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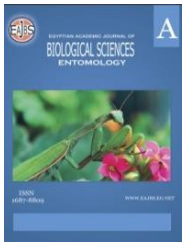

Evaluation Efficiency Sticky Traps on Attraction *Bemisia tabaci* (Gennadius) on Squash Plants under Greenhouse Conditions

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ABSTRACT

This study was carried out to evaluate efficiency sticky traps on attraction *Bemisia tabaci* (Gennadius) on squash plants *Cucurbita pepo* L. (three squash varieties i.e. Arkan, Sama 740 and Andro 174) under greenhouse conditions at Perkash (Giza governorate) during 2017, 2018 seasons. This study contains three experiments, The first experiment aimed to evaluate the efficiency color of the sticky trap on attraction *B. tabaci* through comparison between four colors (yellow, blue, red and white). This experiment was carried out on squash plants during the period (February - March). Results showed that the traps which have yellow color more efficiency than others which have (blue, red, and white) color, respectively. The second experiment aimed to evaluate the efficiency height of the yellow sticky trap on attraction *B. tabaci* through comparison between four heights (2m, 1.5m, 1m and 0.5m) above the ground. And this experiment was carried out on squash plants during the period (April - May). Results showed that the trap which has 2m height above the ground more efficiency than others which have (1.5m, 1m and 0.5m) heights, respectively. The third experiment aimed to evaluation efficiency orientation of the yellow sticky trap on attraction *B. tabaci* through comparison between four orientations (North, South, East and West). And this experiment was carried out on squash plants during the period (June - July). Results showed that had no clear effect of the trap orientation on attraction *B. tabaci*.

INTRODUCTION

Squash (*Cucurbita pepo* L.) fruits are used for local consumption and for export. They contain some nutritional compounds for human feeding such as the moderate quantity of mineral salts, it is eaten cocked as an immature fruit, which is rich with fibers and vitamins or consumed for the mature seed, which is a good source of fats and protein (Abdein, 2016). It has a high economic value, and a nutritive food source especially vitamins and is one of the most popular vegetables grown in Egypt (Shehata *et al*., 2009).

Squash plants infested by a large scale of insects belong to many orders and families such as two-spotted spider mite, aphids and whitefly (El-Dars *et al*., 2013). The last pest whitefly *Bemisia tabaci* (Gennadius) causes numerous damage in both quantity and quality for the crop directly by plant juice to loosen or indirectly by plant disease-transmitting (Abdel-Salam *et al*., 1982; Geoghiou, 1990; Masaki *et al.*, 1991 and Ibrahim, 2005). Also,

more than 200 host plant species were infested by these pests (Abdallah *et al*., 2014). A number of vegetable crops such as tomato, squash, eggplant, cucumber were also subject to *Tetranychus urticae* Koch (Acari: Tetranychidae) infestations during summer plantation causing numerous injuries and yield losses (Kherebe *et al.*, 1984; Heikal and Ali, 2000 and Faris *et al.*, 2004). The whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) caused crop losses by transmitting up to 150 virus species and by inducing plant disorders as likely as squash silver leaf (Polston *et al.*, 2014). Moreover, whitefly secreted honeydew on the leaf surface, which leads to the growth of sooty mold fungi, then reduced the efficiency of leaves during photosynthesis processes (Burger *et al.*, 1988).

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

This study was carried out to evaluation efficiency sticky traps on attraction *B. tabaci* on squash plants under greenhouse conditions. Also, this study was carried out during 2017, 2018 seasons Perkash region (Giza governorate) and this study contain three experiments:

First experiment aimed to evaluation efficiency color of the sticky trap on attraction *B. tabaci* through comparison between four colors (yellow, blue, red and white), Second experiment aimed to evaluation efficiency height of the yellow sticky trap on attraction *B. tabaci* through comparison between four heights (2m, 1.5m, 1m, and 0.5m) above the ground. And the third experiment aimed to evaluation efficiency orientation of the yellow sticky trap on attraction *B. tabaci* through comparison between four orientations (North, South, East and West).

MATERIALS AND METHODS

Experimental Design:

The first experiment aimed to evaluation the efficiency color of the sticky trap on attraction *B. tabaci* through comparison between four colors (yellow, blue, red and white). This experiment was carried out on squash plants during the period (February - March) at both the two tested seasons. Greenhouses in both the two tested seasons were divided into equal four parts. Each part contains a different color of the sticky trap (yellow, blue, red and white). 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 the mean numbers of *B. tabaci* and recorded the data biweekly.

The second experiment aimed to evaluate the efficiency height of the yellow sticky trap on attraction *B. tabaci* through comparison between four heights (2m, 1.5m, 1m and 0.5m) above the ground. And this experiment was carried out on squash plants during the period (April - Mai) in both the two tested seasons. Greenhouses in both the two tested seasons divided into equal four parts. Each part contains a different height of the yellow sticky traps. With it all the agricultural operations all over the two places. And checked up all the sticky traps in both the two locations biweekly to calculate the mean numbers of *B. tabaci* and recorded the data biweekly.

The third experiment aimed to evaluation efficiency orientation of the yellow sticky trap on attraction *B. tabaci* through comparison between four orientations (North, South, East and West). And this experiment was carried out on squash plants during the period (June - July) in both the two tested seasons. Greenhouses in both the two tested seasons divided into

equal four parts. Each part contains a different orientation of the yellow sticky traps. With it all the agricultural operations all over the two places. And checked up all the yellow sticky traps in both the two locations biweekly to calculate the mean numbers of *B. tabaci* and recorded the data biweekly.

Statistical Analysis:

The mean numbers of *B. tabaci* 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 clarifies 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 *Bemisia tabaci* (Gennadius) on squash plants *Cucurbita pepo* L. (three squash varieties i.e. Arkan, Sama 740 and Andro 174) under greenhouse conditions at Perkash (Giza governorate) during 2017, 2018 seasons, and this study was divided into three experiments.

First Experiment:

The first experiment aimed to evaluation the efficiency color of the sticky trap on attraction *B. tabaci* through comparison between four colors (yellow, blue, red and white). And this experiment was carried out on squash plants during the period (February - March) at both the two tested seasons.

Data tabulated in Table (1) showed mean numbers and statically analysis of *B. tabaci* which caught by sticky traps which have different colors (yellow, blue, red and white) in greenhouses squash (three varieties of squash) in Perkash region (Giza governorate) during both of the two tested seasons 2017, 2018.

Table 1: Mean numbers of *B. tabaci* which caught by sticky traps which have different colors on squash plants at both of the two tested seasons 2017, 2018

Trap color	Mean numbers of *Bemisia tabaci*					
	2017			2018		
	Arkan	Sama 740	Andro 174	Arkan	Sama 740	Andro 174
Yellow	11.3^{b}	12.8^{b}	13.6^{b}	10.2^{b}	11.7^{a}	12.3^{b}
Blue	9.4^{b}	10.3^{b}	11.3^{b}	8.4^{b}	9.5^{b}	10.7^{b}
Red	7.3^{b}	9.8^{b}	10.5^{b}	6.8^{b}	8.2^{c}	9.2^{c}
White	5.7^{b}	7.2^{b}	8.9^{b}	3.3^{b}	5.9^{a}	6.8^{d}
F	851.36	748.03	685.25	525.03	634.73	465.53
L.S.D	1.1532	1.1932	1.1372	1.1921	1.1674	1.2643

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

Results showed that the traps which have yellow color more efficiency than others which have (blue, red, and white), respectively. Whereas for the yellow sticky traps the mean numbers of *B. tabaci* which attracted to the traps on the three squash varieties (Arkan), (Sama 740) and (Andro 147) at both of the two tested seasons 2017 and 2018 were (11,3@ 10.2), (12,8@ 11.7) and (13,6@ 12.3) adults/trap, respectively. For the blue sticky traps the mean numbers of *B. tabaci* which attracted to the traps on the three squash varieties at both of the two tested seasons were (9,4@ 8.4), (10.3@ 9.5) and (11.3@ 10.7) adults/trap, respectively. For the red sticky traps the mean numbers of *B. tabaci* which attracted to the traps on the

three squash varieties at both of the two tested seasons were (7.3@ 6.8), (9.8@ 8.2) and (10.5@ 9.2) adults/trap, respectively. For the white sticky traps the mean numbers of *B. tabaci* which attracted to the traps on the three squash varieties at both of the two tested seasons were (5.7@ 3.3), (7.2@ 5.9) and (8.9@ 6.8) adults/trap, respectively.

Statically analyses showed that were highly significant differences between mean numbers of *B. tabaci*, which attracted to the sticky traps, which have different colors at both the two tested seasons.

These results agree with Shen and Ren (2003) who reported that the best method to trap and control *B. tabaci* population in the Cucumber field was a yellow card. Soon *et al*. (2015) studied efficiency yellow and blue sticky traps on attractive western flower thrips and greenhouse whitefly. 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 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*. (2011) who studied attractive effects of different colors on Q-type *B. tabaci* on squash under greenhouses 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 *B. tabaci* through comparison between four heights (2m, 1.5m, 1m and 0.5m) above the ground. And this experiment was carried out on squash plants during (April - Mai) at both the two tested seasons.

Data tabulated in Table (2) showed mean numbers and statically analysis of *B. tabaci* which caught by yellow sticky traps which have different heights (2m, 1.5m, 1m, and 0.5m), respectively above the ground in the greenhouses squash at both the two tested seasons 2017, 2018.

Table 2: Mean numbers of *B. tabaci* which caught by yellow sticky traps, which have different heights on squash plants at both the two successive seasons

Trap height	Mean numbers of *Bemisia tabaci*					
	2017			2018		
	Arkan	Sama 740	Andro 174	Arkan	Sama 740	Andro 174
2m	13.8^{b}	14.2^{b}	15.9^{b}	12.5^{b}	13.2^{a}	14.2^{b}
1.5m	10.7^{b}	12.9^{b}	13.3^{b}	9.7^{b}	10.4^{b}	12.9^{b}
1m	8.2^{b}	10.5^{b}	11.9^{b}	6.5^{b}	8.9^{c}	9.8^{c}
0.5m	6.9^{b}	8.9^{b}	9.1^{b}	5.8^{b}	6.7^{a}	8.3^{d}
F	631.21	567.03	685.25	324.03	654.73	265.53
L.S.D	1.1682	1.1552	1.1982	1.1921	1.1334	1.2823

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

Results showed that the yellow traps which have height 2m above the ground more efficiency than others which have (1.5m, 1m, and 0.5m), above the ground respectively. Whereas for the yellow sticky traps which have 2m above the ground the mean numbers of *B. tabaci* which attracted to the traps on the three squash varieties (Arkan), (Sama 740) and (Andro 147) at both of the two tested seasons 2017 and 2018 were (13,8@ 12.5), (14,2@ 13.2) and (15,9@ 14.2) adults/trap, respectively. For the yellow sticky traps which have 1.5m

above the ground the mean numbers of *B. tabaci* which attracted to the traps on the three squash varieties at both of the two tested seasons were (10,7@ 9.7), (12.9@ 10.4) and (13.3@ 12.9) adults/trap, respectively. For the yellow sticky traps which have 1m above the ground the mean numbers of *B. tabaci* which attracted to the traps on the three squash varieties at both of the two tested seasons were (8.2@ 6.5), (10.5@ 8.9) and (11.9@ 9.8) adults/trap, respectively. For the yellow sticky traps which have 0.5m above the ground the mean numbers of *B. tabaci* which attracted to the traps on the three squash varieties at both of the two tested seasons were (6.9@ 5.8), (8.9@ 6.7) and (9.1@ 8.3) adults/trap, respectively.

Statically analyses showed that were highly significant differences between mean numbers of *B. tabaci*, which attracted to the yellow sticky traps, which have different heights in both of the two tested seasons.

These results were an agreement with Shen and Ren (2003) in China who reported that the best method to trap *B. tabaci* adults using a yellow card in the squash field. And reported that the best method was to hang the yellow card vertically between the rows of the squash plants, and the height of the yellow card is almost kept the same as the top of the squash plants. Maolin *et al.* (2006) 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 *B. tabaci* on greenhouse squash. Fu *et al*. (2015) reported that *B. tabaci* is an important pest on vegetables in greenhouses and studied the yellow sticky cards that were hung in Pepper fields and Cucumber fields. And reported that the best height of yellow sticky cards was top of the Cucumber leaves about 10cm - 50cm higher than the top of the leaves and the best height of the yellow sticky cards were ranged from 1.5m – 2m above the ground. Moreover, Dan and Horowitz (1984) found that the efficiency of the yellow trap was high whereas in the open air they flew >2m above the ground.

Third Experiment:

The third experiment aimed to evaluation efficiency orientation of the yellow sticky trap on attraction *B. tabaci* through comparison between four orientations (North, South, East and West). This experiment was carried out on squash plants during (June - July) at both the two successive seasons 2017, 2018.

Data tabulated in Table (3) showed mean numbers and statically analysis of *B. tabaci* which caught by yellow sticky traps which have different orientations (North, South, East, and West) in greenhouses squash during at both the two tested seasons 2017, 2018.

Table (3): Mean numbers of *B. tabaci*, which caught by yellow sticky traps, which have different orientations on squash, plants at both the two tested seasons.

Trap orientation	Mean numbers of *Bemisia tabaci*					
	2017			2018		
	Arkan	Sama 740	Andro 174	Arkan	Sama 740	Andro 174
North	14.3^{b}	15.7^{b}	16.2^{b}	12.5^{b}	13.5^{a}	15.8^{b}
South	15.6^{b}	17.3^{b}	14.3^{b}	13.7^{b}	15.4^{b}	15.3^{b}
East	12.7^{b}	16.2^{b}	17.5^{b}	13.9^{b}	15.6^{c}	16.4^{c}
West	11.5^{b}	13.4^{b}	14.2^{b}	12.6^{b}	14.7^{a}	15.3^{d}
F	**641.36**	**568.03**	**765.25**	**675.03**	**254.73**	**635.53**
L.S.D	**1.1172**	**1.1252**	**1.1822**	**1.1621**	**1.1554**	**1.2323**

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

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

These results agree with Maolin *et al.* (2006) who reported that the trap orientation had no effect on trap catches, but traps hanged vertically parallel to plant rows trapped slightly more *B. tabaci* adults than those hanged horizontally. Those authors studied the distribution and daily activities of *B. tabaci* adults in a greenhouse (East-West) oriented were investigated with yellow sticky traps. In addition, they found that no significant differences between East and West orientation of the yellow sticky traps in the Cucumber greenhouse. These results agree with those obtained by Xi *et al*. (2008) who studied the orientation of the yellow sticky traps on tomato plants in greenhouses. And reported that had no effect of the orientation of the traps (North, South, East and West) on atttactive *B. tabaci* adults. However, 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 فى جذب حشرة الذبابة البيضاء *Bemisia tabaci* (Gennadius) على نباتات الكوسة تحت ظروف الصوب البلاستيكية

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أجريت هذه التجارب بغرض تقييم فاعلية المصائد اللاصقة فى جذب حشرة الذبابة البيضاء *Bemisia tabaci* (Gennadius) على نباتات الكوسة *Cucurbita pepo* L. (ثلاثة أصناف : أركان , سما 740 , أندرو 174) تحت ظروف الصوب البلاستيكية. كما أجريت هذه التجارب فى منطقة برقاش (محافظة الجيزة) خلال عامى 2017, 2018 ، حيث إنقسمت هذه الدراسة إلى ثلاثة تجارب :

التجربة الأولى :أجريت هذه التجربة بغرض تقييم فاعلية لون المصائد اللاصقة فى جذب حشرة الذبابة البيضاء من خلال مقارنة أربعة ألوان مختلفة للمصائد اللاصقة وهى (الأصفر ، الأزرق ، الأحمر ، الأبيض) . كما أجريت هذه التجربة على نباتات الكوسة وذلك خلال شهرى (فبراير، مارس) و ذلك تحت ظروف الصوب البلاستيكية خلال عامى الدراسة .

وتوصلت النتائج إلى إرتفاع فاعلية المصائد اللاصقة ذات اللون الأصفر بالمقارنة بالمصائد ذات الألوان الأخرى ثم يليها فى الفاعلية المصائد ذات اللون الأزرق ثم المصائد ذات اللون الأحمر وأخيرا المصائد ذات اللون الأبيض. كما أشار التحليل الإحصائى للنتائج إلى وجود فروق معنوية بين تعداد حشرة الذبابة البيضاء التى تنجذب للمصائد اللاصقة ذات الألوان الأربعة المختلفة محل الدراسة .

التجربة الثانية :أجريت هذه التجربة بغرض تقييم فاعلية إرتفاع المصائد الصفراء اللاصقة فى جذب حشرة الذبابة البيضاء من خلال مقارنة أربعة إرتفاعات مختلفة للمصائد الصفراء اللاصقة وهى (2م ، 1.5م ، 1م ، 5. م) عن سطح الأرض . كما أجريت هذه التجربة على نباتات الكوسة وذلك خلال شهرى (أبريل ، مايو) و ذلك تحت ظروف الصوب البلاستيكية فى موقعى الدراسة .

وتوصلت النتائج إلى إرتفاع فاعلية المصائد الصفراء اللاصقة ذات الإرتفاع 2م بالمقارنة بالمصائد ذات الإرتفاعات الأخرى ثم يليها فى الفاعلية المصائد ذات الإرتفاع 1.5م ثم المصائد ذات الإرتفاع 1م وأخيرا المصائد ذات الإرتفاع 5. م . كما أشار التحليل الإحصائى للنتائج إلى وجود فروق معنوية بين تعداد حشرة الذبابة البيضاء التى تنجذب لكلا من المصائد الصفراء اللاصقة ذات الإرتفاعات الأربعة المختلفة محل الدراسة .

التجربة الثالثة :أجريت هذه التجربة بغرض تقييم فاعلية إتجاه المصائد الصفراء اللاصقة فى جذب حشرة الذبابة البيضاء من خلال مقارنة أربعة إتجاهات مختلفة للمصائد الصفراء اللاصقة وهى (الشمال ، الجنوب ، الشرق ، الغرب) . كما أجريت هذه التجربة على نباتات الكوسة وذلك خلال شهرى (يونيه ، يوليو) و ذلك تحت ظروف الصوب البلاستيكية فى عامى الدراسة. وتوصلت النتائج إلى عدم وجود تأثير ملموس لإتجاه المصائد الصفراء اللاصقة على معدل أو فاعلية المصائد فى جذب حشرات الذبابة البيضاء حيث كان معدل جذب المصائد الصفراء اللاصقة للذبابة البيضاء متقاربا فى الإتجاهات الأربعة وذلك خلال عامى الدراسة . كما أشار التحليل الإحصائى للنتائج إلى عدم وجود فروق معنوية بين تعداد حشرة الذبابة البيضاء التى تنجذب لكلا من المصائد الصفراء اللاصقة فى كلا من الإتجاهات الأربعة المختلفة محل الدراسة.