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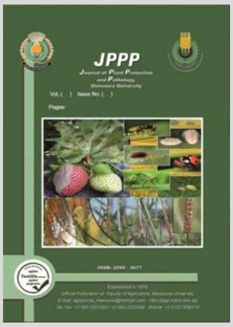
Could Organic Pesticides Be a Good Alternative to Synthetics in Controlling Aphids and Leafhoppers in Tomato Fields?

Hala A.* and S. A. Gaffar*

Central Laboratory for Organic Agriculture, ARC, Egypt



ABSTRACT

We aimed in this investigation to prove that organic pesticides (neem oil and a mixture of cottonseed and sunflower oil) can replace synthetics (malathion) in controlling aphids and leafhoppers attacking tomato under field conditions. The experiment was laid out in a randomized complete block design, during two successive seasons; 2018 and 2019 in a total area of 0.5 ha. Both yellow sticky traps and plant sampling methods were used. Data analyses revealed that the mixture of cotton and sunflower oil gave the highest control levels of both leafhoppers and aphid *Myzus persicae* (Sulzer). Leafhoppers were much more susceptible to all the applied compounds than aphids. Oil mixture proved to be either higher or equal to malathion in its efficiency. Neem oil was less efficient on both pests than malathion. Effectiveness of all tested compounds highly decreased after 14days post treatment. The highest control levels of both pests occurred after three consecutive treatments. Accordingly, cottonseed oil mixed with sunflower oil is very promising in controlling those two pests and can replace malathion in IPM programs in tomato fields in Egypt, taking into consideration repeating the application for three consecutive times with maximum one week between sprayings. Thus, the answer to the study title according to our research is "yes they could" provided that farmers' awareness is raised concerning shifting towards those organic compounds and training them on using such safe, eco-friendly and cost effective natural products is taking into consideration to achieve agricultural sustainability.

Keywords: Cottonseed; sunflower oil; neem; leafhoppers; aphids and tomato

INTRODUCTION

Tomato (*Lycopersicon esculentum* L.) occupies an advancing position among horticultural crops in Egypt in terms of production volume which approximately reached in 2017 about 7.3 million tons (Amna, 2019). It also occupies the largest cultivated area with about 197 thousand ha representing 22.1% of the total vegetables area in the country. In addition, tomato is the most consumed vegetable crop with an annual average of 60 kg representing more than 40% of the average per capita consumption of vegetables (Siam and Abdelhakim, 2018).

However, insect pests remain one of the most significant constraints to tomato production. Tomato plants and fruits are attacked by many destructive insect pests in the field, from the seedling stage till harvesting. Several authors mentioned *Myzus persicae* Sulzer (Hemipter: Aphididae) and *Empoasca decipiens* Paoli (Hemiptera: Cicadellidae) as main pests attacking tomatoes (Shaheen, 1977, Abdallah and Hana, 2015, Blackman and Eastop, 2006, Ishtiaq, 2017).

Aphids' damage is considered among the most serious problems occur in agricultural and horticultural. The yield losses caused by aphid have been estimated to average about 30–50% annually (Ruberson, 1999). Investigations have identified 18 species of aphids attacking tomato in open-field and greenhouses. Thomas *et al*. (2018) carried out an in-depth review of literature and stated *Macrosiphum euphorbiae* (Thomas) and *M. persicae* as the only frequent and common aphid pests of tomato throughout the world.

Myzus persicae, is a small green aphid causing a growth reduction, leaves' shriveling and death of various tissues (Berry 1998). In addition, it produces a huge quantity of honeydew whose crystals act as a magnifying lens that burn plant tissues during sunny days. Moreover, it supports the growth of saprophytic fungi that blocks the stomata causing leaves to fall and impairs photosynthesis. Aphids also are capable of transmitting phytopathogenic viruses that increases plant damage to a high extent (Guerrieri and Digilio, 2008).

The green leafhoppers *E. decipiens*, on the other hand, is one of the most important economic hemipterans pests infesting a wide range of plants causing serious damage, whether directly or indirectly. They are strong fliers and much more mobile than aphids (Chandel *et al*., 2013). In addition, some are capable of transmitting pathogens, including phytoplasmas, bacteria, and viruses. Leafhoppers are considered one of the most serious and economically important pests of potatoes, tomatoes and other solanaceous crops in the Americas and New Zealand (Don, 2012). Injuries of leafhoppers start with a yellowing along leaflet margins, followed by a gradual browning, ending by the death of the leaflet, defoliation causing reduction in yield (Brust, 2013). Leafhoppers, have few natural enemies, therefore, insecticides are the only effective method to control this insect (Radcliffe, 1982).

Appropriate plant protection management strategy might assist in reducing losses in tomato quality and quantity (Siam and Abdelhakim, 2018). Most smallholder vegetable

*** Corresponding author.**
E-mail address: halaadel3528@gmail.com / saad_bio_organic@yahoo.com
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farmers rely on synthetic pesticides to reduce the damage caused by pests. The over and non-rational use of pesticides resulted in negative impacts on health and environment, increased resistance of pests and destroyed beneficial insects (Matthews, 2008, Dhaliwal *et al*. 2010, Gogo *et al*., 2014). *Myzus persicae* was identified as number one resistant insect which was found resistant to more insecticides than any other insect (Tetteh and Glover, 2008).

Members of the organophosphorus group (OP) are the most widely used pesticides, accounting for ~38% of total pesticides used globally (Post, 1998). The OP insecticides were first introduced as pest control agents over 50 years ago (Siegfried and Scharf, 2001). Continuous and excessive use of these compounds has contaminated several ecosystems in different parts of the world (Cisar & Snyder, 2000; Tse *et al*., 2004). Not only that these pesticides affected the environment, but also they have negative effect on the plant's growth and yield. In a study carried out by Gafar *et al*. (2011) in Sudan, they stated that malathion pesticide negatively affected the vegetative growth of potato and its yield. Furthermore, in Egypt, the most common insecticide used against tomato pests, especially aphids and whiteflies, is malathion (Shams El Din, 1991). In the current study we have used malathion insecticide aiming to prove that organic pesticides are capable of controlling aphids and leafhoppers in tomato fields with satisfied percentages of mortality, that in some cases exceeded malathion itself, which consequently could be completely abandoned.

To increase tomato value chain performance, dissemination of Good Agricultural Practices (GAP) replacing traditional ones should be followed. One of the main practices that should be implemented is shifting from synthetic pesticides to safer alternatives. Although this strategy is considered very essential, still, it is the most difficult to implement because it involves a radical change in farmers behavior, especially small ones (Siam and Abdelhakim, 2018). Raising farmers' awareness of the importance of this shift and training them to do that is an essential procedure in IPM programs. Botanical pesticides are super hero alternatives to synthetic chemicals in pest control (Isman, 2006). Research on pesticides of botanical origin are progressing in top gear globally as they are eco-friendly, renewable, indigenously available, easily approachable, readily biodegradable and relatively cost effective (Mathew, 2016). There are four major types of botanical products used for insect control, i.e. neem, pyrethrum, rotenone, and essential oils (Prakash and Rao, 1996).

According to (Mathew, 2016) the botanicals must be evaluated for developing more effective bio-pesticides. Consequently, two botanical compounds have been used in this investigation; neem and cottonseed and sunflower oil mixture. Neem products are derived from the neem tree, *Azadirachta indica (*Mordue and Nisbet, 2000). It is a complex mixture of biologically active materials that affect insects as a feeding deterrent, a repellent, growth regulator, oviposition suppressant, sterilant, or toxin. About 413 different species/subspecies of insect pest were listed by Schmutterer (1995) as susceptible to neem products, including aphids and leafhoppers, the main target pests of the current study. Oil mixtures, on the other hand, exert insecticidal effects or reduce/disrupt insect growth at several life stages (Konstantopoulou *et al*. 1992). Some of these oils have shown outstanding effectiveness against aphids (Behi *et al*., 2019). Cottonseed oil generally has the greatest insecticide power among all the vegetable oils. It also can be mixed with other insecticides to provide a broader spectrum and increased control on pests (Cranshaw and Baxendal, 2013).

Accordingly, the aim of the current study was to prove that organic pesticides, i.e. neem and cottonseed-sunflower oil mixture, are capable of protecting tomato plants from aphids and leafhoppers attacks and could be excellent alternatives to malathion pesticide under Egyptian conditions.

MATERIALS AND METHODS

1- Experimental site, time and area:

The effect of two botanical pesticides and malathion insecticide on both aphids and leafhoppers attacking tomato cultivar zero 42 was studied under field conditions. The investigation was implemented in Kafr El Sheikh Governorate which is located 134 km north of Cairo, in the Nile Delta of Lower Egypt, at latitude: 31° 06' 25.20" N and longitude: 30° 56' 26.99" E. The total area of the experimental farm was about 0.5 ha. The study was carried out during two successive seasons; 2018 and 2019 under a mean temperature of 29± 3.6 and a mean relative humidity of 66.4±1.

2- Experimental design:

The experiment was laid out in a randomized complete block design. The allocated area was divided into 5 plots and each plot was divided into 5 replicates. The area of each plot was 16m x 38m. A distance of about half meter was left between plots and a distance of 30 cm was left between plants. Each plot was planted by about 715 seedlings. Necessary agricultural practices were maintained constantly as needed.

3- Chemical compounds:

The experiment was carried out using the following compounds:

1. Malathion 57% EC (bought from a private company).
2. Neem oil which has 0.03% azardirachtin as an active ingredient (bought from Gaara-Establishment for import and export).

The recommended rate of application of the two previous products was 1000 ml/ feddan (feddan= 0.42 ha).

3. A mixture of cottonseed and sunflower oil (1:1) was prepared in the Central Laboratory of Organic Agriculture, the Agriculture Research Center, Egypt. The product is used at a rate of 1000 ml/100 L water.

Each compound was adjusted, calibrated and sprayed according to the cultivated plot size. The spraying was carried out three times during each season on the 8th and 22nd of June and the 6th July.

4- Results recording:

Pests' population was monitored by using yellow sticky traps measuring 16 x 17 cm. Five traps were distributed in each plot (1 trap/replicate), hanged 30 cm above the top of plants reversing wind direction and adjusted vertically as the crop grows. Pests' numbers were counted after each application and then traps were transferred safely to the laboratory for identification and counting. Reduction percentage was calculated by

Henderson-Tilton's formula (Henderson and Tilton 1955) after one and two weeks post treatment, during two successive sprayings, to monitor pests' population and compare compounds effective periods.

Pests' numbers on tomato plant leaves were also recorded. Samples of ten plants each were randomly selected and 10 leaves from each plant were randomly chosen to detect the number of aphids and grasshoppers after each application.

5- Statistical analysis:

Results were statistically analyzed using SPSS statistical package according to the Analysis of Variance (one and two-way ANOVA were used). LSD was chosen to determine any significant difference among various treatments at $P < 0.05$. Insects' mean numbers ±standard deviation and reduction percentages were also calculated.

RESULTS AND DISCUSSION

Results

1. Green peach aphid, *Myzus persicae* Sülzer

1. Compounds applications in the first season (2018):

Mean numbers of aphids on the yellow sticky traps were counted and results analysis showed that after the first application, the oil mixture (cottonseed and sunflower oil) gave the highest effect as the least numbers of aphids were counted on the traps in plots treated with this compound compared to malathion, neem oil and the control, as shown in Figure (1). Traps in oil mixture plots recorded mean numbers of 4.25±4.5 (a reduction percentage that equals 64.6 %) whereas malathion and neem oil recorded 5.35±4.2 and 10.4±7 (55.4 and 13.3% reduction) respectively. One way ANOVA test showed that, high significant differences between neem oil and all the other treatments (P=0.005). Both malathion and oil mixture showed significant statistical differences compared to the other treatments as well (P= 0.01). Control treatment, on the other hand, recorded the largest aphids' number, i.e. 12± 7.2, and no statistical differences were found between control and neem oil whereas, there were significant differences between control, malathion and oil mixture ($P \leq 0.001$).

Results of the second application revealed that the oil mixture continued to give the best effect where traps collected the least insects' number again (2.75±5) with a reduction percentage of 85%, followed by malathion (3.15±4) and finally comes the neem oil (6.3±7.3). The reduction percentages of both products recorded 82.7 and 65.4%, respectively. Both malathion and oil mixture showed significant differences with neem oil and control treatments, as $P \leq 0.001$. Furthermore, number of insects increased in the control plot reaching 18.2± 12, as illustrated in Figure (1).

Similar results were obtained after the third spraying where oil mixture and malathion insecticide continued to prove their effectiveness against aphids as they recorded mean numbers of 1.75± 3.6 and 1.2± 2.3, (91 and 94% reduction) respectively. Neem oil recorded a higher mean number, i.e. 3±3.1 (85%) whereas control recorded the highest numbers of all (20±12).

2. Compounds applications in the second season (2019)

As shown in Figure (1), results of the second season, first application, proved the findings of the first season. Both malathion and oil mixture caused the highest effect, i.e. 4.5±6.5 and 4.15±4.5 (a reduction percentage of 77.4 and 75%) respectively. Neem oil, on the other hand, caused the least effect as mean numbers of aphids increased up to 7±5 (= 62% reduction). Significant differences appeared between neem oil and both malathion and oil mixture ($P \leq 0.001$). Control mean numbers were 18.4±12.

The reduction percentage of the three products decreased after the second application. Both malathion insecticide and oil mixture caused a reduction percentage of 68.2 and 58.5%, respectively. Reduction percentage in plots treated with neem oil recorded 53.5%. Mean number of the three compounds, respectively, were 4.45±5.5, 5.8±6 and 6.5± 4.5. Numbers in control decreased to 14± 13. Further, on the third application malathion gave the best results of all compounds followed by the oil mixture then the neem oil, i.e. 0.6± 1.5, 2.2± 3.6 and 3.3± 3.7, with reduction percentages of 95.2, 82.4 and 73%, respectively. Control plot recorded mean numbers of 12.5± 10. One way ANOVE proved there were statistical differences between all treatments ($P \leq 0.001$).

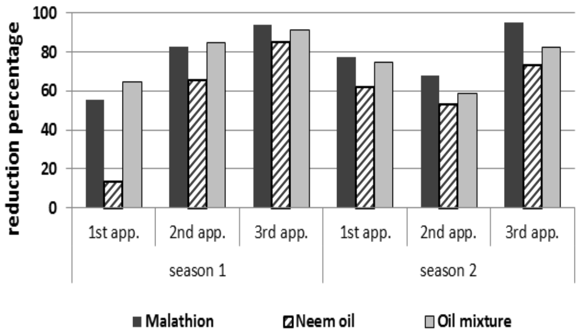

Figure 1. Reduction percentages of aphids' population after treatment with malathion, neem oil and oil mixture through 3 successive applications in two seasons

3. Total results of the first season

Results were subjected to the two way-ANOVA test to calculate the mean numbers of aphids on traps during the whole season after the three successive applications. On the first season the total numbers of aphids in the plot treated with oil mixture were the least (131.6± 8.6), followed by malthion (139.6± 34.2), neem oil (225.4± 22.8) and control (363.6± 20) as illustrated in Figure (2). Statistical differences were detected between all treatments.

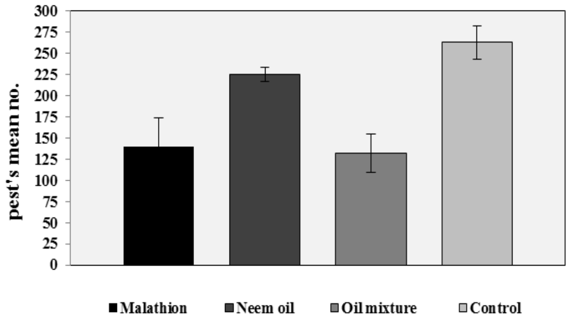

Figure 2. Total mean numbers of aphids after three successive applications during the first season (2018)

4. Total results of the second season

During 2019, overall incidence of aphid pest was low on tomato crop but still there were significant differences between mean numbers in each compound. The oil mixture proved to be the best compound of all used products as by the end of the second seasons it reduced aphids mean number to reach 34.8± 15. Malathion continued to highly control aphids as well and the pest's mean numbers decreased to reach 39.4± 11.3. Aphids' numbers in both neem oil and control were higher as illustrated in Figure (3). Statistical differences were found between all treatments ($P \leq 0.001$).

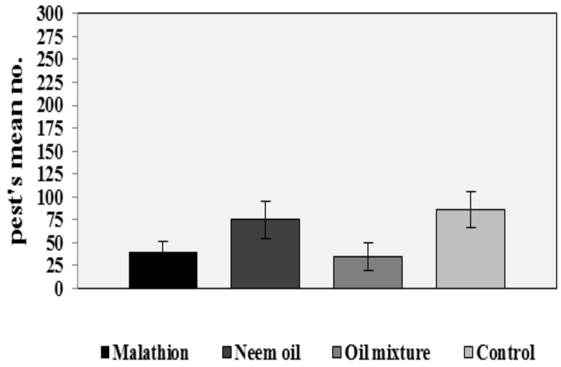

Figure 3.Total mean numbers of aphids after three successive applications during the second season (2019)

5. Sampling results

A sample of ten tomato plants was randomly selected in each plot, ten leaves of each plant were chosen and aphids' numbers were counted on each leaf. Data analysis confirmed traps results as shown in Figure (4). Both oil mixture and malathion gave the least mean numbers of aphids, i.e. 2.7± 2.2 and 2.5± 2, respectively. One way ANOVA showed no statistical differences between both compounds as P= 0.6. Neem oil gave a mean number of 3.25± 2.7, whereas control mean numbers reached 6.5± 3.2. ANOVA test revealed high significant differences between malathion and oil mixture, when compared to control and neem oil (P=0.003).

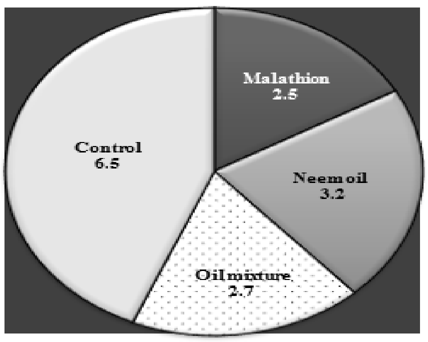

Figure 4. Mean numbers of aphids on tomato plants

2. Leafhoppers:

1. Compounds applications in the first season (2018):

As illustrated in Figure (5), the three compounds, i.e. malathion, oil mixture and neem oil were tested against leafhoppers attacking tomato plant. Data analysis revealed that after the first application the highest effect was obtained in plots treated with oil mixture as mean numbers of leafhoppers recorded 8.5± 6, followed by malathion (10± 13) and neem oil (12.25±14). Control traps collected a mean number of 17±15.5. The three compounds' reduction percentages equaled 50, 41.7 and 28, respectively. One way ANOVA test showed significant differences between all treatments ($P \leq 0.001$).

Moreover, the second application proved oil mixture as the most effective compound again as it caused a reduction percentage of 62% (5.5± 3). The malathion compound was less effective as shown in Figure (5). It caused a reduction of 58.6% followed by neem oil which reduced leafhoppers population by 49%. Mean numbers of malathion, neem oil and control were 6± 12, 7.4± 13 and 14.5± 15, respectively. The third spraying showed low effectiveness of both malathion and neem oil (48 and 44%, respectively) whereas oil mixture treatment caused reduction in the infestation of leafhoppers that reached 68.66%.

2. Compounds applications in the second season (2019):

The second season confirmed the results of season one, especially in relation to the third application. As illustrated in Figure (5) malathion reduction percentage increased after the second spraying and decreased again on the third application (79 and 77.6%, respectively). On the contrary, the effectiveness of oil mixture continued to increase from one application to the next till it reached 86.5% after the 3rd application. Neem oil gave moderate effectiveness although higher than the first season as shown in Figure (5).

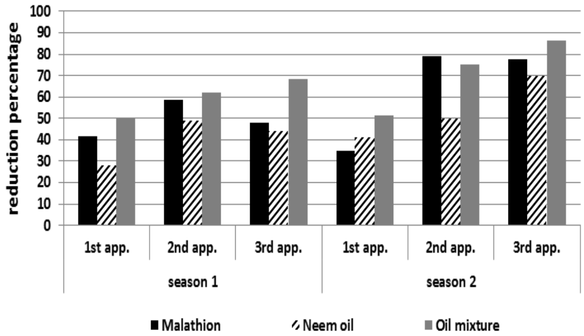

Figure 5. Reduction percentages of leafhoppers population after treatment with malathion, neem oil and oil mixture through 3 successive applications in two seasons

3. Total results of the first season

The total results of the three application carried out in the first season proved that the oil mixture caused the highest effect as the total mean numbers of the leafhoppers recorded 80.8± 29.3, followed by the malathion insecticide that recorded 107.6± 23, as illustrated in Figure (6). On the other hand, the traps distributed in the plots treated with neem oil extract collected 138.6±42. One way ANOVA revealed there were statistical differences between the three compounds as $P \leq 0.001$. Control traps recorded a mean number of 209.8± 32.7.

4. Total results of the second season

The total incidence of jassid in the second season of the experiment faced a significant reduction in all treatments compared to the first season. Results of malathion application recorded a mean number of 42± 11.5, whereas oil mixture recorded 41± 7.6, as illustrated in Figure (7). Neem oil recorded mean number of 74.2± 10, followed by control (154.4± 25.6). ANOVA test proved there were statistical differences as $P \leq 0.001$.

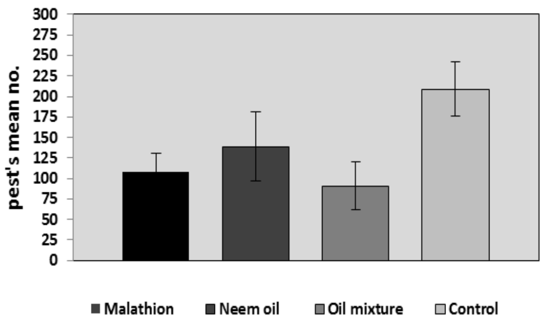

Figure 6. Total mean numbers of leafhoppers after three successive applications during the first season (2018)

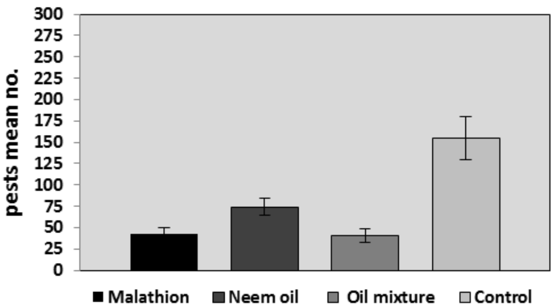

Figure 7. Total mean numbers of leafhoppers after three successive applications during the second season (2019)

5. Sampling results

Sampling results confirmed the traps data as illustrated in Figure (8). Oil mixture mean number counted on the plants recorded 1.83± 3 followed by malathion 2.1± 2.66. On the other hand, neem oil recorded 4 ± 4.5 and control treatment recorded leafhoppers mean numbers of 6± 2.6. Data analysis proved there were significant differences between both treatments as P= 0.028.

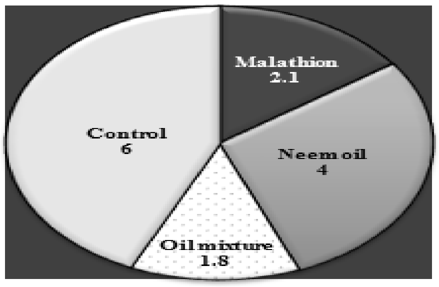

Figure 8. Mean numbers of leafhoppers on tomato plants

3. Comparison between the two pests:

The effect of the malathion insecticide and the two rational pesticides were also compared for both aphids and leafhoppers in tomato experimental field for both seasons. Two-way ANOVA analysis proved that, in general, leafhoppers were more affected by the three compounds than aphids. Oil mixture seems to be the strongest and most efficient compound to control both pests. As illustrated in Figure (9) it caused the highest reduction percentage, i.e. 65.2 and 53.5%, for both leafhoppers and aphids, respectively, followed by the malathion. It was more effective against leafhoppers than aphids and recorded a reduction percentage of 61 and 52.3% for both pests, respectively. Moreover, neem oil was the least effective compound and reduced leafhoppers and aphids population by a reduction percentage of 30 and 16.1%, respectively.

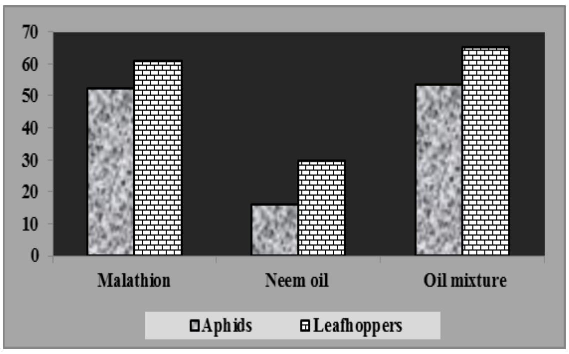

Figure 9. Reduction percentage caused by malathion, neem oil and oil mixture against both aphids and leafhoppers in both seasons

1. Monitoring pests' reduction *vs.* time:

Reduction percentages caused by the oil mixture, neem oil and malathion pesticide was calculated after one and two weeks to assess the decrease in compounds efficiency under field conditions through registering insect mean numbers on the yellow sticky trap in both treated and control plots before and after spraying. Results analysis showed that within 14 days the effectiveness of all compounds decreased at varying rates. One week after application, oil mixture caused 92.3 and 65.5% reduction in leafhoppers population in the first and second spraying, respectively, whereas after two weeks of spraying results showed a high reduction in the mixture efficiency where it reached 32.5 and 37.8%. On the other hand, aphids' population recorded a reduction of 87.2% and 68.8% after one week of the first and second sprays, however, after 14 days of spraying reduction reached 13.3 and 16%, respectively (Figure10).

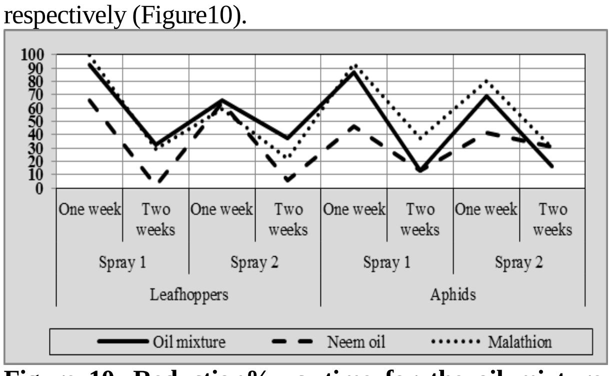

Figure 10. Reduction% *vs.* time for the oil mixture, neem oil and malathion pesticide in leafhoppers and aphids population during two successive sprays

Neem oil showed less effectiveness after two weeks of spraying in the two treatments. A dramatic decrease in the population of both pests occurred, i.e. 2.2 and 5.5% in leafhoppers and 13.3 and 30.6% in case of aphids, respectively. The deterioration in malathion efficiency was highly similar to oil mixture, as illustrated in Figure (10).

Disccusion

Lack of information, due to shortage in agricultural research, might be one of the constraining factors that face tomato production in Egypt (Siam and Abdelhakim 2018). Most of the current insect pests' control measures rely on pesticides despite the hazards they cause to human health and the environment, in addition to the development of resistance by pests (Lin *et al*., 2009). Therefore, we aimed in this study to evaluate other pest control measures that are safe, effective and economically viable with the aim of reducing insecticides hazards and increasing production. It is well known that plant kingdom is treasure trove of natural secondary metabolites from plants (Mathew, 2016). Natural pesticides based on plant-essential oils could represent alternative crop protectants (Mahmoud, 2017). Various essential oils are documented to exhibit acute toxic effects against insects (García *et al*., 2007; López and Pascual-Villalobos, 2010, Khan *et al*., 2017).

Data analyses of the first season (of both yellow sticky traps and sampling on tomato plants) revealed that the mixture of cotton and sunflower oils gave the highest control levels of aphid *M. persicae*, followed by malathion insecticide, whereas neem oil caused the least effect. Using a mixture of two botanical oils was intentional as it was recommended by several researchers. For example, Aziz *et al*. (2018) indicated that mixture of menthol and camphor oil extracts was more effective than using each of them alone. In addition, Rajashekar *et al*. (2012) highlighted that ancient Egyptians and Indians used to mix the stored grains with fire ashes to control pest infestations since ancient times, which mean that the idea of mixing different sources gives more power to the control product.

In the second year of the experiment similar reduction percentages in aphids' numbers were noticed although the overall incidence of aphids' pest was lower in the second season than the first one. This decreased in aphids population in the second season was also noticed and confirmed by Kaur and Singh (2014). One might be attribute that to the efficiency of the first year spraying or other reasons that needs further investigation, as weather conditions did not differ significantly between the two seasons. The superiority of natural oils in controlling aphids' pests was mentioned by several authors. Lin *et al*. (2009) proved that the oil pressed out of the seeds of sugar apple (*Annona squamosa*) was as effective in controlling *Aphis gossypii* Glover, infesting tomato leaves, as the recommended insecticide. Butler and Henneberry (1990) stated that Cottonseed oil induced high levels of *Myzus persicae* mortality on all the food plants they studied. In addition, high mortality percentage (87-95%) was obtained when cottonseed oil was used against *Aphis gossypii* on cotton plant (Butler, *et al*., 1991). Liu and Stansly (1995) also demonstrated that the insecticidal activity of surfactants and oils was good compared to some conventional insecticides. Antos *et al*. (2004) found that the aqueous extract of neem seeds is efficient against the aphid *A. gossypii*, causing nymph mortality and reducing their survival period and fecundity.

Results also proved that repeating application for three consecutive times gave the best results. Oil mixture reduction percentages increased from 64.6 to 85 and 91%, for the three applications of the first season, respectively. The same trend appeared in the second season and for both malathion and neem oil. Thus, it could be concluded that increasing the number of spraying pesticides shows more efficiency in pest control. This conclusion was also emphasized by Abdel-Hameid *et al*. (2017) who found that population of aphids decreased with the use of successive sprays. In line with this finding, Bogran *et al*. (2006) reported repeated applications of oils may be needed to achieve desired levels of control.

Moreover, efficiency of all the tested compounds decreased starting from 8- 14 days post-application under field conditions. Both oil mixture and malathion kept their effectiveness till it reached in both compound ±30% (in leafhoppers) and about 15% and ±30% in aphids, for both compounds, respectively, after 2 weeks post treatment. However, neem oil dramatically decreased in its effectiveness after 2 weeks of spraying. These results were in accordance with Caboni *et al*. (2002) who mentioned that the azadirachtin (one of the active ingredient of neem oil) had a half-life time of 8 days under field conditions and attributed that to photo-degradation. Oliveira *et al*. (2014) and Miresmailli and Isman (2014) confirmed these findings. Further, Isman *et al*. (2011) considered the short residual half- lives of essential oils on plants as an advantage because they enhance oils compatibility with biological control agents and pests' natural enemies, but on the contrary, they said that lack of persistence is a disadvantage and suggested the implementation of two or more carefully- timed applications to reach a satisfactory management of pests, and this recommendation confirm our results in the current study as well.

On the other hand, leafhoppers, as it is known, have few natural enemies, as mentioned by Radcliffe (1982) therefore finding a safe and effective compound for controlling this pest is of great importance. Our experiment showed that leafhoppers were highly susceptible to the three compounds. All products reduced jassid numbers in both seasons. Oil mixture, again, proves its superior over the neem oil and the malathion pesticide. Plant sampling results confirmed this data. However, these results are in contradiction with Rajput *et al*. (2017) who stated that when five bio-pesticides i.e. neem, cooking oil, linseed oil, hing and cotton oil were applied twice against sucking complex jassid, all products reduced pest population, but neem (63.27%) was slightly more effective than cotton oil (62.01%), and both were the most effective of all used oils. In the current investigation we find the opposite, as the mixture of cottonseed and sunflowers oil was more effective (65.2%) against jassid than neem (30% reduction). Yet, when we compare the effectiveness of neem on both pests, i.e. aphids and leafhoppers, we noticed that neem caused almost double the effect on leafhoppers than aphids. These results are in line with what was mentioned in the National Research Council Panel on Neem (1992) where it was declared that nymphs of leafhoppers show considerable antifeedant and growth-regulating effects towards neem, whereas aphids are in general not good candidates for neem as a bio-pesticide.

Furthermore, no significant differences were noticed concerning the effect of both malathion pesticide and the oil mixture on aphids (52.3 and 53.5%, respectively), whereas natural oil caused higher reduction in case of leafhoppers than aphids (61 and 65.2%, respectively).

CONCLUSION

A major limiting factor of tomato production is pest damage. The study results indicates that the botanical oil used (mixture of cottonseed and sunflower oil, 1:1) could be an excellent alternative to malathion insecticide in controlling both leafhoppers and aphids, thus, injuries and damages caused by malathion to health and environment could be avoided to a high extent.

Therefore, we recommend:The integration of cottonseed and sunflower oil mixture as a botanical pesticide in leafhoppers and aphids IPM programs in tomato fields as they are powerful, safe and compatible with natural enemies and bio-control agents.The necessity of raising farmers' awareness concerning the economic and environmental importance of such compounds.Educating and training farmers on the suitable methods to use these bio-pesticides taking into consideration the appropriate rate, numbers of applications/season and the period between sprayings. Monitoring and follow up of pests' population to ensure sustainability.

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هل تستطيع المبيدات العضوية ان تكون بديلا جيدا للمبيدات المصنعة في مكافحة المن ونطاطات الأوراق في حقول الطماطم؟

هاله عادل و سعد جعفر

المعمل المركزي للزراعة العضوية ، مركز البحوث الزراعية ، مصر

نهدف في هذه الدراسة إلي اثبات ان مبيدات الأفات العضوية (زيت النييم وخليط من زيت بذور القطن وعباد الشمس) تستطيع ان تحل محل المبيدات المصنعة (الملاثيون) في مكافحة المن ونطاطات الأوراق التي تهاجم الطماطم تحت الظروف الحقلية. صممت التجربة في شكل قطاعات كاملة العشوائية، خلال موسمين متعاقبين؛ ٢٠١٨ و ٢٠١٩، في مساحة إجمالية قدرها ٠,٥ هكتار. وقد تم استخدام طريقتي المصائد الصفراء اللاصقة وأخذ العينات النباتية. واوضح تحليل البيانات أن مزيج زيت بذور القطن وعباد الشمس حقق أعلى نسبة مكافحة لكل من نطاطات الأوراق والمن *Myzus persicae*. وقد كانت قابلية اصابة نطاطات الأوراق أكبر من المن، وذلك في جميع المركبات المستخدمة. وكانت كفاءة خليط الزيت إما اعلي من الملاثيون أو مساوي له من حيث الكفاءة. في حين كان زيت النيم أقل كفاءة لكلا الآفتين من الملاثيون. وقد انخفضت فعالية جميع المركبات المختبرة بشكل كبير بعد مرور ١٤ يوما من المعاملة ؛ لذلك، فأن تكرار الرش أمر ضروريا لا بد منه. وتحققت أعلى مستويات مكافحة لكلا الآفتان عند تطبيق ثلاثة معاملات متتالية. وعلي ذلك فإن زيت بذرة القطن المخلوط بزيت عباد الشمس يعد وسيلة واعدة في مكافحة هاتين الآفتين ويمكن أن يحل محل الملاثيون في برامج المكافحة المتكاملة للآفات في حقول الطماطم في مصر، مع الأخذ في الاعتبار تكرار المعاملة ثلاث مرات متتالية، بحد أقصى أسبوع واحد بين الرشات. وبالتالي تكون الإجابة عن السؤال المطروح في عنوان البحث هي " نعم تستطيع" بشرط رفع وعي المزارعين بالتحول نحو تلك المركبات العضوية وتدريبهم على استخدام مثل هذه المنتجات الطبيعية الآمنة والصديقة للبيئة وغير المكلفة من اجل تحقيق الاستدامة الزراعية.