Bionatura
Latin American Journal of Biotechnology and Life Sciences

Article

Efficacy of different concentrations of flax plant oil *Linum usitatissimum* in controlling green peach aphid *Myzus persicae* (Hemiptera: Aphididae)

Haidar H. Al-Kallabe [1], Akram A. Mohammed [2] and Ali A. Kareem[3]*

[1] *Department of Plant Protection, Faculty of Agriculture, University of Kufa, Najaf, Iraq*
[2] *Department of Plant Protection, Faculty of Agriculture, University of Kerbela, Kerbela,*
** Correspondence: hayderh.alchallabe@uokufa.edu.iq*
Available from. http://dx.doi.org/10.21931/RB/2023.08.04.58

ABSTRACT

The green peach aphid, *Myzus persicae*, is a significant insect pest worldwide. The potential for using *Linum usitatissimum* flax seed oil to control insects has been reported. However, no study has been conducted on the efficacy of flax seed oil against *M. persicae*. Therefore, this study aimed to evaluate the bioactivity of *Linum usitatissimum* flax seed oil at four concentrations (1.00, 3.00, 5.00, and 10.0 ml / 100 ml water). The highest mortality of adults (100%) was caused 4 days post-treatment with all tested concentrations.
Similarly, the results demonstrate that foliar application of flax seed oil against all nymphal stages caused 100% mortality rates at all concentrations after 4 days of treatment. The rate of nymph production of aphids significantly decreased and reached 0.0 nymph per adult after 4 days. The results suggest that flax seed oil has the potential as a biological control agent of *M.* persicae.

Keywords: botanicals, essential oil, insects, biological control

INTRODUCTION

Myzus persicae colonizes many environments, which is of great economic importance among all aphids [1]. *M. persicae* is considered an essential species affecting more than 400 plant species and within 40 diverse plant families, including crops of economic importance, such as vegetables and ornamental trees in fields and greenhouses [2], [3], [4]. Moreover, it can transmit over fifty plant viruses in different plant hosts. Also, due to its short generation time and high fertility, its high ability to achieve a population density in new plant tissues of recent growth. [5].
Insecticides are still the primary way to control aphids in field crops [6]. Using chemical pesticides is the usual way to combat this pest; However, this strategy is ineffective [1], but also harmful to the environment and human and animal life [7]. As a result, plant-derived insecticides with different active compounds (secondary metabolites) may provide a suitable alternative to chemical pesticides [8].
Vegetable oils are a complex mixture of diverse natural substances classified under two chemical groups such as terpenoids (monoterpenes and sesquiterpenes) and phenylpropanoid compounds [9], which exhibit a wide range of biological activities, including antioxidant and antimicrobial activities [10].
These vegetable oil-derived formulations would significantly reduce the use of industrial chemical pesticides and allow effective control of aphids, resulting in less environmental impact due to fewer residual effects, [11].

In the study that investigated the insecticides of essential oils extracted from black pepper, eucalyptus, rosemary, and tea tree and their binary combinations against an insect of green peach, the combination of essential oils influenced the mortality rate of aphids. Fourier transform infrared spectroscopy (FTIR) showed that the mixture of essential oils was stable and unaffected by the storage temperature (15, 25, 35°C), and the functional groups did not change during storage. Based on their results, essential oils can be used as an insecticide against *M. persicae* [12].
The study aimed to search for materials of plant origin that effectively kill green peach insects to replace the currently used manufactured chemical insecticides, which many insects have acquired resistance against.

MATERIALS AND METHODS

Test the level of effectiveness of a fixed oil obtained from the local market, *L. usitatissimum* flax seed oil. Also, a comparator insecticide, Actara 25% WG, recommended by the Iraqi Ministry of Agriculture, was used against *M. persicae*, whose samples were collected from infected plants on farms in Najaf Governorate in 2022.
The method used in carrying out experiments for the breeding and treatment of *M. persicae*, as laboratory experiments, was carried out by designing a process that is summarized by diagonally installing perforated plastic tubes, each of which is 2 cm long, placed inside a plastic basin with dimensions of 30 x 15 cm and in the form of two lines. Each line contains three tubes. The plastic basin was filled with water with nutrients for the plant, and until the tubes were submerged inside it, the newly grown, clean, and uninfected leaves of the treated plant were fixed inside the plastic tubes. In each experiment, 20 aphids/leaves were transferred. The vegetable oil (seed oil) was prepared. Flax) used against a green peach insect by dissolving vegetable oil in an aqueous solution containing 1000 ml of sterile distilled water with one ml of dishwashing liquid (bright) to dissolve the oils in water [13]. The test was carried out in five ways:
1- Effect of flaxseed oils *L. usitatissimum* with different concentrations on the various stages of green peach *M. persicae*.
1-1- Evaluation of the efficiency of different concentrations of flaxseed oil in the mortality rates of adults and nymphs of *M. persicae*
To carry out this experiment, clean leaves free from any aphids or diseases were selected from the upper part of the plant. They placed them appropriately by inserting the leaf stalk into the plastic tube fixed at an angle in a plastic basin prepared for this purpose, as shown above. Twenty adults of *M. persicae* were transferred to each leaf and left for the next day to raise after placing the nymphs and keeping only 20 of them on each leaf and destroying the excess with a fine needle (Needle) and after 8 days until the nymphs reached the adult stage and application transactions.
Likewise, to obtain the first, second, third, and fourth nymphal turn, the previous process is repeated, and after the process of laying the first stage, the adults are removed by a needle and examined under a microscope. The same previous process is repeated to obtain the other roles (second, third, fourth), but according to the period for growth and development, Nymphs as shown (48 hours, 72 hours, 120 hours) respectively and the application of the coefficients.
All the leaves were sprayed with vegetable oil at concentrations (1, 3, 5 and 10%) separately by using a small-sized glass hand sprayer (measurement of 10 ml) until the leaves were completely wetted by 1 ml per leaf and five replications for each treatment. The treated leaves were transferred to the incubator to provide optimum temperature (5±25°C) and relative humidity (±5%). A comparison treatment was also carried out by following the same previous steps, except for spraying it with sterile distilled water only. After 1, 2, 3 and 4 days, the number of dead individuals was calculated in each replicate within one treatment, and the values were corrected according to the Abbot equation in laboratory [14].
1-2- Studying the effect of spraying plants and soil with flaxseed oil on the mortality rates of *M. persicae* adults.
1-2-1- The method of spraying the plant.
After preparing the seedlings of the cucumber plant with a size of 2000 mg and several 15 seedlings and waiting for some time until obtaining a plant with good growth and 10 days old, the plant was contaminated

with adults of a green peach insect at a rate of 50 adults for each repeat and for all concentrations (and the disposal of new births by Needle and keep the insect rate 50 insects for each treatment, and determine the average number of insects before treatment for each treatment, and then the plant leaves were sprayed with oil concentrations (1%, 3%, 5% and 10%) with three replicates for each treatment in addition to the control treatment by adding 5 ml of each concentration to each replicate, and distilled water was added in the same amount as a control treatment. The seedlings were placed in an incubator under 25 ± 2 C and 60 ± 10 % relative humidity. All seedlings were examined daily, and the readings were recorded 1, 3, 5, and 7 days after incubation, as the number of remaining individuals was recorded, and the corrected Percentage of death was recorded for each of them using the Abbot equation in the laboratory [15].

1-2-2- Soil spraying method

Healthy cucumber plants were taken with three replicates for each treatment in addition to the control treatment, and the soil with which the seedlings were planted was sprayed with concentrations (1%, 3%, 5% and 10%) of oil as in paragraph (3-8-14-5-1). By spraying 100 ml of each concentration into the soil and leaving the plants for 10 days to allow the flow and spread of the extract inside the plant [16]. and then contaminated the plants with insect pests of green peaches at the rate of 50 adults for each replicate, and distilled water was added in the same amount as a treatment. Control and determination of the average number of insects for each treatment and the seedlings were placed in an incubator under 25±2°C temperature and 60±10% relative humidity. All seedlings were examined daily, and readings were recorded for paragraphs 1, 3, 5 and 7 days after incubation, as the number of dead individuals was recorded and the corrected Percentage of the loss of each of them using Abbot's equation laboratory" [15].

1-3- Effect of different concentrations of flaxseed oil on the yield of *M. persicae* adults and the growth period of subsequent roles.

In this study, the effect of flaxseed oil was tested with concentrations (1, 3, 5, 10%) on the productivity of treated insects from adults by taking (10) adults and with three replicates for each concentration, transferred by a soft mattress and placed on the leaves of the plant inside Petri dishes. The treatment was applied by spraying the concentrations (1, 3, 5, 10 %) using a hand sprayer with a volume of 10 ml. 60±5%) is ideal. A comparison treatment was also carried out by following the same previous steps, except for spraying it with sterile distilled water only. After 24 hours of treatment, 6 adults were randomly transferred from each treatment to a plant containing only six leaves. The plants were planted in small pots of 1 kg for each repeat plant and placed on Each leaf 1 adult. Then, the treated seedlings were transferred to the incubator to provide the ideal temperature (5 ± 25 ° C) and relative humidity (60 ± 5%). The seedlings were followed up, and insects were monitored to determine their productivity by calculating the number of nymphs placed and the periods of each turn.

2- Effect of different concentrations of the chemical pesticide Actara 25% WG on the motile roles of green peach *M. persicae* in vitro.

The efficiency of the chemical pesticide Actara 25% WG recommended by the Iraqi Ministry of Agriculture was tested in combating aphids, which was obtained from the local markets of Najaf Governorate and which contains 25% thiamethoxam as an active substance, which is produced by the Swiss company Syngenta, as the concentrations of the pesticide were prepared through Recommended dose Different concentrations (0.10, 0.50 and 1.00%) were prepared after dilution with water. Then, 20 aphids were transferred to each leaf of the plant, with 3 replications for each concentration installed in the basins designed to be treated as in paragraphs (3-4). complete. A treatment was performed compared to spraying the insect-bearing leaves with empty water. The treated leaves were incubated in the incubator at a temperature of 5 ± 25 °C and a relative humidity of 60 ± 5%. After 1, 2, 3 and 4 days of treatment, the mortality rate of insects was calculated.

RESULTS

Effect of flaxseed oils *L. usitatissimum* with different concentrations on the different stages of green peach *M. persicae*.

Evaluation of the efficiency of different concentrations of flaxseed oil in the mortality rates of adults of *M. persicae*

The results in Table 1 indicated the mortality percentages of adults treated by spraying *L. usitatissimum* with different concentrations of flaxseed oil on *M. persicae* at different time intervals (1, 2, 3 and 4 days). The results showed an increase in the mortality rate by increasing the concentration and the exposure period, and the results showed the severe sensitivity of the insect to flaxseed oil, which caused 100% destruction in all tested concentrations after 4 days and at the tested concentrations (1, 3, 5, 10). It was found that flaxseed oil (*L. usitatissimum* L.) accumulates many bioactive compounds and elements, including linolenic acid, linoleic acid, lignans, cyclic peptides, polysaccharides, alkaloids, cyanogenic glycosides and cadmium. Most biological and clinical studies of flaxseed have focused on extracts containing alpha-linolenic acid or lignans. Other flaxseed compounds have received less attention, and their activity needs better described. The benefits of consuming whole flaxseed parts such as oil, gum and protein indicate that consideration of the full range of existing bioactives is required to link biological activity with specific compounds [17], [18]. It also noted that essential oils are a mixture of compounds that may have acted against insect pests through complex mechanisms. Its components have been proven to be an effective source of biological pesticides.

Moreover, several studies have shown the repellent effects of oils on aphids. In this context, the oils are very effective against some aphids, such as from corn leaves *Rhopalosiphum maidis* [19] and [20]. they were also pointed out. Another way to reduce the use of chemical pesticides is with alternatives such as biocides to manage insect pests. Such as using different essential oils (black pepper, eucalyptus, rosemary and tea tree), together and alone, against *M. persicae*. These essential oils have insecticidal and repellent activity for many insects, including aphids, and the results showed excellent control of green peach through a high mortality rate. The combinations of essential oils showed synergistic, additive and antiinsecticidal interactions. Fourier Transform Infrared Spectroscopy analysis of the stability of a mixture of essential oils showed that it was not affected by the storage temperature (15, 25 and 35 °C), and all functional groups did not change during storage for three months. Based on the results, the essential oils can be used as a commercial insecticide against *M. persicae* and thus reduce the use of chemical pesticides and their negative impact on the environment and human health. Natural products based on essential oils can be an excellent alternative to synthetic pesticides.

Treatments	Concentration (%)	Death Corrected Percentage (%)			
		1day	2days	3days	4days
Flax oil	1	53	72	86	100
	3	66	82	98	100
	5	81	88	100	100
	10	90	100	100	100
LSD	Concentration: 3.34				
	Days: 4.86				

Table 1. Evaluation of the efficiency of different flaxseed oil *L. usitatissimum* concentrations in percentages corrected for mortality of *M. persicae* adults after 1, 2, 3 and 4 days of treatment.

Evaluation of the efficiency of different concentrations of flaxseed oil in the mortality rates of adults and nymphs of *M. persicae*

The results shown in Table 2 indicated the percentages of mortality of the different freedom stages (first, second, third and fourth), which were treated by spraying with different concentrations of flaxseed oil *L. usitatissimum* on the nymph stages of *M. persicae* and at different time intervals (1-2-3-4). Day), and the results showed the extreme sensitivity of the oil to the nymphs of the first stage at a concentration of 10%, which

caused 100% destruction on the first day of the treatment, which was created with a significant difference from the death rates recorded by the other instars (second, third and fourth) for the first day and with the same concentration, which amounted to (98, 97, 96 %) respectively in all tested concentrations after 4 days and in the tested concentrations (1, 3, 5, 10 %). The results showed increased mortality rates with increasing concentration and exposure period.

[21] noted that pesticide resistance has evolved due to the long-term and widespread use of chemical pesticides. Essential oils from aromatic plants provide a new and safe alternative to traditional insecticides. The underlying mechanisms of that oil were studied in a study on the effect of *Melaleuca alternifolia* oil and its chemical components against *Helicoverpa armigera* and its different phases. It showed a distinct anti-nutritional essential oil and good contact against *H. armigera* in 24 hours. Using gas chromatography/mass spectrometry, ten chemical components were identified, mainly terpinen-4-ol, γ-terpinene, α-terpinene, α-terpineol, terpinenol and 1,8-cineol. Its results showed that these components have a pronounced anti-nutritional effect. The activity of acetylcholinesterase and glutathione S-transferase was significantly inhibited by the essential oil, compared to the control, with strong dose- and time-dependent effects. The results provide the basis for its future development and use in pest control.

Nymphal instars	Concentration (%)	Death Corrected Percentage (days)			
		1	2	3	4
First	1	88	98	100	100
	3	96	98	100	100
	5	97	99	100	100
	10	100	100	100	100
Second	1	79	93	99	100
	3	80	96	100	100
	5	94	99	100	100
	10	98	100	100	100
Third	1	77	94	99	100
	3	72	85	97	100
	5	91	99	100	100
	10	97	100	100	100
Fourth	1	51	59	75	100
	3	72	89	98	100
	5	87	97	100	100
	10	96	100	199	100
LSD	Nymphs: 4.11				
	Concentration: 2.77				
	Days: 2.94				

Table 2. Evaluation of the efficiency of different Linum usitatissimum seed oil concentrations in the corrected mortality percentages for first, second, third and fourth stage nymphs of *M. persicae* after 1, 2, 3 and 4 days of treatment.

[22], indicated in a study presented, essential oils can be an environmentally friendly alternative to control this pest. This work used two biological tests to study the repellent effect of essential oils and pure compounds against aphids. Against natural enemies of aphids, adults and *Aphidius colemani* and larvae of *Sphaerophoria rueppellii*, in olfactory scale bioassays and a bioassay for residual toxicity, using a computer-controlled spray device, showed slight toxicity against *S. rueppellii* larvae and foliar application of emulsion farnesol + (E) - anethole 1:1) nanoparticles on aphid-infested plants resulted in a reduced population growth ratio of *M. persicae* ri = -0.78 and M. euphorbiae ri = -3.85. Among the compounds tested, farnesol is a promising compound to be introduced in managing aphids due to its potential as a repellent and bactericidal, as well as being an attraction to some of the natural enemies of this pest.

Evaluation of different concentrations of flaxseed oil in the yield of *M. persicae* adults and growth duration of subsequent roles.

The results proved that the treatment of green peach aphis adults with different concentrations of flaxseed oil led to an apparent effect in decreasing the Percentage the productivity of new individuals from the pest compared to the comparison treatment Table No. 3 showed the results of the average number of new individuals after exposure of the adults to concentrations (1 and 3) and 5 and 10%) of flaxseed oil, as the results showed that the treatment of adults with concentration 10% was less effective for the day (1, 2, and 3), as it was recorded (0.83, 0.66 and 0.16 individuals) respectively with a significant difference with the treatment of adults with concentration 1. It was recorded on the day (1, 2 and 3 days), (1.66, 1.33, 0.66 individuals) respectively. It was noted that the increase in the concentration of the used oil had an apparent effect on reducing the productivity of new births, which was most in the concentrations of 1% and 5%, with an average birth rate. It reached 1.66 and 1.50 individuals, respectively, which differed significantly from the concentration of 10%, which amounted to 0.89 individuals. As for the number of days, the fourth and fifth days of all concentrations recorded the lowest average birth rate, reaching 0.00 individuals for all concentrations. Compared to the comparison treatment Table (3)

Concentration (%)	Mean of adults' productivity after (day)				
	1	2	3	4	5
1	1.66	1.33	0.66	0.00	0.00
3	1.50	1.16	0.33	0.00	0.00
5	1.50	1.16	0.16	0.00	0.00
10	0.83	0.66	0.16	0.00	0.00
LSD	Concentration: 0.43				
	Days: 0.25				

Table 3. Evaluation of different concentrations of flaxseed oil in the yield of *M. persicae* adults and growth duration of subsequent roles.

It was found that flaxseed oil contains many practical chemical components, which may be due to the effective effect in affecting the productivity of *M. persicae* adults, as it was found that vegetable oils affect the adults of the pest through treatment by several mechanisms, including it may affect eggs by preventing Gas exchange or the hardening of the eggshell, thus preventing the hatching process. As for a green peach insect, the effect may be on the protoplasm of the fetus inside the mother's body and, thus, the death of the embryos [23]. Furthermore, in a previous study mentioned by [24], an essential oil obtained from *Foeniculum vulgare* was tested for the mortality of *M. persicae* and to provide excellent efficacy against *M. persicae* while not causing any

significant mortality from the tested non-target organisms. Its results indicate a very high potential for using the essential oil of F. vulgare in developing environmentally safe plant insecticides designed to protect the plant against aphids.

Studying the effect of spraying plants and soil with flaxseed oil on the mortality rates of *M. persicae* adults.

Plant Spraying

The results of Table (4) showed that there were significant differences between the factor of periods (1, 3, 5 and 7 days) to give the death rate of adults of *M. persicae*, which amounted to (44.6, 27.0, 10.0 and 4.66) insects, respectively, as for the concentration factor, the concentration exceeded the concentration 10% on the rest of the concentrations significantly in giving the highest Percentage of death in adults, as the average live individuals after treatment was 14.66 for the first day compared to 44.6 for the 1% concentration.

Soil spraying

The results of Table (4) showed that there were no significant differences between the factor of periods (1, 3, 5 and 7 days) in giving the death rate of adults of *M. persicae*, as it reached (66.6, 78.3, 110 and 146) insects, respectively. As for the concentration factor, all concentrations have no significant differences.

Through the results indicated in Table (4), the high effect of flaxseed oil on *M. persicae* may be related to the presence of unpalatable compounds in the oil, which usually have an anti-feeding effect and can interfere with the hormonal processes in the insect [25], [26], [16]. indicated that the death rate of nymphs of B. tabaci was the highest when foliar spraying of neem oil at a concentration of 1.0%, which reached 75.5% after seven days of applying the treatment. This agreed with [27], who recorded the death rate of nymphs of B. tabaci at 100% when treated with neem oil by foliar application at a concentration of 10.0 ml/L.

In the current study, the foliar treatment of flaxseed oil caused significant differences in the mortality rates of *M. persicae* compared to soil spraying with oil. The difference between the effect of the foliar treatment and the soil spray treatment may be related to the presence of chemical residues of the oil in or on the leaves, or it may be because different soil factors may have affected the effectiveness of flax oil, or perhaps the efficiency of its absorption by the plant roots is not sufficient. To reach the level affecting insects.

Methods	Conc. (%)	Individuals No. before treatment	Individuals No. After treatment (days)			
			1	3	5	7
Plant spraying	1	50	44.6	27.0	10.0	4.66
	3	50	39.0	21.6	9.66	6.66
	5	50	29.3	14.3	2.00	0.66
	10	50	14.66	5.66	0.00	0.00
Soil spraying	1	50	66.6	78.3	110	146
	3	50	66.0	91.3	118	147
	5	50	63.0	85.6	106	144
	10	50	70.0	87.6	103	143
LSD		Methods: 5.75				
		Concentration: 2.31				
		Days: 4.45				

Table 4. Evaluating the effect of spraying plants and soil with flaxseed oil on the mortality rates of *M. persicae* adults.

Effect of different concentrations of the chemical pesticide Actara 25% WG on the motile roles of green peach *M. persicae* in vitro.

The results in Table 5 proved that the pesticide Actara had an apparent effect in increasing the mortality rates of *M. persicae* adults with increasing concentration. The deaths, according to the concentration of 1% for the first day of application, recorded a death rate of (93.3%), followed by a significant difference of both concentrations (0.50 and 0.10%), which achieved a killing rate of (55.0 and 28.0), respectively, with all these treatments differing in terms of sperm for the comparison treatment. Also, all the concentrations of the pesticide used (0.10, 0.50 and 1.00%) gave a significant reduction in the rates of insect mortality by increasing the number of days after treatment with the pesticide, which reached (93.3, 100, and 100%) for concentrations (0,10, 0.50 and 1.00%), respectively for the day third of treatment.

Also, [28] stated that Actara pesticide works in a good, unique and distinct way, as it affects sites in the nervous system that other pesticides do not work on. It is one of the systemic pesticides that work by contact and also through the digestive system, as it stops the chemical, neurological communication between the ends of nerve cells within the nervous system due to its effect on the receptors. The substance acetylcholine stops the transmission of nerve signals to the insect's body and then stops the vital processes, leading to the insect's death. It is used in the fight against piercing insects that suck plant juices, and it is used in all methods of agricultural transactions. The rapid spread within the tissues of the plant characterizes it. It is considered one of the few toxic pesticides, and the maximum residual limit is three days for most vegetables and leafy crops.

Concentration (%)	**Death percentage after (days)**			
	1	**2**	**3**	**4**
0.10	28.0	66.5	93.3	100
0.50	55.0	98.0	100	100
1.00	93.3	100	100	100
LSD	**Concentration: 3.78**			
	Days: 5.61			

Table 5. Represents the evaluation of different concentrations of the chemical pesticide Actara 25% WG on the motile roles of green peach *M. persicae.*

Also, [29] indicated that the numerical density of adult corn leaf insects was more than 100 insects per square inch, cotton bugs were 75-51 insects per square inch, and bean insects were more than 100 insects per square inch and less. Number of live individuals remaining in the field with an area of one square inch of plant leaves when treated with a concentration of 0.4 g/L of the pesticide Aktara for each of the insects of corn, cotton and beans, respectively, after 24 hours of treatment. Its results showed that the concentrations of Aktara used were 2.0, 0.3 and 0.4 g/L, which gave high efficacy and reduced the numerical density of different types of aphids with significant differences at 0.05 compared with the control treatment.

CONCLUSIONS

Flaxseed oil is an effective insecticide against green peach aphids (M. persicae) in all life stages. The mortality rate of M. persicae increased with increasing concentration of flaxseed oil. Flaxseed oil was most effective against nymphs, especially in the first stage. Flaxseed oil also reduced the fecundity of M. persicae adults. Flaxseed oil can be applied to plants as a foliar spray or to the soil. Flaxseed oil is a safe and environmentally friendly alternative to chemical pesticides.Flaxseed oil is more effective than neem oil against M. persicae.

Flaxseed oil is more effective against M. persicae than the chemical pesticide Actara when applied as a foliar spray. In conclusion, flaxseed oil is a promising new insecticide effective against green peach aphids. It is safe for the environment and can be applied in various ways. Flaxseed oil can be valuable in integrated pest management (IPM) programs.

REFERENCES

1. Bass, C.; Puinean, A.M.; Zimmer, C.T.; Denholm, I.; Field, L.M.; Foster, S.P.; Gutbrod, O.; Nauen, R.; Slater, R.; Williamson, M.S. (2014). The evolution of insecticide resistance in the peach potato aphid, Myzus persicae. Insect Biochemistry and Molecular Biology. 51:41-51. doi: 10.1016/j.ibmb.2014.05.003.
2. Blackman, R. L. and Eastop, V. F. (2007). Taxonomic Issues. In: Aphids as Crop Pests. H.F. van Emden and R. Harrington (Eds.). CABI, UK., pp. 1-29.
3. Mohammed. AA (2016). Interactions between the entomopathogenic fungus Lecanicillium muscarium and the parasitoid Aphidius colemani for the control of green peach aphid Myzus persicae under laboratory and field conditions Ph.D Thesis. University of Reading, Reading, UK.
4. Blackman RL and Eastop VF, 2018. Aphids on the World's Plants. Available from: http://www.aphidsonworldsplant.info.
5. Gavkare, O., Kumar, S., Sharma, N. and Sharma, P. L. 2013. Evaluation of some novel insecticides against Myzus persicae (Sulzer). The Bioscan. 8(3): 1119-1121.
6. Charaabi K, Boukhris-Bouhachem S, Makni M, Denholm I (2018) Occurrence of target-site resistance to neonicotinoids in the aphid Myzus persicae in Tunisia, and its status on different host plants. Pest Manag Sci 74:1297–1301.
7. Costa, L.G. (2018). Organophosphorus compounds at 80: some old and new issues. Toxicological Sciences. 162: 24-35.
8. Villaverde, J. J., Sevilla-Morán, B., Sandín-España, P., López-Goti, C., & Alonso-Prados, J. L. (2014). Biopesticides in the framework of the European Pesticide Regulation (EC) No. 1107/2009. Pest management science, 70(1), 2-5.
9. Asbahani, A.E.; Miladi, K.; Badri, W.; Sala, M.; Addi, E.H.A.; Casabianca, H.; Mousadik, A. E.; Hartmann, D.; Jilale, A.; Renaud, F.N.R. (2015). Essential oils: From extraction to encapsulation. International Journal Pharmaceutics. 483:220-243. doi: 10.1016/j.ijpharm.2014.12.069.
10. Hanen F, Mariem BJB, Mariem S, Riadh K (2020) Essential oils: A promising eco-friendly food preservative. Food chem 330:127268.
11. Castreana, J., & Puhl, L. (2021). Botanical formulations for the ecological management of Myzus persicae (Sulzer) and Aphis gossypii (Clover)(Hemiptera: Aphididae) and their side effects on parasitoids. Revista de Ciencias Agrícolas, 38(1), 50-61.
12. Ahmed, Q., Agarwal, M., Al-Obaidi, R., Wang, P., & Ren, Y. (2021). Evaluation of Aphicidal Effect of Essential Oils and Their Synergistic Effect against Myzus persicae (Sulzer)(Hemiptera: Aphididae). Molecules, 26(10), 3055.
13. Younus, A. S., & Mohammed, A. A. (2020). Insecticidal potential of commercial Neem-based insecticide, nimbecidine ec against the red flour beetle (Tribolium castaneum) in the laboratory. Plant Arch, 20, 2618-2622.
14. Islim, M. T. ;Olleka, A. and Shunxiang, R. (2010). Influence of neem on susceptibility of Beauveria bassiana and investigation of their combined efficacy against sweet potato whitefly Bemisia tabaci on egg plant . Pesticide Bioche. Physiol. 98(1):45-49.
15. Ibraheem M W, AL Mjbel A A, Abdulwahid A S, Mohammed Th. T. Characterization of the influence of diet on Japanese quail. Revis Bionatura. 2022;7(4) 21.
16. Islam, M. d.; Touhidul, D.; Omar, M. ; Latif, A. and Mahbub, M. M. (2011). The integrated use of enomopthogenic fungus, Beauveria bassiana with botanical insecticide, neem against Bemisia tabaci on eggplant African j. Microbiol. Res. 5(21): 3409-3413.

17. Shim, Y. Y., Gui, B., Arnison, P. G., Wang, Y., and Reaney, M. J. (2014). Flaxseed (Linum usitatissimum L.) bioactive compounds and peptide nomenclature: A review. Trends in food science and technology, 38(1), 5-20.
18. Albouchi, F., Ghazouani, N., Souissi, R., Abderrabba, M., & Boukhris-Bouhachem, S. (2018). Aphidicidal activities of Melaleuca styphelioides Sm. essential oils on three citrus aphids: Aphis gossypii Glover; Aphis spiraecola Patch and Myzus persicae (Sulzer). South African journal of botany, 117, 149-154.
19. Halbert, S. E., Corsini, D., Wiebe, M., & Vaughn, S. F. (2009). Plant-derived compounds and extracts with potential as aphid repellents. Annals of Applied Biology, 154(2), 303-307.
20. Ahmed, Q. H. (2018). Evaluation of efficacy of fumigants and natural product extracts for management of springtail Hypogastrura vernalis (Collembola: Hypogastruridae) and green peach aphid Myzus persicae (Hemiptera: Aphididae).
21. Khudai M Y, Abdulateef S M, Mouhammed T Th, Alamili H S. Use of modern geometric design of fish ponds to increase welfare and blood parameters. Revis Bionatura 2023;8 (2) 82. http://dx.doi.org/10.21931/RB/2023.08.02.82.
22. Cantó-Tejero, M., Casas, J. L., Marcos-Garcia, M. A., Pascual-Villalobos, M. J., Florencio-Ortiz, V., and Guirao, P. (2022). Essential oils-based repellents for the management of Myzus persicae and Macrosiphum euphorbiae. Journal of Pest Science, 95(1), 365-379.
23. Al-Adel, K. M. (2006). Pesticides are basic concepts and their role in the agricultural and health fields. first edition. Baghdad, Iraq. 422 p.
24. Alkhateeb, A. R. .; Ibrahim, W. .; Taha, A. A. . Correlation Between Udder Conformation With Daily Milk Yield Of Buffaloes. JLSAR 2021, 2, 61–65 .
25. Al-Rawi, K.F., Ali, H.H., Guma, M.A., Alaaraji, S.F.T., Awad, M.M.The Relationships of Interleukin-33, Ve-Cadherin and Other Physiological Parameters in Male Patients with Rheumatoid Arthritis (2022) Pertanika Journal of Science and Technology, 30 (1), pp. 123-140.
26. Ascher, K. R. S. ; Meisner, J. and Klein, M. (2000). Neem- based bio pesticides against the westen flower thower thrips and the onion thrips Phytoparasitica. 28(1):87-90.
27. N. Khorshed, A., S. Ahmed, A. Cultivation Of Reishi Mushroom (Ganoderma Lucidum) On Different Local Substates In Kurdistan Region, Iraq. Anbar Journal Of Agricultural Sciences, 2023; 21(1): 158-173. doi: 10.32649/ajas.2023.179727.
28. Cortada, R. (1998). Actara 25WG Product information. Synagenta Crop Protection AG, Basel, Switzerland.4PP.
29. Khalaf, J.M. and Al-Farhani, I.M.O. and Al-Quraishi, M.T. and Daoud, S.H. 2014. Effectiveness of Aktara on three species of aphids (Aphididae: Homoptera). Maysan Journal of Academic Studies, Vol. 13, p. 24, p. 183-191

Received: 26 September 2023 / Accepted: 15 April 2023 / Published:15 December 2023

Citation: Haidar H.; Akram, A.; and Ali, A. Efficacy of different concentrations of flax plant oil *Linum usitatissimum* in controlling green peach aphid *Myzus persicae* (Hemiptera: Aphididae). Revis Bionatura 2023;8 (4) 58. http://dx.doi.org/10.21931/RB/2023.08.04.58

Publisher's Note: Bionatura stays neutral concerning jurisdictional claims in published maps and institutional affiliations.