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EFFECT OF TWO PLANT EXTRACTS AND FOUR AROMATIC OILS ON *Tuta absoluta* POPULATION AND PRODUCTIVITY OF TOMATO CULTIVAR GOLD STONE

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ABSTRACT

Plants extracts and essential oils were used in pest management in different crops against various pests. Under field conditions, we examined the effect of two plant extracts and four essential aromatic oils on the response of tomato hybrid cultivar Gold Stone to *Tuta absoluta* infestation. Also, their effects on some growth characteristics of tomato plants as well as their total phenolic compounds and total flavonoids contents were explored in the two successive summer seasons of 2011 and 2012. The treatments were Lemon grass extract (*Cymbopogon citratus*) at 25 gm /L., Garlic extract (*Allium sativum*) at 5ml / L., Eucalyptus oil *(Eucalyptus spp.*) at 0.5%, Rue oil *(Ruta graveolens*) at 0.5%, Anise oil (*Ocimum basilicum*) at 0.5%, Basil oil *(Pimpinella anisum*) at 0.5%. Ethyl acetate (Solvent) and tap water (Control). The plants were sprayed three times at two week intervals starting after 40 days from transplanting. All treatments reduced population density of *Tuta absoluta* significantly. The highest reduction was recorded by garlic extract followed by lemon grass extract and basil oil. Lemon grass extract significantly increased L-ascorbic acid (Vitamin C) contents in tomato fruits followed by basil oil. Also, garlic extract increased the yield of tomato significantly followed by eucalyptus oil in the first season while in the second season, anise oil followed by garlic extract were insignificantly increased the fruit yield than the other tested treatments. On the other hand, garlic extract recorded the highest values of total phenolic compounds (TPCs) and total flavonoids (TFs) in unifested and infested – treated tomato leaves.

Keywords: Lemon grass extract (*Cymbopogon citratus*), Garlic extract (*Allium sativum*), Eucalyptus oil *(Eucalyptus spp.*), Rue oil *(Ruta graveolens*), Anise oil (*Ocimum basilicum*), Basil oil *(Pimpinella anisum*), *Tuta absoluta*, Tomato.

INTRODUCTION

Tomato leafminer, *Tuta absoluta* Meyrick (Lepidoptera: Gelechiidae) is an important pest of tomato (Hussein *et al*., 2014). After its initial detection in eastern Spain in 2006, it rapidly invaded various other European countries and spread throughout the Mediterranean basin (Desneux *et al.*, 2010). Currently, Egyptian tomato fields were infested with *Tuta absoluta* since 2009 and it became one of the economic pest of tomato and other Solanaceous plants (NAPPO, 2012). *T. absoluta* larvae can cause yield losses of up to 80 - 100% by attacking tomato leaves, flowers, stems, and especially fruits of tomato crops in both greenhouse and open field tomato (Desneux *et al*., 2010). Synthetic pesticides are currently the most effective means of pest control. However, the

unceasing and indiscriminate uses of these substances have not only caused adverse effects on mammals' health, but have also affected many other non-target organisms (Bughio and Wilkins, 2004). They are also responsible for the development of insecticide-resistance phenomenon (Suinaga *et al*., 1999; Lietti *et al*., 2005). However, extracts and pure compounds isolated from different plants could be used for controlling insect pests. Natural product-based pesticides can sometimes be specific to the target species and have unique modes of action (Duke *et al*., 2003). Plant products have several uses in insect control (Trindade *et al*., 2000; Moreira *et al*., 2004; Farghaly *et al*., 2009; Moreno *et al*., 2011; Salari *et al*., 2012). These products have also been studied for acute toxicity, antifeedant, or repellent, and fumigant effects, as well as inhibiting reproduction of many pest species (Ben *et al*., 2010). Some of tropical plants extracts were used for pest control as *Acmella oleracea* extract which showed high insecticidal activity and could be used to control *Tuta absoluta* (Moreno *et al*., 2011). However, plant extract can be increased capability for activating defense responses of plants. Aqueous leaf extract of neem might be stimulate the plant natural defence response and provided the control of pathogen that its extract led to the changes in plant metabolism and exhibited high level of enzymes and content of phenolic compounds (Guleria and Kumar, 2006). Therefore, neem, pepper and garlic bulb extracts have been reported to be effective against some crop pests species (Ahmed *et al*., 2009). Also, garlic and ginger extracts were much effective against some pests of cowpea (Ben *et al*. 2010). Garlic showed the highest effects on *T. absoluta* second instar larvae while, basil leaves extract exhibited the least effect (Ghanim and Abdel Ghani, 2014). On the other hand, essential aromatic oils were used for control many pests on various crops. Further, while resistance development continues to be an issue for many synthetic pesticides, it is likely that resistance will develop more slowly to essential-oil-based pesticides owing to the complex mixtures of constituents that characterize many of these oils (Koul et al., 2008). Whereas, Gorski and Tomczak (2010) used basil oil, citronella oil, eucalyptus oil, juniper oil and patchouli oil, in the control of foxglove aphid. The strong adverse effects of *J. excelsea*, *J. oxycedrus, F. vulgare, P. anisum, R. officinalis, J. regia and L. nobilis* essential oils were showed on the reproductive performance of cabbage aphids (Işık and Görür, 2009). Other essential oils from various plants such as lemon grass (*Cimbopogon winteriana*), Eulcalyptus globulus, rosemary *(Rosemarinus officinalis*), vetiver (*Vetiveria zizanoides*), clove (*Eugenia caryophyllus*) and thyme (*Thymus vulgaris*) are known for their pest control properties. While peppermint (*Mentha piperita*) repels ants, flies, lice and moths; pennyroyal (*Mentha pulegium*) wards off fleas, ants, lice, mosquitoes, ticks and moths. Spearmint (*Mentha spicata*) and basil (*Ocimum basilicum*) are also effective in warding off flies (Koul and Walia, 2009). Thrips can be significantly reduced when plants sprayed with the combination of essential oils and kaolin especially tea tree oil (Reitz et al.,2008) or with leaf extract mixtures of Neem + Eucalyptus, Neem + lemon grass, Neem + bitter leaf, Neem + tomato, and Eucalyptus + African curry (in that order) than on unsprayed plants (Oparaeke et al.,2005). Eventhough both essential oils of

Eupatorium buniifolium and *Artemisia absinthium* chemically differed, they exhibited insecticidal and antifungal activity not only by direct contact but also by contact with their vapors against the tested organisms,*Trialeurodes vaporariorum* and *Tuta absoluta*, and the fungi *Alternaria spp*. and *Botrytis cinerea* (Umpiérrez, 2012). In this experiment, two plants extracts and four essential aromatic oils were evaluated to identify their impact on the population densities of *Tuta absoluta* tomato pest as well as their effects on the growth and yield of tomato cv. Gold stone.

MATERIALS AND METHODS

Two farm trials of this experiment were grown in two successive summer seasons, in 2011 at the Experimental Farm, Faculty of Agriculture, Minia University, and in 2012 at private farm, Talla village,Minia governorate. In both seasons, Seeds of cultivar Gold stone were planted on 26th April in the nursery trays. The plants were transplanted into the experimental field after 40 days. The experimental plots were 3.5x4 m and contained 24 plots. The distances between the plants were 40 cm and 100 cm between the rows. The plants were sprayed three times at two week intervals. The first spray was after 40 days from transplanting. The studied treatments were:

1- Eucalyptus oil *(Eucalyptus spp.*) at 0.5%.
2-Rue oil *(Ruta graveolens*) at 0.5%.
3-Anise oil (*Ocimum basilicum*) at 0.5%. 4- Basil oil *(Pimpinella anisum*) at 0.5%.
5-Lemon grass extract (*Cymbopogon citratus*) at 25 gm /L.
6-Garlic extract (*Allium sativum*) at 5ml / L.
7-Ethyl acetate which was used as solvent of the essential oil at 0.5cm^3/L.
8-Control plants which were sprayed with the tap water.

Aqueous extract preparation:

1. Garlic extraction: (*Allium sativum*): Garlic extraction was prepared according to the method described by (Brooklyn Botanic Garden, 2000) using the following items: 250 gm. of garlic fresh bulbs were shoped and strained in ginder, then the shoped bulbs were soaked in one liter of distilled water for one hour. The mixture was filtered through Whatman's filter paper NO.1. and was considered as stock solution. Stock solution was stored in brown bottle container and was kept in refrigerator (5C°).A control set was also run in parallel with distilled water.
2. Lemongrass extraction: (*Cymbopogon citratus*). The extraction was prepared according to Stoll (2000) as follow:

Dried leaves of lemongrass were powdered and strained. Fifty grams of powdered dried leaves were soaked in two liters of distilled water for six hours. The mixture was strained and filtered through Whatman's filter paper NO.1. A control set was also run in parallel with distilled water.

In all treatments, Misrol at 0.14 was used as wetting agent. The plants received ammonium nitrate (33%), calcium superphosphate (15.5%) and

potassium sulphate (48%) at the rate of 150, 300 and 100 Kg per feddan. These amount of fertilizers were added at three batches during the growing season. The experiment was arranged as Randomized Complete Block Design with three replications. Neither fungicides nor insecticides were applied. The other cultural practices were followed as recommended for commercial production of tomato (Mohamad and Desouky, 2005).

T. absoluta pest population attacking tomato plants during the period of study was recorded as indicator to the effectiveness of the used treatment. After 7 and 14 days of treatments, three replicates were tested.

A. Field data

T. absoluta infestation: The percentage of reduction was calculated according to Henderson and Tilton formula (1955).

Plant growth, fruit and yield characteristics:

- Dry weight of 250 g. of above ground growth as well as from mature fruits were determined in the second season. The samples were dried for 5 to 6 hours at $70^{O}C$ until constant weight and the fresh/dry ratio of the sample were calculated as follows:
- % of dry weight = (sample dry weight/250)*100

B. Chemical constituents of fruits:

- Total soluble solids TSS was determined by a hand refractometer (Carlizeiss Jena 1 DDR 783255) in a fruit juice obtained by squeezing the flesh after cutting the fruit crosswise.
- L - Ascorbic acid content was determined using 2, 4-Dichlorophenolindophenol blue dye (Cox,H.E. and Pearson D, 1962) and expressed as mg/100g fruit fresh weight.
- pH of tomato fruit juice was measured using pH digital instrument model Hi 98127-HANNA- as described by Dilmacunal et al.(2011).
- Number of locules/Friut. (Number of locules of ten fruits in each plot were used).
- Average fruit weigh: (The fruits/ treatment after each picking were used and their average was estimated).
- Shape index: (The shape index = $\frac{\text{diameter}}{\text{width of fruit}}$).
- Thickness of pericarp: (Thickness of flesh was determined by dermis tool).

-Percentage of Insect-infested Fruit = $\left(\frac{\textbf{Insect-infested fruit}}{\textbf{Total fruits}} 100\right)$

C. Yield (tones/Feddan). (Total weight of fruits per plot were determined and converted to tons/feddan).

- Extraction and determination of total phenolic compounds (TPCs) & total flavonoids (TFs):

TPCs were extracted from tomato leaves by MeOH-HCl and determined by method of Taga *et al*. (1984). The TFs content was determined by methods of Zhuang *et al.* (1992).

Statistical analysis:

Data were analyzed using the MSTAT statistical software (MSTAT Inc., USA), with comparison of means using Duncan's separation test.

RESULTS

Efficacy of two plant extract and four aromatic oils against *Tuta absoluta* in the first season is shown in Table (1). All treatments reduced the total numbers of mines of *Tuta absoluta* per plant. At 48 DAC (days after cultivation), mean mines per plant was not significantly differed on plant treated with various treatments whereas, garlic extract recorded the highest reduction percentage of mines per plant followed by lemon grass and basil oil. The reduction percentages of mines per plant were 66.49%, 63.94% and 63.27% for garlic extract, lemon grass extract and basil oil, respectively. At 55 DAC, mean mines counts per plant was not significantly differed on plant sprayed with lemon grass extract, rue oil and anise oil than counts on plant treatment with basil oil. The lowest mean number of mines per plant was recorded by garlic extract treatment, it was 16.33 compared to 44.73 mines/plant in control. At 64 DAC, lemon grass treatment was on par with all aromatic oils except for eucalyptus oil that recorded the higher mean mines per plant (27.53) than other treatments. Plants treated with garlic extract were recorded the lowest mean mines counts/plant (19.47) compared to water-treated plants (63.67). The effect of all treatments in reducing the population density of *Tuta absoluta* on plant were not significantly differed among them except for plants treated with eucalyptus oil at other monitoring days after cultivation. However, garlic extract was the best treatment which recorded the lowest percentage of *T. absoluta* infested plants. The reduction percentage of total number of mines per plant were 68.37, 68.60 and 69.32% by garlic extract at 71, 79 and 89 DAC, respectively. Similar results were observed in the second season, although the populations of pest were much lower (Table 2). Although, all treatments were significantly reduced the total number of mines per plant, there were insignificant differences among them. In the second season, at 48 DAC, lemon grass extract recorded the highest reduction percentage followed by garlic extract, rue oil and basil oil, respectively. The reduction percentages were (68.29%), (67.07%), (62.20%) and (60.98%), respectively. However, garlic extract recorded the highest reduction percentage of mines/plant followed by lemon grass and basil oil, respectively, at 55 and 64 DAC. These percentages of reductions were 70.00%, 68.33% and 65.00%, respectively, at 55 DAC and 76.47%, 74.51% and 68.63%, respectively, at 64 DACin this season. Foliar damage by *T. absoluta* in infested treated-plants remained constant at 71, 79 and 86 DAC compared to control whereas, garlic extract and lemon grass extract recorded the lowest values followed by basil oil treatment. Means of mines/plant were 2.60, 2.60 and 3.27 at 71, 79, and 86 DAC, respectively compared to untreated control plants which recorded 10.87, 11.67 and 12.00 mines/plant at the same dates, respectively.

Table (1) Efficacy of two plant extract and four aromatic oils against *Tuta absoluta* on tomato cv. Gold stone hybrid in season 2011.

Treatment	1 st spray				2 nd spray				3 rd spray			
	48 DAC	% Red.	55 DAC	% Red.	64 DAC	% Red.	71 DAC	% Red.	79 DAC	% Red.	86 DAC	% Red.
Lemon grass ex.	10.8C	63.94	18.47CD	58.72	22.00CD	65.45	23.40D	65.62	24.00D	66.35	25.47D	65.43
Garlic ex.	10.0C	66.59	16.33D	63.49	19.47D	69.43	21.53D	68.37	22.40D	68.60	22.60D	69.32
Eucalptus oil	14.6C	51.33	23.53C	47.39	27.53C	56.76	29.80C	56.22	30.67C	57.01	31.60C	57.11
Rue oil	12.4C	58.63	19.20CD	57.08	22.47CD	64.71	23.85D	64.96	24.58D	65.54	25.52D	65.36
Anise oil	12.3C	59.07	19.27CD	56.93	22.20CD	65.13	23.53D	65.43	24.00D	66.35	24.20D	67.15
Basil oil	11.0C	63.27	18.87CD	57.82	21.87CD	65.66	23.07D	66.11	23.53D	67.01	23.60D	67.97
Ethylacetate	25.4B	15.71	34.40B	23.10	47.67B	25.13	54.00B	20.67	54.59B	23.47	45.00B	38.92
Control	30.1A	-	44.73A	-	63.67A	-	68.07A	-	71.33A	-	73.67A	-
Significance at 0.05 level	*		*		*		*		*		*	

Means followed by a common letter are not significantly different at 5% level. DAC= Day after cultivation.

Table (2) Efficacy of two plant extract and four aromatic oils against *Tuta absoluta* on tomato cv. Gold stone hybrid in season 2012.

Treatment	1 st spray				2 nd spray				3 rd spray			
	48 DAC	% Red.	55 DAC	% Red.	64 DAC	% Red.	71 DAC	% Red.	79 DAC	% Red.	86 DAC	% Red.
Lemon grass ex.	1.73B	68.29	2.53B	68.33	2.60C	74.51	2.60C	76.07	2.60C	77.71	2.60C	78.33
Garlic ex.	1.80B	67.07	2.40B	70.00	2.40C	76.47	2.60C	76.07	2.60C	77.71	2.60C	78.33
Eucalptus oil	2.63B	51.83	4.23B	47.08	4.50C	55.88	4.63C	57.36	4.63C	60.29	4.63C	61.39
Rue oil	2.07B	62.20	3.13B	60.83	3.47C	66.01	3.53C	67.48	3.53C	69.71	3.53C	70.56
Anise oil	2.53B	53.66	3.20B	60.00	3.53C	65.36	3.60C	66.87	3.60C	69.14	3.60C	70.00
Basil oil	2.13B	60.98	2.80B	65.00	3.20C	68.63	3.27C	69.94	3.27C	72.00	3.27C	72.78
Ethylacetate	4.27A	21.95	7.00A	12.50	7.53B	26.14	7.93B	26.99	8.27B	29.14	8.27B	31.11
Control	5.47A	-	8.00A	-	10.20A	-	10.87A	-	11.67A	-	12.00A	-
Significance at 0.05 level	*		*		*		*		*		*	

Data recorded on percentage of infested fruits are presented in Table (3) & (4). In the first season, all treatments were significantly reduced *T. absoluta* damaged fruits compared to control. Plants treated with lemon grass extract were recorded the lowest percentage of *T. absoluta* infested fruits (about 5%) followed by basil oil (about 7%) compared to water - treated plant (about 27%). However, the effect of garlic extract on infested fruits percentage was not significantly differed than other aromatic oils treatments. In the second season, all treatments reduced infested–fruits insignificantly compared to control (Table 4). *T. absoluta* population was low and about 15% of the fruit in the control plots being damage. Basil oil recorded the lowest percentage of infested fruits (4%) followed by ethylacetate (solvent) (about 6%),Rue oil (about 8%) and lemon grass extract (about 9%). Fruits in the tested

treatments did not differ statistically in the fruit weight, fruit shape index, TSS, number of locules in both seasons and in pericarp wall thickness in season 2012 and pH in season 2011(Table 5). In season 2012, pericarp wall thickness of fruits in plants treated with basil oil were higher (0.67cm) compared to 0.65cm in untreated plants. However, eucalyptus oil recorded the lowest value (0.60 cm). The effect of two plant extracts and other remaining aromatic oils on pericarp wall thickness did not significant differ than control. In season 2011, all treatments were significantly reduced pH compared to control. The effect of all plant extracts and aromatic oils treatments except rue oil on pH character did not significantly differ from ethylacetate–control treatment. On the other hand, the treated plants produced fruits with higher contents of ascorbic acid. The increment in ascorbic acid in tomato fruits was significantly more pronounced in lemon grass extract and basil oil treatments in the first season and in basil oil and lemon grass extract treatments in the second season.

Table (3) Effect of two plant extracts and four aromatic oils on percentage of infested fruits, 2011.

Treatment	Uninfested	%Uninfested	Infested			
			Tuta	No. of mines/fruit	Bollworm	No. of mines/fruit
Lemon grass ex.	23.67	94.67 A	0.66	0.66	0.66	0.66
Garlic ex.	21.67	86.67 ABC	2.33	2.33	1.00	1.00
Eucalyptus oil	21.00	84.00 ABC	1.33	1.33	2.67	2.67
Rue oil	20.67	82.67 ABC	2.67	2.67	1.67	1.67
Anise oil	20.23	81.33 ABC	3.00	3.00	1.67	1.67
Basil oil	23.33	93.33 AB	1.00	1.00	0.66	0.66
Ethylacetate (Solvent)	20.00	80.00 BC	2.00	2.00	3.00	3.00
Control	18.33	73.32 C	3.67	3.67	3.00	3.00
Significance at 0.05 level		*				

Table (4) Effect of two plant extracts and four aromatic oils on percentage of infested fruits, 2012.

Treatment	Uninfested	%Uninfested	Infested			
			Tuta	No. of mines/fruit	Bollworm	No. of mines/fruit
Lemon grass ex.	22.67	90.67	2.33	1.27	0.00	0.00
Garlic ex.	21.00	86.67	2.33	1.50	1.00	0.67
Eucalyptus oil	22.00	88.00	3.00	1.00	0.00	0.00
Rue oil	23.00	92.00	2.00	1.00	0.00	0.00
Anise oil	20.00	85.33	3.33	1.61	0.33	0.33
Basil oil	23.50	96.00	1.00	0.67	0.00	0.00
Ethylacetate (Solvent)	23.00	93.33	1.67	1.67	0.00	0.00
Control	21.00	85.33	2.67	2.67	1.00	0.33
Significance at 0.05 level		ns				

Means followed by a common letter are not significantly different at 5% level. DAC= Day after cultivation.

Table (5) Effect of two plant extracts and four aromatic oils on tomato fruit characteristics of hybrid cultivar Gold stone in two successive seasons, 2011 & 2012.

Treatment / Season	Fresh weight (gm)		Shape index		TSS (^{O} Brix)		No. of locules		Thickness of pericarp		L- Ascorbic acid mg/100g		pH	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Lemon grass ex.	101.80	92.67	1.05	1.03	3.33	2.57	5.11	5.00	0.67	0.64 AB	16.35 A	16.04 AB	4.27 B	4.93
Garlic ex.	109.07	92.93	1.07	1.01	3.22	2.67	4.89	5.00	0.63	0.62 AB	14.11 BC	11.93 BCD	4.20 B	4.63
Eucalyptus oil	102.28	94.13	1.06	1.00	3.67	2.89	5.11	5.00	0.61	0.60 B	13.36 BC	14.20 ABC	4.40 B	4.60
Rue oil	110.53	96.53	1.06	1.05	3.39	2.67	5.06	5.44	0.61	0.61 AB	14.91 AB	9.34 D	4.50 AB	4.63
Anise oil	98.13	89.73	1.07	1.04	3.37	2.45	4.89	5.00	0.56	0.61 AB	14.11 BC	12.68 ABCD	4.27 B	4.67
Basil oil	98.77	88.53	1.05	1.05	3.37	2.56	5.00	5.22	0.66	0.67 A	15.23 AB	16.79 A	4.40 B	4.77
Ethylacetate (Solvent)	103.53	85.07	1.10	1.03	3.44	3.11	4.99	5.00	0.59	0.60 B	12.99 BC	8.96 D	4.33 B	4.63
Control	102.07	80.80	1.13	0.99	3.00	2.89	4.89	5.11	0.63	0.65 AB	12.24 C	9.71 CD	4.80 A	4.53
Significance at0.05 level	ns	ns	ns	ns	ns	ns	Ns	ns	ns	**	**	**	*	Ns

Means followed by a common letter are not significantly different at 5% level. DAC= Day after cultivation.

Data recorded on yield are presented in Table (6) and Fig (1). In the first season, all treatments were affected significantly the total yield compared to the control. Garlic extract was the best treatment in increasing tomato yield followed by eucalyptus oil and lemon grass. Basil oil application was decreased the total yield (16.53 Ton/Fed.) compared to control (19.01 Ton/Fed.). In the second season, the application of various aromatic oils and plant extracts were affected insignificantly fruits yield. However, anise oil recorded the highest total yield followed by garlic extract, basil oil and eucalypts oil. Total fruits yield of plants treated with lemon grass extract in the second season nearly were on par with control. On the other hand, all treatments affected significantly the percentage of dry weight of fruits and vegetative growth in the second season (Table 6). Although all treatments significantly reduced the percentage of dry weight of fruits, the percentage of dry weight of vegetative growth were significantly increased by these treatments compared to control. The percentage of dry weight of vegetative growth of plants treated with eucalypts oil equaled to value which obtained from ethylacetate-treated control. Whereas, the significantly highest percentage of dry weight of vegetative growth occurred in basil oil followed by garlic extract and anise oil treatments compared to control.

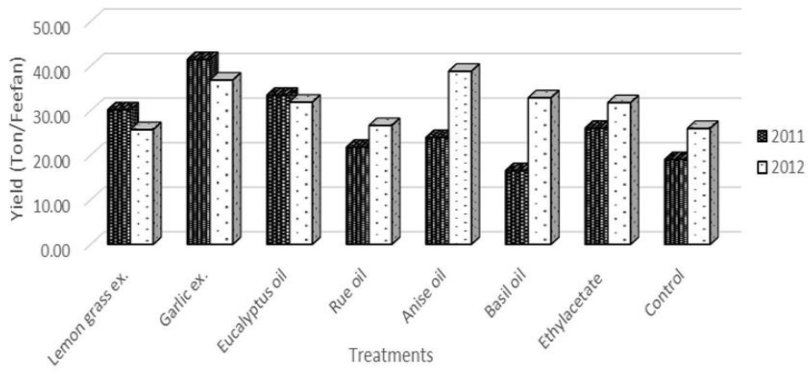

Fig (1): Efficacy of two plant extractes and some aromatic oils on yield in two successive seasons (2011 & 2012).

Data presented in Table (7) and Fig (2) and Fig(3) show that total phenolic compounds (TPCs) and total flavonoids (TFs) were affected in uninfested and infested tomato leaves after 24 hours of plant extracts and essential oils foliar treatments. TPCs values were ranged from 10.00 to 23.00 mg/100g and 14.00 to 36.00 mg/100g in uninfested and infested plants, respectively. The highest values were 23.00 mg/100g and recorded in uninfested plants treated with garlic extract followed by 19.00 mg/100g and 18.00 with eucalyptus oil, rue oil and lemon grass, respectively. In infested plants, the highest values of TPCs were 36.00 mg/100g and recoded in garlic extract-treated plants followed by 26.00 and 24.00 mg/100g with rue oil and eucalypts oil, respectively. The spraying of uninfested and infested tomato leaves with garlic extract increased TPCs concentration with 367.35% compared to unsprayed plants (Fig 2). On the other hand, the highest values of TFs were 57.50 and 87.65 mg/100g which recorded in uninfested and infested plants treated with garlic extract, respectively, followed by lemon grass extract. The values of TFs were 44.56 and 56.79 mg/100g recorded in lemon grass uninfested and infested –treated plants, respectively. As shown in Fig(3) the spraying of both uninfested and infested tomato plants with garlic extract led to sharp increase in TFs concentration with about 6 fold than unsprayed leaves.

Table (6) Efficacy of two plant extracts and four aromatic oils on yield in two successive seasons (2011 & 2012).

Treatment / Season	Dry weight/ 250 gm. Of fruits	% of dry weight of fruits	Dry weight /250 gm. Of vegetative growth	% of dry weight of vegetative growth	Yield (Ton/Feedan)	
	2012		2012		2011	2012
Lemon grass ex.	11.34	4.53 B	89.64	35.86 B	30.19 BC	25.72
Garlic ex.	12.02	4.81 B	92.51	37.00 B	41.46 A	36.85
Eucalyptus oil	11.75	4.70 B	78.86	31.54 C	33.45 B	31.89
Rue oil	11.99	4.80 B	87.13	34.85 BC	21.79 DE	26.66
Anise oil	13.81	5.53 AB	91.85	36.74 B	23.96 CDE	38.84
Basil oil	14.09	5.64 AB	102.32	40.93 A	16.53 E	32.88
Ethylacetate (Solvent)	15.33	6.13 A	79.36	31.74 C	26.06 BCD	31.78
Control	15.03	6.12 A	85.89	34.35 BC	19.01 DE	25.99
Significance at 0.05 level		*		*	*	ns

Means followed by a common letter are not significantly different at 5% level. DAC= Day after cultivation.

Table (7) Total phenolic compounds and total flavonoids in uninfested and infested tomato leaves after 24 hours of plant extracts and essential oils treatments.

Treatment	TPCs mg / 100 g		TFs mg / 100 g	
	Uninfested	Infested	Uninfested	Infested
Lemon grass ex.	18.00	22.00	44.56	56.79
Garlic ex.	23.00	36.00	57.50	87.65
Eucalyptus oil	19.00	24.00	18.97	23.97
Rue oil	18.00	26.00	17.87	22.66
Anise oil	10.00	14.00	8.90	13.98
Basil oil	12.00	15.00	12.09	15.08
Without spray	8.60		12.90	
Ethylacetate	12.70		31.75	
Control	9.80		14.70	

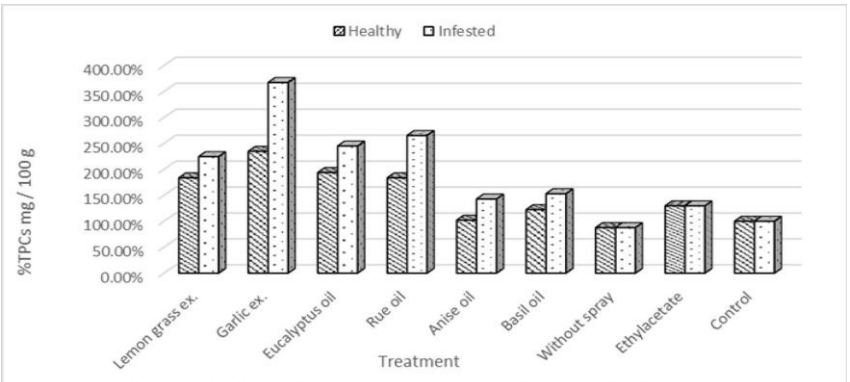

Fig (2) Total phenolic compounds in healthy and infested tomato leaves after 24 hours of plant extract and essential oils treatments.

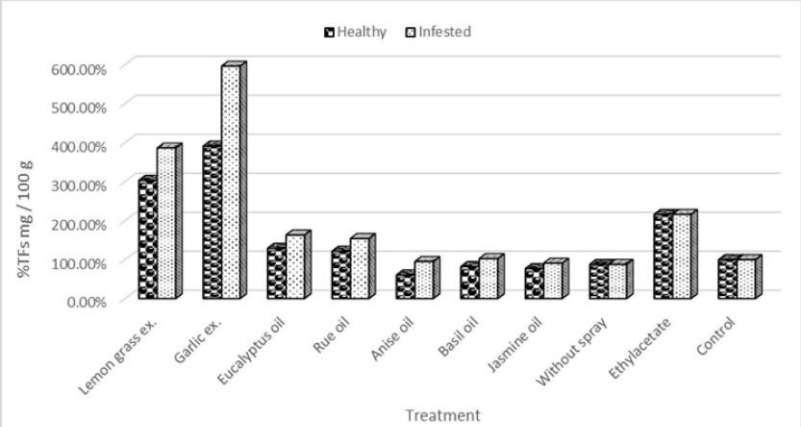

Fig (3) Total flavonoids in healthy and infested tomato leaves after 24 hours of plant extract and essential oils treatments.

DISCUSSION

Plant extracts are known to possess toxic organic poison that is effective in reducing insect pest population (Gaby, 2000). Literature has been documented several studies where extracts, isolated compounds or mixture products have been evaluated for their efficacy against a variety of pests. These studies have been comprehensively reviewed (Rosell et al. 2008). Also, the essential oils were renewed with emerging demonstration of their fumigant and contact insecticidal activities to a wide range of pests (Koul *et al*., 2008). The aim of this work to study the response of tomato plants to some plant extracts and essential oils against *Tuta absoluta*. All treatments recorded a significant reduction in *T. absoluta* population. The highest reduction of *T. absoluta* population was obtained after tomato plants treated with garlic extract. These results were in agreement with those reported by Ghanim and Abdel Ghani (2014), who showed that highest effects of garlic on *T. absoluta* second instar larvae under laboratory conditions but it had a moderate effects on *T. absoluta* under greenhouse conditions. Also, garlic leaf lectin (ASAL) has been found to have detrimental effect on growth and survival of two important homopteran insect pests, *Lypaphis erysimi*, commonly known as aphids and *Dysdercus cingulatus* (red cotton bug) (Bandyopadhyay et al., 2001). Neem, garlic and ginger extracts contain insecticidal properties that are lethal to a wide range of insects (Oparaeke, 2007). A mechanism of garlic extract effects based on the presence of an olerisine substance, a volatile oil and the antifeedant characters of garlic due to the presence of an essential oil (allyl propyl disulphide and daily disulphide) (Ben et al., 2010 and Ghanim and Abdel Ghani, 2014)). Lemon grass extract and essential aromatic oil reduced the population of *T. absoluta* on plant significantly. The results obtained were in agreement with Moreno et al. (2011) who found that the

crude hexane extract of *Acmella oleracea* produced high insecticidal activity and can be used to control *T. absoluta* in organic or conventional crops. However, antifeedant and larvicidal activity of ethyl acetate, leaf and flower extracts of *Ocimum canum* and *Ocimum sanctum* against lepidopterans suggested their capability as an ideal ecofriendly approach for the control of the agricultural pests (Kamaraj et al.,2008). Also, The essential oils such as those of lemon grass (*Cymbopogon winterianus*) and *Eucalyptus globulus* that were known for their pest control properties and basil (*Ocimum basilicum*) are also effective in warding off flies (Koul and Walia,2009). Plant essential oil, like this from *O. sanctum* was either toxic or growth inhibitory against *Spodoptera litura* larvae (Sharma *et al*., 2001). 1,8-cineole from *Eucalyptus globules* and citronellal from lemon grass were among the most active constituents against insects (Koul *et al*.,2008). On the other hand, 1,8- cineole exhibited both contact and fumigant toxicity when tested against *T. castaneum* (Koul *et al*.,2008). Moreover, essential oil constituents such as thymol, citronellal and α- terpineol were effective as feeding deterrent against tobacco cutworm, *S. litura.* Synergism or additive effects of combination of monoterpenoids from essential oils had been reported against *S. litura* larvae (Hummelbrunner and Isman, 2001). The effect of two plant extracts and the essential aromatic oils on fruit damage resulted in less *T. absoluta* – damaged fruits. Similar results with other pests were obtained by Panhwar (2002) who reported that good aqueous solution of garlic would effectively control worms, beetles and thrips in cowpea. Also, Ghanim and Abdel Ghani (2014) showed that Basil leaves exhibited the lowest initial kill on *T. absoluta*. After 3 days, the concentration 6% of this tested plant exhibited significantly higher effects than that of 2%. Similalrly, essential oils of *Ocimum sanctum* caused 20% mortality to 3rd instar *S. litura* larvae (Sharma *et al*., 2001). On the other hand, the obtained results indicated that all treatments insignificantly affected fresh weight, shape index, TSS, no. of locules and thickness of pericarp in season 2011 and pH in season 2012. Different results were showed by Tyiagi et al. (1990) who found that plant growth improved and plant weights also increased with increasing concentration of leaf lemon grass extract and with longer dip duration. All treatments affected thickness of pericarp in season 2012 and pH in season 2011. Also, most treatments were significantly increased L- ascorbic acid in both seasons. Interestingly, the tested plant extracts and essential oils were affected the percentage of dry weight of fruits and vegetative growth of tomato plants significantly. Also, the two plant extracts and most of the used essential aromatic oils increased the total yield of tomato in the first season whereas, in the second season all treatments had no significant effects on tomato yield. Garlic extract was the best treatment and gave the highest yield of tomato fruits in the first season while it was the second in the second season. Similar results were showed by Ahmed et al. (2009) on cowpea. Also, the obtained results correspond positively with the earlier work conducted by researchers which they showed that plant extracts increase the yield of vegetables by protecting them from insect pests (Panhwar, 2002). However, plant extracts application at flowering and pod formation stages reduced the

level of infestation of insect pests and increased yield of pea plants (Panhwar, 2002). However, the chemical of analysis total phenolic compounds and total flavonoids showed that garlic extract had a sharp increase in TPCs and TFs leaves contents in both uninfested and infested leaves of tomato. These results were in agreement with those obtained by Miean and Mohamed (2001), Lanzotti (2006) and Bozin et al. (2008). They reported that garlic extract was characterized by more polar compounds of phenolic, steroidal origin (glycosylated and flavonoids) which showing interesting pharmacological properties. According to the obtained results, it can be concluded that foliar application of garlic extract, lemon grass extract and basil oil on tomato plants reduced *T. absoluta* population and improved the quality and quantity of tomato fruit yield.

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تـأثير اثنـين مـن المستخلصـات النباتيـة وأربعـة مـن الزيـوت علـى تعداد حـافرة أوراق الطماطم والانتاجية لصنف الطماطم جولد ستون

نهال حسين[١] ، محمد ابراهيم [٢] ، سيف النصر جاد الحق [٣]،هشام شعلان [١] و ماهر حماد [٢]
١-معهـــد بحـــوث وقايـــة النبـــات- قســـم بحـــوث افـــات الخضـــر-الجيـــزة-الـــدقى
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١- في الموسم الأول أدت جميع المعاملات إلى خفض أعداد الأنفاق/نبات. وقد سجل مستخلص الثوم أعلى نسبة خفض في عدد الأنفاق ويليه مستخلص حشيشة الليمون ثم زيت الريحان. وقد تحصل على نتائج مشابهه في الموسم الثاني، على الرغم من أن تعداد الأفة كان أقل بكثير.أدت جميع المعاملات لخفض إصابة الثمار بالآفة مقارنة بالكنترول. في كلا الموسمين.

٢- لم تؤثر أي من المعاملات المستخدمة على وزن الثمرة، شكل الثمرة، المواد الصلبة الكلية، عدد الغرف بالثمرة في كل من الموسميين (٢٠١١ ، ٢٠١٢)، وكذلك لم يكن هناك اختلاف في سمك الجدار الخارجي في موسم ٢٠١٢ وعلى صفة الحموضة للثمار في موسم ٢٠١١.

٣- ازدادت نسبة حامض الأسكوربيك في ثمار النباتات المعاملة بمستخلص حشيشة الليمون وزيت الريحان في الموسم الأول، وعند المعاملة للنباتات بزيت الريحان ومستخلص حشيشة الليمون، على التوالي في الموسم الثاني.

٤- في الموسم الأول، كان مستخلص الثوم من أفضل المعاملات التي أدت لزيادة المحصول الكلي للثمار ويليه زيت الكافور ومستخلص حشيشة الليمون. وقد أدت المعاملة بزيت الريحان لخفض المحصول الكلي للثمار (١٦,٥٣ طن/فدان) مقارنة بالكنترول (١٩,٠١ طن/فدان). في الموسم الثاني، سجلت المعاملة بزيت الينسون أعلى محصول ويليه المعاملة بمستخلص الثوم ثم زيت الريحان ثم زيت الكافور.

٥- أثرت جميع المعاملات على نسبة الوزن الجاف للثمار وللنمو الخضري في الموسم الثاني. وجد أن هناك تاثير علي المركبات الفينولية الكلية وكذلك الفلافونيدات الكلية في أوراق الطماطم وذلك بعد ٢٤ ساعة من المعاملة الورقية لكل من النباتات السليمة والمصابة بالمستخلصات النباتية والزيوت الأساسية.

ومن خلال هذه النتائج، يمكن استنتاج أن المعاملة الورقية لنباتات الطماطم بكل من مستخلص الثوم، مستخلص حشيشة الليمون، زيت الريحان ، يؤدي لخفض الكثافة العددية لحافرة أوراق الطماطم وكذلك تحسين محصول الثمار من حيث الجودة والكمية.