



Toxicity of some essential oils on *Thrips tabaci* (Thysanoptera: Thripidae) and potential phytotoxicity of seeds onion plants *Allium cepa*

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Abstract

Natural oils play an important role in reducing the population density of insect pests, in addition to several advantages that make them the best compared to insecticides. As, it is distinguished by its lack of resistance to insect pests, and the use of oils in integrated control programs reduces environmental pollution problems and ultimately obtains a healthy food product. In this study, it includes experimenting with several natural oils, namely lemon oil, mint oil, and neem oil, and comparing them with mineral oil in terms of the exterminating ability of thrips that infect onion plants, as well as knowing the phytotoxicity of these oils on onion seeds. The results showed that the highest death rate of *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) was recorded for lemon oil, as it ranged from 58.68% to 83.0% at concentrations from 1 ml to 5 ml /L. of water, while the lowest death rate was recorded for neem oil, where the death rate ranged from 49.3% to 61.5% at concentrations from 1 to 5 ml /L. of water, while the death rates were average for both peppermint and mineral oil. The LC50 values for the lemon oil were 0.6053 ml/l. We found that lemon oil had the highest effect on the germination rate, and the germination rate reached 30% compared to the control. Also, results indicated that the highest phytotoxicity was mineral oil at a concentration of 20 ml / L., where the toxicity percentage was phytotoxicity reached 68.0%, while the treatment with peppermint oil was the least in terms of phytotoxicity.

Keywords: Natural oils, toxicity, *T. tabaci*, onion seeds and phytotoxicity

Introduction

Onion plants *Allium cepa* L. are planting in the world for 4000 years, China and India considered as the highest production of onion plants in the world. Onion plants continent of folic acid, magnesium, vitamin B6 and minerals, in addition to having many antioxidants and extraordinary source of vitamin Egypt ranks fourth internationally after China, India and USA, whereas the area planted with onions arrived at 228,000 acres and 15 tons to acre equivalent to 3000000 tons in a year.

Thrips tabaci Lindeman (Thysanoptera: Thripidae) attacking a wide range of plants the most important are onion plants causing very deform in the quality and quantity of onion products. Thrips is a piercing insect that sucks plant sap. Its length ranges from 0.8 to 1.2 mm. This insect spreads on the lower surface of the leaves. As a result of the absorption of plant sap from the outer epidermal cells of the leaves, these cells become empty as they are filled with air bubbles, causing a silver color.

Thrips (Larvae and adults) are feeding on leaf parts of onion plants which become injured by silvery and white marks (Crüger and Hommes, 1990) [8]. In cases of severe infection, deformations of the leaves occur, and the plant becomes unmarketable. In addition, this insect causes dwarfing modern plant growth and causes cessation of growth, in addition to transmitting viral diseases.

Natural oils are highly effective materials for controlling the number of insect pests, which work to control the number of insects without reaching the critical economic level. In addition, it is safe for the environment and its use does not cause the appearance of insect resistance, as it works to dissolve the waxy layer of the insect and prevents the insect from settling on the vegetable parts treated with oils.

Essential oils are defensive devices system in plants against phytophagous and even eliminate them (Rice and Coats, 1994) [17]. There are many natural oils that have a highly toxic effect, as it turned out that clove oil, cinnamon oil, and lemongrass oil are among the highly toxic oils on thrips *Frankliniella schultzei* Trybom (Thysanoptera: Thripidae) and mealybug *Pseudococcus jackbeardsleyi* Gimpel and Miller (Hemiptera: Pseudococcidae) (Jarongsak and Ammorn, 2016) [11].

This study chose lemon oil, mint oil and neem oil due to the effects on activity insects such as moulting and growth. Lemon oil was content of high acidic, so was repellent of insects (Wiltz *et al.*, 2007) [24]. Peppermint oil is a substance in many cedars, eucalyptus, citrus and mints (Appel *et al.*, 2001) [6]. Mint oil demonstrate efficacy against insects in the past. Neem oil holds the view of at least 100 biologically active compounds (Shiry *et al.*, 2021) [20]. But it was considered to be probably secondary to the action of azadirachtin in stopping up or choking cytoskeleton development and actively dividing cells in the insects bodies (Morgan, 2009) [15]. Using natural oils to control insects has a positive effect on the environment and on human health. Where the excessive and indiscriminate utilize of pesticides in the field causes many environmental risks such as water and air pollution as well as food pollution, in addition to the presence of pesticide decrease in the soil because of spraying with pesticides, which exposes the seeds planted in this soil to contact with these residues, which may affect the germination rate and growth rate of the plant.

Pesticides after application showed changes in morphological plants due to physiochemical reactions such as rearrangement and deactivation upon joining to soil, photolysis, autolysis (Mahmood *et al.*, 2014) [13]. Therefore, this study aims to study the indirect effects of the use of

natural oils compared to mineral oil in the case of precipitation in the soil because of spraying to combat the thrips insect on the seeds in contact with this soil.

In the current study consists of some items:

1. Toxicity of different concentrations of lemon oil, mint oil, neem oil and mineral oil to reduce the number of *T. tabaci*.
2. Percentage of Seeds germination and survival, shoot length (Cm), root length (cm) and root shoot length.
3. Phytotoxicity, tolerance index and seedling vigor index for these oils on seeding of onion plants.

Materials and methods

1. Toxicity of some oils on *Thrips tabaci*

The work has been conducted in Central Laboratory of Organic Agriculture –Agricultural Research Center, Giza-Egypt. Onion was planted under house glass conditions and after the infestation occurred by *T. tabaci* insects, infested plants were sprayed with different oils. After 24 hours onion leaves were taken to the laboratory then the plants were divided into replicates, each replicate contains 20 insects with three concentrations of oils. The effect of these oils: Lemon oil:(1,3,5ml/l), neem oil (Nimbecidine 0.03% Azadirachtin): (3,5,7ml/l), mint oil: (1,2,3ml/l) as natural oils, and mineral oil as chemical oil (KZ OIL 95% EC): (10,15, 20ml/l). The oils were used in this study to reduce the population of *T. tabaci* on onion plants. The death rate was calculated after 24, 48 and 72 hours from being treated with different concentrations of oils. The percentage of reduction has been calculated by (Abbott's formula, 1925)^[3]. Determine LC50 and LC90 values according to (Finny, 1971). Toxicity index for LC50/LC50 for most effective compound/LC50 for other test compounds X100 in agreement with Sun (1950)^[21].

2. Treating onion seeds with oils

To study the effect of these oils on morphological traits of onion seeds after germination. Ten homogeneous onion seeds were randomly selected for treatment; each treatment has three replicates with ten seeds. Seeds were incubated for one day after washing with water and treated with different concentrations of oils and using control without any treatment with water only. After 24 hours the treated seeds and control were placed on two layer filter papers with distilled water in petri dish for two weeks with adequate supply of distilled water under 25-26 C⁰ laboratory conditions (Firdos *et al.*, 2018)^[9].

3. Percentage of Seeds Germination (G %), Survival (S %) and Root Shoot Length

Different morphological assessments of onion seedling examine such as

3.1. (G %)

(G %) was taken on third day after blowing on filter paper by counting the number of seeds germinated dividend total number of seeds remedied multiplication 100 (Akinci and Akinci, 2010)^[2].

3.2. (S %)

Survival (S %) was calculated after 7days of germination, S % (the ratio between the total number of seedlings survived and total number of seed remedied multiplication 100.

3.3. Root Shoot Length (RSL %)

Has been calculated the ratio between root (R) and shoot (F) length after 14 days of planting.

4. Phytotoxicity percentage (P %) and Tolerance Index (TI)

P % and TI % were calculated on 15th day (P%) calculated according to converted method of Chou *et al.* (1978)^[7] and Tolerance Index (TI) according to Turner and Marshal (1972)^[22].

$$P \% = \frac{\text{shoot or root length of control} - \text{shoot or root in test treatments}}{\text{shoot or root length of control}} \times 100$$

$$\% \text{ TI} = \frac{\text{Mean length of longest shoot or root in test treatments}}{\text{Mean length of longest shoot or root length of control}} \times 100$$

5. Seedling Vigor Index (SVI)

(SVI) is assessment by multiplying germination% and seedling length (Abdul-Baki and Anderson,1973)^[4].

6. Statistacal analysis

Variable were analyzed in (Anova) one way analysis of variance, using Costat soft, comparative analysis were conducted for the significant results using LSD at 0.05 probability.

Results and discussion

1. Toxicity of oils on *Thrips tabaci*

Table (1) indicates that the highest death rate was recorded for lemon oil, as it ranged from 58.68 % to 83.0 % at concentrations from 1 ml to 5 ml /L, while the lowest death rate was recorded for neem oil, where the death rate ranged from 49.3 % to 61.5% at concentrations from 1 to 5 ml /L, while the death rates were average for both peppermint and mineral oil. Table (2) shows the LC50 values for the tested oils, where the results indicated that the LC50 was 0.6053, 3.2945, 1.14 and 7.64 for lemon oil, neem oil, peppermint oil and mineral oil, respectively. Also, LC90 was 8.3062, 122.05, 47.69 and 31.59 for those oils in the same order. So LC90/LC50 was highest in mint oil (41.8) and lowest in mineral oil (4.1). Also, the toxicity index was 100 for lemon oil and for mint oil was 53, but for neem and mineral oil was less and recorded at 18.3 and 7.9.

Natural oils generally work to reduce the number of insects in the field, such as thrips, aphids, whiteflies, and mealybugs. This is due to the oils acting as a feeding inhibitor and their ability to suffocate the insect, as it covers the body of the insect, so the respiratory stomata are closed, which impedes the breathing process, which leads to the death of the insect. During this investigation observed that lemon oil had the highest

Table 1: Effect of some oils on *Thrips tabaci* under laboratory conditions.

Treatment of oils	Con. (ml/l).	Mortality%			Total mortality%
		24 hr.	48hr.	72hr.	
Lemon oil	1	56.3	60.5	59.26	58.68
	3	79.56	82.96	81.6	81.37

	5	83.0	84.5	81.5	83.0
Neem oil	3	45.4	49.7	52.8	49.3
	5	56.5	53.56	53.0	54.3
	7	63.7	62.9	57.9	61.5
Mint oil	1	45.6	49.6	45.2	46.8
	3	52.9	52.3	50.1	51.7
	5	65.9	71.4	67.0	69.1
Mineral oil	10	58.	60.5	57.7	58.76
	15	77.4	75.5	71.5	74.8
	20	81.0	80.3	78.0	79.7

Table 2: Toxicity of some oils on *Thrips tabaci* under laboratory conditions.

Treatment of oils	LC50	LC90	Slope ± S.D.	LC90/LC50	Toxicity index	R	P	X ²
Lemon oil	0.6053	8.3062	1.1±0.27	13.7	100	0.915	0.3466	0.885
Neem oil	3.2945	122.05	0.81±0.48	37.0	18.3	0.974	0.692	0.156
Mint oil	1.14	47.69	0.839±0.25	41.8	53.0	0.971	0.414	0.66
Mineral oil	7.64	31.59	2.08±0.62	4.1	7.9	0.986	0.590	0.268

R= Regression, P= Probability, χ^2 =Chi-Square

Effect of all the oils tested on the thrips insect, and this effect is due to the lemon oil containing terpenes and geraniol compounds. The results obtained in this study are consistent with Rodina *et al.* (2023) [18], where found that the oils have an exterminating effect on insects, especially bedbugs mealybug, where they recorded that lemongrass oil is more toxic than peppermint oil on coconut bugs, where the percentage of lemongrass oil eradication reached 100% for nymphs and adult stage at the highest concentration (10000 ppm) after 72 hours of treatment.

Wessal *et al.* (2019) [29] tested some natural oils, namely sesame, cotton, sunflower and ground nut on thrips under field conditions for two seasons. They concluded that the tested oils proved highly efficient in reducing the thrips population during a period ranging from two days to a week, these results harmony with our study.

Natural extracts of oils can reduce the activity of insect pests, as they act as a deterrent to feeding, affecting reproduction, laying eggs, and influencing the stages of growth and development of insects (Isman, 2006) [10]. Also, Maria *et al.* (2016) [14] noted that the average damage caused by the thrips insect on onion plants in the untreated plots was higher than that of the plots treated with cinnamon oil and orange oil. And Ali *et al.* (2011) [5] studied the effectiveness of some natural oils mixed on the thrips insect, and he concluded that a mixture of cottonseed oil with lemongrass oil at 0.5% caused a reduction rate of up to 100% in the adult stages of the thrips insect.

Also, Shiry *et al.* (2021) [20] reported that neem oil containing the active substance azadirachtin can affect 90 % sucking piercing pests that attack eggplant plants. They also recorded that all samples collected from eggplant plants that were treated with neem oil did not contain any residue of this oil. The effect of neem oil is that it acts as an inhibitor to feeding and preventing moulting, which leads to incomplete growth stages of the insect and thus reduces its number in the field.

2. Phytotoxicity of some oils on seeds of onion plant

Table (3) shows the effect of different concentrations of different oils in terms of germination percentage (G %), survival % (S %) (Figure 1), stem length, root length and RSL ratio. The results showed that mint oil (1 and 2) had the highest effect on the (G %) and (S %) which reached 91.67% and 88.33%, respectively for (G %) and for (S %) mint (1 and 2) recorded 83.33 %, and also 76.67 % for mint

(3) compared to the control, which recorded 86.67 %, then neem oil at a concentration 3 ml./ L which recorded 86.67 %, In addition, there were significant differences between all treatments, except for the control, peppermint oil and neem oil (3). no significant between them. Neem oil recorded 86.67 % for (G %). And 80 % for (S %). But it was observed that the lowest (G %) and (S %) of onion seedlings were 30 % and 31.67 % respectively at the highest concentration of lemon oil (3 ml/L).

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Also, the result appeared to have no significant deferent for the treatments with mint oil (1 and 2 ml/L) and mineral oil (10 ml/L) with control (11.5 %) for shoot length (cm) which recorded for mint oil (1 and 2 ml/L) 10.5 % for both and 10.17 % for mineral oil. While in the other treatments it was less than the control and the lowest shoot lengths were in the treatment with neem oil at a concentration of (7 ml/L) and mineral oil at a concentration of (15 and 20 ml/L), by statistical analysis it was found that no significant between them. But in the root length, there was a significant difference for all concentrations of different treatments with the control, which recorded 9.17 cm, while the best of these lengths immediately after the control was the treatment with peppermint oil at a concentration of (2 and 3 ml/L) which recorded 8 and 7.67 (cm) and mineral oil at a concentration of (10 ml/L) which recorded 7.10 (cm), and it was found that there was no difference between them.

The result appeared as the RSL% and was calculated

because this ratio is very important to know the functional balance between the process of photosynthesis and the process of water absorption by the roots. In Table (3), it was noted that this percentage was the highest in the case of

seeds not treated with oils, as it was 0.8%, and this percentage decreased in all treatments as the concentration increased except the treatment with mint oil at concentration 3 ml/L which recorded 0.94 %.

Table 3: Effect of some oils on morphological traits on seedling of onion (*Allium cepa*) under semi-field conditions.

Treatments	Con. (ml/l)	Germination%	Survival%	Root length (cm)	Shoot length (cm)	Root shoot length (RSL %)
Control	0.0	86.67 ^{ab}	86.67 ^a	9.17 ^a	11.50 ^a	0.80 ^b
Lemon oil	1	56.67 ^{cde}	58.33 ^b	6.50 ^{cd}	9.00 ^{cde}	0.72 ^{bcd}
	2	53.33 ^{de}	56.67 ^b	5.03 ^{ef}	8.17 ^{def}	0.61 ^{de}
	3	30.00 ^f	31.67 ^c	4.93 ^{ef}	7.70 ^{efg}	0.64 ^{cde}
Neem oil	3	86.67 ^{ab}	80.00 ^a	6.97 ^{bcd}	9.17 ^{bcd}	0.76 ^{bc}
	5	66.67 ^c	60.00 ^b	5.17 ^{ef}	8.00 ^{def}	0.64 ^{cde}
Mint oil	7	60.00 ^{cde}	55.00 ^b	4.20 ^{fg}	6.63 ^{gh}	0.63 ^{cde}
	1	91.67 ^a	83.33 ^a	6.00 ^{de}	10.50 ^{ab}	0.58 ^e
	2	88.33 ^{ab}	83.33 ^a	8.00 ^b	10.50 ^{ab}	0.76 ^{bc}
Mineral oil	3	80.00 ^b	76.67 ^a	7.67 ^b	8.10 ^{def}	0.94 ^a
	10	63.33 ^{cd}	60.00 ^b	7.10 ^{bc}	10.17 ^{abc}	0.70 ^{bcd}
	15	56.67 ^{cde}	51.67 ^b	5.17 ^{ef}	6.83 ^{gh}	0.75 ^{bc}
	20	50.00 ^e	56.67 ^b	3.83 ^g	5.50 ^h	0.69 ^{bcd}

Values in each column followed by the same letter are not significantly different at P ≤ 0.05.

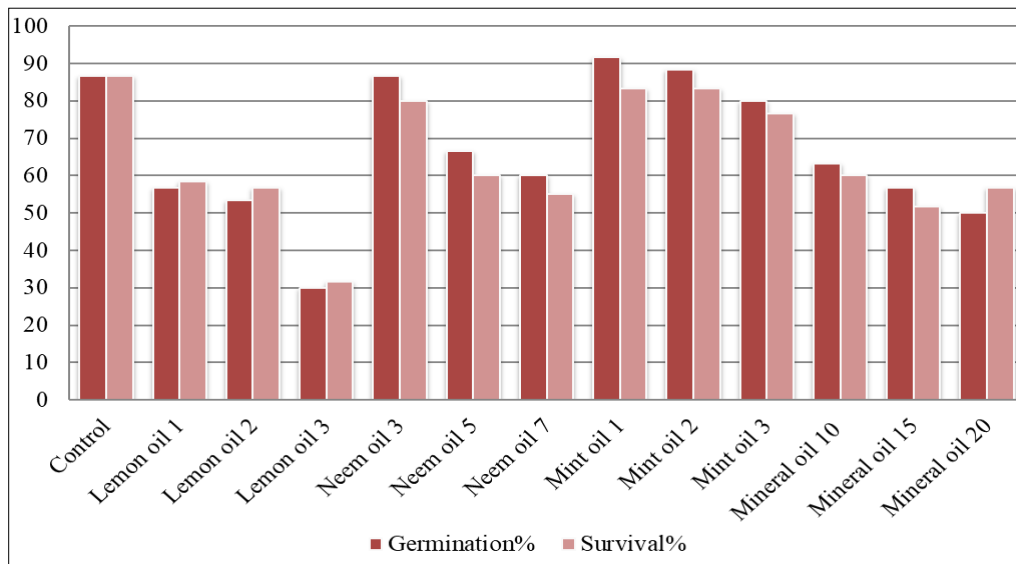


Fig 1: Effect of different concentrations from treatments in the germination % and survival %.

Table (4) indicates the percentage of phytotoxicity (P %) of control was 0.0%. The results in this table showed also that there were no significant differences among mineral oil (10 and 20 ml/L) (Which were recorded at 60 and 68 %, respectively), neem oil (3 and 5 ml/L) (they were recorded 60 and 66.83 % respectively) and lemon oil (3 ml/L) (Which

was recorded 60.33 %). The result also indicates that the highest phytotoxicity was for mineral oil at a concentration of 20 ml/L which reached 68.0%, while the treatment with peppermint oil was the least in terms of phytotoxicity, as it recorded 33.4% at a concentration of (3 ml/L).

Table 4: Phytotoxicity of some oils on seedling of onion (*Allium cepa*) under semi-field conditions.

Treatments	con	Phytotoxicity %	Tolerance index %	Seedling vigor index
Control	0.0	0.00 ^h	0.00 ^f	3150 ^a
Lemon oil	1	52.40 ^{cd}	0.68 ^d	1350 ^{fg}
	2	58.3 ^{bcd}	0.58 ^e	1200 ^{gh}
	3	60.33 ^{abc}	0.76 ^{bc}	740.0 ⁱ
Neem oil	3	60.00 ^{abc}	0.58 ^e	1988 ^t
	5	66.83 ^{ab}	0.77 ^b	1626.7 ^e
	7	42.93 ^{ef}	0.67 ^d	1330 ^{fg}
Mint oil	1	33.63 ^g	0.76 ^{bc}	2703.3 ^b
	2	40.8 ^{fg}	0.88 ^a	2813.3 ^b
	3	33.4 ^g	0.69 ^d	2433.3 ^c
Mineral oil	10	60 ^{abc}	0.70 ^{cd}	1466.7 ^{ef}
	15	50.00 ^{de}	0.71 ^{bcd}	1233.3 ^{gh}
	20	68.00 ^a	0.57 ^e	1033.3 ^h

Values in each column followed by the same letter are not significantly different at P ≤ 0.05.

As for the tolerance index there were significant among different concentrations of the treatments and the control which recorded 0 %. The highest of these percentages was 88 %, which was achieved by the treatment with peppermint oil at a concentration of 2 ml/L, then followed by the treatments with neem oil, lemon, mint, and finally the mineral oil, which had no significant differences between them at specific concentrations, such as treatment with each of neem at a concentration of 5 ml/L which scored 77 %, lemon oil at a concentration of 3 ml/L and mint at a concentration of 1 ml/L both scored 76 % and mineral oil at a concentration of 15 ml/L which recorded 71%. When analyzing the results obtained from Seedling Vigor Index (SVI); there was a significant among the control and all the different concentrations of the treatments, while the highest value of Seedling Vigor Index was recorded in the control and its value was 3150. Then followed by the treatment with Mint oil at a concentration of (1 and 2 ml/L) which scored (2703 and 2813), respectively. In contrast to the control, the lowest of these values for the Seedling Vigor Index resulted from the treatment with Lemon oil at a concentration of 3 ml/L which was recorded (740).

Paudel and Gupta (2009) ^[16] studied the effect of some essential oils on seed germination of *Parthenium hysterophorous*, they found that eucalyptus, lemongrass and camphor oils significantly at ($P < 0.05$) decreased seeds germination to all concentrations. And, Sarić-Krsmanović *et al.* (2019) ^[19] tested some essential oils on germination and seedling growth of velvetleaf, they showed that reduce of seed germination, radical length, shoot of velvetleaf with increasing of essential oils concentration. Also, obtained that thyme and lemon balm more powerful bio-herbicidal effects compared other oils.

Lokesh *et al.* (2021) ^[12] studied the effect of some plant oils on the storage of onion (*A. cepa*) seeds. They recorded that treated with neem oil (10 ml/Kg seeds) were better seeds quality with 65.67% of germination, these results agree with our study.

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