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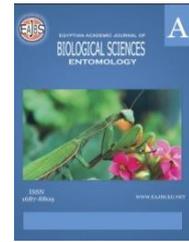
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Effect of the Insect Infestation by *Myzus persicae* and *Trialeurodes vaporariorum* on the Annual Production of Strawberry Under Glasshouse Conditions

Gamila, A. M. Heikal; Heba, A. Alghnam; Salem, M. M. Hagar and Emam, A. S.

Plant Protection Research Institute, A.R.C., Dokki, Giza, 12618 Egypt

E-mail* : dr.ashrafsalah@yahoo.com

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ABSTRACT

This study was carried out to study the effect of the insect infestation by The Green Peach Aphid, *Myzus persicae* (Sulzer) (Hemiptera: Aphididae) and The Greenhouse Whitefly, *Trialeurodes vaporariorum* (Westwood) (Homoptera: Aleyrodidae) on the quantity of the annual production of the strawberry crop, *Fragaria ananassa* (L.). This study was carried out at Tokh region (Qaliobya Governorate) during two successive seasons 2020, 2021 under glasshouse conditions.

This study was divided into three parts, first part studied the population fluctuation of *M. persicae* and *T. vaporariorum* on strawberry plants during the two successive seasons, second part studied the effect of insect infestation by the two insects on the quantity of the annual production of strawberry fruits at the two successive seasons compared to control (which did not infest with any insect) and third part studied the effect of insect infestation by the two insects on the internal components of strawberry fruits.

Results obtained showed that the infestation by *M. persicae* and *T. vaporariorum* reduced the quantity of annual production of strawberry fruits compared to control (which was non-infested by the same insects). Also, results obtained showed that the infestation by the same insects reduced both total sugar and total protein on strawberry fruits compared to control.

INTRODUCTION

Strawberry (*Fragaria ananassa* L.) considers one of the most important vegetable plants in Egypt and all over the world which is cultivated both on the open field and under glasshouse conditions. Also, its cultivated area increased gradually during the last years, especially in the newly reclaimed areas for purposes of local consumption and exportation to the foreign markets. Gamila *et al.* (2018)

Egypt considers one of the largest producers and exporters of strawberries (seedlings and fruits) all over the world where it ranks fifth in the world in the production and export of strawberries (seedlings and fruits), The area of the plantation with strawberry seedlings both fresh seedlings and freezing seedlings in Egypt is about 21573 fed. It is divided into about 16459 fed (fresh planting) and about 5113 fed (cooled planting). Food and Agriculture Organization (F.A.O), 2017

Strawberry plants are infested by many different insects such as Green Peach Aphid, *Myzus persicae* (Sulzer) (Hemiptera: Aphididae) which has one of the most important insects that infesting strawberry plants. Bernardi *et al.* (2013) in Brasil reported

that *M. persicae* consider a very dangerous insect pest of strawberry plants in Southern Brasil and cause numerous damages in both quantity and quality for the crop directly. Also, Jian and Nick (2009) in California found that the Green Peach Aphid, *M. persicae* has emerged as a major insect pest of many horticultural crops such as strawberry in California.

Also, The Greenhouse Whitefly, *Trialeurodes vaporariorum* (Westwood) (Homoptera: Aleyrodidae) has one of the most dangerous insects that infesting strawberry plants both in open fields and under glasshouse conditions. Toscano and Jian (2015) reported that greenhouse whitefly *T. vaporariorum* recently become a major insect pest of many horticultural crops in California and causes numerous damages in both quantity and quality for strawberry plants. Also, Zalom *et al.* (2017) reported that greenhouse whitefly *T. vaporariorum* consider a serious pest of strawberry plants in California.

This study was carried out to study the effect of the insect infestation by The Green Peach Aphid, *M. persicae* and The Greenhouse Whitefly, *T. vaporariorum* on the quantity of annual production of strawberry crop. This study was carried out at Tokh region (Qalioby Governorate) during two successive seasons 2020, 2021 under glasshouse conditions.

MATERIALS AND METHODS

This study was carried out to study the effect of the insect infestation by The Green Peach Aphid, *Myzus persicae* (Sulzer) (Homoptera: Aphididae) and The Greenhouse Whitefly, *Trialeurodes vaporariorum* (Westwood) (Homoptera: Aleyrodidae) on the quantity of the annual production of strawberry crop. This study was carried out at Tokh region (Qalioby Governorate) during two successive seasons 2020, 2021 under glasshouse conditions.

Experimental Design:

This study was conducted on strawberry plants *Fragaria ananassa* (L.) which were grown in Tokh region (Qalioby Governorate) under glasshouse conditions during successive seasons 2020, 2021. The glasshouse in each season with an area of 27x45 m was divided into three parts, the first part was left as control, the second part had artificially infestation by *M. persicae* and the third part had artificially infestation by *T. vaporariorum*. Each part contains 5 plots (3x5 m²) for each, and each part is isolated completely from others. Strawberry seedlings were planted in glasshouse conditions at the same time in March month (the planting time of strawberry plants). All agricultural operations of irrigation and fertilization and others are completely identical in the glasshouses at the two seasons were done without the application of any insecticide. The first part of the glasshouse left free from insect infestation as control and artificially infestation was done by *M. persicae* in the second part and by *T. vaporariorum* in the third part with careful observation of the mean numbers of these pests during the plant growth period. At the end of the first and second growing season calculated a quantity of strawberry crop per square meter from both of the three parts at the two tested seasons.

Statistical Analysis:

In the experiments, the effect on the insect infestation by *M. persicae* and by *T. vaporariorum* on the quantity of annual production of the strawberry crop. And the effect of the infestation by the same pests on the total soluble sugar and total protein of the strawberry fruits were subjected to analysis of variance (ANOVA) and the means were compared by L.S.D. test at 0.05 level, using SAS program (SAS Institute, 1988). The sugar and protein were analyzed by a High-Pressure Liquid Chromatograph (HPLC).

RESULTS AND DISCUSSION

This study was carried out to study the effect of the insect infestation by The Green

Peach Aphid, *Myzus persicae* (Sulzer) and The Greenhouse Whitefly, *Trialeurodes vaporariorum* (Westwood) on the quantity of the annual production of strawberry crop. This study was carried out at Tokh region (Qaliobyah Governorate) during two successive seasons 2020, 2021 under glasshouse conditions.

Therefore, this study was divided into three parts, the first part studied the population fluctuation of the two insects on strawberry plants during the two successive seasons. The second part studied the effect of the infestation by the same two insects on the quantity of annual production of strawberry fruits. And the third part studied the effect of insect infestation by the two insects on the internal components of strawberry fruits.

-Population fluctuation of *M. persicae* and *T. vaporariorum* on strawberry plants at the two successive seasons 2020, 2021:

Data tabulated from Table (1) show population fluctuation of *M. persicae* and *T. vaporariorum* on strawberry plants at the two successive seasons 2020, 2021. Data obtained showed that the mean number of *M. persicae* and *T. vaporariorum* per leaf at season 2020 were (26.1, 17.9), respectively. Whereas the mean number of *M. persicae* and *T. vaporariorum* per leaf at season 2021 were (23.2, 15.1), respectively.

Table 1: Population fluctuation of *M. persicae* and *T. vaporariorum* on strawberry plants at Tokh region at the two successive seasons 2020, 2021.

Date	Population fluctuation/leaf			
	2020		2021	
	<i>M. persicae</i>	<i>T. vaporariorum</i>	<i>M. persicae</i>	<i>T. vaporariorum</i>
1 March	16	11	15	9
7 March	18	13	16	11
15 March	22	14	19	12
22 March	24	16	22	14
29 March	25	17	24	15
5 April	27	19	25	17
12 April	29	21	27	19
19 April	32	23	29	20
26 April	35	25	31	22
3 May	33	22	28	19
10 May	30	20	25	17
17 May	27	18	23	14
24 May	25	17	21	12
31 May	22	15	20	11
Total	365	251	325	212
Mean	26.1	17.9	23.2	15.1
F(0.05)	573.24	655.73	585.22	689.77
L.S.D	1.0235	1.0084	1.0473	1.0592

Means within columns bearing different subscripts are significantly different ($P < 0.05$).

These results are in agreement with those obtained by Dicker (2015) who found that the strawberry aphid *Pentatrichopus fragaefolii* (Cock.) population increased during the period from March to May. Jansen and Warnier (2017) in Belgium reported that aphid *Myzus persicae* were found in greater numbers during March and April period and caused deformation of the strawberry leaves. Carter *et al.* (2015) in California studied the population dynamics of greenhouse whitefly on strawberry plants and found that insect populations increased during spring season.

Effect of Infested Strawberry Plants by *M. persicae* and *T. vaporariorum* on the Quantity of Annual Production of Strawberry Crop:

This experiment was carried out to study the effect of infested strawberry plants by *M. persicae* and *T. vaporariorum* on the quantity of annual production of the strawberry crop (fruits) at the two successive seasons 2020, 2021. Means of the quantity of annual production of strawberry fruits per square meter were calculated at the two tested seasons for infested plants by the two insects compared to control (non-infested).

Data tabulated in Table (2) shows means of the quantity of annual production of the strawberry fruits which infested by *M. persicae* and *T. vaporariorum* compared to control (non-infested) at the two examined seasons whereas at season 2020 the means of the quantity of annual production of strawberry fruits which infested by *M. persicae* were 1.9 kg/m² that means about 8 tons/feddan whereas means of the quantity of annual production of strawberry fruits which infested by *T. vaporariorum* were 2.4 kg/m² that means about 10 tons/feddan, and mean of the quantity of annual production of strawberry fruits which non-infested by any insects (control) were 3.6 kg/m² that means about 15 tons/feddan.

Table 2: Effect of insect infestation by *M. persicae* and *T. vaporariorum* on the annual production of the strawberry crop (fruits) after picking compared to control.

Insect	Annual production of fruits kg/m ²		Annual production of fruits Ton/Feddan	
	2020	2021	2020	2021
<i>M. persicae</i>	1.9	2.4	8	10
<i>T. vaporariorum</i>	2.4	2.9	10	12
Control	3.6	3.9	15	16
F(0.05)	573.43	642.61	549.66	689.21
L.S. D	1.0213	1.0562	1.0671	1.0032

Means within columns bearing different subscripts are significantly different (P < 0.05).

Whereas at season 2021 means of the quantity of annual production of strawberry fruits which infested by *M. persicae* were 2.4 kg/m² which means about 10 ton/feddan, whereas the mean of the quantity of annual production of strawberry fruits which infested by *T. vaporariorum* was 2.9 kg/m² that means about 12 ton/feddan, and mean of the quantity of annual production of strawberry fruits which non-infested by any insects (control) were 3.9 kg/m² that means about 16 ton/feddan.

The statistical analysis shows highly significant differences between the quantity of annual production of strawberry fruits infested by *M. persicae* and *T. vaporariorum* compared to non-infested fruits (control) at both the two examined seasons.

These results are in agreement with those obtained by Coman *et al.* (2016) in Romania who found that the infestation by strawberry aphids affected directly on the annual production of strawberry crop. Also, Zhang (2013) in China found that the annual production of the strawberry crop had been severely affected by the infestation with aphid and whitefly. Legard and Chandler (2003) studied the annual production of strawberry crops under different conditions and reported that the annual production of strawberry crops was affected seriously with infestation by aphid and whitefly both in open fields and under glasshouse conditions.

Effect of Insect Infestation by *M. persicae* and *T. vaporariorum* on the Internal Components of Strawberry Fruits:

Data tabulated in Table (3) show the total soluble sugar and total protein content in strawberry fruits after infestation by *M. persicae* and *T. vaporariorum* compared to

control at the two successive seasons 2020, 2021. Whereas in season 2020 the total soluble sugar and total protein content at the strawberry fruits which infested by *M. persicae* and *T. vaporariorum* and the control were (23.47, 16.53 mg/g), (29.35, 20.15 mg/g), (37.25, 27.21mg/g), respectively. Whereas in season 2021 the total soluble sugar and total protein content at the strawberry fruits which infested by *M. persicae* and *T. vaporariorum* and the control were (21.44, 15.21 mg/g), (26.35, 18.25 mg/g), (35.75, 25.33mg/g), respectively.

Statistical analysis in Table (3) shows highly significant differences between the total soluble sugar and total protein in strawberry fruits infested by *M. persicae* and *T. vaporariorum* compared to control at the two examined seasons.

Table 3: Determination of total soluble sugar and total protein at strawberry fruits (mg/g) at Tokh Region (Qaliobya Governorate) during seasons 2020, 2021.

Insect	2020		2021	
	Total sugar	Total protein	Total sugar	Total protein
<i>M. persicae</i>	23.47 ^a	16.53 ^a	21.44 ^c	15.21 ^c
<i>T. vaporariorum</i>	29.35 ^b	20.15 ^b	26.35 ^c	18.25 ^c
Control	37.25 ^c	27.21 ^c	35.75 ^c	25.33 ^c
F (0.05)	325.53	389.67	472.22	423.51
L.S.D	1.0235	1.0082	1.0332	1.0214

Means within columns bearing different subscripts are significantly different ($P < 0.05$).

The obtained results are in agreement with those obtained by Song and Zheng (2017) who studied the effect of infestation by aphid and whitefly on the interior components of strawberry fruits and found that the total sugar and total protein in strawberry fruits reduced as a result to the infestation by aphids and whitefly. Gerardi and Leone (2012) studied the changes in the internal components of strawberry fruits such as protein, sugar, and vitamins, which are infested by aphids and whitefly, and reported that serious infestation by aphids and whitefly affected seriously on the most internal components of strawberry fruits.

Also, the obtained results are in agreement with those obtained by Marcel (2015) in France who studied the quantitative changes in soluble sugars (glucose, fructose, and sucrose) of strawberry fruits as a result of infestation by aphids and whitefly and estimated the damage occurred as a direct result of that infestation.

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ARABIC SUMMARY

أثر الإصابة الحشرية بحشرة من الخوخ الأخضر والذبابة البيضاء على كمية الإنتاج السنوى من الفراولة تحت ظروف الصوب الزجاجية

جميلة عبد الرحمن محمد هيكل, هبه عبد الجليل الغنام, هاجر محمود محمود سالم وأشرف صلاح إمام
معهد بحوث وقاية النباتات - مركز البحوث الزراعية - الدقى - الجيزة - 12618 مصر

الهدف من إجراء الدراسة هو معرفة تأثير الإصابة الحشرية بحشرتى من الخوخ الأخضر *Myzus persicae* و الذبابة البيضاء *Trialeurodes vaporariorum* على كمية الإنتاج السنوى من الفراولة تحت ظروف الصوب الزجاجية. حيث أجريت التجربة بمنطقة طوخ محافظة القليوبية على مدار عامى 2020 @ 2021 و ذلك تحت ظروف الصوب الزجاجية.

توصلت النتائج المتحصل عليها إلى إنخفاض متوسط محصول الفدان السنوى من ثمار الفراولة المنتج تحت ظروف الصوب الزجاجية فى حالة الإصابة بحشرة من الخوخ الأخضر *M. persicae* وذلك مقارنة بالإنتاج السنوى للفدان فى حالة عدم وجود إصابة وذلك خلال عامى الدراسة 2020 , 2021. كما أوضحت النتائج كذلك إنخفاض متوسط محصول الفدان السنوى من ثمار الفراولة المنتج فى حالة الإصابة بحشرة الذبابة البيضاء *T. vaporariorum* وذلك مقارنة بالإنتاج السنوى للفدان فى حالة عدم وجود إصابة بالحشرة وذلك أيضا فى عامى الدراسة 2020, 2021. كما أوضحت النتائج المتحصل عليها كذلك إلى إنخفاض متوسط محصول الفدان السنوى من ثمار الفراولة فى حالة الإصابة بحشرة من الخوخ الأخضر *M. persicae* عنه فى حالة الإصابة بحشرة الذبابة البيضاء *T. vaporariorum* كما أوضحت النتائج المتحصل عليها كذلك إلى وجود فروق معنوية عالية بين متوسط محصول الفدان السنوى من ثمار الفراولة فى حالة الإصابة بحشرة من الخوخ الأخضر *M. persicae* عنه فى حالة الإصابة بحشرة الذبابة البيضاء *T. vaporariorum* وذلك مقارنة بمتوسط محصول الفدان السنوى من ثمار الفراولة الخالى من الإصابة الحشرية (الكنترول).

كما أوضحت النتائج التى تم التوصل إليها كذلك إلى تأثر المحتويات الداخلية لثمار الفراولة ولا سيما المحتوى الكلى من السكريات وكذلك المحتوى الكلى من البروتين بالإصابة بكلتا الحشرتين موضع الدراسة . حيث تبين إنخفاض المحتوى الكلى للسكريات وكذلك المحتوى الكلى من البروتين فى ثمار الفراولة المصابة بكلتا الحشرتين موضع الدراسة وذلك مقارنة بالمحتوى الكلى من السكريات والبروتين الموجود فى ثمار الفراولة الخالية من الإصابة الحشرية (الكنترول).