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Full Length Research Paper

Efficiency of Zinc sulfate and some volatile oils on some insect pests of the tomato crop

Sawsan, S. Moawad, Aziza Sharaby, Ibrahim M. Ebadah and Huda El-Behery

Pests and Plant Protection Department, National Research Center, Cairo

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The test was targeted to compare the efficacy of different components (including, Zinc Sulfate, Clove, Bitter orange) on some insect pests of the tomato crop during winter season. The data was cleared that spraying tomato leaves by 2.5% zinc sulfate only capable causing mortality to *Bemisia, Liriomyza* and *Tuta* reached 53.8, 62.5 and 62.55%. While spraying the natural oil only caused mortality ranged between 70 to 90%. The highest reduction to *Bemisia* and *Tuta* infestation was recorded in case of treatment with clove oil only or in combine with bitter orange and zinc sulfate. In general, mixed three component together had ability to cause the highest mortality of Tuta larvae, reached 97%.

Keyword: Zinc Sulfate, Clove, Bitter orange, Tomato crop, *Liriomyza trifolii, Tuta absoluta Bemisia argentifolii.*

INTRODUCTION

Insect pest infestation is one of the most devastating aspects of tomato planting. They are infested by several insect pests which caused reduction quality and qualitative of the market yield. Probably, the most common insect pests attack the tomato crop are serpentine leaf miner *Liriomyza trifolii* Burgess (Diptera: Agromizidae) Silver leaf Whitefly, *Bemisia argentifolii* Bellows and Perring (Homoptera: Alerodidae) and tomato leafminer *Tuta absoluta* Meyrick (Lepidoptera: Gelechiidae) during winter season in Egypt (Abd-Rabou 2005 and Simmons and Abd-Rabou 2007). Heavy infestation by the insect pests caused reduction the photosynthetic capacity of the plant, or transmission granulosis viruses' disease which affects the development of flowers and fruits.

To overcome insect pests must be started before the pests' levels reach economic threshold level. The protection control method by using fertilizers or natural oils considers the safest and promising way to minimize insect population and lesser usage insecticide.

Zinc Sulfate is the inorganic component which act as safety fertilizer to plant which increased crop yield and as insect growth regulator that disrupted endocrine system of insect (Sharaby et al.2013). On the other hand, usage natural plant oil in control program considered one of the most safety materials due to disability to persist for long time, i.e. low their residue. They have antifeedants, repellency or/and toxic effect toward insect pests.

The present work aimed to evaluate the efficiency of Zinc Sulfate and some natural plant oils (alone or combine together) to protect of the tomato plants from some insect pests infestation.

*Corresponding Author's Email: abzs9999@yahoo.com

MATERIALS AND METHODS

Tomato plant seedling (2 weeks old) (Cherry cultivar) were obtained from the nursery plantation then cultivated into plastic pots (50×50×20cm.) filled with silt. For each experiment were used thirty tomato plants. All potted plants were placed under natural insect infestation in National Research Center Park. Each pot was prepared by added usual fertile soil and planted with three saplings of tomato plants. After three weeks of plantation were sprayed the plant shouts by the prepared materials as shown in table 1 by aid handle sprayer 500ml. The tested oils concentrations were mixed with one drop of Tween (60%) as emulsifier and two drop of glycerin (99%) as fixed to (less oil volatility).

Tested oils were sprayed one time and each one was replicated thirty times (i.e 10 pots X 3 plants). The sample was collected at interval time (three days, one week and two week) to investigate under stereomicroscopy and then calculated the follows:

$$1\text{- Real mortality \%} = \frac{\text{(Control- Treated) X 100}}{\text{100 – Control}}$$

(Abbott's formula 1925)[4]

$$2\text{- Infestation \%} = \frac{\text{Total number of immature stage X 100}}{\text{Total no. of investigated leaflets}}$$

$$3\text{- Repellency \%} = \frac{Tc - Tt \text{ X } 100}{Tc}$$

Where, Tc = total no. of immature stages in control

Tt = total no. of immature stages in treatment

RESULTS

1- Effect on the white fly, *Bemisia argentifolii:*

Table 2 and Figure 1 illustrated that all treatments were recorded mortality to immature stages of whitefly and repulsion to mature stages that caused reduction in mean number of egg deposition compare to control test. The most effective one was treatment by mixture of bitter orange with clove, clove alone and bitter orange mix with Zinc sulfate which were recorded mean real mortality percentage in immature stage ranged between 74.8 to 70.7% compare to control was recorded 0.0%. While treatment by Zinc sulfate only or mixed with bitter orange caused mortality reach to 53.8 and 54.6% immature stage of white fly. On the other hand, treatment by clove only or clove mixed with Zinc sulfate caused the highest repulsion effect to tomato white fly over the two weeks, were 72.5 and 72.3% followed by treatment by mixture of bitter + clove + Zinc sulfate, reached to 66.3%. While treatment by Zinc sulfate only caused the lowest repellent effect (24.4%).

2-Effect on tomato leaf miner:

2.1. *Liriomyza trifolli:*

The most treatments caused relatively reduction in percentage of infestation by serpentine leaf miner, but the highest one recoded more than 60% infestation reduction in case treatment tomato plant by (Clove +Zinc Sulfate) followed by clove only 56.9% (Table 3). While all of tested components caused real mortality percentage ranged from 50% to 96%. The highest mortality percentages were recorded in case of treatment by clove alone or (Zinc Sulfate + bitter orange+ Zinc Sulfate) cleared percentage of mortality 93.3and 96% respectively) after two weeks of treatment.

2.2. *Tuta absoluta:*

Table (4) cleared that spray tomato plant by (Clove oil + ZnSO47H2O) or mixture of the three tested components or mixture of bitter orange with zinc sulfate caused the highest percentage of real mortality to larval stage of *Tuta* reached to 98, 97 and 93.3%. On other hand treatment by mixture of clove oil with zinc sulfate and clove oil only caused the highest reduction in number of *Tuta* tunnels, recorded 62.2 and 56.9% respectively.

DISCUSSION

The obtained results indicated that the foliar spraying the tomato plants by (Zinc Sulfate +Clove) or bitter orange or the combination of the three materials together caused better protection to tomato plant from infestation by *T. absoluta*, while the natural oils also separately caused better protection from *L. trifolii* and B. *argentifolii* compare with other treatments or control.

The previous studies were confirmed that Zinc (Zn) is an important essential micronutrient for plant. Zn is an essential metal for normal plant growth and development, since it is a constituent of many enzymes and proteins organisms (Cakmak, 2000). Foliar sprays fix the problem for the plant and relatively help the plant to become more tolerant to insect attack but it can't prevent them. Padhee and Mishara (1993) found that Zinc application has been shown to impart resistance against insect pests to rice. Sarwar (2011) studied the effect of Zinc fertilizer application on the incidence of rice stem borer *Scirpophaga sp.* in rice crop, he found that Zn had significant influences on the stem borer population and paddy yield over the unfertilized control. Al-Dhafar1 and Sharaby (2012) recorded that Zinc Sulfate solution was capable to disrupting growth, development and

Table 1. Tested materials, source and concentrations.

Tested materials	Obtained source	Conc. of the spray solution
1-Zinc sulfate, $ZnSo_4 7H_2O$ (Pure Powder)	(oxford laboratory Mumbai)	2.5mg/100ml water /3pots
2- Clove oil, *Syzygium aromatic* L.	Sigma (Germany)	5µl/100ml water /3pots
3-bitter orange, *Citrus aurantium* amara	Haraz (saudia Arabia)	5µl/100ml water /3pots
Combination of (1+2+3) Or (1+2) or (1+3) or (2+3)	---	At the same ratio from each stock solution of each material

Table 2. Effect of different treatments on population of tomato white fly Bemisia argentifolii on tomato plant.

Treatment (Conc. %)	After three day of treatment				After two week of treatment				Mean mortality %
	Mean no. of eggs /20 Leaflets	Mean number of nymph/100 leaflets		Real Mortality %	Mean no. of eggs /20 leaflets	Mean number of nymph/100 leaflets		Real Mortality %	
		alive	die			alive	die		
Without treatment (control)	75	14	--	--	128	85	1	--	--
$ZnSO_4 7H_2O$ (2.5%)	28	64	66	50	21	21	29	57.5	53.8
Bitter orange (5µl) mix with $ZnSO_4 7H_2O$ (2.5%)	24	26	46	63.9	17	4	14	77.5	70.7
clove (5µl) mix with $ZnSO_4 7H_2O$ (2.5%)	16	19	32	62.7	10	2	5	71.4	67.1
Bitter orange (5µl) and clove mix with $ZnSO_4 7H_2O$ (2.5%)	21	7	15	68.2	20	23	16	41.02	54.6
Bitter orange (5µl) mix with clove (5µl)	29	26	95	78.5	3	4	10	71.1	74.8
Bitter orange (5µl)	38	16	26	61.9	35	10	18	63.9	62.9
Clove (5µl)	27	11	28	71.8	10	2	5	71.1	71.5

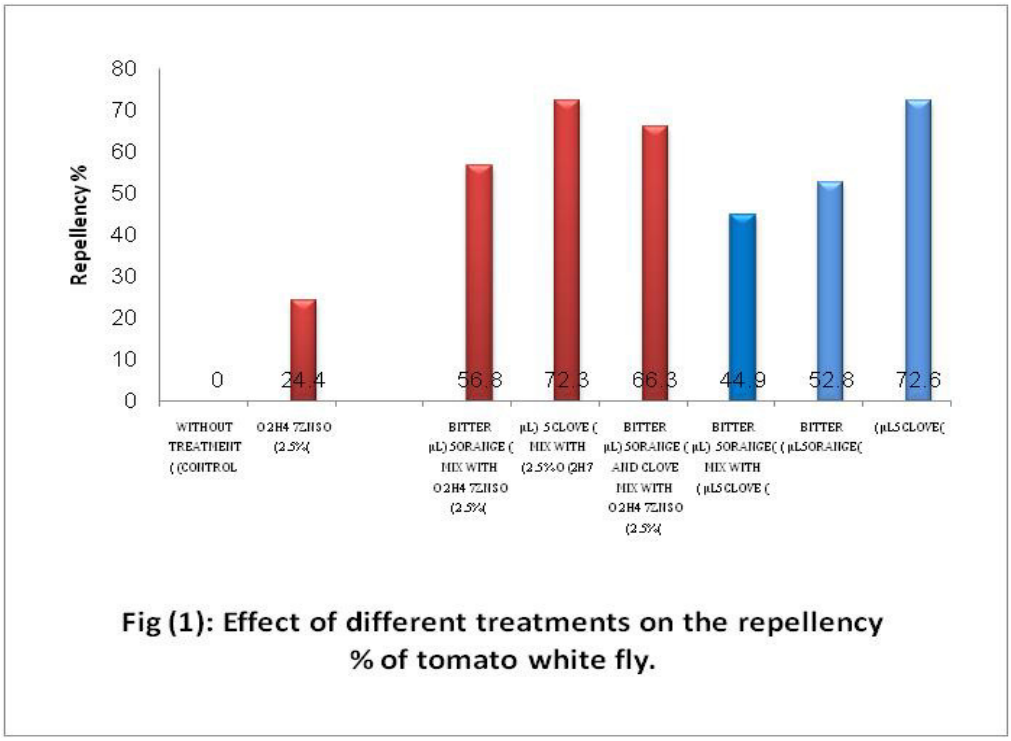

Fig (1): Effect of different treatments on the repellency % of tomato white fly.

Table 3. Effect of different treatments on population of Liriomyza trifollii on tomato plants

Treatment (conc.%)	Investigation after two week of treatment				
	Mean number of leaflets	Mean no. of infested leaflets	% of infestation	Infestation reduction %	Real Mortality %
Without treatment (control)	155	28	18.1	--	--
$ZnSO_4$ $7H_2O$ (2.5%)	295	49	16.6	8.2	62.5
Bitter orange (5µl) mix with $ZnSO_4$ $7H_2O$ (2.5%)	295	23	7.8	56.9	77.8
clove (5µl) mix with $ZnSO_4$ $7H_2O$ (2.5%)	190	13	6.8	62.2	96
Bitter orange (5µl) and clove mix with $ZnSO_4$ $7H_2O$ (2.5%)	315	40	12.7	29.8	94
Bitter orange(5µl) mix with clove (5µl)	295	29	9.8	45.9	50
Bitter orange(5µl)	265	27	10.2	43.6	56
Clove(5µl)	235	31	13.2	27.1	93.3

Table 4. Effect of different treatments on infestation by tomato leaf miner, *Tuta absoluta*.

Treatment (Conc.%)	Investigation after three week of treatment				
	Mean number of investigated leaflets/plant	Mean no. of tunnels/ leaflets	Infestation %	Infestation reduction %	Real Mortality %
Without treatment (control)	155	37	23.9	--	--
$ZnSO_4$ $7H_2O$ (2.5%)	295	14	4.7	8.2	62.5
Bitter orange (5µl) mix with $ZnSO_4$ $7H_2O$ (2.5%)	235	9	3.8	27.1	93.3
clove (5µl) mix with $ZnSO_4$ $7H_2O$ (2.5%)	190	11	5.7	62.2	98
Bitter orange (5µl) and clove mix with $ZnSO_4$ $7H_2O$ (2.5%)	315	16	5.1	29.8	97
Bitter orange(5µl) mix with clove (5µl)	295	21	7.1	45.9	50
Bitter orange(5µl)	265	26	9.8	43.6	56
Clove(5µl)	295	5	1.7	56.9	77.8

reproduction of *Rhynchophorus ferrugineus.*

On the other side, there are several studies were proved the role of volatile oil as deterrence or antecedent or toxicant for large scale of insects (Mesbah, et al., 2006; Dayan et al., 2009 and Maia and Moore, 2011). The searches agree with the present results as Moawad et al. (2013) who found that Clove, eugenol and isoeugenol caused highly reduction percentage of penetration and accumulative mortality of *T. absoluta* larvae and ovipositional deterrence reaction towards its' adult stage. Many bibliographical data are available on repellency and toxicity effect of clove oils to immature stages of different insect pests rather than the tomato pests as (Trongtokit, et al., 2005, Bhat and Kempraj, 2009 and Moawad and Al Gamdy, 2012).

CONCLUSION

The obtained results were stressed and put highlight around the role of some safety materials as natural plant oils or Zinc Sulfate (alone or combine together) in reduction the rate of insect pests' infestation under field condition (especially during early stage of plant growth). Zinc Sulfate alone was able to give relatively 50% protection to tomato plant from insect pests infestation, beside we noticed that it increase the whole number of plant leaves. On other side, the natural plant oils especially clove alone can be given protection reached to more than 70%. The combination natural plant oils with Zinc sulfate was elicited protection more than each one only.

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