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Original Article

Effect of nine pesticides against the date palm mite, *Oligonychus afrasiaticus* (Acari: Tetranychidae) and the predatory mite, *Amblyseius swirskii* (Acari: Phytoseiidae) under laboratory and field conditions.

Efeito de nove pesticidas contra o ácaro da tamareira, *Oligonychus afrasiaticus* (Acari: Tetranychidae) e o ácaro predador, *Amblyseius swirskii* (Acari: Phytoseiidae) em condições de laboratório e de campo.

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Abstract

Date palm trees, their cultivation and harvesting have become challenging due to infestations caused by some specific mites including *Oligonychus afrasiaticus* (McGregor) (Tetranychidae). Current research has been carried out to investigate the efficiency of nine pesticides against eggs and date palm mite, *Oligonychus afrasiaticus* against nine pesticides. Side effects of the nine pesticides were also examined on predatory mite, *Amblyseius swirskii* Athias-Henriot (Phytoseiidae). Mites and their eggs were treated with the recommended dosage of nine pesticides namely, Bifenazate 24%, Bifenthrin 10%, Matrine 0.6%, Imidacloprid 37% + Abamectin 3%, Sulphur 99.5%, Micronized Sulphur 80%, Mineral oil 95%, Pyrethrin 1.5% and Hexythiazox 10%, while they were present in their natural environment on the date palm trees in the experimental fields. Highest mortality of 91.16% was observed when *O. afrasiaticus* was treated with Bifenazate (24%) followed by 87.31%, 85.20%, 72.06%, 71.34%, 65.35%, 64.14%, 61.06% and 24.25% in case of Bifenthrin 10%, Matrine 0.6%, Imidacloprid 37% + Abamectin 3%, Sulphur 99.5%, Micronized Sulphur 80%, Mineral oil 95%, Pyrethrin 1.5%, and Hexythiazox 10%, respectively. A minimum hatching of 25.74% was observed when eggs of *O. afrasiaticus* were treated with Hexythiazox 10% and the highest success of hatching (99.07%) was seen when treatment was given with Imidacloprid 37% + Abamectin 3%. When same trials with same nine pesticides were performed on predatory mite; *Amblyseius swirskii*, the highest mortality in terms of percentage reduction (75.63%) was observed with Bifenthrin and the lowest (14.69%) with Matrine. Nine pesticides used in this study have distinct toxicity against targeted mite, their eggs and the predatory mite. A two steps control strategy is recommended for this treatment. First spray Hexythiazox at the egg laying stage and then at the moving stage of mites by using Matrine which is toxic to mites but negligibly toxic to predatory mites. Further studies are recommended to evaluate varied actions of the pesticide against eggs, phytophagous mites, and predatory mites.

Keywords: date palm, *Oligonychus afrasiaticus*, predatory mite, chemical control, hatching rate.

Resumo

As tamareiras, seu cultivo e colheita tornaram-se desafiadores devido às infestações causadas por alguns ácaros específicos, incluindo *Oligonychus afrasiaticus* (McGregor) (Tetranychidae). A pesquisa atual foi realizada para investigar a eficiência de nove pesticidas contra ovos e o ácaro da tamareira, *Oligonychus afrasiaticus*. Os efeitos colaterais dos nove pesticidas também foram examinados no ácaro predador, *Amblyseius swirskii* Athias-Henriot (Phytoseiidae). Os ácaros e seus ovos foram tratados com a dosagem recomendada de nove pesticidas, a saber: Bifenazato 24%, Bifentrina 10%, Matrina 0,6%, Imidacloprida 37% + Abamectina 3%, Enxofre 99,5%, Enxofre Micronizado 80%, Óleo Mineral 95%, Piretrina 1,5% e Hexitiazox 10%, enquanto estavam presentes em seu ambiente natural nas tamareiras nos campos experimentais. A maior mortalidade de 91,16% foi observada quando *O. afrasiaticus* foi tratado com Bifenazato (24%), seguido por 87,31%, 85,20%, 72,06%, 71,34%, 65,35%, 64,14%, 61,06% e 24,25% no caso de Bifentrina 10%, Matrina 0,6%, Imidacloprida 37% + Abamectina 3%, Enxofre 99,5%, Enxofre Micronizado 80%, Óleo Mineral 95%, Piretrina 1,5% e Hexitiazox 10%, respectivamente. Uma eclosão mínima de 25,74% foi observada quando os ovos de *O. afrasiaticus* foram tratados com Hexythiazox 10%, e o maior sucesso de eclosão (99,07%) foi visto quando o tratamento foi realizado com Imidacloprid 37% + Abamectina 3%. Quando os mesmos ensaios com os mesmos nove pesticidas foram realizados no ácaro predador, *Amblyseius swirskii*, a maior mortalidade

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em termos de redução percentual (75,63%) foi observada com Bifenthrin e a menor (14,69%) com Matrine. Nove pesticidas usados neste estudo têm toxicidade distinta contra o ácaro alvo, seus ovos e o ácaro predador. Uma estratégia de controle em duas etapas é recomendada para este tratamento. Primeiro pulverize Hexythiazox no estágio de postura de ovos e depois no estágio de movimentação dos ácaros usando Matrina, que é tóxico para os ácaros, mas insignificantemente tóxico para os ácaros predadores. Estudos adicionais são recomendados para avaliar as variadas ações do pesticida contra ovos, ácaros fitófagos e ácaros predadores.

Palavras-chave: tamareira, *Oligonychus afrasiaticus*, ácaro predador, controle químico, taxa de eclosão.

1. Introduction

Saudi Arabia is among the largest date (*Phoenix dactylifera)* producing countries and shares 17% of the worldwide market. By 2025, date palm tree cultivation will reach 33 million, leading to annual date production of 1.5 tons, in the Kingdom (FAO, 2020). However, date crops are facing challenges due to ever growing number and variety of pests (El-Shafie et al., 2017). Across the Middle East around 8 million dollars are expended each year to overcome infestations caused by pests and other environmental factors (https://www.kaust.edu.sa, June 2023). Eleven species of phytophagous mites were identified on date palms and causing serious damage to the quality and production of dates (Bolland et al., 1998; Palevsky et al., 2003, 2004; Ben Chaaban et al., 2011). The date mite, *Oligonychus afrasiaticus* (McGregor) (Acari: Tetranychidae) is considered the most dominant mite pest of date palm in the Middle East and North Africa. It has been reported from the following countries: Palearctic area: Algeria (André, 1932; McGregor, 1939), Tunisia (Pagliano, 1951), Saudi Arabia (El-Baker, 1952), Afrotropical area: Niger Chad, Mauritania, Mali (Munier, 1952), Morocco (Pereau- Leroy, 1958), Libya (Martin, 1958), Sudan (Baker and Pritchard, 1962), Iraq (FAO, 1966), Iran (Gentry, 1965), Yemen (El-Haidari, 1981), Egypt (Zaher et al., 1982), Oman (MOA, 1989; 1992) and United Arab Emirates (Gassouma, 2005). Infestations occur throughout the sweltering, arid summer. Time of invasion differs based on the date palm variety. The Medjool variety's initial infestation begins in early May. While it begins in the first week of July for the Deglet Noor variety and around late May to early July is when the Barhee variety is infested, and the Populations peak between the middle of July and the beginning of August (Bass'Haia, 1999; Aldosari 2009; Ben Chaaban et al., 2012). Then, the population decreases gradually throughout August and September (Ben Chaaban et al., 2011). *Oligonychus afrasiaticus* mainly feeds on date fruits for food. Mites attack young green fruits as they emerge, resulting in numerous tiny fissures and the creation of gum-like exudates on the fruit's surface. Even at 45 °C, the mites remain active and create dense webbing that collects dust. Webbing may cover the entire fruit bunch in cases of severe infestations. Severe infestations can result in economic losses, and the webbing makes the date fruit inappropriate, even for processing (Negm et al., 2015). Furthermore, the physicochemical characteristics of dates are adversely affected by this pest. There is a significant reduction in the amount of water and total soluble solids, especially sugars (Ben Chaaban and Chermiti, 2009). As a first resort, pesticides have been employed to control *O. afrasiaticus* (Al-Doghairi, 2004; Kamel et al., 2007; Aldosari, 2009). To control this mite, growers typically sprinkle bunches with sulfur multiple times a year (Palevsky et al., 2004). In the absence of alternative strategies developed and implemented by pest managers to address this pest, this trend is probably going to continue. The insecticide Cinnamaldehyde, used for controlling insects, also gives good control of *O. afrasiaticus* in Saudi Arabi (Alhewairini et al., 2023). Abdel Ghani et al. (2022a) and Al-Azzazy et al. (2024) evaluated the efficiency of silver nanoparticles and zinc oxide nanoparticles against all stages of the date palm mite, *O. afrasiaticus* and it appeared to be an effective control agent for *O. afrasiaticus*. Also, Huwa-San TR50 was recommended for the control of *O. afrasiaticus* (Alhewairini and Al-Azzazy, 2017). Al-Qassim is the region of Saudi Arabia that is famous for its variety, quality, and production of dates. Until now, elimination of the date palm mites has been a serious issue because pesticides used against pests result in the development of resistance and recommended dosage becomes impotent. Thus, it was essential to understand which pesticides work best against this mite. The aim of this study is to investigate the efficiency of nine pesticides against eggs and moving stages of the date palm mite, *O. afrasiaticus*. Side effects of the nine pesticides were also examined on predatory mite, *A.swirskii*.

2. Materials and methods

2.1. Field experiments

The field experiments were carried out during May and June of the 2022 and 2023 seasons using short heighted medium-laden date palm trees of Sokary variety at the Experimental Research Station, Qassim University, Buraidah, Qassim, Saudi Arabia. The selected trees were not sprayed recently with any pesticide during the season and were already infested with the phytophagous mite *Oligonychus afrasiaticus* (McGregor) (Tetranychidae). The predacious mite *Amblyseius swirskii* Athias-Henriot (Phytoseiidae) was also identified on the selected palm trees. Nine commercial pesticides were evaluated in date palm orchards against the date mite *O. afrasiaticus*. Baifplus (Bifenthrin 10%), Floramite (Bifenazate 24%), Piowetsulf (Micronized sulphur 80%), Aphi killer (Pyrethrin 1.5%), Mineral oil (mineral oil 95%), Frexo (Imidacloprid 37% + Abametin 3%), Sulphur (Sulphur 99.5%), Sophora (Matrine 0.6%) and Hexyron (Hexythiazox 10%). Spraying solutions were applied using a 15 L fixed pressure hand sprayer (obtained from the local market). The spray solution was directed mainly to date bunches until it ran off. The Sulphur 99.5% was used by dusting fruit bunches with burlap at the rate of 20 kg/ 1000 m^2. Untreated control trees were sprayed with the available irrigation well water. Each pesticide

and control treatments were conducted in triplicate using randomly selected palm trees, three palm trees for each pesticide and the same number for the control treatment. Date fruits, representing all bunches, were picked randomly from each tree before treatment, these were then placed in polyethylene bags, transferred to the laboratory, and examined under a binocular microscope to determine the initial population of date palm mite, *O. afrasiaticus* and the predatory mite *A. swirskii* as a pre-spray count. Post treatment population was counted after three days. Date samples were transferred to the laboratory for counting of moving individuals of both mites.

2.2. Laboratory experiments

Bunches of infested date fruits were obtained, and dates were naturally infested with *O. afrasiaticus*. Dates were separated from the strands and placed in an uncovered Pyrex® Petri dish (10 cm in diameter × 4 cm high) as a stock culture. To evaluate tested pesticides on the hatching percentage of *O. afrasiaticus* eggs, and to acquire same aged cohort's *O. afrasiaticus* eggs, 40 gravid females of *O. afrasiaticus* from the stock culture were deposited on each new fruit of date palm, which had undergone testing in advance to ensure they were free of any eggs or motile stages, every date in its own Petri dish. The eggs laid by *O. afrasiaticus* were counted as a pre-spray count after two days. The same concentrations mentioned above were tested on egg stage of *O. afrasiaticus* and compared with the control (well water). The experiments were carried out in a lab. environment at 35 ± 1°C and 12:12 hours L:D. Every 24 hours of a week, the hatching rate was observed. Identification of predatory mite, *A. swirskii* was confirmed according to (Chant and McMurtry, 2003, 2005, 2007).

2.3. The pesticides and their recommended dosage (concentrations used).

1- Floramite (Bifenazate 24%) at the concentration of 60 ml/ 100 L of water
2- Baifplus (Bifenthrin 10%) at the concentration of 30 ml/ 100 L of water
3- Sophora (Matrine 0.6%) at the concentration of 200 ml/ 100 L of water
4- Frexo (Imidacloprid 37% + Abamectin 3%) at the concemtration of 150 g/ 100 L of water
5- Sulphur (Sulphur 99.5%) at the concentration of 20 kg/ 1000 m2 (dusting)
6- Piowetsulf (Micronized sulphur 80%) at the concentration of 300 g/ 100 L of water
5- Mineral oil (mineral oil 95%) at the concentration of 1 L/ 100 L of water
8- Aphi killer (Pyrethrin 1.5%) at the concentration of 100 ml/ 100 L of water
9- Hexyron (Hexythiazox 10%) at the concentration of 50 ml/ 100 L of water

2.4. Statistical analysis

The percentage reduction in the average populations of *O. afrasiaticus* and predatory mite *A. swirskii* and the average percentage of the number of larvae hatching from eggs of *O. afrasiaticus* were calculated using the equation of Henderson and Tilton (1955).

$$\text{Corrected Mortality \%} = \left(1 - \frac{Cb \times Ta}{Ca \times Tb}\right) \times 100 \quad (1)$$

Where: *Cb* is the number of mites or laid eggs in untreated control before spray, *Ca* is the number of mites or hatched larvae in untreated control after spray, *Tb* is the number of mites or laid eggs in treatment before spray and *Ta* is the number of mites or hatched larvae in treatment after spray.

The mortalities of the phytophagous mites and the predatory mites were calculated manually by direct observation. Thereafter, the obtained data for all variables were statistically analyzed using One-way analysis of variance (ANOVA).

3. Results

3.1. Effect of nine pesticides on the date palm mite Oligonychus afrasiaticus under field conditions

The toxicity of nine pesticides was observed on date palm mite, *O. afrasiaticus* under field conditions. Reduction in the number of dead mites within the selected area was observed during the three days after the spray. Results are given in Table 1. Highest mortality of 91.16% was observed with Bifenazate (24%) followed by 87.3, 85.20, 72.06, 71.34, 65.35, 64.14, 61.06 and 24.25% in case of Bifenthrin (10%), Matrine (0.6%), Imidacloprid (37%) + Abamectin (3%), Sulphur (99.5%), Micronized sulphur (80%), Mineral oil (95%), Pyrethrin (1.5%) and Hexythiazox (10%), respectively. Bifenazate showing 91.16% mortality is the most toxic to date palm mite, *O. afrasiaticus*.

3.2. Effect of nine pesticides on egg hatching the date palm mite Oligonychus afrasiaticus under laboratory conditions.

Anti-hatching potential of nine pesticides was observed on eggs of *O. afrasiaticus* under laboratory conditions. Success of hatching from the treated eggs was counted by counting the number of active larvae seen on date fruit. Results of percentage hatching are given in Table 2. Least hatching (25.74%) was observed when eggs were treated with Hexythiazox (10%), followed by 45.24, 46.96, 48.22, 53.07, 66.23, 67.55, 93.18, and 99.07% in case of Micronized sulphur (80%), Sulphur (99.5%), Mineral oil (95%), Pyrethrin (1.5%), Bifenazate (24%), Bifenthrin (10%), Matrine (0.6%) and Imidacloprid (37%) + Abamectin (3%), respectively. Hexythiazox treated eggs have shown the least percentage of hatching, so it is the most toxic to eggs (Figure 1).

3.3. Effect of nine pesticides on predatory mite A. swirskii associated with date palm trees.

Toxicity of the nine pesticides was also observed on predatory mite; *Amblyseius swirskii* that is commonly found on date palm trees. Results are given in Table 3. The number of dead predatory mites within the selected area was counted during three days after the spray. Highest mortality of 75.62% was observed with Bifenthrin (10%),

Table 1. Effect of nine pesticides on the date palm mite *Oligonychus afrasiaticus* under field conditions.

Pesticides	Concentration (ppm)	No. of mites/fruit		
		Pre-spray count	Average post-spray count *	Reduction % **
Bifenazate 24%	60 ml/ 100 L of water	17.70	1.50	91.16 a
Bifenthrin 10%	30 ml/ 100 L of water	14.80	1.80	87.31 a
Matrine 0.6%	200 ml/ 100 L of water	14.80	2.10	85.20 a
Imidacloprid 37% + Abamectin 3%	150 g/ 100 L of water	16.80	4.50	72.06 b
Sulphur 99.5%	20 kg/ 1000 m2 (dusting	22.20	6.10	71.34 b
Micronized Sulphur 80%	300 g/ 100 L of water	14.60	4.85	65.35 b
Mineral oil 95%	1 L/ 100 L of water	19.20	6.60	64.14 b
Pyrethrin 1.5%	100 ml/ 100 L of water	22.50	8.40	61.06 b
Hexythiazox 10%	50 ml/ 100 L of water	15.70	11.90	24.25 c
Control	-	14.50	13.90	-

*Counts made three days post treatment. **Mortality values calculated by the Henderson-Tilton's equation. Different letters in the vertical columns denote significant difference (F-test, $P < 0.05$).

Table 2. Number of larvae hatching from eggs of the date palm mite *Oligonychus afrasiaticus* treated with nine pesticides under laboratory conditions.

Pesticides	Concentration (ppm)	No. of eggs and larvae /fruit		
		Average number of eggs pre-spray count	Average number of larvae post-spray count *	Hatching (%) **
Bifenazate 24%	60 ml/ 100 L of water	23.40	15.50	66.23 a
Bifenthrin 10%	30 ml/ 100 L of water	18.80	12.70	67.55 a
Matrine 0.6%	200 ml/ 100 L of water	30.80	28.70	93.18 b
Imidacloprid 37% + Abamectin 3%	150 g/ 100 L of water	32.30	32.00	99.07 b
Sulphur 99.5%	20 kg/ 1000 m² (dusting)	24.70	11.60	46.96 c
Micronized Sulphur 80%	300 g/ 100 L of water	26.30	11.90	45.24 c
Mineral oil 95%	1 L/ 100 L of water	25.30	12.20	48.22 c
Pyrethrin 1.5%	100 ml/ 100 L of water	22.80	12.10	53.07 c
Hexythiazox 10%	50 ml/ 100 L of water	26.80	6.70	25.74 d
Control	-	24.10	24.00	-

*Counts made one-week post treatment. ** Hatching percentage calculated with the Henderson-Tilton's equation. Different letters in the vertical columns denote significant difference (F-test, $P < 0.05$).

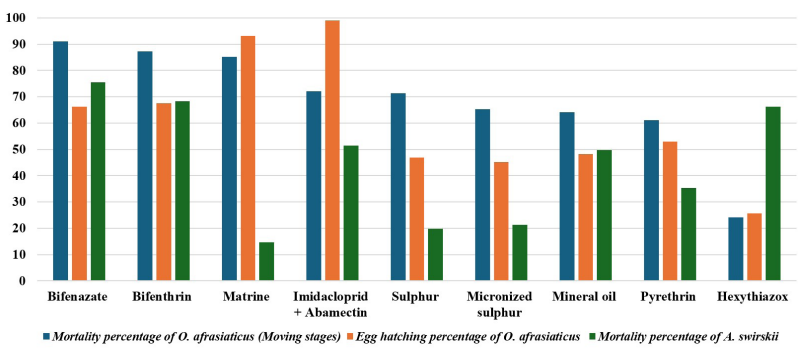

Figure 1. Effect of nine pesticides against moving stages and eggs of spider mite, *O. afrasiaticus* and moving stages of predatory mite, *A. swirskii*.

Table 3. The mortality percentage of the predatory mite *Amblyseius swirskii* Athias-Henriot (Phytoseiidae) associated with date palm trees treated with nine pesticides under field conditions.

Pesticides	Concentration (ppm)	No. of predatory mites		
		Pre-spray count	Average post-spray count *	Reduction % **
Bifenazate 24%	60 ml/ 100 L of water	5.30	1.60	68.30 a
Bifenthrin 10%	30 ml/ 100 L of water	5.60	1.30	75.62 a
Matrine 0.6%	200 ml/ 100 L of water	4.80	3.90	14.69 b
Imidacloprid 37% + Abamectin 3%	150 g/ 100 L of water	5.20	2.40	51.54 c
Sulphur 99.5%	20 kg/ 1000 m^2 (dusting)	3.80	2.90	19.87 b
Micronized Sulphur 80%	300 g/ 100 L of water	6.40	4.80	21.25 b
Mineral oil 95%	1 L/ 100 L of water	7.30	3.50	49.66 c
Pyrethrin 1.5%	100 ml/ 100 L of water	8.60	5.3	35.29 d
Hexythiazox 10%	50 ml/ 100 L of water	5.60	1.80	66.25 a
Control	-	4.20	4.00	-

*Counts made three days post treatment. **Mortality values calculated by the Henderson-Tilton's equation. Different letters in the vertical columns denote significant difference (F-test, $P < 0.05$).

followed by 68.30, 66.25, 51.54, 49.66, 35.29, 21.25, 19.87, and 14.69% with Bifenazate (24%), Hexythiazox (10%), Imidacloprid (37%) + Abamectin (3%), Mineral oil (95%), Pyrethrin (1.5%), Micronized sulphur (80%), Sulphur (99.5%), and Matrine (0.6%), respectively. Matrine with 14.69% mortality was found to be the least toxic to the predatory mite.

4. Discussion

In Saudi Arabia like other date producing countries, the date palm trees, *Phoenix dactylifera* L. (Arecales: Arecaceae), are highly susceptible to various mites. The most notorious species is the date palm mite, *O. afrasiaticus* (McGregor) (Acari: Tetranychidae). The date palm mite, *O. afrasiaticus* is a serious pest of the date palm fruits at the ripening stage and is very common in Qassim region of Saudi Arabia like some other countries (Dhouibi, 1991; Khoualdia et al., 1997; Alhewairini et al., 2023). Previously, many pesticides and chemicals have been reported that can effectively control date palm mite *O. afrasiaticus* like Kelthane, Neoron, Tedion were used by Al Doghairi, 2004. Alhewairini reported better control over date palm mites by using Hawa-San TR50 and Oxamyl, separately and in combination at different ratios (Alhewairini and Al-Azzazy, 2017). However, there is a common problem with all pesticides that the targeted enemies become resistant with the repeated use of the same pesticide. Resultantly, we are bound to increase the applied concentration for effective control, which is harmful to farmers, domestic animals and to predatory mites resulting in the loss of natural biological control. Hence, there is immense need for the time to find an effective and safe alternative strategy to protect date palm crops from the damages caused by phytophagous mites (Al-Azzazy and Alhewairini, 2024). The present study was designed to test a range of selected pesticides aiming at the three layers of control of phytophagous mites, first, by inhibiting hatching of eggs, second, by killing feeding stages and third, by saving predatory mites to promote biological control. In this study nine pesticides, Bifenazate (24%), Bifenthrin (10%), Matrine (0.6%), Imidacloprid (37%) + Abamectin (3%), Sulphur (99.5%), Micronized sulphur (80%), Mineral oil (95%), Pyrethrin (1.5%) and Hexythiazox (10%) have been evaluated for their toxicity against phytophagous mites, inhibition of hatching and protection to predatory mites. Matrine causing 85.20% mortality to phytophagous mites (Table 1) and only 14.69% to predatory mites (Table 2) can be the best choice of farmers subject to its safety to humans, pets, and birds in the region. Hexythiazox showing only 25.74% success of hatching, is highly toxic to eggs but it is safe to mites (24.25% mortality). At the same time, it is fatal to predatory mites causing 66.25% mortality, especially at the immature stages (Table 3), hexythiazox is highly toxic to mite eggs, larvae, and nymphal stages, according to previous studies (Anonymous, 1984; Chapman, 1986; Chapman and Marris, 1986; Alhewairini and Al-Azzazy, 2021; 2023a). Furthermore, hexythiazox is the least harmful to humans if used within safe ranges (Saad et al., 2018). Alhewairini and Al-Azzazy (2023b) reported that the lethal effects of hexythiazox decrease with the maturity of the mites. This explains the low mortality rate of the date palm mite, *O. afrasiaticus* 24.25% in this study. It might be because of their exoskeleton ages, there is less surface absorption. Furthermore, the suppression of physiological processes may be a part of the method of action. Alhewairini and Al-Azzazy (2023) found a similar result when using hexythiazox on seven different species of mites. Additionally, more studies are suggested to assess the hexythiazox absorption process on the surface of immature and adult mites as well as their death mechanism. It is also necessary to investigate the differential action of hexythiazox on various mite eggs. The Matrine 0.6% and Imidacloprid 37% + Abametin 3% when sprayed on the eggs of *O. afrasiaticus* had little effect

on hatching as compared to their mortality in the case of the moving stages. It is therefore recommended that the hexythiazox should be used at the pre-hatching stage to have effective control over the date palm mite, *O. afrasiaticus*. In comparison to other pesticides examined, the obtained results here showed that sulfur can produce a discernible deformity in the cuticle of dead *O. afrasiaticus* as well as in the shell of non-hatched eggs (Alazzazy, 2005; Shimizu and Ichi, 2022). Furthermore, it results in 71.34% mortality in moving stages of *O. afrasiaticus*. The results reported here were in line with those of Alazzazy (2005), who found that 77.6% of the mango red mite *Oligonychus mangiferus* died when sulfur was employed as a control. Deep studies on the life cycle of mites and predatory mites are recommended. The current findings revealed a significant difference between date palm mite *O. afrasiaticus* and predatory mite, denoting reduced toxicity of tested pesticides towards the predatory mite *A. swirskii* except for Hexythiazox pesticide as the opposite happenedin its case. The studied pesticides may have an impact on phytophagous mites by direct ingestion of spray droplets, contact poisoning, or ingestion when the mites are crawling on sprayed fruits. The reason for the pesticides' enhanced activity against phytophagous mites could be attributed to their ability to penetrate their thin body wall, inters skeletal membranes, or body apertures. In contrast, the exoskeleton of predatory mites is thicker, and features shields on both the dorsal and ventral surfaces (Duso and Fontana, 2002; Zannou et al., 2007) might stop the pesticides studied from entering bodily tissues. Furthermore, predatory mites only feed on phytophagous mites that are actively feeding, and it is improbable for them to feed on intoxicated individuals, thus decreasing the quantity of pesticides that the predatory mite receives (Abdel Ghani et al., 2022b).

5. Conclusion

In summary, these results show that the highest mortality of 91.16% was observed with Bifenazate (24%). Also, Hexythiazox treated eggs have shown the least percentage of hatching, so it is the most toxic to eggs. The Highest mortality of the predatory mite *A. swirskii* 75.62% was observed with Bifenthrin (10%). While Matrine with 14.69% mortality was found to be the least toxic to the predatory mite.

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