EFFICIENCY OF INSECT-PROOF SCREENS IN EXCLUDING THREE MAJOR PESTS OF STRAWBEERY INTO THE GREENHOUSE

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ABSTRACT: In recent years, the use of the insect-proof screens in protection of greenhouse crops has been increasingly recognized. In this study, the effectiveness of three types of insect-proof screens for their exclusion of *Frankliniella occidentalis*, *Chaetosiphon fragaefolii* and *Tetranychus urticae* have been evaluated in laboratory conditions (L:D 16:8, 27±2 °C Temp., and 60±10% R.H.). The tested insect-proof screens were the 5×5 (5×5 threads per cm^2), 13×23, 30×34 and Agryl p-17. In each cylindrical container, which was sealed by every one of the above mentioned insect-proof screens at one end, 50 individuals were placed. In this experiment, flowers and leaves of strawberry were used as an incentive for the insect to move through the openings of insect-proof screens. The control percent of screens was evaluated by calculating the number of insects in which were existed in the containers after 24 hours. The results of this experiment indicated that the 5×5 insect screen, which is widely used in greenhouses, did not exclude these pests really. Results also indicated that 94% of *C. fragaefolii* controlled by the 13×23 screen, compared to not efficient of this screen in excluding of *F. occidentalis* and *T. urticae*. 100% of *C. fragaefolii,* 46.66% of *F. occidentalis* and 13.8% of *T. urticae* controlled by the 30×34 screen. However, control percent was higher for *C. fragaefolii* than for *F. occidentalis* and *T. urticae* and this was related to the larger size of the strawberry aphid as compared to the western flower thrips and twospotted spider mite.

KEY WORDS: Insect-proof screens, Mechanical barrier, *Frankliniella occidentalis*, *Chaetosiphon fragaefolii*, *Tetranychus urticae*, Strawberry, Greenhouse.

Over the past 30 years, western flower thrips, F*rankliniella occidentalis* (Pergande), has become one of the most prominent agricultural pests throughout the world (Thoeming et al., 2003). F. *occidentalis* feed by piercing plant cells with their mouthparts and sucking out the contents. The piercing of a flower cell causes the death_of single cells, making a bronzed semblance on the strawberry fruit (Obrycki, 2004; Steiner, 2009). Adults and larvae feed in the same way, so both stages contribute to plant damage (Reitz, 2009). The strawberry aphid, *C. fragaefolii*, can affect yields because it transmits viruses such as the *strawberry mild yellow edge virus* (SYEV), *strawberry crinkle virus* (SCV) and *strawberry mottle virus* (SMV) (Rondon & Cantlliffe, 2004; Cedola & Greco, 2008). Twospotted spider mite, *Tetranychus urticae* Koch is most economically important pests in strawberries. *T. urticae* feed on the underside of the leaf, piercing the chloroplast containing palisade and spongy parenchyma cells in the mesophyll layer at a rate of 18-22 cells/min (Rondon et al., 2005; Fraulo et al., 2009).

The use of the insect-proof screens in protection of greenhouse crops has been increasingly recognized in recent years (Bartzanas et al,. 2002; Bailey et al., 2003; Fatnassi et al., 2003; Hanafi et al., 2005; Valera et al., 2006). Although pesticides will remain an important tool for pest management in greenhouse crops, non chemical methods must be introduced to reduce damage to the environment and to delay the development of pest's resistance (Fatnassi et al., 2003; Hanafi et al., 2005). The use of insect screens in greenhouses have been found to be an efficient method for reducing insect migration into the greenhouse (Teitel et al., 1999; Bartzanas et al,. 2002; Hanafi et al., 2005), and subsequent for reducing the number of pesticide applications targeting the insect pests and vectors (Soni et al., 2005; Hanafi et al., 2005; Katsoulas et al., 2006).

The efficiency of insect-proof screens as a mechanical barrier (Berlinger et al., 1996; Fatnassi et al., 2003; Shilo et al,. 2004; Hanafi et al., 2005; Valera et al., 2006) depends on the dimensions of the pores. However, the density of the threads alone does not suffice to determine the average dimension of the pores; the diameter of the fibers must be also known. In most instances, the screens are characterized by the term "mesh", which is the number of threads per inch in each direction. For example, a 50-mesh screen has 50 threads per inch of material. If the mesh and thread thickness are known the size of the opening can be obtained by subtracting the thread size from the reciprocal of the mesh; so a 50 mesh screen with a thread thickness of 0.15 mm has openings with a width of 0.35 mm (i.e. 1/50=0.02 inches=0.5 mm; subtracting the thread thickness of 0.15 mm gives 0.35 mm) in each direction. If the openings are rectangular, the screen will have openings of 0.48 mm by 0.27 mm if the thread thickness is 0.15 mm (Hanafi et al., 2005).

There are several commercial screens which have variable efficiencies in excluding insect pests. These screens have various sizes and have been used to exclude a certain number of insect pests of greenhouse crops. Depending on the target pest, the openings size in the screen must clearly be smaller than the size of the insect (Table 1) (Hanafi, 2005).

The maximum sizes of the openings in a insect-proof screen to exclude some important insect pests are given in table 2. In Europe and North Africa, the screens are identified as 6×9, 10×14 or 10×22, which means that these screens have rectangular openings. For example, a 10×20 screen has 10 threads by 20 threads in a centimeter square (Hanafi et al., 2005).

The objective of this work was to experimentally investigate the influence of several types of insect proof screens (13×23 and 30×34 as compared to indexes of positive (Agryl/P17) and negative (5×5) control) used to prevent of three major pests of strawberry of intrusion.

MATERIAL AND METHODS

In this study, we have evaluated in laboratory conditions (L:D 16:8, 27±2 °C Temp., and 60±10% R.H.) the effectiveness of three types of insect-proof screens for their exclusion of the two spotted spider mite (TSSM), *Tetranychus urticae* Koch (Acari: Tetranychidae), the western flower thrips, *Frankliniella occidentalis*(Pergande) (Thysanoptera: Thripidae) and the strawberry aphid, *Chaetosiphon fragaefolii*(Cockerell) (Homoptera: Aphididae). The insect-proof screens tested were the 13×23 (13×23 threads per cm^2) and 30×34, against a negative control (5×5, ability pests to cross) and to a positive control (Agryl/P17, a protective crop cover, not ability pests to cross). The insects were collected from an experimental greenhouse of the Iranian Research Organization for Science and Technology (IROST) in Tehran, Iran.

In this experiment we have using one plastic cylindrical for each replicate. In each cylindrical container which was sealed by every one of the above mentioned insect-proof screens at one end (9 cm in diameter and 10 cm in height), 50 individuals were placed. Hence each screen was tested as a barrier between inner and outer space of cylindrical container. In this experiment, flowers and leaves of strawberry were used as an incentive for the insect to move through the openings of insect-proof screens. The control percent of insect screens was evaluated by calculating the number of insects that there were in the containers after 24 hours. We have evaluated two treatments: T1 (13×23), T2 (30×34), as compared to a negative control (5×5) and to a positive control (Agryl/P17). Each treatment was replicated three times. Analyzing data calculate by Design Expert (version 7.0.0) software.

RESULTS AND DISCUSSION

The control percent of insect screens were evaluated by calculating the number of insects that were in the containers after 24 hours. The results of this experiment indicated clearly that the 5×5 insect screen, which is widely used in greenhouses, did not really exclude these pests. The results of control percent of pests evaluated in this experiment through the different screens are indicated in Fig 2. The results of this experiment indicated that, the 13×23 insect screen could control 94% penetration of C. fragaefolii as compared to the 30×34 screen which controlled 100% of this species (Fig. 1.a). There was significant difference between the 13×23 and 30×34 insect screens in the control of *C. fragaefolii* (F= 27, P< 0.0065, df= 1). However, control percent were higher for *C. fragaefolii* than for *F. occidentalis* and *T. urticae* and this is related to the larger size of the strawberry aphid as compared to the western flower thrips and two spotted spider mite. These results also indicated that the average of control percent and excluding of *F. occidentalis* was zero for the 13×23 insect screen and 46.66% for the 30×34 one (Fig. 1.b). The comparison of the results also indicated that there was not significant difference between these screens for control of *F. occidentalis* (F= 7, P<0.0572, df=1). The 13×23 and 30×34 screens excluding of *T. urticae*, zero and 13.8% respectively. There was a significant difference between these screens for control of this pest (Fig. 1.c). Hence, results shown that these screens are not efficient in control and excluding of *T. urticae* (F= 36.60, P< 0.0038, df=1).

The results also have been compared with indexes of positive (Agryl/P17) and negative (5×5 screen) control for performance evaluation of these screens in the controlling of tested pests (Fig. 2 and table 3). The comparison of the 13×23 and 30×34 screens with the index of positive control (Agryl/ p-17) indicated the adequate control potency of these screens in exclusion of C. fragaefolii (F=7227.00, P<0.0001, df=3).As a result, these screens can be used as an anti-aphid screen. The comparison between of negative control index (5×5 screen) and the 13×23 screens indicated not efficient of this screen in excluding of F. occidentalis. But there was a significant difference between negative and positive control indexes and the 30×34 screen (F=29.14, P<0.0001, df=3). There was not a significant difference between the 13×23 screen and negative control index(5×5 screen) for control of T. urticae(F=1781.63, P<0.0001, df=3). However, there was a significant difference between the 30×34 screen and index of negative control, but this screen cannot provide a suitable control for excluding of this pest.

Berlinger et al. (1996) indicated that screens also effectively excluded other insects equal or greater in size than whiteflies e.g. aphids and leafminers. The insect-proof screens must be installed before planting and fixed thoroughly to prevent even the smallest opening. Screening greenhouses with a suitable insect-proof screen minimizes pest immigration, significantly decreases pesticide applications, provides the basis for the implementation of an IPM program, and enables the use of bumble bee pollinators. Consequently, all greenhouse strawberry and many other greenhouse crops need protective screens nowadays.

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LITERATURE CITED

Bailey, B. J., Montero, J. I., Perez Parra, J., Robertson, A. P., Baeza, E. & Kamaruddin, R. 2003. Airflow resistance of greenhouse ventilators with and without insect screens. Biosystems Engineering, 86 (2): 217–229.

Bartzanas, T., Boulard, T. & Kittas, C. 2002. Numerical simulation of the airflow and temperature distribution in a tunnel greenhouse equipped with insect-proof screen in the openings. Computers and Electronics in Agriculture, 34: 207–22.

Berlinger, M. J., Lebiush-Mordenchi, S. & Rosenfeld, J. 1996. State of the art and the future of IPM in greenhouse vegetables in Israel. IOBC/WPRS Bulletin, 19 (1): 11-14.

Cedola, C. & Greco, N. 2008. Presence of the aphid, Chaetosiphon fragaefolii, on strawberry in Argentina. Journal of Insect Science, 10 (9): 1-9.

Fatnassi, H., Boulard, T. & Bouirden, L. 2003.Simulation of climatic conditions in full-scale greenhouse fitted with insect-proof screens. Agricultural and Forest Meteorology, 118: 97–111.

Fraulo, A. B., Cohen, M. & Liburd, O. E. 2009. Visible/near infrared reflectance (VNIR) spectroscopy for detecting two spotted spider mite (Acari: Tetranychidae) damage in strawberries. Environmental Entomology, 38 (1): 137-142.

Hanafi, A., Amouat, S., Miftah, S. & Bouharroud, R. 2005. Efficiency of insect nets in excluding whiteflies and their impact on some natural biological control agents. Available from: http://www.actahot.org/members/ shawpdf?booknrarnr=646-47

Katsoulas, N., Bartzanas, T., Boulard, T., Mermier, M. & Kittas, C. 2006. Effect of vent openings and insect screens on greenhouse ventilation. Biosystems Engineering , 93 (4): 427–436.

Obrycki, J. 2004. The effects of thrips on strawberry production in Iowa. Leopold Center Progress Report, 13: 28-30.

Reitz, S. R. 2009. Biology and ecology of the western flower thrips (Thysanoptera: Thripidae): The making of a pest. Florida Entomologist, 92 (1): 7-13.

Rondon, S. I. & Cantliffe, D. J. 2004. Chaetosiphon fragaefolii (Homoptera: Aphididae): a potential new pest in florida?. Florida Entomologist, 87 (4): 612-615.

Rondon, S. I., Cantliffe, D. J. & Price, J. F. 2005. Population dynamics of the cotton aphid, Aphis gossypii(Homoptera: Aphididae), on strawberry grown under protected structure. Florida Entomologist, 88 (2): 152-158.

Shilo, E., Teitel, M., Mahrer, Y. & Boulard, T .2004. Air-flow patterns and heat fluxes in roof-ventilated multi-span greenhouse with insect-proof screens. Agricultural and Forest Meteorology, 122: 3–20.

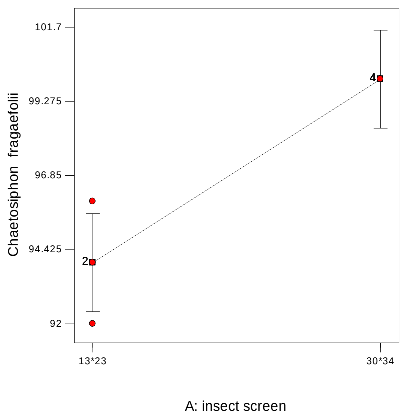
Soni, P., Salokhe, V. M. & Tantau, H. J. 2005. Effect of screen mesh size on vertical temperature distribution in naturally ventilated tropical greenhouses. Biosystems Engineering, 92 (4): 469–482.

Steiner, M. 2009. NSW Agriculture, Gosford, NSW. Which thrips is that? A guide to the key species damaging strawberries. NSW Agriculture and Horticulture Australia. Available from: http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/177330/strawberry-thrips.pdf.

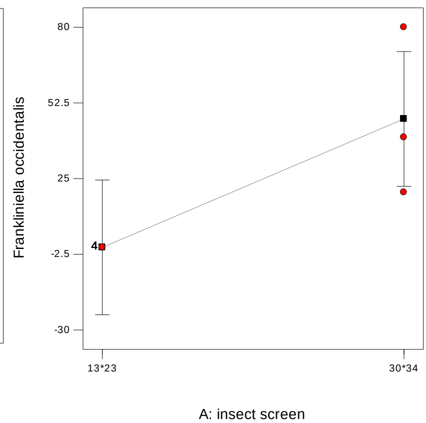
Teitel, M., Barak, M., Berlinger, M. J. & Lebiush-Mordechai, S. 1999. Insect proof screens: their effect on roof ventilation and insect penetration. Acta Horticulturae, 507: 29–37.

Thoeming, G., Borgemeister, C., Setamou, M. & Poehling, H. M. 2003. Systemic Effects of Neem on Western Flower Thrips, Frankliniella occidentalis (Thysanoptera: Thripidae). Journal of Economic Entomology. 96 (3): 817-825.

Valera, D. L., Alvarez, A. J. & Molina, F. D. 2006. Aerodynamic analysis of several insect-proof screens used in greenhouses. Spanish Journal of Agricultural Research, 4 (4): 273-279.



(a)



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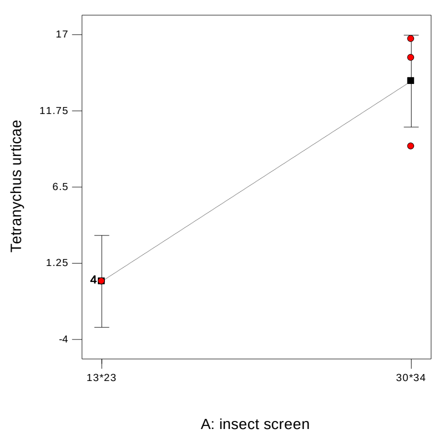

(c)

Figure 1. Control percent of pests through insect-proof screens 13×23 and 30×34.
a) *Chaetosiphon fragaefolii* **b)** *Frankliniella occidentalis* **c)** *Tetranychus urticae*.

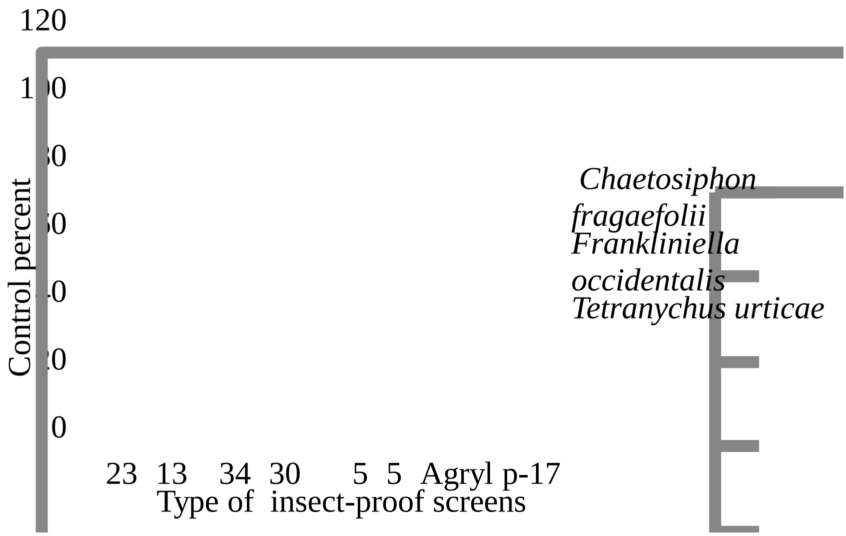

Figure 2. Control percent of *Chaetosiphon fragaefolii*, and *Frankliniella occidentalis* and *Tetranychus urticae* through different insect screens (13×23 & 30×34) as compared to a positive control (Agryl/P17) and to a negative control (5×5), in laboratory conditions.

Table 1. Width and length in millimeter of some important insect pests of greenhouse crops (Hanafi et al., 2005).

Insect pest	Width(mm)		Length(mm)
	Thorax	Maximum	
Serpentine leaf miner (*Liriomyza trifolii*)	0.608	0.850	0.177
Sweet potato whitefly (*Bemisia tabaci*)	0.615	0.870	0.181
Melon aphid (*Aphis gossypii*)	0.355	0.239	0.236
Greenhouse whitefly (*Trialeurodes vaporariorum*)	0.288	0.709	0.128
Silverleaf whitefly (*Bemisia argentifolii*)	0.239	0.565	0.107
Western flower thrips (*Frankliniella occidentalis*)	0.215	0.267	0.126

Table 2: Maximum dimension of openings in a insect-proof screen to exclude some important insect pests of greenhouse crops (Hanafi et al., 2005).

Insect pest	Hole size (mm)	Mesh *
Serpentine leaf miner (Liriomyza trifolii)	0.61	34
Sweet potato whitefly (*Bemisia tabaci*)	0.46	42
Melon aphid (*Aphis gossypii*)	0.34	52
Greenhouse whitefly (*Trialeurodes vaporariorum*)	0.29	58
Silverleaf whitefly (*Bemisia argentifolii*)	0.24	66
Western flower thrips (*Frankliniella occidentalis*)	0.19	76

*Based on thread diameter of 0.15 mm