Research Article

Analysis of Volatile Compound at Different Age of Corn Crops Used as *Bemisia tabaci* Repellent

Retno Wikan Tyasningsiwi¹, Witjaksono²*, & Siwi Indarti²

¹Directorate of Horticultural Crop Protection, Ministry of Agriculture
Jln. AUP Pasar Minggu, South Jakarta 12520 Indonesia

²Department of Plant Protection, Faculty of Agriculture, Universitas Gadjah Mada
Jln. Flora No. 1, Bulaksumur, Sleman, Yogyakarta 55281 Indonesia

*Corresponding author. E-mail: witjaksono@ugm.ac.id

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ABSTRACT

*Bemisia tabaci* is one of the red chili pests that plays a role as a Begomovirus vector. This vector can be controlled through Integrated Pest Management (IPM) practices. One of the potential practices is by utilizing corn as a barrier crop to prevent the vector from attacking the main crop. The aim of this research was to examine the repellence activity of the volatile compound obtained from various ages of corn crop against *B. tabaci*. The volatile compound was collected from the corns at 4 week after planting (WAP), 6 WAP, 8 WAP, 10 WAP, and 12 WAP. Volatile compound capture device was designed with two solvents, i.e. hexane and ethanol, then the volatile compound analyzed by Gas Chromatography Mass Spectrometry (GC-MS). *B. tabaci* repellency against volatile compound was examined using Y-tube olfactometer. Each treatment was employed with 5 replications. Data were analyzed using ANOVA with 95% and further analyzed by Least Significant Different (LSD). The parameter observed was the total of *B. tabaci* avoided the volatile compound tested until half of the control olfactometer arm. The results showed that all ages of the corn produced repellent compound and the most optimal were corn aged 12 WAP with repellency rate of 83.72%. GC-MS analysis identified the volatile compound were citronella, limonene, β-phellandrene, β-caryophyllene, 1.8 cineole, farnesol, caryophyllene, and patchouli alcohol.

Keywords: *Bemisia tabaci*, corn crop, repellent compound

INTRODUCTION

*Bemisia tabaci* (whitefly) is a pest that transmit a Begomovirus (yellow virus). *B. tabaci* is a very effective vector because based on greenhouse experiment within 24-hour inoculation period a single *B. tabaci* adult was able to transmit Begomovirus (the chili curly yellow disease) up to 40%, after left for 48 hours sucking the source of the inoculum. The effectiveness of transmission has doubled when 3 adults were used (Sulandari, 2004). The percentage of affected plants will increase with the increasing number of viruliferous whitefly (containing viruses) (Mehta et al., 1994). The virus was transmitted by *B. tabaci* persistently, which means the virus will be in the insect body as long as the insect lives. Begomovirus transmission only occurs through *B. tabaci* adult and can not be obtained through contact transmission or seeds (Aidawati et al., 2002; Jones, 2003; Sulandari, 2004; Hidayat & Rahmayani, 2007).

*B. tabaci* start indicating resistance to several types of insecticides, such as organophosphate, carbamate, and synthetic pyrethroids. For this reason, pest management based on ecological and economic approaches with Integrated Pest Management (IPM) are needed (Sugiyama, 2005; Setiawati et al., 2007). The development of the current and future concepts of IPM leads to bio-intensive novels, which utilize biological resources in nature, such as using natural enemies, resistant varieties, natural pesticides, repellent plants, attracting plants, or crop borders (Frisbie & Smith, 1991; Hoddle et al., 1998).

One of the pest control objectives in cultivation or farming is to manage the planting environment in such a way that it becomes inconvenient for pest to develop, hence reduce pest population and plant damage (Untung, 2006), including planting crop borders around cultivated crops, which are non-host plants or plants which are not preferable by the targeted pest. Non-host plants not only make the
cultivated crops difficult to be found but also serve as a physical barrier for pests to find the crop. Corn plants planted around chili can reduce whitefly populations by 53% (Moreau, 2010). The use of crop borders can suppress disease incidence by viruses transmitted through insect vectors (Difonzo et al., 1996; Fereres, 2000). Friarini (2017) also showed that the population of B. tabaci in red chili plant area surrounded by corn plants was lower than that was not surrounded by corn plants.

Corn contains volatile compounds, e.g. as attractants or repellents. Attractants are chemical compounds that attract insects to come, while repellents are chemical compounds that repel insects to move away from the compound. This is confirmed by Friarini (2016), which suspected that corn has chemical compounds able to repel B. tabaci. Chemical compounds, including volatiles, that are terpenoids, aromatic phenols, alcohols, aldehydes, and nitrogen with molecular weights ranging from 100–200, usually derived from secondary compounds produced by plants (Schoonhoven et al., 1998). Corn cob and silk has compounds such as flavonoids, carotene, quercetin, alkaloids, simple phenols (e.g. p-coumaric, saponin, tannin, anthocyanin, and protokatekin) (Guo et al., 2009). Therefore, this study was aimed to determine the compound content of corn at a certain age that could be used as B. tabaci repellents.

PLANTING CORN

The corn variety used in this study was BISI-2. Fifty plants were planted in polybags (10 cm in height), and 10 plants were used for each age of corn to extract volatile compounds: 5 plants used n-hexane solvents, and 5 plants used ethanol solvents.

MASS REARING OF B. TABACI

Mass rearing of B. tabaci used the method by Rinaldi et al. (2016) with modifications: 250 B. tabaci adults from tomatoes planting were put inside a cage cloth (1.5 m × 1.5 m × 1.5 m) filled with tomato, eggplant, and red chili plants as host plants. Twenty host plants aged 4 WAP were placed in the cage. An infected plant was replaced with a new healthy plant. B. tabaci adults used in this study were from the second generation (F2) after collection from the field. Ten females of B. tabaci used in this study were one-day old for each treatment in each replication. The purpose of using B. tabaci females was referring to Hasyim et al. (2016), which stated that female whitefly has a higher level of virus transmission efficiency than male.

CORN VOLATILE COMPOUND COLLECTION

Corn volatile compounds were collected using a volatile compound capture device according to the method by Heath & Manukian (1994) which has been modified (Figure 1). This tool comprises of several parts: a solvent storage measuring tube, a corn plant storage tube, an air pump, and a balloon mounted on the bottom of the plant storage tube. The corn plant storage tube was designed airtight hence volatile compounds that come out from the corn plant will be captured and collected immediately. The extraction of volatile compounds was conducted by putting the same age of five corn plants into the plant storage tube. Solvents (n-hexane and ethanol) were placed alternately in the solvent storage measuring tube. The amount of solvent used was 7 ml for each collecting work. Plants that have been put into storage tube were left for one day. Thereafter, volatile compounds were captured by pumping balloon at the bottom of the tube then compounds came out, which indicated by the presence of air bubbles that infiltrated the solvent (n-hexane and ethanol). Volatile compounds collected in solvents were taken and put into small glass vials,
A: number of adults in control
N: number of adults in the solution of the compound of corn plants
Level 1 = repellent value between 0.1–20%
Level 2 = repellent value between 20.1–40%
Level 3 = repellent value between 40.1–60%
Level 4 = repellent value between 60.1–80%
Level 5 = repellent value between 80.1–100%

B. tabaci chose stimulating compounds in one of the Y tube hands (Amalia, 2015).
B. tabaci was allowed to choose and waited for 10 minutes to walked to the 7 cm Y tube hand from the base and stayed for one minute at that location. If B. tabaci did not elect any of which within 10 minutes, it was deemed to have no response (Meilin, 2012). The parameters observed in this experiment were the number of B. tabaci which avoids volatile compounds of corn plants at various ages.

Data Analysis
In this study, if B. tabaci did not choose the arm containing corn compound it means that the insect avoided stimulating from corn compound. Data were analyzed with ANOVA and continued with the LSD test at 95% confidence level.
RESULTS AND DISCUSSION

The olfactometer assay showed that the number of *B. tabaci* moving towards the control arm (n-hexane) was significantly different from the treatment on the arm containing extract of corn plants. In the control, *B. tabaci* was less repelled compared to the treatment of plant age. The corn plant that most repelling *B. tabaci* was age 12 WAP (8.6) and age 8 WAP (8), where insects preferred to moved toward control (n-hexane). As for treatments using ethanol, the result showed that the control was significantly different from other treatments of corn plants from various ages. In control, *B. tabaci* adult was only slightly repelled compared to the treatments. It was considered that in the treatments with volatile compounds from various ages found compounds that were able to repel *B. tabaci*. The highest number of *B. tabaci* repelled by volatile compounds with ethanol was in aged 12 WAP (8.6), which were not significantly different from volatile compounds aged 10 WAP (7.8). Whereas at age 10 WAP (7.8) there was no significant difference with volatile compounds from age 8 WAP (7.2). From treatments above, the most repelled number of *B. tabaci* was at the age of 12 WAP. The use of n-hexane and ethanol solvents showed that both treatments have the same plant age that produced the highest repellent to *B. tabaci* (12 WAP) (Table 1).

The GC-MS analysis of volatile compounds of several ages of corn plants, which dissolved in n-hexane and ethanol solvents, detected several compounds which in some previous studies were mentioned as insect repellents (Table 1). Monoterpene compounds have a rejection effect on mosquitoes including α-pinene, cineol, eugenol, limonene, terpinolene, citronellol, citronellal, camphor, and thymol. Likewise with sesquiterpenes, such as β-caryophyllene (Nerio et al., 2010). Citronellol and geraniol are resistant to *B. tabaci* adults (Delletre et al., 2015).

In this analysis, patchouli alcohol was also detected, which in cymbopogon and eucalyptus extract acts

<table>
<thead>
<tr>
<th>Plant Age (WAP)</th>
<th>Detected Repellent Compound</th>
<th>Repellence of <em>B. tabaci</em> (% ± SE)*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n-hexane solvent</td>
<td>ethanol solvent</td>
</tr>
<tr>
<td>4</td>
<td>Geranyl acetate</td>
<td>Bornyl acetate</td>
</tr>
<tr>
<td>6</td>
<td>Citronellyl acetate</td>
<td>36.19 ± 10.50a</td>
</tr>
<tr>
<td>8</td>
<td>Limonene</td>
<td>Patchouli alcohol</td>
</tr>
<tr>
<td></td>
<td>Citronella</td>
<td>Citronella acetate</td>
</tr>
<tr>
<td></td>
<td>Eugenol</td>
<td>Geranyl acetate</td>
</tr>
<tr>
<td></td>
<td>β-Caryophyllene</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Farnesol</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>1,8-Cineole</td>
<td>Champene</td>
</tr>
<tr>
<td></td>
<td>Farnesol</td>
<td>Myrcene</td>
</tr>
<tr>
<td></td>
<td></td>
<td>β-Phellandrene</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Citronella</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Caryophyllene</td>
</tr>
<tr>
<td></td>
<td></td>
<td>β- Farnesene</td>
</tr>
<tr>
<td></td>
<td></td>
<td>α-Patchouline</td>
</tr>
<tr>
<td>12</td>
<td>1,8-Cineole</td>
<td>β-Patchouline</td>
</tr>
<tr>
<td></td>
<td>Farnesol</td>
<td>Caryophyllene</td>
</tr>
<tr>
<td></td>
<td></td>
<td>β- Caryophyllene</td>
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<tr>
<td></td>
<td></td>
<td>α- Patchouline</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Patchouli alcohol</td>
</tr>
</tbody>
</table>

Remarks: *Values ± SE followed by the same letter were not significantly different according to LSD (α = 0.05)
ACKNOWLEDGMENT

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LITERATURE CITED


