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Evaluation Efficiency Sticky Traps on Attraction Whitefly, *Trialeurodes vaporariorum* on Strawberry Plants Under Glasshouse Conditions

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ABSTRACT

This study was carried out to evaluate efficiency sticky traps on attraction *Trialeurodes vaporariorum* (Westwood) (Homoptera: Aleyrodidae) on strawberry plants *Fragaria ananassa* (L.) (Three strawberry varieties i.e. Sweet charli, Chandler and Festival) under glasshouse conditions at two locations (governorates), Nobariya (Behera governorate) and Perkash (Giza governorate) during season 2019/2020.

This study contains three experiments; the first experiment aimed to evaluate the efficiency color of the sticky trap on attraction *T. vaporariorum* throughout comparison between four colors (yellow, red, white and blue). Results showed that the traps which have yellow color more efficiency on attractive *T. vaporariorum* than others which have (blue, red, and white) color, respectively. Second experiment aimed to evaluation efficiency height of the yellow sticky trap on attraction *T. vaporariorum* through comparison between four heights (2m, 1.5m, 1m and 0.5m) above the ground. Results showed that the trap which have 2m height above the ground more efficiency on attractive *T. vaporariorum* than others which have (1.5m, 1m and 0.5m) heights, respectively. Third experiment aimed to evaluation efficiency orientation of the yellow sticky trap on attraction *T. vaporariorum* through comparison between four orientations (North, South, East and West). Results showed that had no clearly effect of the trap orientation on attraction *T. vaporariorum*.

INTRODUCTION

Strawberry plants, *Fragaria ananassa* (L.) consider one of the most important vegetable plants in Egypt and all over the world which is cultivated in the open field and under glasshouse conditions. Also, its cultivated area increased gradually during the last years all over the world, especially in the newly reclaimed areas for purposes of local consumption and exportation to the foreign markets. Francisco, *et al.* (2011)

Egypt considers one of the largest producers and exporters of strawberry (seedlings and fruits) all over the world where it ranks fifth in the world in the production and export of strawberry (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 feds (fresh planting) and about 5113 feds (cooled planting). Food and Agriculture Organization (F.A.O), 2017

Strawberry plants infested by a large scale of insects belong to many orders and families such as The Greenhouse Whitefly, *Trialeurodes vaporariorum* (Westwood)

(Homoptera: Aleyrodidae). Which has recently become a major insect pest of strawberries in Southern California and causes numerous damages in both quantity and quality for the crop directly by plant juice to loosen or indirectly by plant disease-transmitting John, *et al.* (2002). Also, Jian and Nick (2007) in California found that the greenhouse whitefly, *T. vaporariorum* has emerged as a major insect pest of many horticultural crops such as strawberry in California.

Sticky traps still consider the best method which used to control and also predict the infestation by whitefly on different crops. And consider the method which more efficient to control this insect. Shen and Ren (2003) reported that the best method to trap whitefly adults in the jasmine and carnation fields were using a yellow card. Also, Dan and Horowitz (1984) found that yellow sticky traps were useful to monitor the whitefly *Bemisia tabaci* population in the rose field and some ornamental plants.

This study was carried out to evaluate the efficiency of sticky traps on attraction *T. vaporariorum* on Strawberry plants *F. ananassa* (three strawberry varieties i.e. Sweet charli, Chandler, and Festival) under glasshouse conditions at two locations (governorates), Nobariya (Behera governorate) and Perkash (Giza governorate) during season 2019/2020.

This study contains three experiments; the first experiment aimed to evaluate the efficiency color of the sticky trap on attraction *T. vaporariorum* throughout comparison between four colors (yellow, red, white, and blue). The second experiment aimed to evaluate the efficiency height of the yellow sticky trap on attraction *T. vaporariorum* thorough a comparison between four heights (2m, 1.5m, 1m, and 0.5m) above the ground. The third experiment aimed to evaluate the efficiency orientation of the yellow sticky trap on attraction *T. vaporariorum* a thorough comparison between four orientations (North, South, East, and West).

MATERIALS AND METHODS

This study contains three experiments; the first experiment aimed to evaluate the efficiency color of the sticky trap on the attraction of The Greenhouse Whitefly, *Trialeurodes vaporariorum* (Westwood) (Homoptera: Aleyrodidae) throughout comparison between four colors (yellow, red, white, and blue). The second experiment aimed to evaluate the efficiency height of the yellow sticky trap on attraction *T. vaporariorum* through a comparison between four heights (2m, 1.5m, 1m, and 0.5m) above the ground. The third experiment aimed to evaluate the efficiency orientation of the yellow sticky trap on attraction *T. vaporariorum* through a comparison between four orientations (North, South, East, and West).

Experimental Design:

Experiments were carried out on strawberry plants (fresh seedlings) which were cultivated on mid of September at both the two tested locations (governorates), Nobariya (Behera governorate), and Perkash (Giza governorate) during season 2019/2020. Glasshouses in both the two tested locations were divided into equal three big separate parts, each big part divided into four small separate parts. Each small part is divided into three equal plots for the three varieties of strawberry plants. The first experiment which tested color of the trap was carried out on the first big part whereas each color of the four colors of traps was distributed between the four small parts. The second experiment which was tested the height of the trap was carried out on the second big part whereas each height of the four heights of traps was distributed between the four small parts. The third experiment which tested the orientation of the trap was carried out on the third big part whereas each orientation of the four orientations of traps was distributed between the four small parts. With same all the agricultural operations all over the two places. And checked up all the sticky traps in both the two locations biweekly to calculate mean numbers of *T. vaporariorum* and recorded the

data biweekly.

Statistical Analysis:

The mean numbers of *T. vaporariorum* were analyzed statistically using a one-way analysis of variance. When ANOVA indicates that significant differences were found, ($P < 0.05$) means were separated by a Least Significant Differences Test (LSD), the simple correlation (r) and regression coefficient value (b) was adopted to clarify the change in population due to change in each of the tested factors and the mean values compared with the Least Significant Differences (LSD) as well as, SAS program (SAS Institute 1988).

RESULTS AND DISCUSSION

This study was carried out to evaluate efficiency sticky traps on attraction *Trialeurodes vaporariorum* (Westwood) (Homoptera: Aleyrodidae) on Strawberry plants *Fragaria ananassa* (L.) (three strawberry varieties i.e. Sweet charli, Chandler, and Festival) under glasshouse conditions at two locations (governorates), Nobariya (Behera governorate) and Perakash (Giza governorate) during season 2019/2020.

This study contains three experiments; the first experiment aimed to evaluate the efficiency color of the sticky trap on attraction *T. vaporariorum* throughout comparison between four colors (yellow, red, white, and blue). The second experiment aimed to evaluate the efficiency height of the yellow sticky trap on attraction *T. vaporariorum* through a comparison between four heights (2m, 1.5m, 1m, and 0.5m) above the ground. The third experiment aimed to evaluate the efficiency orientation of the yellow sticky trap on attraction *T. vaporariorum* through a comparison between four orientations (North, South, East, and West).

First Experiment:

The first experiment aimed to evaluate the efficiency color of the sticky trap on attraction *T. vaporariorum* through a comparison between four colors (yellow, blue, red, and white).

Data tabulated in Table (1) showed mean numbers and statically analysis of *T. vaporariorum* which caught by sticky traps which have different colors (yellow, blue, red, and white) in glasshouses strawberry (three varieties of strawberry) in the two tested locations during season 2019/ 2020.

Table 1: Mean numbers of *T. vaporariorum* which caught by sticky traps which have different colors on strawberry plants at both of the two tested locations during season 2019/ 2020

Trap color	Mean numbers of <i>T. vaporariorum</i>					
	Behera Governorate			Giza Governorate		
	Sweet charli	Chandler	Festeval	Sweet charli	Chandler	Festeval
Yellow	13.5 ^c	14.5 ^c	15.3 ^b	12.5 ^c	13.5 ^a	14.7 ^b
Blue	10.4 ^b	11.7 ^b	12.5 ^c	8.7 ^b	10.5 ^b	11.5 ^a
Red	8.7 ^a	9.8 ^a	10.8 ^a	6.5 ^a	8.5 ^c	8.3 ^c
White	6.8 ^b	7.9 ^b	8.7 ^b	4.3 ^c	5.9 ^a	6.5 ^a
F	754.36	835.03	675.15	625.33	745.73	825.13
L.S. D	1.1202	1.1042	1.1452	1.1731	1.1254	1.2353

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

Results showed that the traps which have a yellow color more efficient than others which have (blue, red, and white), respectively. Whereas for the yellow sticky traps the mean numbers of *T. vaporariorum* which attracted to the traps on the three strawberry varieties

(Sweet charli), (Chandler) and (Festeval) at both of the two tested locations Nobariya (Behera governorate) and Perkash (Giza governorate) were (13.5@ 14.5@ 15.3), (12.5@ 13.5@ 14.7) adults/trap, respectively. for the blue sticky traps the mean numbers of *T. vaporariorum* which attracted to the traps on the three strawberry varieties at both of the two tested locations were (10.4@ 11.7@ 12.5), (8.7@ 10.5@ 11.5) adults/trap, respectively. For the red sticky traps the mean numbers of *T. vaporariorum* which attracted to the traps on the three strawberry varieties at both of the two tested locations were (8.7@ 9.8@ 10.8), (6.5@ 8.5@ 8.3) adults/trap, respectively. For the white sticky traps the mean numbers of *T. vaporariorum* which attracted to the traps on the three strawberry varieties at both of the two tested locations were (6.8@ 7.9@ 8.7), (4.3@ 5.9@ 6.5) adults/trap, respectively

Static analyses showed that were highly significant differences between the mean numbers of *T. vaporariorum* which attracted to the sticky traps which have different colors at both the two tested locations.

These results in agreement with Houten and Knapp (2011) who reported that the best method to trap and control *T. vaporariorum* population in the strawberry field was a yellow card. Soon *et al.* (2015) studied efficiency yellow and blue sticky traps on attractive western flower thrips and greenhouse whitefly on strawberry plants and reported that the yellow sticky traps were more attractive to western flower thrips and greenhouse whitefly than blue sticky traps under greenhouses conditions. Yao and Zheng (2008) studied the tropism of *B. tabaci* imagoes to different colors, and they found that the yellow color of the traps had the best effect on alluring the insect in a period of 44 days, and the next was a green color and red color, respectively. The number of imagoes trapped by the yellow board was significantly greater than that traps by other color boards (green, red) respectively. And these results also agreements with Gong *et al.* (2014) who studied the attractive effects of different colors on Q-type *B. tabaci* on strawberry under glasshouses conditions and they showed that *B. tabaci* was strongly attracted by yellow color traps compared with other colors (blue, red) respectively.

Second Experiment:

The second experiment aimed to evaluate the efficiency height of the yellow sticky trap on attraction *T. vaporariorum* through a comparison between four heights (2m, 1.5m, 1m, and 0.5m) above the ground.

Data tabulated in Table (2) showed mean numbers and statically analysis of *T. vaporariorum* which caught by yellow sticky traps which have different heights (2m, 1.5m, 1m, and 0.5m), respectively above the ground in the glasshouse's strawberry (three varieties of strawberry) in the two tested locations during season 2019/ 2020.

Table 2: Mean numbers of *T. vaporariorum* which caught by yellow sticky traps which have different heights on strawberry plants at both of the two tested locations during season 2019/ 2020

Trap height	Mean numbers of <i>T. vaporariorum</i>					
	Behera Governorate			Giza Governorate		
	Sweet charli	Chandler	Festeval	Sweet charli	Chandler	Festeval
2m	15.8 ^a	16.5 ^c	17.2 ^b	14.5 ^a	15.3 ^c	16.5 ^a
1.5m	11.5 ^b	12.3 ^b	12.7 ^c	10.5 ^b	11.4 ^b	12.8 ^a
1m	8.5 ^c	9.5 ^a	10.5 ^a	6.7 ^a	8.7 ^c	9.7 ^c
0.5m	5.3 ^b	6.3 ^a	8.9 ^c	4.8 ^c	6.9 ^a	7.5 ^a
F	735.87	851.67	622.77	633.71	722.21	881.22
L.S.D	1.1302	1.1202	1.1032	1.1521	1.1314	1.2523

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

Results showed that the traps which have a height 2m above the ground more efficient than others which have (1.5m, 1m, and 0.5m), respectively. Whereas for the height 2m above the ground of the yellow sticky traps the mean numbers of *T. vaporariorum* which attracted to the traps on the three strawberry varieties (Sweet charli), (Chandler) and (Festeval) at both of the two tested locations Nobariya (Behera governorate) and Perkash (Giza governorate) were (15.8@ 16.5@ 17.2), (14.5@ 15.3@ 16.5) adults/trap, respectively. for the height 1.5m above the ground of the yellow sticky traps the mean numbers of *T. vaporariorum* which attracted to the traps on the three strawberry varieties at both of the two tested locations were (11.5@ 12.3@ 12.7), (10.5@ 11.4@ 12.8) adults/trap, respectively. For the height 1m above the ground of the yellow sticky traps, the mean numbers of *T. vaporariorum* which attracted to the traps on the three strawberry varieties at both of the two tested locations were (8.5@ 9.5@ 10.5), (6.7@ 8.7@ 9.7) adults/trap, respectively. For the height 0.5m above the ground of the yellow sticky traps, the mean numbers of *T. vaporariorum* which attracted to the traps on the three strawberry varieties at both of the two tested locations were (5.3@ 6.3@ 8.9), (4.8@ 6.9@ 7.5) adults/trap, respectively

Static analyses showed that were highly significant differences between the mean numbers of *T. vaporariorum* which attracted the yellow sticky traps which have different heights at both the two tested locations.

These results were in agreement with obtained by Mohammad and Lim (2016) who reported that the best method to trap *T. vaporariorum* adults using a yellow card in the strawberry field. And reported also that the best method was to hang the yellow card vertically between the rows of the strawberry plants, and the height of the yellow card 2m above the ground was more effective. Sampson (2008) reported that trap height showed significant influence on trap catches, which that trap height 1.5m above the ground more effective than which 0.5m above the ground and reported also that the height of the trap was effective in controlling the adult population of *T. vaporariorum* on greenhouse strawberry. Kim and Shin (2019) in South Korya reported that *T. vaporariorum* is an important pest on strawberry crops in greenhouses and studied the yellow sticky cards that were hung in strawberry fields and reported that the best height of the yellow sticky cards was ranged from 1.5m – 2m above the ground.

Third Experiment:

The third experiment aimed to evaluate the efficiency orientation of the yellow sticky trap on attraction *T. vaporariorum* through a comparison between four orientations (North, South, East, and West).

Data tabulated in Table (3) showed mean numbers and statically analysis of *T. vaporariorum* which caught by yellow sticky traps which have different orientations (North, South, East, and West), respectively in the glasshouse's strawberry (three varieties of strawberry) in the two tested locations during season 2019/ 2020.

Obtained results and statically analyses showed that were not significant differences between the mean numbers of *T. vaporariorum* which attracted the yellow sticky traps which have different orientations in both the two tested locations.

These results in agreements with those obtained by Maolin *et al.* (2012) who reported that the trap orientation had no effect on the trap catches, but traps hanged vertically parallel to plant rows trapped slightly more *Bemisia tabaci* adults than those hanged horizontally, and they found that no significant differences between East and West orientation of the yellow sticky traps in the cucumber glasshouse. Also, theses result in agreement with those obtained by Xi *et al.* (2008) who studied the orientation of the yellow sticky traps on tomato plants in greenhouses.

Table 3: Mean numbers of *T. vaporariorum* which caught by yellow sticky traps which have different orientations on strawberry plants at both of the two tested locations during season 2019/ 2020

Trap orientation	Mean numbers of <i>T. vaporariorum</i>					
	Behera Governorate			Giza Governorate		
	Sweet charli	Chandler	Festeval	Sweet charli	Chandler	Festeval
North	13.6 ^c	15.3 ^b	16.2 ^a	13.7 ^c	14.5 ^b	15.3 ^c
South	11.5 ^b	13.9 ^b	14.5 ^c	11.5 ^b	12.4 ^b	13.8 ^a
East	12.5 ^c	14.5 ^a	15.2 ^a	12.3 ^a	13.5 ^c	14.5 ^c
West	10.4 ^a	12.9 ^c	13.7 ^b	10.9 ^c	11.7 ^a	12.9 ^b
F	825.83	731.27	712.32	653.75	737.61	731.55
L.S. D	1.1202	1.1312	1.1212	1.1201	1.1304	1.2013

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

And reported that had no effect of the orientation of the traps (North, South, East, and West) on attractive *B. tabaci* adults. But they found that the yellow sticky traps trapped *B. tabaci* adults significantly reduced when the traps were placed parallel to tomato rows more than those placed perpendicular to tomato rows on every sampling date.

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ARABIC SUMMARY

تقييم فاعلية المصائد اللاصقة في جذب حشرة الذبابة البيضاء (*Trialeurodes vaporariorum* (Westwood)) على نباتات الفراولة تحت ظروف الصوب الزجاجية (Homoptera: Aleyrodidae)

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معهد بحوث وقاية النباتات - مركز البحوث الزراعية - الدقى - الجيزة - مصر

أجريت هذه التجارب بغرض تقييم فاعلية المصائد اللاصقة في جذب حشرة الذبابة البيضاء *T. vaporariorum* على نباتات الفراولة *Fragaria ananassa* ثلاثة أصناف @Sweet charli @ Chandler تحت ظروف الصوب الزجاجية. كما أجريت هذه التجارب في منطقتين (محافظتين) مختلفتين: النوبارية (محافظة البحيرة) ومنطقة برقاش (محافظة الجيزة). خلال عام 2019, 2020، حيث إنقسمت هذه الدراسة إلى ثلاثة تجارب:

التجربة الأولى: أجريت هذه التجربة بغرض تقييم فاعلية لون المصائد اللاصقة في جذب حشرة الذبابة البيضاء من خلال مقارنة أربعة ألوان مختلفة للمصائد اللاصقة وهي (الأصفر، الأزرق، الأحمر، الأبيض). وتوصلت النتائج إلى ارتفاع فاعلية المصائد اللاصقة ذات اللون الأصفر بالمقارنة بالمصائد ذات الألوان الأخرى ثم يليها في الفاعلية المصائد ذات اللون الأزرق ثم المصائد ذات اللون الأحمر وأخيرا المصائد ذات اللون الأبيض. كما أشار التحليل الإحصائي للنتائج إلى وجود فروق معنوية بين تعداد حشرة الذبابة البيضاء التي تنجذب للمصائد اللاصقة ذات الألوان الأربعة المختلفة محل الدراسة.

التجربة الثانية: أجريت هذه التجربة بغرض تقييم فاعلية ارتفاع المصائد الصفراء اللاصقة في جذب حشرة الذبابة البيضاء من خلال مقارنة أربعة ارتفاعات مختلفة للمصائد الصفراء اللاصقة وهي (2م ، 1.5م ، 1م ، 0.5م) عن سطح الأرض. وتوصلت النتائج إلى ارتفاع فاعلية المصائد الصفراء اللاصقة ذات الارتفاع 2م بالمقارنة بالمصائد ذات الارتفاعات الأخرى ثم يليها في الفاعلية المصائد ذات الارتفاع 1.5م ثم المصائد ذات الارتفاع 1م وأخيرا المصائد ذات الارتفاع 0.5م. كما أشار التحليل الإحصائي للنتائج إلى وجود فروق معنوية بين تعداد حشرة الذبابة البيضاء التي تنجذب لكلا من المصائد الصفراء اللاصقة ذات الارتفاعات الأربعة المختلفة محل الدراسة.

التجربة الثالثة: أجريت هذه التجربة بغرض تقييم فاعلية إتجاه المصائد الصفراء اللاصقة في جذب حشرة الذبابة البيضاء من خلال مقارنة أربعة إتجاهات مختلفة للمصائد الصفراء اللاصقة وهي (الشمال، الجنوب، الشرق، الغرب). وتوصلت النتائج إلى عدم وجود تأثير ملموس لإتجاه المصائد الصفراء اللاصقة على معدل أو فاعلية المصائد في جذب حشرات الذبابة البيضاء حيث كان معدل جذب المصائد الصفراء اللاصقة للذبابة البيضاء متقاربا في الإتجاهات الأربعة وذلك في موقعي الدراسة. كما أشار التحليل الإحصائي للنتائج إلى عدم وجود فروق معنوية بين تعداد حشرة الذبابة البيضاء التي تنجذب لكلا من المصائد الصفراء اللاصقة في كلا من الإتجاهات الأربعة المختلفة محل الدراسة.