

**POPULATION FLUCTUATIONS OF VEGETABLE WHITEFLIES [*Bemisia tabaci* (Risso) (Hemiptera: Aleyrodidae)] IN TOMATOES GREENHOUSES IN SOUTHWEST MEDITERRANEAN REGION OF TURKEY**

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**Abstract**

*Bemisia tabaci* (Blanchard) (Diptera: Agromyzidae) is an important pest in tomato greenhouses in Ortaca, Mugla, Western Turkey. This study was carried out during the spring and autumn seasons of 2019 in five different tomato greenhouses, each 1,000 m<sup>2</sup> in size. Population densities of adult *B. tabaci* in insecticide-treated and non-treated used when it is necessary, this will provide successful and integrated management against *B. tabaci*. Greenhouses were compared by using yellow sticky traps. Ten traps were placed in the non-treated greenhouse and ten traps in the insecticide-treated greenhouse. Yellow sticky traps were changed weekly and the number of flies counted in order to compare the two greenhouses. In addition to monitoring the whitefly population, in each greenhouse 100 plants were checked and the ratio of infested plants, the ratio of infested leaves per plant and the number of larvae per leaf were recorded weekly. The population density of the whitefly was almost the same in both insecticide-treated and non-treated greenhouses. Thus, it was concluded that using yellow sticky traps will be healthier and more cost effective than using pesticides. Furthermore using pesticides is risky for the environment and the use of yellow sticky traps can easily reduce the number of pesticide applications. If yellow sticky traps are used in the greenhouse in a completely isolated environment and the appropriate insecticide is used when it is necessary, this will provide successful and integrated management against *B. tabaci*.

**Keywords:** tomato, *Bemisia tabaci*, population density, Turkey, yellow sticky traps

**1. INTRODUCTION**

In Turkey, a total of 69.200 ha is under vegetable production in greenhouses, of which 62% are tomato production (Anonymous, 2018). *Bemisia tabaci* is Bemisia tabaci (Gennadius) has been known to cause economic losses in cotton and vegetable crops in southern Turkey since 1966 (Ulusoy & Ülgentürk 2003). This whitefly species has become an increasingly important pest and vector of plant viruses in agricultural crops in tropical and subtropical regions throughout the world (Roditakis et al., 1997, Shepard et al., 1998, Bayhan et al., 2006, Steven et al., 2010). *B. tabaci* has also got some biotypes. The B biotype was described in the southeastern Turkey. It is considered a distinct biological type based on its unusually broad host range, high reproductive success, and ability to induce a silvery phenotype in leaves of colonized plant species (Karut et al., 2014).

The farmer applies insecticides for a minimum of 6 times, and a maximum of 14 times, in each production period. For that reason, these applications make the cost of the production increase to some extent. This study was carried out in insecticide-treated and non-treated greenhouse conditions in order to use yellow sticky traps to control *B. tabaci* and determine the efficiency of these traps, with the aim of lowering the insecticide applications to the minimum level.

This objective of this study was compared the relative trapping efficiency of yellow sticky traps in greenhouses in 2019. This information will improve monitoring of these pests in cotton and enhance integrated pest management programs.

## 2. MATERIALS AND METHODS

### 2.1. Materials

The materials of this study were *Bemisia tabaci* (vegetable whitefly) and tomatoes.

### 2.2. Methods

#### 2.2.1. Study site

This study was carried out during 2019 in Ortaca (Mugla, Turkey) on tomato plants grown under two different commercial greenhouse conditions.

#### 2.2.2 Greenhouses

The study was carried out in five different greenhouses belonging to a local farmer, each 1,000 m<sup>2</sup> in size and built of an iron framework covered with polyethylene. In order to prevent contamination from outside, all ventilation openings were closed with fly nets (of hole size 0.5 mm) in both greenhouses. One of the greenhouses was chosen as the non-treated greenhouse and no insecticide treatment was applied throughout the production period. The other greenhouse was treated with the insecticides commonly used in the area. During the study, the fly nets in both greenhouses were replaced annually. Insecticide applications were recorded. The favorable climatic conditions in Ortaca allow two tomato growing seasons each year (November to June and August to November.)

#### 2.2.3. Insecticides

Insecticides were applied by the farmer according to local growers' practices at least 6 times in each production period. The following commercial insecticides were used at manufacturers' recommended rates by the farmer: 240 g/l Spiromesifen (Agrobest, Batugan), 100 g/l Buprofezin + 20 g/l Lambda-cyhalothrin (Agrobest, Anhorgup), 200 g/l Abamectin (Agrotez, Gemini 200 SL) 250 g/l Cypermethrin (Koruma Klor, Siperkor 25 EC). In the 2019 each of the seven insecticides was used once.

#### 2.2.4. Mass trapping and sampling

The traps used in the study were constructed from yellow plastic boards (20x15 cm). The boards were coated on both sides with a sticky coating [Temo Bi non-poisonous special glue (Kollant SPA, Padova, Italy)]. At each sampling date all traps were placed randomly in each greenhouse. In this study, 10 traps were placed in the non-treated greenhouse and 10 traps were placed in the insecticide-treated greenhouse. Traps were elevated 10 cm above the top of the plants. The traps were changed every week in order to compare findings and the numbers of flies on each side of the boards were counted and recorded.

In addition to monitoring the whitefly larva population, in both greenhouses 100 randomly selected plants were checked (Yaşarakıncı & Hıncal 1996; Steven et al., 2010) and were studied with the weekly observation throughout the production period. On each date, the following items were recorded in each greenhouse: the ratio of infested plants (%), the ratio of infested leaves/plant and the number of larvae/leaf.

#### 2.2.5. Data analysis

The data were evaluated by the SPSS software program. Data from each year were analyzed separately. Comparisons between the numbers of the whitefly adults from each treatment trap were initially analyzed using a one-way analysis of variance (ANOVA), and means were separated by the least significant difference (LSD) range test.

## 3. RESULTS

Insecticides were applied 6 or 7 times in the insecticide-treated greenhouse in each of two different production periods by the farmer, that is, two periods in spring and two in autumn. The catches (mean  $\pm$  SE) and analysis of variance of the adults of *B. tabaci* on yellow sticky traps during 2019 are

presented in Table 1.

In 2019 when the experiments were carried out, it was determined that the *B. tabaci* adult population at the beginning of the spring production period was more than in autumn, because lettuce, which the pest's preferred food, was produced in both fields and greenhouses during the winter season. As a result of this, *B. tabaci* could begin spring with a high, ready population. However, in the spring 2019 production, there was a severe outbreak of *Verticillium* sp., which, despite all efforts, resulted in death of all the plants. Therefore, this period was curtailed to 9 weeks. The heavy disease pressure can be seen in the reduction of leaf numbers caused by defoliation.

In both greenhouses in the spring of 2019, the densest adult population was recorded in May. Adult whitefly population was determined to be approximately three times more in the non-treated greenhouse than it was in the insecticide-treated greenhouse in the spring production period of 2019. Although insecticide was applied in an attempt to lower the density of the whitefly population in this period, when the average results obtained from traps are observed, it can be clearly seen that the density of whitefly population was not reduced. This result was the highest density of adult population that was met among the four production periods of the experiment. In the spring production period of 2019, the number of adults in the non-treated greenhouse was rather low; nevertheless, it was 30% higher than the number of adults in the insecticide-treated greenhouse. The number of adults in the insecticide-treated greenhouse was brought down to its lowest level by insecticide applications in May. However, it was seen that the density of the pest population was higher than in the non-treated greenhouse, even though insecticide was applied in the months of June and July. During the autumn production period of 2019, for the first time, the number of adult whiteflies that were caught by the traps in the insecticide-treated greenhouse was three times higher than in the non-treated greenhouse. In the spring production period, the density of adults in the non-treated greenhouse was 30% higher than in the insecticide-treated greenhouse.

**Table 1.** Catches (mean±SE) of adults of *Bemisia tabaci* on yellow sticky traps in each greenhouse in 2019

| Month     | Non-treated greenhouse     | Insecticide-treated greenhouse |
|-----------|----------------------------|--------------------------------|
| April     | 372.6±43.79 <sup>c</sup>   | 115.9±19.28 <sup>c</sup>       |
| May       | 1,617.5±39.02 <sup>a</sup> | 72.0±7.10 <sup>d</sup>         |
| June      | 1,120.6±45.09 <sup>b</sup> | 247.7±16.41 <sup>b</sup>       |
| July      | 95.8±10.14 <sup>d</sup>    | 342.8±48.47 <sup>a</sup>       |
| Average   | 801.6±60.20                | 194.6±10.72                    |
| August    | 150.6±20.97 <sup>b</sup>   | 2.1±1.23 <sup>c</sup>          |
| September | 15.2±5.09 <sup>c</sup>     | 533.1±86.09 <sup>b</sup>       |
| October   | 286.1±42.11 <sup>a</sup>   | 624.9±62.50 <sup>a</sup>       |
| Average   | 112.9±11.59                | 290.0±29.08                    |

<sup>abc</sup> Means followed by different lower case letters are significantly different within a column by the least significant difference range test ( $P < 0.05$ )

**Table 2.** Some infestation data for immature stages of *B. tabaci* in each greenhouse in 2019

| Month     | Non-treated greenhouse |             | Insecticide-treated greenhouse |             |
|-----------|------------------------|-------------|--------------------------------|-------------|
|           | Infested plants (%)    | Larvae/leaf | Infested plants (%)            | Larvae/leaf |
| Spring    |                        |             |                                |             |
| April     | 87.5/31.3              | 1.5/3.0     | 67.0/31.0                      | 1.5/3.0     |
| May       | 96.0/27.8              | 32.0/18.2   | 68.6/34.5                      | 29.0/22.5   |
| Jun       | 100.0/67.2             | 65.7/13.4   | 95.0/81.8                      | 50.0/12.4   |
| July      | 100.0/0.0              | 72.2/0.0    | 100.0/0.0                      | 49.0/0.0    |
| Average   | 95.9/45.8              | 42.7/15.5   | 82.7/53.3                      | 32.3/16.7   |
| Autumn    |                        |             |                                |             |
| August    | 0.0/62.0               | 0.0/13.7    | 0.0/40.0                       | 0.0/7.0     |
| September | 31.0/30.6              | 21.9/34.9   | 25.0/68.4                      | 17.5/14.2   |
| October   | 82.0/72.0              | 54.6/15.8   | 75.0/100.0                     | 49.0/81.9   |
| November  | 100.0/92.0             | 39.5/51.9   | 100.0/100.0                    | 42.9/107.5  |
| Average   | 53.3/57.6              | 29.0/16.2   | 50.0/73.5                      | 27.4/46.7   |

The monthly averages of some observations related to the infested plant ratio, the infested leaves/plant ratio and the number of larvae/leaf of *B. tabaci* in both greenhouses during 2019 are shown in Table 2. In both greenhouses, it can be seen that the density of *B. tabaci* in the leaves was higher in the 2019 spring production period than. However, the pest density in the leaves was higher in the autumn production period.

In the spring production period of 2019, the percentage of plants infested by whiteflies is, on average, 13.2% higher in the non-treated greenhouse than in the insecticide-treated greenhouse. In the autumn production period of 2019, similarly, the plants in the non-treated greenhouse were 3.3% more infested than the plants in the insecticide-treated greenhouse. On the other hand, in spring 2019, in spite of applying insecticide, the percentage of infested plants was 7.5% higher in the insecticide-treated greenhouse than it was in the non-treated greenhouse. Similar results were met in autumn and spring production periods of 2019; there were 15.7% more infested plants in the insecticide-treated greenhouse than in the non-treated greenhouse.

In the spring production period of 2019, the number of infested leaves per plant was 4% higher in the non-treated greenhouse than it was in the insecticide-treated greenhouse. It was also 2% higher in the autumn production period. However, the ratio in the insecticide-treated greenhouse was 2.3% and 3.5% higher in spring and autumn of 2019, respectively.

Looking at the number of larvae per leaf, during the spring and autumn production periods, 10.4 and 1.6 more larvae per leaf were observed in the non-treated greenhouse. In 2019, the number of larvae/leaf was 1.2 and 30.5 higher in the insecticide-treated greenhouse than in the non-treated greenhouse in spring and autumn, respectively.

In 2019, it was observed that the adult population of *B. tabaci*, the ratios of infested plants and leaves, and the number of larvae per leaf were much higher in the non-treated greenhouse than they were in the insecticide-treated greenhouse. However, the data obtained in 2019 was, the density of pest, the ratios of infested plants and leaves and the number of larvae per leaf were much higher in the insecticide-treated greenhouse than in the non-treated greenhouse.

The leaves counted. In autumn 2019, although the number of adults caught by traps in the insecticide-

treated greenhouse was 3 times higher than that in the non-treated greenhouse, the density relating to leaf counts was higher in the non-treated greenhouse. This shows that insecticide applications reduce larvae population in the insecticide-treated greenhouse when compared to the non-treated greenhouse. However, in autumn of 2019, the *B. tabaci* density was contrarily higher in the non-treated greenhouse, though it was higher in the insecticide-treated greenhouse at the time of the leaf count. Despite insecticide applications, it was observed that larvae increasingly continued to damage the plants in this period.

#### 4. DISCUSSION

*B. tabaci* can present serious problems to cucumber growers during the cotyledon stage of plant growth and may cause problems at fruit maturation under farm conditions. Insecticide is applied at least 6 times in each production period and this causes the cost of the yield to increase. In the spring production period of 2019, the density of *B. tabaci*, the number of adults caught by yellow sticky traps, and also the numbers of infested leaves obtained from the counts were all higher than they were in other production periods. This shows that the applications of insecticide reduce the population. However, in the autumn production period, although the densities of adults were nearly the same on yellow sticky traps in both insecticide-treated and non-treated greenhouses, it was seen that the density of leaf larvae was seriously higher on the leaves counted in the insecticide-treated greenhouse. This proved that larvae continued to damage the plants in spite of insecticide applications. By comparing the production periods of 2019, it was seen that the density of *B. tabaci* was rather different on yellow sticky traps and population could not be reduced below the economic threshold level of 4–5 larvae/leaf (Ministry of Agriculture 1996) because of the high population in greenhouses. In conclusion, it was observed that *B. tabaci* was a serious pest species in tomato greenhouses in Ortaca (Mugla) and, in spite of applying insecticide in both production periods, it continued at a high population level and damaged the crop. However, the population level was almost the same in both insecticide-treated and non-treated greenhouses. Lua et al. (2012) reported that using yellow sticky traps can easily reduce the number of pesticide applications. The findings of this study are also supported by the studies of Yaşarakıncı and Hıncal (1996), Yaşarakıncı et al., (2000) in tomato greenhouses in the same region. If the greenhouse is completely isolated and yellow sticky traps are used, and also if the appropriate insecticide is applied when it is necessary, it will provide successful and integrated management against *B. tabaci*.

#### 5. CONCLUSION

In conclusion, it was observed that *B. tabaci* was a serious pest species in tomato greenhouses in Ortaca (Mugla) and, in spite of applying insecticide in both production periods, it continued at a high population level and damaged the crop. However, the population level was almost the same in both insecticide-treated and non-treated greenhouses. Their results are supported to the results of this study. Briefly, using yellow sticky traps will be healthier than using pesticide, which increases the cost of production and is risky for the environment. Heinz et al. (1992), Lua et al. (2012) reported that using yellow sticky traps can easily reduce the number of pesticide applications. The findings of this study are also supported by the studies of Yaşarakıncı and Hıncal (1996), Yaşarakıncı et al., (2000) in tomato greenhouses in the same region. If the greenhouse is completely isolated and yellow sticky traps are used, and also if the appropriate insecticide is applied when it is necessary, it will provide successful and integrated management against *B. tabaci*.

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