EFFECT OF NON-CONVENTIONAL METHODS TO CONTROL LIRIOMYZA TRIFOLII, APHIS GOSSYPII AND TETRANYCHUS URTICAE

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Abstract

Insect pest control is considered one of the important issues in the agricultural field. Chemicals insecticide is the conventional method to reduce pest population. Despite that chemicals are not the best method; it is an effective methods for pest control. The present study utilizing non-conventional method to control some major pests (leaf miner; *Liriomyza trifolii*, Aphis; *Aphis gossypii* and spider mite; *Tetranychus urticae*) that are infesting crops under protected cultivation (greenhouse). Under current study, the non-conventional methods as: the microwave radiation, infrared radiation at different exposure times: 1, 2 and 3 min and ultraviolet radiation at different exposure times (1, 2, 3, 6 and 9 min.) are used. The study was carried out under laboratory conditions at the Agricultural Engineering Research Institute (AEnRI), Agricultural Research Center (ARC). The results indicated that, using microwave or using infrared radiation for 1 min. exposed time kill 100% of *Liriomyza trifolii* population, But *Aphis gossypii* produced 100% of mortality by using microwave at 3 min. exposure time. Also, using infrared radiation for 1 min. caused 100% of insect mortality. *Tetranychus urticae* controlled by using infrared for 1 min. or using microwave at 3 min. exposure time. Meanwhile, ultraviolet radiation has no mortality effect on the above three mentioned pests, but it has been observed that, insect behavior was changed to de-active movement or hyper active movement for *Tetranychus urticae* only.

KEY WORDS: microwave radiation, infrared radiation, ultraviolet radiation, greenhouse, Mortality.

INTRODUCTION

Insect pests cause severe damage to vegetable crops grown in greenhouses. Insect survey of animal pests provide the growers full picture of plant damage risk. Crop losses due to pests and diseases are a major threat to incomes of rural families.

Although, Cerda *et al.,* (2017) mention that both primary (26%) and secondary yield losses (38%) caused by foliar pests and diseases can be severe in a perennial crop. At a global scale, yield losses due to pests and diseases ranging from 20% to 40% were quantified in rice, wheat, barley, maize, potatoes, soybeans, cotton, and

coffee in different countries and regions (Oerke 2006 and Oerke *et al.,* 1994). The yield losses in the world about 400 billion $ yearly (Abde-Emageed 2014).

Annotated lists of insects associated with cucumber plants are recorded, which include both phytophagous and beneficial species. Additional notes are given to the most important pests. Greenhouses is one of the protected cultivation system used to produce cash crops, such as vegetables and flowers. Certain plastic covers protect plants from adverse weather condition and increase resistance to pest attack (Amna *et al.,* 2012). Leafminer is larvae live in tunnel between the upper and lower surfaces of leaves, making unsightly white blotches or twisting lines. Different species produce different types of mines that may vary according to the host plant. The mines and punctures interfere with photosynthesis which will reduce crop yields. Punctured and mined tissue are susceptible to diseases, such as bacterial leaf spot on chrysanthemum (Susan *et al*., 2001). Aphids are the most injurious and serious pests attack different crops in Egypt and the Globe, (Ibrahim, 1994). Aphis *Craccivora* Koch., is considered one of the most injurious pests infests cucumber plantations and other leguminous species in Egypt (El-Heneidy *et al*., 1998; El-Defrawi *et al*., 2000, and Abdel-Rahman *et al*., 2005). Abou-Taka and Zohdy (1990) recorded that the spider mites in Egypt are one of the most serious pests damage vegetable plants, Susan *et al.,* (2001) stated that the two-spotted spider mite is the most important mite species infesting floral crop, it feeds on the underside of leaves, removing leaf cell contents. Two-Spotted Spider Mites (TSM); *Tetranychus urticae* causes severe to damage plants by piercing and sucking the contents of cells, which results in speckling on leaves as the cells turn yellow and die. Although most of mites found on the backsides of leaves, the damage will be visible on both leaf surfaces; when damage increases, the whole leaf may turn yellow. The carmine strain of TSM, causes serious damage to tomato. Yield losses start to occur on tomato and cucumbers cultivated in greenhouse, about 30% of the leaf surface area is damaged. Although infestation rates, two-spotted spider mites can suppress flower and leaf development, ultimately affect the quality and quantity of berries produced (Sances *et al.,* 1982).

Chemicals control is considered as a major method to reduce pest infestations. It is consider a conventional control method, however, this method affects the human health, causes hazard diseases to human and has side effects on other non-targeted organisms live in surrounded the environment. Currently, the world trend to produce safe food on the sustainable agricultural. The use of insecticides to control aphids generally, leads to several problems, such as increasing resistant of aphids, due to substances excessive use, induction of pollution to human and beneficial

insects such honey bees, insect parasitoids and predators (Maghraby, 2012). In Egypt, the cost of chemicals about 890 million L.E, yearly (Abde-Emageed, 2014).

The non-conventional methods in this study means using non chemicals to pest control, such as microwave radiation, infrared radiation and ultraviolet radiation. Microwave radiation technology used to control pests of grain and stored products (Wang and Tang, 2001). Fleming *et al.,* (2003) found that microwaves heated woody up to the temperature of 60 ^{0}C within 5 min., instead of 123 min., conventional heating and recommended microwave treatment to eradicate Asian long horned beetles in solid wood packing materials. Subramanyam (2004, 2005) reported mortality from flameless catalytic infrared heaters on adults of the saw toothed grain beetle, rice weevil, red flour beetle, lesser grain borer and merchant grain beetle. UV radiation could be used to disturb the behavior of insects; for example, white flies, thrips, and aphids show a distinct preference for UV radiation (Costa and Robb 1999 and Costa *et al.* 2002). On the other hand, UV radiation, particularly UV-B radiation (280-315 nm), is harmful to organisms. UV-B radiation directly damages DNA and is absorbed by certain coenzymes and pigments in vivo, raising these molecules to an excited state; the excitation energy is eventually transferred to water molecules, yielding reactive oxygen species (ROS). The UV-mediated formation of (ROS) also causes DNA damage (Beehler *et al.* 1992), which can be lethal, particularly to small organisms such as mites. Therefore, UV radiation may have pesticide effects against insect species. Both UV-A at wavelength (λ_{max} = 350 nm) and UV-B at wavelength (λ_{max} = 300 nm) radiation could be used to repel spider mites.

Therefore, the current study presents non-conventional methods; microwave radiation, infrared radiation and ultra-violet radiation to control *Liriomyza trifolii*, *Aphis gossypii* and *Tetranychus urticae* in greenhouse.

MATERIALS AND METHODS

- Experimental location and equipment:

Insects collection was carried out at greenhouses experimental area, Dokki, Giza district, Egypt, during season 2016 for studying three different radiation treatments (Microwave, Infrared and Ultra-violet radiation) at different exposure times 1,2, 3, 6 and 9 min. Population density of pests (leaf miner *Liriomyza trifolii*, Aphis *Aphis gossypii* and spider mite), *Tetranychus urticae* (Koch)) in greenhouse. Cucumber was sown on 17th Feb. 2016. Each agriculture practices were carried out according to recommendation issued by Ministry of Agriculture and Land Reclamation. After three weeks of cultivation, chosen ten randomly leaves at different levels of plants and picked up per treatment, then kept in tightly closed paper bags and transferred to the

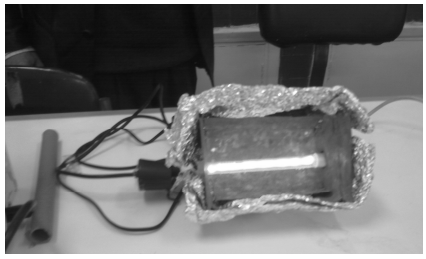
(AEnRI) laboratory at the same day for delaminating the treatments, and to identifying the treatments effect on insect, the samples were examined by stereomicroscope. The total numbers of insects were registered and the mean were calculated number of different pests on cucumber plant. The samples were examined and carried out in the main laboratory at the Agricultural Engineering Research Institute to study the effect of different radiation treatments (Microwave, Infrared and Ultra-violet rays) on insect's samples. After exposing the insect to the radiation, it was examined immediately under stero microscope in order to measure the status of insect.

-Pests were exposed to different radiation generated from the following tools:

1- Modified Microwave oven (KMW20-MWNNN-01, 230-240V, 1000 W, 2450 MHz, China) was used at three exposure times 1, 2 and 3 minutes. The modified microwave oven used without base to suit the experiments.

2- Infrared Lamp (1.2 -1.4 µm, 230V, 250 W, Poland) for three exposure times 1, 2 and 3 minutes, the lamps was set at 20 cm height from the samples.

3- Ultra Violet Lamp (SNXIN, 15W, China). The lamp was installed in a metal frame at 5 cm height from samples.



- **Measurements:**

1- Infrared thermometer with laser pointer (Model 42525A, virsion4, made in Taiwan, range -20 to 400^{0}C, accuracy ± 3% of reading or ± 3 ^{0}C) used to measure the temperatures.

RESULTS AND DESCUSSION

The study focused on three insects; leaf miner *Liriomyza trifolii*, Aphis *Aphis gossypii* and spider mite, *Tetranychus urticae* causing damages on crops grown in greenhouse. Insects were exposed to the three different radiation treatments at different exposure times listed on tables to study the behavior of each insect before and after exposure to radiation, accordingly, calculate mortality percentage.

1- Leaf miner; *Liriomyza trifolii*

The results found in Table (1) the mortality percentage of *L. trifolii* insect was 100% when insects exposed to microwave radiation and infrared radiation at 1, 2 and 3 min. The temperature of the samples, when microwave radiation used, were increased as an average from 40.2, 52.9 and 68.0 ° C, respectively under the exposure time were 1 to 2 to 3 minute, respectively, meanwhile infrared radiation temperatures were increased form 39.0 , 57.0 and 60.0 ° C, respectively, under the exposure time 1, 2 and 3 minute, respectively. So, using microwave and infrared radiation for 1 min. were effective. The mortality percentage was 100%. With this respect, it is found that an increasing the exposure time under microwave treatment to 3 min. or increasing the infrared radiation to 2 min. caused leave's shrinkage. Where, the increasing of exposure time made dry leaves. So, using ultra violet radiation has no effect on the pests at 1, 2 and 3 min., but, when Ultra violet radiation time exposure was increased to 6 and 9 min. it was observed that, the insect behavior became hyper active.

Table 1. Effect of different radiations on *L. trifolii* at different exposure times.

Exposure time, min. / Treatments	Radiation type								
	Microwave			Infra-red			Ultra violet		
	1	2	3*	1	2*	3**	1	2	3
Temperature, ° C.	40.5	50.7	70.0	39.0	48.6	58.0	31.0	31.0	33.0
	40.0	52.9	68.0	50.0	57.0	60.0	31.0	31.0	33.0
	40.2	55.0	65.0	44.0	57.5	59.0	31.0	31.0	33.0
No. of exposed pest	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
No. of survived pest	0	0	0	0	0	0	1	1	1
	0	0	0	0	0	0	1	1	1
	0	0	0	0	0	0	1	1	1
Mortality percentage	100	100	100	100	100	100	0	0	0
	100	100	100	100	100	100	0	0	0
	100	100	100	100	100	100	0	0	0
Pest status	Dead	Dead	Dead	Dead	Dead	Dead	No effect	No effect	No effect

* Leave's Shrinkage

** Dry Leaves

2- Aphis; *Aphis gossypii* :

The data presented in Table (2), indicate that, microwave radiation of exposure time of 3 min., the mortality percentage of *A. gossypii* was 100%, but using infrared radiation less than 2 min. was not effective. Meanwhile, using infrared radiation under 1 min. exposure time, resulted in slow movement of a *A. gossypii*. Increasing the exposure time to 2 min. for the infrared radiation result, leave's shrinkage. Using ultraviolet radiation made hyper active only, at 3, 6 and 9 min. exposure time, but mortality percentage was zero.

Mortality percentage increases when increasing the exposure time using microwave and infrared radiation. But ultraviolet radiation has no effect on the mortality percentage. It is clear that ultraviolet radiation conducted the lowest level of temperature (37^0C) compared to both temperature after treatment of microwave radiation (ranged from 40.4 to 84^0C) and infrared radiation (ranged from 47 to 65^0C).

Table 2. Effect of different radiations on *A. gossypii* at different exposure times.

Exposure time, min. / Treatments	Radiation type								
	Microwave			Infra-red			Ultra violet		
	1	2	3*	1	2*	3*	3	6	9
Temperature, ° C.	40.6 40.4 42.0	50.7 60.9 81.0	77 68 84	47 53 54	51.9 59 59	59 65 61	37 37 37	37 37 37	37 37 37
No. of exposed pest	17 9 7	16 6 5	15 15 4	20 5 9	18 9 8	13 11 7	5 15 10	4 19 4	9 13 17
No. of survived pest	16 5 4	15 1 3	0 0 0	8 0 0	0 0 0	0 0 0	5 15 10	4 19 4	9 13 17
Mortality percentage	5.9 44.4 42.9	6.25 83.3 40	100 100 100	60 100 100	100 100 100	100 100 100	0 0 0	0 0 0	0 0 0
Pest status	Dead	Dead	Dead	De- active movement + Dead	Dead	Dead	Hyper active	Hyper active	Hyper active

* Leave's Shrinkage

3- Spider mite, *Tetranychus urticae*

Table (3) showed that, the different behavior of *T. urticae*, the effective method to control insect was using infrared radiation under 2 and 3min. exposure time, but under 1 min. showed insect slow movement and death. Microwave radiation was effective at exposure time 3 min. Ultraviolet has no effect at all for exposure time 3 min. Therefore, increasing the exposure time to 6 and 9 min. caused insect de-active movement or hyper activation.

Table 3. Effect of different radiations on *T. urticae* at different exposure times.

Exposure time, min. / Treatments	Radiation type								
	Microwave			Infra-red			Ultra violet		
	1	2	3*	1	2**	3**	3	6	9
Temperature, ° C.	40.6 40.4 42.0	50.7 60.9 81.0	77 68 84	37 53 54	51.9 59 59	59 65 61	37 37 37	37 37 37	37 37 37
No. of exposed pest	22 17 10	15 6 21	11 20 18	8 10 8	20 12 7	12 24 13	13 20 8	6 8 14	6 10 19
No. of survived pest	22 17 10	14 5 19	0 17 0	8 0 0	0 0 0	0 0 0	13 20 8	6 8 14	6 10 19
Mortality percentage	0 0 0	6.7 16.7 9.5	100 15 100	0 100 100	100 100 100	100 100 100	0 0 0	0 0 0	0 0 0
Pest status	Hyper active	Hyper active	Dead+ Hyper active	De- active movement + Dead	Dead	Dead	lo effect	De- active movement	About 50% Hyper active +50% de-active

* Leave's Shrinkage

** Dry Leaves

CONCLUSION

The conventional method to control insects is chemical, but non-conventional methods under current research investigation. Three types of radiations were used. Expose Leaf miner *Liriomyza trifolii* one minute of microwave radiation or infrared radiation the insect mortality percentage was 100%, meanwhile, *Aphis gossypii* exposed to microwave radiation at 3 minutes or infrared radiation for 1 minute, mortality percentage was 100%. The spider mite *Tetranychus urticae* exposed to microwave radiation at 3 minutes, mortality percentage was 100%, but expose insect to infrared radiation at 1 minute, the mortality percentage was 100%. All three pests were exposed to ultra violet radiation at exposure time 1, 2, 3, 6 and 9 minutes has no effect on insect mortality at all, but it is observed that, some pest's behavior has changed to de-active movement. Meanwhile, some insect's behavior has changed to hyper active movement.

RECOMENDATION

The paper recommended to use infrared radiation to some control pests (*Liriomyza trifolii*, *Aphis gossypii* and *Tetranychus urticae*). It has high effect of insect mortality 100% of pests at short time 2 min. exposure time using lamps 230V, 250 W at 20 cm height from the infected plant. Future studies should be carried out to study the effect of using waves on insect system physiological, also, the waves effect on the leaves of plant. Ultraviolet waves should be studed.

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" تأثير طرق المكافحه غير التقليديه على حشرات صانعه الانفاق والمن والعنكبوت الأحمر"

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تعد مكافحه الافات من أهم العمليات الزراعيه. واستخدام الكيماويات طريقة شائعة للمكافحه على الرغم من أنها لا تعتبر وسيله مثلى للمكافحه. ويهدف هذا البحث الى استخدام طرق غير تقليديه لمكافحه بعض اصابات الافات الرئيسية مثل (صانعه الانفاق ، المن ، العنكبوت الأحمر) التى تصيب المحاصيل المزروعه بالبيوت المحميه . والطرق غير التقليديه التى استخدمت هى ثلاثه انواع من الموجات الاشعاعيه (أشعه الميكروويف ، الأشعه تحت الحمراء ، ألأشعه فوق البنفسجيه) حيث تم تعريض الافات لفترات تعرض مختلفه (١، ٢، ٣ دقيقة) وبالنسبه للأشعه فوق البنفسجيه تم التعريض لمده (١، ٢، ٣، ٦، ٩ دقيقة). وقد تم اجراء التجارب المعمليه بالمعمل المركزى لأجهزه القياس – معهد بحوث الهندسه الزراعية التابع لمركز البحوث الزراعيه – وزارة الزراعه واستصلاح الأراضى. وأوضحت النتائج المتحصل عليها انه تم الحصول على نسبه قتل ١٠٠% باستخدام أشعه الميكروويف والأشعه تحت الحمراء عند التعرض لمده دقيقة بالنسبه لصانعه الأنفاق أما بالنسبه للمن تم الحصول على نسبه قتل ١٠٠% باستخدام أشعه الميكروويف عند التعرض لمده ٣ دقيقه ، الأشعه تحت الحمراء عند التعرض لمده ١ دقيقه، أما بخصوص الأكاروس تم الحصول على نسبه قتل ١٠٠% باستخدام أشعه الميكروويف لمده ٣ دقيقه ، الأشعه تحت الحمراء لمده ١ دقيقه. اما باستخدام ألأشعه فوق البنفسجيه لم يتم الحصول على أى نسبه قتل فوريه عند تعريض الافات للأشعه ولكن تم ملاحظه أن الافات التى تم تعريضها لهذه الأشعة أدى الى أن تكون بطيئه الحركه أو تزداد سرعتها بشكل ملحوظ وخاصه العنكبوت الأحمر.