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Test for Local Insect Traps Against Some Solanacea Insects Plant Under Greenhouse Conditions in Riyadh, Saudi Arabia

تقييم المصائد اللونية المحلية ضد بعض آفات الفصيلة الباذنجانية داخل البيوت المحمية في منطقة الرياض، بالمملكة العربية السعودية

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Abstract: Trapping efficiency of seven different colored sticky traps (Green, Fluorescent yellow, Orange, Pink, Red, White and Yellow) was evaluated in some solanacea plants, tomatoes *(Lycopersicon esculentum),* eggplant *(Solanum melongena)* and sweet pepper *(Capsicum spp.)* crops, for whitefly *(Bemisia argentifolii),* leafminers *(Liriomyza trifolii),* thrips *(Thrips tabaci)* in Riyadh, Saudi Arabia. The traps were placed at four different heights (0.5, 1.0, 1.5 and 2.0 m above the ground). The experiment was laid out in a Completely Randomized Block Design (CRBD) with four replications during Autumn 2001, Spring and Autumn 2002. Significantly high insect populations were trapped on Fluorescent yellow, yellow and green colored sticky traps. No significant differences were witnessed between mean number of various insects caught on sticky traps placed at different heights but more insects were trapped at 0.5-1.5m.
Keywords: Greenhouse, insect pests, sticky traps, tomato, eggplants, insects trapping efficiency, sweet peppers, thrips, leafminers, whiteflies population dynamics, visual traps and colored traps.

المستخلص: يعتبر اصطياد الحشرات عن طريق المصائد اللونية، من أهم العمليات لتقدير الكثافة العددية لهذه الحشرات داخل المزارع المحمية. تستهدف هذه الدراسة إلي إختبار كفاءة سبعة الوان (الاخضر، الاصفر الفاقع، البرتقالي، الاحمر الفاتح ، الاحمر، الابيض، الاصفر العادي) لمصائد صنعت محلياً، تم وضعها على اربعة ارتفاعات مختلفة على فارق إرتفاع 0.5 متراً لكل مصيدة (0.5، 1.0، 1.5 و 2.0 متر)، ومن ثم اختبارها في اصطياد الذبابة البيضاء و صانعات الانفاق، و التربس على بعض نباتات الفصيلة الباذنجانية (الطماطم *Lycopersion esculentum*، الباذنجان *Solanum melongeria*، والفلفل البارد *Capscum spp*) المزروعة داخل البيوت المحمية بمنطقة الرياض. صممت التجربة باستخدام تصميم القطاعات العشوائية المتكاملة بأربعة مكررات خلال موسمين متتاليين خريف (سبتمبر-أكتوبر) 2001 و ربيع وخريف(مارس-مايو و سبتمبر-أكتوبر) 2002م. تشير النتائج الى تفوق المصائد ذات الالون الاصفر الفاقع، والاصفر العادي، والاخضر في اصطياد الحشرات بدرجة معنوية اكبر من الالوان الاخرى. كما انه لم يكن هناك أي فروق معنوية في إحصاء الحشرات التي قد اصطيدت على المصائد عند وضعها على ارتفاعات مختلفة.
كلمات مدخلية: مزارع محمية، آفات، حشرات، ذبابة بيضاء، فصيلة باذنجانية، طماطم، باذنجان، فلفل بارد.

Introduction

Vegetables produced in Saudi Arabia are vulnerable to attack by a variety of insect pests which does not only deteriorate their quality but also are detrimental to potential yield. Greenhouses provide an excellent, stable environment for insects that facilitate their rapid multiplication. Population dynamics of organisms is governed by a combination of factors including inherited properties of individuals and environmental attributes (Clark *et al.*, 1967). Tomatoes, sweet-peppers and egg-plant as members of Solanaceae family are important vegetable crops, grown in greenhouses in Saudi Arabia. They are attacked by a number of greenhouse insect pests such as whiteflies *(Bemisia argentifolii),* leafminers *(Liriomyza trifolii),* thrips *(Thrips tabaci)* and aphids. (Al-Abdulmohsin, 1993) reported two whiteflies species *Bemisia tabaci* and *Trialeurodes vaporariorum* as pests of vegetable crops in Saudi Arabia. Whiteflies inflect both direct damage by sucking the sap and indirectly by transmitting the tomato yellow leaf curl virus (Al-Abdulmohsin, 1997).

Apart from other abnormalities, whitefly feeding reduces the chlorophyll by 40%-50% (Jimenez *et al.* 1995). Leafminers belonging to the genus Liriomyza Mik are serious pests of many horticultural crops throughout the world (Spencer, 1973). Males are unable to create their own punctures, but many other researchers indicated that males feed from punctures created by females (Musgrave *et al.*, 1975); (Oatman and Michelbacher, 1958).

The mines formation in leaves can reduce

photosynthesis which varies according to size and mine location (Parrella *et al.*, 1985) and may kill young plants (Elmore *et al.*, 1954). The size of leaf mines varies with the size of the adult female (Oatman and Michelbacher, 1958). Gregarious feeding by thrips adults and larvae on leaves results in the formation of silvery patches which turn brownish as the tissues dry up beneath the epidermis and this ultimately induces premature leaf fall (Ananthakrishman, 1971) and (Lewis, 1973).

Use of sticky cards proved successful to detect early infestation in greenhouse. Placement of yellow sticky cards, both inside and outside the greenhouse is necessary for a successful whitely management program (McHough, 1991). Whiteflies, lieafminers and thirps are mostly attractive to yellow sticky cards, whereas blue sticky cards are paritculary attractive to thrips (Gill and Sanderson, 1998); (Kawai and Kitamura, 1988). (Al-Ayedh and Al-Doghairi 2004) reported a significantly high trapping efficiency with fluorescent yellow. (Greany *et al.* 1977) found that Caribbean fruitflies Anastrepha suspensa (Loew) are attracted to orange and yellow colors of the fruit which they attack. (Bremman and Weinbaum 2001) found preference for yellow sticky traps while comparing psyllid response toward different colored (red, blue, green, white and clear) sticky traps.

(Vaishampayan *et al.* 1975) showed that initial alightment of greenhouse whitefly Trialeurodes vaporariorum (Westw.) is predominantly elicited by color of the host plant rather than the suitability. They also detcted that insect landing was mainly elicited by yellow light having a wavelength of (500-600nm) (Woolley, 1971), a major component of the reflection from green leaves. Herbivorous insects are highly discriminating while searching for food and oviposition sites utilizing visual or olfactory stimuli (Todd *et al.*, 1990); (Aluja and Prokopy, 1993).

Sticky trap efficiency varies with position of trap's placement in the crop (Byrne *et al.*, 1986); (Gillespie and Vernon 1990); (DeGooyer *et al.*, 1998); (DeGooyer, 1997 and Chandler, 1985). But some studies also showed no difference for insect traping afficiency while placing color sticy traps at various hights (Schuster *et al.* 1980); (Al-Ayedh and Al-Doghairi, 2004).

The objective of this study is to determine the trapping efficiency of local sticky colored traps placed at different heights to attract insect pests attacking some members of solanacea family such as tomatoes, egg plant and sweet pepper vegetable crops grown in greenhouse.

Materials and Methods

The experiment was conducted at Muzahmia research station, Natural Resources and Environment Research Institute, King Abdulaziz City for Science and Technology (KACST), Riyadh, Saudi Arabia. The experiment was carried out during September-October, Autumn, 2001 and Spring and Autumn, March-May, 2002 and September-December, 2002, to evaluate the trapping efficiency of local colored sticky traps for monitoring greenhouse insect pests population dynamics in Tomato, Sweet pepper and Egg-plant crops.

Seven colored traps (fluorescent yellow, green, yellow, orange, pink, red and transparent (control) were designed locally, from colored boards covered with clear solofan cut into pieces of equivalent sizes of (14 x 14 cm) and coated with adhesive tangle-trap. Trap heights were also added during 2002 as a factor affecting the trapping efficiency of sticky traps. These traps were suspended at (0.5m, 1.0m, 1.5 m and 2.0 m) height above the ground to compare their relative trapping efficiency with respect to position.

The trap catch was collected weekly for counting and identification of trapped insects. The experiment was carried out using a Completely Randomized Block Design (CRBD) with seven colored traps treatments and four replications. Data were transformed into logarithm, and treatment means were compared using Student-Newman-Keuls Test (SNKT) at 5% probability level using SAS v8 (SAS Institute, 1998).

Results and Discussion

The results of the data recorded during autumn, Sept-Oct. 2001 indicated a significantly higher number of whiteflies trapped on fluorescent yellow and green traps, followed by orange and yellow traps, which also exhibited no statistical difference. No significant difference was observed between pink, red and transparent (Table 1).

During spring (March-May), 2002 a significantly higher number of leafminers was recorded on green colored sticky traps followed by yellow, fluorescent yellow and orange colored traps which remained statistically at par with each other. Whereas, a significantly lower number of leafminers was trapped on red, transparent (control) and pink colored traps. Results showed a significantly higher number of thrips catches on fluorescent yellow, followed by green, orange and yellow colored traps that were found statistically dissimilar. Whereas, no significant differences were witnessed on pink and

Table (1): Mean number of insects captured on sticky traps of various colors in Greenhouse planted with Tomato, Sweet pepper and Egg-plant during the season Autumn 2001 and Spring & Autumn 2002**.

Trap colors	Mean number of insects captured					
	Autumn Sept - October 2001		Spring March - May 2002		Autumn Sept. - October 2002	
	Whitefly	Leafminers	Leafminers	Thrips	Leafminers	Thrips
Yellow	115.00b	6.41b	2.38c	22.82d	40.59a	342.21a
F. Yellow	267.42a	6.31b	2.99b	58.17a	23.50b	181.79b
Green	258.60a	7.93a	3.94b	40.06b	22.18b	114.89c
Orange	141.02b	4.73b	2.40c	28.36c	16.40c	152.63c
Transparent (Clear)	12.52c	2.88c	6.38a	1.51f	6.23d	75.15d
Red	24.30c	3.11c	0.95d	5.37e	8.01d	30.71e
Pink	31.20c	1.90d	0.73d	18.31e	3.93e	160.26c

* *Means in vertical columns followed by the same letter are not statistically different at P<.05 SNK Test.*

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red colored traps. In case of control the thrips trapping remained minimum. During Autumn (Sept.-Oct), 2002, yellow colored sticky traps presented significantly higher number of leafminers catches followed by fluorescent yellow and green which were not significantly different. The rest of the traps caught significantly lower number of leafminers. Yellow colored sticky traps also trapped significantly higher number of thrips followed by fluorescent yellow traps. The results revealed no significant difference for thrips trapping between pink, green and orange colored sticky traps, while the rest of the colored traps presented significantly lower thrips trapping (See, table 1).

The results of the study indicated that insects show a preference towards the colors that have more intense reflectance and wavelength such as fluorescent yellow, yellow and green colored sticky traps. The findings are in line with (Al-Ayedh and Al-Doghairi 2004) who evaluated the relative efficacy of various colored traps and reported significantly higher insects trapping with fluorescent yellow. (Lapis and Borden 1995) reported that fluorescent yellow trap having high reflective intensity when compared to the lower reflective intensities of less preferred yellow traps, and indicated that both wavelength and intensity of reflecting light affect insect's response to its host. Insects are attracted to spectral reflectance ranging from (350-650 nm), whereas different colors vary in bandwidth such as ultraviolet (300-400nm), Blue (400-500nm), green (500-560nm), yellow (560-590nm), orange (590-630) and red (650nm) (Menzel, 1979). A range of herbivorous insects respond positively to yellow color which demonstrates that, for insects, yellow color establishes a super-normal foliage type stimulus that gives out peak energy in similar bandwidth as peak energy emitted by natural leaves detected by insects, but at higher reflective intensity (Tanton, 1977) and (Prokopy, 1972). Certain aphid species that feed on host plants having saturated leaves color are not attracted to unsaturated yellow surfaces, which shows the insects preference for specific characteristics while searching a potential host (Kring, 1967).

During spring (Mar.-May) 2002, higher numbers of leafminers were observed in traps placed at (0.5m), (1.00m) and (1.50m) heights respectively, which were found statistically equal with each other. Significantly higher numbers of thrips were recorded from sticky traps placed at (0.50m). However, the numbers caught at (1.00m), (1.50m) and (2.00m) heights showed no significant differences.

The data recorded during Autumn (Sept.-Oct.) 2002, related to the position of various colored sticky traps, revealed no significant differences between mean number of leafminers trapped on sticky traps placed at different heights from ground. Whereas, a significantly higher number of thrips was trapped at (1.00m) level which remained statistically at par with the mean numbers of thrips caught at (0.5m) and (1.50m) heights (Table 2).

These results partially revealed no significant differences between mean numbers of various insects caught on sticky traps placed at different heights but significant differences were witnessed between insects trapped at (2.00m), (0.5m) and (1.5m) heights.

Table (2): Mean number of insects captured on sticky traps at different heights in greenhouse planted with Tomato, Sweet pepper and Egg-plant during the season 2002.**

Trap heights (m)	Mean number of insects captured			
	Spring, 2002 Mar.-May		Autumn, 2002 Sept.-Oct	
	Leaf miners	Thrips	Leaf miners	Thrips
2.00	2.31c	13.00b	15.50a	118.91c
1.50	2.67b	20.17b	17.70a	142.05b
1.00	3.14ab	27.85b	18.87a	198.58a
0.50	3.19a	38.35a	16.98a	144.83ab

* *Means in vertical columns followed by the same letter are not statistically different at P<.05 SNK Test.*

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Thus our findings agree with the results of (Schuster *et al.*, 1980) who recorded no differences in adult catches on sticky traps at various heights in tomato crop. (Al-Ayedh and Al-Doghairi 2004) also reported no significant differences between average number of various insects trapped at different heights from ground level. The present results showed that more insects were captured at (0.5m) and (1.5m) heights. (Chandler 1985) recorded significantly more adult leafminers catches at (30 cm) height using yellow traps. Sticky traps placement at suitable height with respect to a particular crop is very important for monitoring insect pest populations (Byrne *et al.*, 1986). Yellow sticky traps placed even at the top of alfalfa canopy presented promising results (DeGooyer *et al.*, 1998). Our results confirm that in insect pests monitoring, placement of traps at optimum position is imperative for desired results (Smith, 1976).

During autumn (Sept.-Oct.) 2001, a significantly higher whitefly population was recorded in tomato crop followed by eggplant and sweetpeppers, respectively, which were found statistically different from each other, while leafminer populations remained statistically similar in all three crops. Results of the data recorded during spring (March-May) 2002, revealed no significant differences for leafminers populations in tomato, eggplant and sweetpeppers crops, whereas, a significantly higher thrips population was recorded in tomato followed by sweetpeppers and eggplant, respectively. During Autumn (Sept.-Oct) 2002, significantly higher leafminers population was recorded in sweetpeppers followed by eggplant and tomato crop which remained statistically similar. Significantly more thrips were recorded in tomato crop which remained statistically at par with thrips population recorded in eggplant whereas a significantly lower population was recorded in sweetpeppers (Table 3).

The results recorded during Autumn (Sept.-Oct) 2001, Spring (March-May) 2002 and Autumn (Sept.-Oct) 2002, has depicted an increasing trend in insect pests populations from Spring towards Autumn for whiteflies, thrips and leafminers.

Table (3): Mean number of insects trapped in Tomato, Sweet pepper and Egg-plant during Sept.-Oct. Autumn 2001, Mar.-May, Spring and Sept.-Oct., Autumn 2002.**

Crops	Mean number of insects trapped					
	Autumn Sept.-Oct. 2001		Spring Mar.-May 2002		Autumn Sept.-Oct.2002	
	Whitefly	Leafminers	Leafminers	Thrips	Leafminers	Thrips
Tomato	214.15a	5.47a	2.84a	45.25a	13.67b	165.32a
Eggplant	115.91b	4.53a	2.85a	12.76c	15.10b	151.59a
Sweetpeppers	34.28c	4.26a	2.78a	16.42b	23.08a	136.36b

* *Means in vertical columns followed by the same letter are not statistically different at P<.05 SNK Test.*

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(Al-Abdulmohsin 1997) also reported a peak for whitefly populations during April to June in Saudi Arabia. (Traboulsi 1994) stated that a temperature of (26°-32°C) and (60%-70%) relative humidity are optimum ranges for whitefly development, which usually prevail in greenhouses used for vegetable production in Saudi Arabia.

Conclusion

More insects responded positively to fluorescent yellow and yellow colored sticky traps having high reflective intensity. Based on these results we propose the use of these traps in greenhouses which could greatly improve the pest monitoring system. Although sticky traps placed at various heights did not present any significant differences. However, the traps placed at (0.5m), (1.00m) and (1.5m) heights trapped more insects. Further explorations are needed for more understanding of the role of visual stimuli to draw more unequivocal conclusions. Also further experiments could be carried out using coloured attractive plants.

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References

Al-Ayedh, H. and M. Al-Doghairi, (2004). Trapping efficiency of various colored traps for insects in cucumber crop under greenhouse conditions in Riyadh, Saudi Arabia. Pak. J. Biol. Sci., **7** (7): 1213-1216.

Al-Abdulmohsin, A. M. (1993). Biological study in whitefly B. tabaci in Riyadh Region. (Unpub.) M.Sc. Thesis, King Saud University, Kingdom of Saudi Arabia.

Al-Abdulmohsin, A. M. (1997). Management of the whitefly-virus complex. FAO Plant Prod. and Prot. Paper. **143:** 55-56.

Aluja, M. and R. J. Prokopy, (1993). Host order and visual stimulus intraction during intra-tree host finding behavior of Rhagoletis pomonella flies. J. Chem. Ecol., **19**: 2671-2696.

Ananthakrishman, T.N. 1971. Thrips in Agriculture, Horticulture and Forestry. Diagnosis, bionomics and control. J. Sci. Ind. Res. **30**: 113-46.

Boller, E.F. and R.J. Porkopy, (1971). Response of European cherry fruit flies to colored rectangles. J. Econ. Entomol. **64**: 1444-1447.

Bremman, E.B. and S.A. Weinbaum, (2001). Psyllid responses to colored sticky traps and the colors of juvenile and adult leaves of the heteroblastic host plant Eucalyptus globulus. Environ. Entomol. **30** (2): 365-370.

Byrne, D.N., P.K. Von Bretzel, and C.J. Hoffman, (1986). Impact of trap design and placement when monitoring for the sweet potato whitefly (Homopotera: Aleyrodidae). Environ. Entomol. **15**: 300-304.

Chandler, L.D. (1985). Flight activity of Liriomyza trifolii (Diptera: Agromyzidae) in relationship to placement of yellow traps in Bell pepper. J. Econ. Entomol. **78**: 825-828.

Clark, L. R., P.W. Geier, R.D. Highes and R.F. Morris. (1967). The ecology of insect populations in theory and practice. Methuen, London, U.K.

DeGooyer, T.A. (1997). Population dynamics and management of potato leafhoppers and other insect pests in forage system. (Unpub.) PhD dissertation, Iowa State University, Ames, Iowa.

DeGooyer, T.A., L.P. Pedigo and M.E. Rice, (1998). Development of sticky traps sampling technique for potato leafhopper Adults. J. Agri. Entomol. **15** (1): 33-37.

Elmore, J. C., Rammey, C.A. Jr. (1954). Injury to pepper plants by the pea leaf miner. J. Econ. Entomol. **47** (2): 357-58

Gill, S. and J. Sanderson, (1998). Ball identification guide to greenhouse pests and beneficials. Ball Publishing, Batavia, USA.

Gillespie, D. R. and R.S. Vernon, (1990). Trap catch of western flower thrips (Thysanoptera: Thripidae) as affected by color and height of sticky traps in mature greenhouse cucumber crops. J. Econ. Entomol. **83** (3) : 971-975.

Greany, P.D., H.R. Agee, A.K. Burditt, and D.L Chambers, (1977). Field studies on color preferences of the Caribbean fruit fly, Anastrepha suspensa (Deptera:Tephritidae). Entomol Exp. Appl., **21**: 63-71.

Jimenez, D.R., R.K. Yokomi, R.T. Mayer and J.P. Shapiro, (1995). Cytology and physiology of silverleaf whitefly-induced squash silverleaf. Physiol. Mol. Plant Pathol. **46**: 227-242.

Kawai, A. and O. Kitamura, (1988). Population management of Thrips palmi Karmy and fruit, vegetables in greenhouse. ***In:*** Proceedings 28th International Congess of Entomology, Vancouver.

Kring, J.B. (1967). Alighting of aphids on colored cards in a flight chamber. J. Econ. Entomol. **60**: 12-17.

Lapis, E.B., and J.H. Borden, (1995). Role of wavelength-specific reflectance intensity in host selection by Heteropsylla cubana Crawford (Homoptera: Psyllidae) Pan-Pacific Entomologist. **71** (4): 209-216.

Lewis, T. (1973). Thrips: Their Biology, Ecology and Economic importance. London: Academic. 349pp

McHough, J. (1991). Monitoring the first line of defense. Greenhouse Grower. February. 66 p.

Menzel, R. (1979). Spectral sensitivity and color vision in invertebrates: Hand Book of Sensory Physiology Vol. 7. Sect. 6A. Berlin/New York, Springer, 503-80pp.

Musgrave, C. A., Poe, S. L., Bennett, D.R. (1975). Leaf miner population estimation in polycultured vegetables. Proc. Fla. State Hortic. Soc. **88**: 156-60

Oatman, E.R., Michelbacher, A. E. (1958). The melon leafminer, Liriomyza pictella (Thomson) (Diptera:Agromyzidae). Ann. Entomol. Soc. Am. **51** (5): 557-66

Parrella, M. P.., Jones, V. P., Youngman, R. R., Lebeck, L. M. (1985). Effect of leaf mining and leaf stippling of Liriomyza spp. On photosynthesis rates of Chrysanthemun. Ann. Entomol. Soc. Am. **78** (1): 90-93

Prokopy, R.J. (1972). Response of apple maggot flies to rectangles of different colors and shades. Environ. Entomol. **1**: 720-726.

Prokopy, R.J. and E.D. Owens, (1978). Visual generalist version of visual specialist phytophagous insect: host selection behavior and application to management. Entomol. Exp. Appl. **24**: 409-420.

Prokopy, R.J. and E.D. Owens, (1983). Visual detection of plants by herbivorous insects. Ann. Rev. Entomol. **28**: 337-364.

SAS Institute. (1998). SAS User's Guide: Basics, Version 8. SAS Institute, Cary, NC.

Schuster, D.J., R.T. Montgomery, D.L. Gibbs, G.A. Marlowe, Jr., J.P. Jones and A.J. Overman, (1980). The tomato pest management program in Manatee and Hillsborough Counties, 1978-1980. Proc. Fla. State Hortic. Soc. **93**: 235-239.

Smith, J.G. (1976). Influence of crop background on aphids and other phytophagous insects on brussel sprouts. Ann. App. Biol. **83**: 1-13.

Spencer, K. A. (1973). Agromyzidae (Diptera) of economic importance. Ser. Entomol. (Hague) **9:** 1-418.

Tanton, M.T. (1977). Behavioral response to different wavelength bands and attraction to color by larvae of the mustard beetle Phaedon cochleariae. Entomol. Exp. Appl. **22**: 35-42.

Todd, J.L., P.L Phelan, and L.R. Nault, (1990). Interaction between visual and olfactory stimuli during host finding by leafhopper, Dalbulus maidis (Homoptera: Cicadellidae) J. Chem. Ecol., **16**: 2121-2133.

Traboulsi, R. (1994). Bemisia tabaci: a report on its pest status with particular reference to the Near East. FAO Plant Prot. Bull. **42** (1/2): 33-58.

Vaishampayan, S.M., G.P. Waldbauer, and M. Kogan, (1975). Visual and olfactory responses in orientation to plants by the greenhouse whitefly, Trialeurodes vaporariorum (Hoomoptera: Aleyrodidae). Entomol. Exp. Appl., **18**: 412-422.

Woolley, J.T. (1971). Reflectance and transmittance of light by leaves. Plant Physiol. **47**: 656-662.

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