Available online freely at www.isisn.org

Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network

RESEARCH ARTICLE BIOSCIENCE RESEARCH, 2017 14(2): 354-361. **OPEN ACCESS**

Evaluate and assess the use of some insecticides of plant origin against *Scritothrips citri* Moulton (*Thysanoptera, Thripidae*) in reducting distortions orange fruits for export

Salem S. A., A.M.E. Abd-El Salam, Ahmed S. Reda, Abdel-Raheem M. A.* and EL-Hawary F. M.

Pests & Plant Protection Department, National Research Centre, 33rd El Bohouth St, (Postal code: 12622) Dokki, Giza**, Egypt**.

***Correspondence: abdelraheem_nrc@yahoo.com** **Accepted:** 29 May 2017 **Published online:** 04 July 2017

Citrus thrips, *Scritothrips citri* moulton is an important pest of citrus in Egypt in last two decades. To propose an alternative to chemical control, the toxicity or repellency of 4 plant extracts was evaluated against nymphs and adults thrips in the orchards. The feeding of citrus thrips on young and mature fruit causes scarring marking and rind bleaching, respectively. These blemishes reduce fruit quality, thereby reducing the pack out of export quality fruit and rendering some fruit unsalable. The results showed highly significant differences in repellency among extract types, concentrations and their interactions. The level of its efficacy was classified into two categories as strong, and weak based on hierarchical ascendant classification. The authors identified neem Azal-TS and rosemary as good repellents, while the others were classified as moderate. Repellency of extracts increased with the increase of application numbers, for example, five times spraying more effect than one or two times applications. The important damage to fruits is the increase of the damaging percentage fruits and decrease fruit qualities. The reduction in yield for export in control reached to 1584 kg. /fed. (2015 season) and 1392 kg. /fed. (2016 season). The use of botanical extracts could be useful in developing integrated pest management strategies for thrips on orange crops. This work aim to decrease the damaged of fruit weights to minimize weight, for these reason, the treatments were carried out. The average weight yield per feddan was about 12 tons (the weight of 5 fruits was one kg and 12 tons = 60000 fruits).

Keywords: *Scritothrips citri* moulton; botanical extracts; damage young & mature citrus fruits; control; export; Egypt.

INTRODUCTION

Plant protection plays an important role in addition to good quality production. In spite of development of various modern synthetic insecticides, heavy losses of yield are recorded by the attack of pests. Excessive and indiscriminate use of chemical insecticides has unlimited hazards for human beings and every naturally growing population (Iqbal, et al. 2007).Citrus thrips is of greatest economic importance on Egypt, which attack navel orange, desert citrus. On fruits, the citrus thrips punctures epidermal cells, leaving scabby, greyish or silvery scars on the rind. Thrips damage is higher on fruit located on the outside canopy where fruit is also susceptible to wind damage and sunburn. Thrips has a history of rapidly developing resistance to chemicals that are used repeatedly and frequently for its control. Fortunately, citrus thrips resistance problems are often localized. Citrus thrips has reduced the pack out of export -quality oranges. Lemons and render some fruit unsalable. First

and second larvae feed actively on tender leaves and small fruits, especially under the sepals of small fruits. The other two instars are pupation stages and do not feed, but complete development on the ground in litter beneath the tree or in the crevices of the tree. Fruit damage is caused primarily by the feeding of larval stage of citrus thrips, which caused scarring marking and rind bleaching (Baker et al. 2000).The significant period for damage to occur is the six weeks following petal fall. Adult citrus thrips are small, orange-yellow insects with fringed wings. During spring and summer , females lay about 20 eggs in new leaf tissue, young fruit of green twigs; in fall, overwintering eggs are laid mostly in the last growth flush of the season. Overwintered eggs hatch in March about the time of the new spring growth. First instars nymphs are very small. They feed actively on tender leaves and fruit especially under the sepals of young fruits. The nymphs complete development on the ground or in the crevices of trees. The control of citrus thrips has been restricted to the use of foliar organophosphate insecticides, and these sprays disrupt the biological control of other citrus pests. Monitoring citrus for the target pest begins at the initiation of bloom, but becomes critical at petal fall (90% blossom drop) in late-March to early April. Treatment of young, non-bearing trees in a grove is not recommended except in severe cases. Making control of thrips on fruit more difficult in later years. Nowadays the ground cover plants were identified as a potential source of natural enemies of arthropod pests citrus (Liang and Huang, 1994). A number of natural enemies attack citrus thrips on citrus. The botanical extracts are relatively nontoxic to beneficial insects and mites. Chemical insecticides (Dimethoate) were used when the damage approaches to maximum damage. Before the development of synthetic insecticides, materials derived from plants provided means for crop protection. Plant species have the ability to synthesize a variety of secondary metabolites that are not essential for their growth and development (Rosenthal and Berenbaum, 1991), but are important in the protection against predators and microbial pathogens and interaction of plants with other organisms (Schafer and Wink, 2009).Insecticides of plant origin have certain advantages, they do not persist in the environment, they present a relatively low risk to other organisms and they are nontoxic to mammals (Weinzierl, 2000; Scott, et al.2003). In the recent years, there are about or more than 200 plants in the entire world used as botanical insecticides (Pavela, 2009). On the other hand, many authors studied the feasibility of using the plant extracts for controlling different insects belonging to different orders (Salem, et al. 2014; 2016& 2017; Abd El-salam, et al. 2013; Ismail, et al. 2014, 2016[a& b]). The objective of the present study was to evaluate and assess the efficacy of some plant extracts for the control of citrus thrips in citrus orchards.

MATERIALS AND METHODS

From March 1st to end of September 2015 &2016, treatments were carried out in Menofyia, Governorate, Quesnis province. The region cultivated with different crops (wheat; maize &vegetables). Between this area , there is a big zone or orchard which was chosen as experimental area to apply the treatments cultivated with *Citrus sinensis* var. navel orange . The yard has very good climatic conditions for growing citrus trees. The chosen orchard has a high degree of isolation from other orchards and not received any chemical insecticides or fungicides applied or pruning processes two years before treatments. The chosen farm is surrounded by a fence of casuarina trees (*Casuarina equisetifolia;* Fam. casuarinaceae) (6 m. high). Flowering beginsin mid-March to mid- April in both two experimental seasons and it can be change within few days according to the environmental conditions. The tested botanical extracts used are: garlic oil (*Allium sativum)* at 5ml/L.; mint oil (*Mentha* species) at 5ml/L.; rosemary oil (*Rosmalinus officinalis* L.) at 5ml/L. and NeemAzal-TS (*Melia azadirachta*) at rate of 0.5%. The ground motor with capacity of 100 lit. was used . In September 2015, the experimental area was inspected once to determine the % of thrips infestation, which found a high level. The treatment zone was about 5feddans, 20 years old. For the experimental design one feddan only was chosen to carry out the applications. The number of trees per feddan is about 165 trees. The experimental area was divided into 5 plots each one contain 30 trees, the sixth plot was left as check control. Each plot contain 30 trees represent 5 replicates each replicate contain 6 trees.

Experimental design:

Monitoring fruit for citrus thrips: Select trees that are three to four rows in from the outside edge of the size plot. Samples 20 young fruit from each corner of the plot for a total of 50 fruit. Take

only two healthy dark green fruit from outside, sunny branches of each tree. Look for thrips on the stem end of the fruit under the calyx. Count fruit as infested only if it has one or more wingless first or second instars larvae. Recount the total fruit infested with immature citrus thrips and calculate the % of infested fruits. For each material used the plot trees (30 trees) divided to 5 units each unit received the application spraying as follow:

Unit no. one: Received five sprays (22/3; 29/3; 5/4; 12/4 & 19/4/2015 and 29/3; 5/4; 12/4; 19/4 & 26/4/2016), the treatments begins after one week from the bloom time(the bloom time recorded was in 15/3/2015 & 22/3/2016.

Unit no. two: Received four sprays (29/3 - 5/4/ - 12/4 - 19/4/2015 & 3/4 - 10/4/- 17/4 - 24/4/2016), and then left without treatments to the end of season.

Unit no. three: Received three sprays (5/4 - 12/4 - 19/4/2015 & 10/4 - 17/4/ 24/4/2016), and then left without spray applications to the end of season.

Unit no. four: Received two sprays (12/4 - 19/4/2015 & 17/4 - 24/4/2016), then left without treatments to the end of season.

Unit no. five: Received one spray (19/4/2015 & 24/4/2016).

Between each two units, one rowwas left without treatments. One week before harvest, the number of fruits in 100 kg. were counted and recorded (about 500 fruits approximately). Yield (tons/feddan) was calculated by determine the, (total weight of orange fruits per plot were determined) and then converted to tons/feddan. The average weight fruits produced from one feddan was about 12 tons about 60000 fruits.

Statistical analysis:

The experiment was arranged as Randomized Complete Block Design with five replications. Data were analyzed using the MSTAT statistical software (MSTAT Inc., USA), with comparison of means using Duncan's separation test. In order to study the simultaneous effect of the four extracts on damaged yield, the partial regression formula termed the C-multipliers was adopted

RESULTS

First of all, the repellency of extracts increased as the number of applications. The average of survival nymphs ranged between 3.2 to 5.0 **;** 3.0 to 4.9 ; 3.7 to 5.4 and 4.4 to 5.5 nymphs in plots treated with neem Azal-TS ; rosemary ; garlic oil and mint oil extracts, respectively at season 2015 (Table 1). While the results recorded at season 2016 (Table 2) showed the same trend, the alive nymphs ranged between, 4.0 to 5.1 (neem Azal-TS); 3.7 to 4.7 (rosemary); 3.6 to 5.1 (garlic oil) and 3.3 to 5.3 (mint oil), respectively. In general, the repellency of extracts were significantly differs with control results. The using of tested materials one or two applications not significant recorded between it and control (Tables 1&2). Based on the Hierarchical Ascendant Classification analysis of repellency effects, the different plant extracts were categorized into 2 classes: good and moderate. Mint oil extract showed the lowest effect between all the botanical extracts used compared with the untreated control. Although, all treatments were significantly reduced the survival nymphs, there were some insignificant differences recorded between them. Concerning the effect of used materials, data observed and recorded in (Table 3) revealed that the percentage of infested young fruits (19/4/2015 & 26/4/2016) after one week from the last sprays was differs in all plots . In the first season 2015, all treatment were significantly reduced damaged fruits compared to control. Trees treated with neem Azal-TS extracts were recorded the lowest percentage of *Scritothrips citri* infested young fruits (5.3%) followed by rosemary extracts (6.0%) compared to untreated control (11.3%). However, the effect of garlic oil extracts on infested young fruits was significantly differed compared with control (Table 3). In 2016 season, (Table 3), the data recorded showed that the results were similar to the data obtained in 2015 season. Neem Azal-TS represent the first one with high effect on the percentage of infested young fruits, which recorded 4.7% (P0.019) followed by rosemary extracts data (5%), the data of two obvious extracts significantly differ with control (10.3%). On the other hand, the garlic and mint extracts gave not highly but moderate significant compared with control.Table (4), showed the effect of *Scritothrips citri* Moulton populations on yield quality. One day before harvest (October month), the effect of the target pest on young fruits damage were carried out. In the first season (2015), all treatments were affected significantly on the total yield quality compared to the untreated control. The neem Azal-TS and rosemary extracts were the best materials for reduction the population of target pest. Which decreasing the percentage of damage fruits,

Table (1): Efficacy of some plant extracts against citrus thrips in season 2015.

Treatment	Plot No.	No of sprays	Mean No. of nymphs stages (1st&2nd) /6 young fruits						Average ± SE	Total Avg.
			Spray dates							
			15/3	22/3	29/3	5/4	12/4	19/4		
Neem-Azal-TS	1	5	4.8±0.4	4.0±0.3	3.3±0.2	3.0±0.1	2.3±0.3	2.0±0.4	3.2±0.3	4.1
	2	4	5.5±0.2	5.7±o.4	5.5±0.3	2.9±0.4	2.1±0.1	2.3±0.3	4.0±0.5	
	3	3	5.4±0.1	6.1±0.4	5.0±0.2	3.8±0.1	2.1±0.3	2.4±0.2	4.1±0.3	
	4	2	5.2±0.2	5.2±0.4	5.5±0.3	3.4±0.1	2.6±0.4	3.1±0.2	4.2±0.4	
	5	1	5.3±0.2	5.5±0.3	5.6±0.4	5.0±0.3	4.5±0.2	4.0±0.4	5.0±0.5	
Rosemary	1	5	5.2±0.2	5.4±0.3	3.2±0.2	3.0±0.1	2.1±0.2	1.0±0.2	3.3±0.4	4.9
	2	4	5.7±0.4	5.8±0.2	5.0±0.3	4.3±0.2	3.1±0.1	2.0±0.3	4.3±0.4	
	3	3	4.8±0.1	4.0±0.3	5.3±0.3	3.2±0.2	3.0±0.2	2.1±0.1	3.7±0.5	
	4	2	5.0±0.3	5.2±0.1	5.7±0.2	5.9±0.2	3.7±0.3	2.9±0.1	4.7±0.5	
	5	1	4.7±0.1	5.7±0.3	5.6±0.1	4.8±0.2	4.9±0.3	3.5±0.1	4.9±0.4	
Garlic oil	1	5	4.4±0.2	5.6±0.4	4.3±0.2	4.4±0.1	4.4±0.1	4.0±0.2	4.5±0.3	4.6
	2	4	3.9±0.1	4.6±0.3	4.0±0.1	3.4±0.4	3.5±0.2	3.0±0.1	3.7±0.3	
	3	3	4.6±0.3	4.7±0.4	4.9±0.1	4.4±0.4	4.0±0.1	3.7±0.2	4.4±0.5	
	4	2	5.1±0.1	5.5±0.3	5.6±0.2	5.9±0.3	5.8±0.1	4.3±0.3	5.4±0.5	
	5	1	4.4±0.1	4.7±0.4	5.8±0.2	5.8±0.4	5.7±0.2	4.6±0.4	5.2±0.6	
Mint oil	1	5	5.2±0.1	5.5±0.3	5.0±0.2	4.4±0.3	4.0±0.2	3.2±0.4	4.6±0.5	4.9
	2	4	4.4±0.4	5.1±0.3	5.0±0.3	4.3±0.1	4.0±0.3	3.6±0.2	4.4±0.5	
	3	3	5.2±0.1	5.2±0.4	6.1±0.2	5.7±0.3	4.6±0.3	4.0±0.1	5.1±0.4	
	4	2	4.8±0.1	5.0±0.2	5.3±0.3	5.9±0.3	5.2±0.1	4.1±0.2	5.1±0.5	
	5	1	5.6±0.4	5.5±0.3	5.7±0.1	5.9±0.4	6.1±0.2	4.2±0.3	5.5±0.4	
Control			5.0±0.1	5.6±0.4	5.9±0.5	6.2±0.4	6.7±0.5	7.1±0.3	6.1±0.4	6.0

Table (2): Efficacy of some plant extracts against citrus thrips in season 2016.

Treatment	Plot No.	No. of sprays	Mean No. of nymphs stages (1st&2nd) /6 young fruits						Average ±SE	Total Avg.
			Spray dates							
			22/3	29/3	5/4	12/4	19/4	26/4		
Neem-Azal-TS	1	5	4.8±0.1	5.0±0.3	4.3±0.4	4.0±0.1	4.0±0.3	3.3±0.1	4.3±0.5	4.2
	2	4	4.2±0.2	5.1±0.4	5.0±0.2	4.6±0.1	4.0±0.4	3.3±0.2	4.0±0.4	
	3	3	5.1±0.3	5.4±0.1	5.9±0.3	5.0±0.2	4.7±0.3	3.7±0.1	5.1±0.5	
	4	2	5.0±0.2	5.2±0.3	5.5±0.3	5.6±0.4	5.0±0.1	4.2±0.3	5.1±0.4	
	5	1	4.4±0.1	4.5±0.4	4.8±0.3	5.4±0.3	5.6±0.3	4.3±0.1	4.8±0.5	
Rosemary	1	5	4.5±0.4	4.0±0.2	4.0±0.2	3.7±0.1	3.6±0.2	3.0±0.3	3.8±0.4	4.3
	2	4	4.3±0.1	4.4±0.3	4.0±0.4	3.8±0.2	3.0±0.3	2.4±0.4	3.7±0.5	
	3	3	4.8±0.3	5.1±0.2	5.5±0.4	5.0±0.2	4.3±0.3	3.4±0.2	4.7±0.3	
	4	2	4.0±0.4	5.2±0.3	5.6±0.3	5.8±0.3	4.4±0.3	3.1±0.2	4.7±0.5	
	5	1	4.3±0.1	4.4±0.3	4.9±0.2	5.2±0.2	5.5±0.4	4.1±0.5	4.7±0.6	
Garlic oil	1	5	4.7±0.2	4.8±0.3	3.4±0.4	3.0±0.2	3.0±0.1	2.6±0.1	3.6±0.3	4.5
	2	4	4.9±0.1	5.1±0.3	5.0±0.1	4.8±0.2	4.3±0.3	4.0±0.1	4.7±0.5	
	3	3	5.1±0.2	5.2±0.3	5.4±0.4	5.0±0.3	4.7±0.1	3.2±0.3	4.8±0.5	
	4	2	4.4±0.2	4.8±0.3	4.9±0.2	5.1±0.3	4.6±0.4	3.4±0.1	4.5±0.4	
	5	1	4.6±0.4	4.9±0.2	5.2±0.2	5.7±0.4	5.9±0.1	4.3±0.4	5.1±0.5	
Mint oil	1	5	4.8±0.1	4.7±0.4	3.4±0.3	3.0±0.2	1.9±0.1	2.1±0.4	3.3±0.5	4.8
	2	4	4.4±0.3	4.5±0.2	3.7±0.4	3.8±0.1	2.9±0.2	2.0±0.1	3.6±0.3	
	3	3	4.7±0.3	4.8±0.1	5.0±0.1	5.1±0.1	4.4±0.3	2.7±0.2	4.5±0.5	
	4	2	4.9±0.3	5.0±0.4	5.0±0.1	5.7±0.4	5.6±0.2	5.4±0.3	5.3±0.5	
	5	1	4.0±0.1	4.3±0.4	4.6±0.2	5.8±0.3	5.9±0.4	4.9±0.2	4.9±0.5	
Control			4.2±0.2	4.7±0.2	5.0±0.3	5.4±0.1	6.2±0.3	6.3±0.4	5.3±0.1	

Table (3): Effect of different plant extracts on percentage of infested young fruits, 2015 & 2016.

Treatment	Total number of inspected young fruits "60" (5 replicates)			
	2015		2016	
	Number of infested fruits ±SE.	% infested young fruits	Number of infested fruits ±SE.	% infested young fruits
Neem Azal-TS	3.2± 0.04	6.4	4.9± 0.04	9.8
Garlic oil	7.0±0.05	14.0	7.3±0.03	14.6
Mint oil	8.0± o.o3	16.0	7.7± 0.05	15.4
Rosemary	5.0±0.05	10.0	5.1±0.02	10.2
Control	10.1±0.04	20.2	10.0±0.05	21.0

Means followed by a common letter are not significantly different at 5.0 % level.

Table (4): Relationship between efficacy of four botanical extracts and *S. citri* population on orange yield quantity and quality in two successive seasons 2015/2016 at harvest time

Tested materials	Total No. inspected mature fruits (100/5 replicates) (500 fruits)									
	2015				Fold of increase in damage yield (quality)	2016				
	Number and % of damaged fruits /500 fruits in treated plots / one feddan			Weight losses/ feddan (Kg.)		Number and % of damaged fruits /500 fruits in treated plots /one feddan			Weight losses/feddan (Kg.)	Fold of increase in damage yield (quality)
	Treated plots	% damaged	One feddan			Treated plots	% damage	One feddan		
Neem Azal-TS	33	6.6	3960	792	50.0	30.0	6.0	3600	720	51.7
Rosemary	36	7.2	4320	864	54.5	34.0	6.8	4080	816	58.6
Garlic oil	45	9.0	5400	1080	68.2	39.0	7.8	4680	936	67.2
Mint oil	48	9.6	5760	1152	72.7	42.0	8.4	5040	1008	72.4
Control	66	13.2	7920	1584	-----	58.0	11.6	6960	1392	------

followed by garlic and mint extracts. At the time of harvest, the differentiation between control and tested materials for its effect on yield quality showed highly significant effect. Neem Azal-TS and rosemary extracts have a highest effect on the damaged fruits quantity (neem, 6.6% & rosemary, 7.2%). In second season 2016, Table (4), showed that the effect of tested materials on the quality of young fruitsnearly to data 2015, with some differs, may be due to the changing of environmental conditions. The neem and rosemary extracts have the priority (6.0%; 6.8%), compared with control (11.6%) of these thrips, is most common and can be very abundant during bloom, on the, small fruits and flush growth.

DISCUSSION

Plant extracts are known to possess toxic organic position that is effective in reducing insect pest population (Fuglie 1998 and Gaby 2000). Over all, these are very few insect natural enemies of citrus thrips in the canopy of citrus trees in this study. Those that are present are mostly generalist predators that don't appear to be having a large impact on thrips numbers. Many authors have developed way of making their own extracts from different plants. These are low in cost locally available and have proved to be effective for the control of insect pests. Neem Azal-TS is better result followed by rosemary extracts against *Scritothrips citri* Moulton. The scale up studies and required to understand the mechanisms of bio-control extracted from different plants and used against thrips or other insect pests will be helpful in replacing the pesticides harmful to the environment and the human beings. Because this work aim to decrease the damaged of fruit weights to minimize weight, for these reason, the treatments were carried out. The average weight yield per feddan is about 12 tons, the weight of 5 fruits was about one kg, therefore, 12 tons = 60000 fruits. Table (4), showed that the neem extracts gave a good result (6.0 to 6.6% only damaged fruits represent 792.0 kg /feddan. compared with untreated control (11.6 to 13.2% damaged fruits) represent 1584.0 kg/feddan. Table (4) showed that, there is differentiation between the weight losses in treated and control area. The reduction in the yield (damaged fruits) differs by the different between plant extracts species. The population density of nymphs ranged between 4.1 to 4.9 nymphs (2015 season) and between 4.2 to 4.8 nymphs (2016 season), where Chi-square value 11.22 was significant.

CONCLUSION

Finally, cosmetic damage results in the fruit being downgraded for the fresh market. Taste and eating quality of the fruit are not affected. A heavy infestation can result in early death of leaves and distorted fruits in late season sometimes the crop may be reduced

CONFLICT OF INTEREST

The present study was performed in absence of any conflict of interest.

AUTHOR CONTRIBUTIONS

M. Abdel-Raheem designed and performed the experiments, wrote the manuscript and also Published it, Sadek A. designed and performed the experiments and collection data, A. M. E. designed the experiments and analysis data. Ahmed S. and Fatma reviewed the manuscript. All authors read and approved the final version.

REFERENCES

Abd El-Salam, A.M.E.; Salem, H.A. and Salem, S.A. 2013. Bio-control agents against theleaf miner, *Liriomyza trifolii* in faba bean fields. Archives of Phytopathology and Plant Protection. 46: 1054 - 1060.

Baker, G.; Jackman, D.J.; Keller, M.; MacGregor, A. & Purvis, S. 2002. Development of an Integrated Pest Management system for thrips in Citrus (Adelaide, SARDI).

Fuglie, S.L. 1998. Producing Food without Pesticides Local Solution to Crops Pest Control in West Africa . Church- World

Service, Dakar, Senegal: 140.

Gaby, S. 2000. Natural Crop Protection in the Tropics.2nd Enlarged and Revised edition .Margraf Verlag Press,:502.

Iqbal, M.F.U.; Maqbool, M.R. Asi and S. Aslam 2007. Determination of pesticide residues in brinjal fruit at supervised trial. J. Anim. Plant Sci., 17: 21-23.

Ismail, I.A.; N.A. Farag; R.S. Abdel-Rahman; M.A. Abdel-Raheem and H.M.Radwan .2014. Insecticidal activity of some plant extracts rich in coumarin against cowpea beetle, *Callosobruchus maculatus* (Fab.) (Coleoptera: Bruchidae). Egyptian Journal of Biological Pest Control, 24: 465-469.

Ismail, I.A. and R.S. Abdel-Rahman and M.A. Abdel-Raheem. 2016[a]. Utilization of certain plant extracts and entomopathogenic fungi for controlling the black fig fly, *Lonchaea aristella* on fig trees. International Journal of Chem Tech Research, 9:3542.

Ismail, I.A.; R.S. Abdel-Rahman and M.A. Abdel-Raheem .2016 [b]. Economical evaluation of different methods for controlling fig longihorne beetle, *Hesperophanesgriseus* (Coleoptera: Cerambycidae) on fig trees. International Journal of ChemTech Research, 9:122-125.

liang, W. & M. Huang, 1994. Influence of citrus ground cover plants on arthropod communities in China : A review . Agriculture, ecosystems and Environment 50: 29-37.

Pavela, R. 2009. Effectiveness of some botanical insecticides against *Spodoptera littoralis* Boisduvala (Lepidoptera , Noctudiae), *Myzus persicae* Sulzer(Hemiptera, Aphididae) and *Tetranychus urticae* Koch (Acari,Ttranychidae). Plant Protect. Sci., 45: 161-167.

Rosenthal, G.A. and Berenbaum, M.R. 1991. Herbivores; Their interaction with secondary, Vol. II. Ecological and evolutionary processes, 2 nd edition Academic press, San Diego.

Salem, S.A.; Ahmed S. Reda and Abd El-Salam, A.N.E. 2014.lab-field evaluation of some neem productions and chemical insecticides against red palm weevil, *Rhynchophorusferrigineus* Oliv. (Coleoptera, Curculionidae). Canadian Journal of Plant Protection,2 : 60- 63 .

Salem, S.A. ; AbdEl-Salam, A.M.E.; Abdel-Raheem, M.A.; Farage, N.A. and El-Hawary, F.M. 2016.Field studies to assess the efficiency of bio-extracts against the scourge of onion crops, *Thrips tabaci* Lindeman in Egypt. Der Pharma Chemica, 8:74-77.

Salem, S. A.; Abd El-Salam, A.M.E.; Abdel-Raheem, M. A.; Farag, N. A. and El Hawary, F.M. 2017. Some promising plant species for the use as biological control agents against land snails populations. Der Pharma Chemica, 9:57-60.

Schafer, H. and Wink, M. 2009. Medicinally important secondary metabolites in recombinant microorganisms or plant progress in alkaloid biosynthesis. Biotechnology Journal, 4: 1684-1703.

Scott, I.M.; Jensen H.; Scott, J.G.; Isman,M.B.; Arnason, J.T. and Philogene, B.J.R. 2003. Botanical insecticides for controlling agricultural pests. Piperamides and the colorado potato beetle ,*Leptinotarsadecemlineata* Say (Coleoptera, Chrysomelidae). Archives of Insect Biochemistry and Physiology 54: 212 – 225.

Weinzierl,R.A. 2000. Botanical insecticides, soaps and oils. In; Biological and Biotechnological control of insect pests (IE. Rechcigl, NA Rechcigl, eds) Lewis publisher, Boca Baton, New York, USA, 110 - 130.