggplant, tomato and mungbean as trap crops. As the main crop, Chilli pepper was planted in plots measuring 7 m x 4 m with a spacing of 60 cm x 70 cm. Trap crops were planted around the chilli pepper plots, with 16 plants in each plot. The results showed a significant difference between whitefly populations and the intensity of their attacks in plots without trap crops and plots with mungbean traps. The biggest chilli weight was obtained from plots with mungbean trap plants. State that mungbean has the best potential as trap crop to control *B. tabaci.*

Keywords: Trap crops, habitat manipulation, pest control, whitefly, chilli pepper

Abstrak: Kutu kebul *Bemisia tabaci* merupakan salah satu hama penting pada tanaman cabai dan juga serangga vektor penyebab penyakit daun kuning. Penelitian bertujuan untuk membandingkan populasi kutu kebul dan intensitas serangannya terhadap produksi cabai pada petak dengan atau tanpa tanaman perangkap. Penelitian ini menggunakan tanaman terong, tomat dan kacang hijau sebagai tanaman perangkap. Tanaman cabai sebagai tanaman utama ditanam pada petak berukuran 7 m x 4 m dengan jarak tanam 60 cm x 70 cm. Tanaman perangkap ditanam mengelilingi petak tanaman cabai, masing-masing petak sebanyak 16 tanaman. Hasil penelitian menunjukkan bahwa terdapat perbedaan yang nyata antara populasi kutu kebul dan intensitas serangannya pada petak tanpa tanaman perangkap dan petak dengan tanaman perangkap kacang hijau. Bobot cabai terbesar diperoleh dari petak dengan tanaman perangkap kacang hijau. Dapat disimpulkan bahwa kacang hijau efektif digunakan sebagai tanaman perangkap untuk meminimalisir serangan kutu kebul pada tanaman cabai.

Kata kunci: Tanaman perangkap, manipulasi habitat, pengendalian hama, kutu kebul, cabai

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INTRODUCTION

One of the problems in cultivating chilli pepper is the attack of insect pests. *Bemisia tabaci*, commonly known as whitefly, is one of the important pests of chilli pepper (Saad et al., 2015). The pest attacks more than 600 species of horticultural crops (Oliveira et al., 2001) and causes direct damage to plants (Ning et al., 2015; Padilha et al., 2021) and it acts as a vector of plant diseases (De Marchi et al., 2017; Ghosh et al., 2019).

The damage caused by the pest has been studied and controlled for the last three decades (Pedigo & Higley, 1992). Some whitefly pest control methods commonly used include the use of plants resistant to pests and diseases (Greathead, 1991), intercropping between main crops and barrier crops (Smith & Mcsorley, 2000; Pankeaw et al., 2011; De Marchi et al., 2017), and chemical control by spraying insecticide (Satar et al., 2018). The management of habitats, such as the use of trap crops and intercropping systems, is an important strategy of integrated pest control (González-Chang et al., 2019) and effective in reducing the population density of *B. tabaci* (Zhang et al., 2020).

Trap crops are one of the whitefly pest control methods (Smith & Mcsorley, 2000; Schuster, 2004), but the method is rarely implemented. Some types of plants reported as whitefly trap crops are melon, sunflower, and corn (Zhang et al., 2020). Mung bean, eggplant, and tomato are host plants of whitefly (Hilje & Stansly, 2018), so they have the potential to trap crops of whitefly. The study aimed to compare the population of whitefly and their attack intensity to the production of chilli pepper on a plot with or without trap crops.

MATERIALS AND METHODS

Study Area

The study was conducted on the agricultural land of the society of Lumpoknyo, Luwuk-Banggai Regency, Central Sulawesi Province, Indonesia. The study was conducted from July to December 2020, from chilli pepper seeding, planting, and observation, to production.

Research Design

The study implemented a group random design consisting of 4 treatments, namely a plot without trap crops (control), a plot of chilli pepper with trap crops of eggplant, a plot of chilli pepper with trap crops of tomato, and a plot of chilli pepper with trap crops of mung bean. Each treatment was repeated four times, so there were 16 experiment units where each plot was made with a size of 7 m x 4 m. The chilli pepper was planted at a distance of 60 cm x 70 cm, and trap plants were planted around the chilli plants with a spacing of 130 cm x 130 cm for 16 plants. The distance between the chilli pepper and the trap crops was 50 cm. Whitefly population count was observed on the chilli leaves at the top, middle and bottom, each consisting of 3 leaves. The parameters observed were the population of whitefly, the attack intensity, and the weight of chilli pepper per plot.

Data Analysis

The data on the whitefly population were observed by directly calculating the number of individuals present on the leaves of chilli pepper, while the attack intensity of whitefly was analyzed using the formula referring to Fattah et al., (2020):

$$\text{IS} = \sum \frac{ni \times Vi}{N \times V} \times 100\%$$

IS = attack intensity (%)
ni = number of crops attacked in certain category
vi = scale value of each attack category
N = number of crops observed
V = scale value of highest attack

The scale values of attack as the following by Neves et al., (2006) with modified range and category of scale:

0 = no damaged leaves
1 = leaf damage 1-14%
2 = leaf damage 15-40%
3 = leaf damage 41-50%
4 = leaf damage 51-80%; and
5 = leaf damage 81-100%

The data on population, intensity and weight of chilli peppers per plot were analyzed using analysis of variance (ANOVA) and continued by Tukey test to compare the results of each plot.

RESULTS AND DISCUSSION

Population of whitefly

Whitefly (*B. tabaci*) had a broad range of hosts, covering more than 600 species of crops (Oliveira et al., 2001). Based on the results of the analysis of variance, the treatments did not have any effect on the size of the whitefly population during the observation of 2nd, 3rd, and 5th week after planting (WAP) (Table 1), but there was a difference between the sizes of the population of each treatment. The size of the whitefly population during the observation of 2nd week after planting showed that the plot with trap crops of tomato produced the greatest average size of population (11.25) compared to the other plots.

Table 1. The average of whitefly population during the observation of 2, 3, and 5 weeks after planting.

Trap crops	Average of population		
	2 WAP	3 WAP	5 WAP
Control	6,50[a]	18,25[a]	54,50[a]
Tomato	11,25[a]	14,75[a]	37,25[a]
Mung bean	4,25[a]	14,25[a]	18,00[a]
Eggplant	7,25[a]	21,50[a]	53,50[a]
p-value	*0,389*	*0,536*	*0,180*

However, during the observation of 3rd week after planting, it showed that the size of the population on the plot with trap crops of eggplant produced the greatest average size of population (21.50) compared to the other plots. The observation of the 4th, 6th, 7th, 8th, and 9th week after planting, the use of trap crops significantly affected the whitefly population's size (Table 2).

Table 2. The average of whitefly population during the observation of 4, 6, 7, 8, and 9 weeks after planting.

Trap crops	Average of population				
	4 WAP	6 WAP	7 WAP	8 WAP	9 WAP
Control	32.50^{a}	68.25^{a}	61.75^{a}	93.25^{a}	89.25^{a}
Tomato	15.75^{ab}	38.75^{ab}	29.25^{ab}	34.50^{b}	36.00^{b}
Mung bean	7.75^{b}	23.00^{b}	19.50^{b}	17.25^{c}	28.50^{b}
Eggplant	22.00^{ab}	43.00^{ab}	48.75^{ab}	44.25^{b}	40.25^{b}
p-value	*0.024**	*0.033**	*0.015**	*0.000***	*0.000***

Remarks: The values represented by the same letters were not different.
* = p-value < 0.05; ** = p-value < 0.01

The size of the whitefly population during the observation of the 4th, 6th, 7th, 8th, and 9th WAP showed that the plot without trap crops (control) produced the greatest average population size compared to the other plots. The size of the whitefly population on the plot with trap crops of mungbean had the smallest number of individuals compared to the other plots. The analysis of variance showed that the size of the whitefly population on the plot with trap crops of mungbean was different from the control plot. There was a significant difference in the whitefly population on the plot without trap crops and the plot with trapped crops of mung bean. In the cultivation of chilli pepper, mungbean was effective as a trap crop to minimize the population of *B. tabaci* on the chilli pepper. Mungbean is a host plant of *B.tabaci* (Taggar & Gill, 2016), and a great size of the population is frequently found on mungbean plant (Kumar et al., 2019; Min et al., 2020).

In addition to mung bean, trap crops of eggplants also showed a significant population size. However, the Tukey test results were similar to the population on the plot without trap crops. Eggplant is one of the host plants preferred by *B. tabaci* (Hasanuzzaman et al., 2016; Hasanuzzaman et al., 2018), and a great size population is frequently found on eggplants (Karut et al., 2018; Mohammadali et al., 2019; Sudarjat et al., 2019).

Attack Intensity

The intensity of whitefly attack on chilli pepper during the observation of 3 to 9 WAP showed that the percentage of attack intensity was high on the control treatment (Table 3). The analysis of variance showed that during the observation of 3 to 9 WAP, the treatment using trap crops of mungbean had a significant effect on the intensity of whitefly attack on the chilli pepper.

The intensity of the pest attack was centralized on the plot of chilli pepper without trap crops (control), different from the plot using trap crops. It was because, on the control plot, no other plants became the source of food or host plants and barriers against pest *B. tabaci*. According to Perfecto & Sediles, (1992); Finch & Collier, (2000), border cropping is a pest barrier to finding the main crop and alternative hosts. Additionally, Nderitu et al., (2008) report that the use of border cropping in the strategy of pest control relates to the behaviour of pest flying activity in finding host plants to colonize, feed, and reproduce. Management of habitat using the intercropping system can reduce the level of *B. tabaci* attacks (Zhang et al., 2020) and the spread of the virus brought by whitefly (Hooks & Fereres, 2006).

Table 3. The intensity of whitefly attack on chili pepper during the observation of 3 to 9 WAP.

Trap crops	Intensity of Attack						
	3 WAP	4 WAP	5 WAP	6 WAP	7 WAP	8 WAP	9 WAP
Control	73.33^{a}	80.00^{a}	80.00^{a}	70.00^{a}	75.00^{a}	85.00^{a}	95.00^{a}
Tomato	36.67^{b}	38.33^{b}	38.33^{b}	40.00^{bc}	45.00^{b}	45.00^{b}	45.00^{b}
Mung bean	38.33^{b}	40.00^{b}	40.00^{b}	30.00^{c}	40.00^{b}	35.00^{b}	35.00^{b}
Eggplant	38.33^{b}	40.00^{b}	40.00^{b}	60.00^{ab}	60.00^{ab}	50.00^{b}	55.00^{b}
p-value	*0.000***	*0.000***	*0.000***	*0.005***	*0.005***	*0.001***	*0.000***

Remarks: The values represented by the same letters were not different.
* = p-value < 0.05; ** = p-value < 0.01

In general, pest attacks in monocultural planting systems tend to be higher than in the intercropping system (Arsyad et al., 2020; Fattah et al., 2020). Besides that, the ability of *B. tabaci* to produce eggs (fecundity) (Di et al., 2018) and its survival rate (Zhang et al., 2014) tend to be higher on monocultural condition than the intercropping system.

Average weight of chilli peppers/plot (ounce)

The treatment using trap crops of tomato, mung bean, and eggplant significantly affected the average chilli pepper weight per plot (Table 3). The highest chilli weight was found on the plot using mungbean trap crops (4 ounces). The percentage of *B. tabaci* attacks on the plot of mungbean was the lowest compared to the other plots. *B. tabaci* attack on chilli pepper affected the physiological process and products of chilli peppers.

Table 4. Average weight of chili peppers per plot

Trap crops	Average	*p-value*
Control	2.25 ^{a}	*0.000***
Tomato	3.25 ^{c}	
Mung bean	4.00 ^{d}	
Eggplant	2.75 ^{b}	

Remarks: The values represented by the same letters were not different.
** = p-value < 0.01

Whitefly attack can cause direct damage, such as the occurrence of honeydew that becomes a growing medium for fungi (Lee & Zhang, 2018), and indirect damage in the form of stomata closing, formation of chlorotic spots on leaves that interferes with the photosynthesis process (Jeevanandham et al., 2018) that affects the growing process and plant products (Byrne & Bellows, 1991).

CONCLUSIONS

Based on the research results, it can be concluded that mungbean is the most effective trap crop compared to the other two types of trap crop. The plots using mungbean traps also produced the highest average fruit weight compared to other plots. Trap crops are an alternative control strategy that must be applied to suppress the population and intensity of *B. tabaci* attacks on red chilli peppers.

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