Lethal and Sublethal Effects of Mixed Pesticides on *Tetranychus urticae* Koch and its Predator *Phytoseiulus persimilis*

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Abstract

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Tetranychus urticae Koch is considered one of the most economically important pests on a wide range of crops in orchards worldwide. *T. urticae* control has been largely based on the utilization of acaricides. Sublethal effects of Romectin gold 32.8% SC (Abamectin 2.8% + Imidaclopride 30%) and AgriFlix 18.56% SC (Thiamethoxam 15.24% + Abamectin 3.23%) were studied on toxicity index and life-table parameters of *T. urticae*. LC_{25} concentration of Romectin gold and AgriFlix that were 0.0019 and 0.013 ppm, respectively, were utilized for sublethal studies. All acaricides showed a significant effect on *T. urticae.* Results obtained indicated that Romectin gold was the compound that had the higher effect on adult females of *T. urticae* and its predatory mite *P. persimilis* than AgriFlix. Sublethal concentrations of Romectin gold and AgriFlix may influence the durability of pre-adult stages, longevity, and biological parameters of *T. urticae.* The duration of life cycle of both females and males decreased significantly compared to the control with no significant effect between the two tested compounds. At the same time, Romectin gold produced the highest life cycle and life span. AgriFlix significantly decreased the pre-oviposition period with the lowest time of 1.10 days compared with 2.00 days for the control. To the contrary, Romectin gold had no significant effect on the pre-oviposition period. On the other hand, treatments with both Romectin gold and AgriFlix decreased significantly the oviposition period compared with the control. Romectin gold and AgriFlix significantly reduced the total number of eggs produced per female. AgriFlix acaricide decreased the total number and the daily rate of eggs produced by 73.36 and 65.05%, respectively. Results showed that exposure of females to sublethal concentrations of Romectin gold and AgriFlix reduced the net reproductive rate (R_0), while intrinsic rate (r_m) was increased compared to the control. Similarly, the finite rate of increase (exp_{rm}) for the control was significantly higher than that for Romectin gold and AgriFlix. Additionally, it was found that mean generation time (T) of the control was significantly shorter than that of Romectin gold and AgriFlix. Meanwhile, sex ratio was the same for control, Romectin gold and AgriFlix.

Keywords: Sublethal effects, toxicity index, Life-table parameters, Abamectin, Imidaclopride and Thiamethoxam.

Introduction

The two spotted spider mite, *Tetranychus urticae* Koch is one of the main significant pests of numerous horticultural and field crops and attacks in excess of 200 host plant species (Abdallah *et al.,* 2014). The importance of this mite pest does not just cusse immediate harm to the plant but also it diminishes the photosynthesis and transpiration rate of the plant leaves causing low yields (Golam, 2002). There has been an expanding interest in controlling spider mites by control tactics other than chemical pesticides and specifically by biological control agents. The phytoseiid mite, *Phytoseiulus persimilis* is an effective hunter feeding on *Tetranychus* species (McMurtry and Croft, 1997). Predatory mites in the subclass Acari, family Phytoseiidae, are frequently an important control component in agricultural systems, and *Phytoseiulus persimilis* is broadly utilized in integrated pest management (IPM) programs all over the world.

However, few investigations showed that, despite the adequacy of phytoseiid predators for biological control of spider mites on their host plants, the predators alone most likely unable to keep up spider mite populations below economic injury level for an extended period of time (Kim *et al.*, 2005). At present, efforts are made to reduce the use of chemical pesticides and increase the use of environment friendly components within integrated pest management (IPM) programs. Nonetheless, the search for pesticides that are compatible with IPM programs is an interesting approach.

Two-spotted spider mite pest has a high reproductive potential and short life cycle that encourage fast obstruction advancement of numerous acaricides often after a few utilizations (Van Leeuwen *et al.,* 2015). Although different techniques have been used for *T. urticae* management (O’Neal *et al*., 2015), the utilization of pesticides remains fundamental for controlling them in numerous agro-ecosystems and maintain their numbers below economic injury level. If utilized properly, pesticides could suppress high populations of the two-spotted spider mite. In any case, pesticides treatments are responsible for the decrease of associated predatory mites.

Recently, numerous endeavors have been made to dodge the harm caused by this pest utilizing some regular acaricides, however the broad use of such pesticides generally produce resistance to these chemicals (Massoud *et al.*, 2018). Understanding the impacts of synthetic compounds and the effect of their residues on *T. urticae* and

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its related predatory mites is fundamental for pest management. The selectivity of pesticides against beneficial arthropods should also be considered. Specific insecticides have a few benefits over broad-spectrum insecticides including more limited pre-harvest intervals because of their lower mammalian toxicity and greater compatibility with biological control because of their less harmful consequences on natural enemies. Information on miticides selectivity to predatory mites is imperative to their usage in IPM programs (Sayed *et al.,* 2019).

The importance of the current investigation is to assess the toxicity or selectivity of two mixed acaricides and insecticides against the predator *P. persimilis* and its prey *T. urticae* under laboratory conditions, as well as to evaluate the sublethal impacts of these products against two-spotted spider mite, and consequently to determine the potential of these pesticides to include in management of *T. urticae* populations applied at appropriate rates. The objectives were to expose *T. urticae* males and females to LC_{25} concentration and estimate life-table parameters. The results of this study could be seen as a starting point for field research to improve the management of spider mites management in Egypt.

Material and Methods

Tested mites

The original populations of *Tetranychus urticae* and its predator were obtained from infected castor bean plants from Mansoura district (Dakahlia Governorate). The mites were identified at the Acarology Laboratory, Plant Protection Research Institute, ARC by following the detailed descriptions reportedearlier (Zhang and Jocobson, 2000; Zhang, 2003). *T. urticae* raised on castor bean and berry leaves during summer and on castor bean leaves during winter. These leaves were cleaned and placed on moistened cotton wool pad in Petri dishes. Spider mite individuals were transferred to the leaves by the aid of fine camel's hairbrush. Breeding leaves were changed twice weekly during summer and once weekly during winter. Adding water was done twice weekly during summer and once weekly during winter to prevent the escape of *T. urticae* individuals (Abd El-Wahab, 2003).

The predacious mite *Phytoseiulus persimilis* was raised in plastic boxes (26 x 15 x 10 cm), a cotton pad was placed in the middle of each box, provisioned with water as a hindrance to keep predatory mite individuals from escaping, in addition to a Knot foot strip at the box edges. Exceptionally, infested castor leaves with *T. urticae* were given as food sources to predacious mite in the laboratory. Individuals of the predator mite, *P. persimilis,* were obtained from mass rearing on spider mites *T. urticae* obtained from open field (Heikal and Ibrahim, 2002).

Tested insecticides

The commercial insecticides of Romectin gold 32.8% SC (Abamectin + Imidaclopride) and AgriFlix 18.56% SC (Thiamethoxam 15.24% + Abamectin 3.23%) were selected for trials because of their widespread use on fruits and vegetables in most conventional agriculture.

Toxicological experiments

Laboratory experiments were conducted to investigate the activity of various tested compounds against *T. urticae* (adult females). The toxic effect of the tested materials was evaluated by leaf-dip technique as descripted by Dittrich (1962), and is described as follows:

Several concentrations of the tested insecticides were prepared for testing. Castor bean leaf discs (2 cm diameter) were dipped in each concentration for 15 sec., and left to dry for one hour. Discs were placed on cotton wool pads in Petri dishes (9 cm diameter). 10 adult females of *T. urticae* 0-48 h old, were transferred to treated castor leaf-discs for each replicate, by using camel hairbrush with the aid of a stereomicroscope. All treatments were kept under laboratory conditions. Six concentrations were prepared for every insecticide selected based on the preliminary tests. The concentrations were 1, 0.5, 0.1, 0.05, 0.01 and 0.005 ppm for Romectin gold and 500, 100, 10, 1, 0.1 and 0.01 ppm for AgriFlix. Five leaf discs (five replicates) were used for each concentration. In addition, control discs were dipped in distilled water only. Observations were taken 24, 48, 72, 96 and 120 hr. after treatment. Mortality rates were calculated and corrected by using Abbott's formula (Abbott,1925) and they were statistically analyzed according to Finney (1971). The tested materials were compared according to their efficiency on mites using LC_{50}, LC_{90} and toxicity lines slopes. The toxicity index was measured (Sun's equation) (Sun, 1950) using a computerized (LDP Line) program developed by Ehab M. Baker, Plant Protection Research Institute, ARC, Egypt.

On the other hand, the same previous methods were followed with the tested predatory mite *P. persimilis*. Ten adult predatory females were transferred onto each leaf disc supplemented with *T. urticae* as the prey. There were five replicates for each insecticide concentration treatment and the control.

Effect of sublethal concentration of tested insecticides on *T. urticae* biological measurements

An experiment was conducted to evaluate the comparative effect of the insecticides sub-lethal concentration (LC_{25}) on *T. urticae* adult females. Leaf-dip technique was used as described by Dittrich (1962). Leaf-discs were placed in Petri-dishes on moistened cotton pad after treatments by LC_{25} concentration of Romectin gold and AgriFlix that were 0.0019 and 0.013 ppm, respectively. Fifty newly emerged unmated adult females, of nearly the same age, were transferred with fifty adult males to leaf discs by the aid of camel's hairbrush and a stereomicroscope. Control discs were dipped in distilled water only. After 24 hours of exposure, the surviving mites in each treatment were transferred to new clean leaf discs free of insecticide residue for oviposition. Laid eggs were transferred individually on new clean leaf discs, each egg considered as replicate, 50 replicates were used for each insecticide to evaluate the developmental times (egg to adult). A twice daily monitoring (12 hours intervals) of eggs were carried out until maturity.

For mite fecundity evaluation, a newly emerged female coupled with a newly emerged male obtained in the same experiment were placed on treated leaf discs with LC_{25} concentration of insecticides for 24 hours then removed as mentioned before. Each couple of male and female considered as a replication unit, and there were 20 replicates for each examined insecticide. Mites were monitored daily and laid eggs were counted until all mites died naturally. Mites were transferred to new leaf discs weekly. Adult longevity and fecundity were recorded. Life table parameters: net reproduction rate (R_0), mean generation time (T), intrinsic rate of increase (r_m) and finite rate of increase (exp_{rm}) were calculated from survivors and fertility schedules (Birch, 1948; Constantino, 1993). The intrinsic rate of increase (rm) was estimated using the iterative bisection method from the Euler–Lotka equation (Grassly and Fraser, 2008)

$$\sum_{x=0}^{\infty} x^{-r(x-1)} l_x m_x = 1$$

With the age indexed from zero (Goodman 1982), gross reproductive rate was calculated as follows:

$$\text{GRP} = \sum mx$$

Net reproductive rate represents the mean number of offspring that an individual can produce during its lifetime and was calculated as follows:

$$R_{0=} \sum_{x=0}^{\infty} l_x m_x$$

Mean generation time defined as the period that a population needs to increase to R0-fold of its size was calculated as follows:

$$\text{T} = \frac{\text{InR0}}{r}$$

The finite rate of increase was calculated as follows:

$$\boldsymbol{\lambda} = e^r$$

Statistical analysis

Data collected from the two spotted spider mite experiments were statistically analyzed according to one way analysis of variance (ANOVA) and the least significant difference (L.S.D) method and Duncan's Multiple Range Test were used to compare the difference between the treatment mean values as described by Gomez and Gomez (1984).

Results and Discussion

Toxicity of tested insecticides

Toxicity bioassay tests results of tested insecticides Romectin gold 32.8% SC and AgriFlix 18.56% SC are summarized in Table 1 based on LC_{50} median lethal concentration values calculated for mites five days after treatment at P=0.05. Results obtained indicated that Romectin gold was the compound that had the higher effect on adult females of *T. urticae* than AgriFlix, as the calculated LC_{50} was 0.0185 ppm with a toxicity index (Ti) of 100 and 2.211 ppm with a toxicity index (Ti) of 1.451, respectively. In addition, results showed that Romectin gold displayed higher slope (0.683) over AgriFlix (0.439). Elsadany *et al*. (2021) reported that the slope value is considered as an indicator of the reaction between the chemical and the tested organism. As the highest slope value means greater homogeneity of the organism response towards the pesticide, whereas the low slope value demonstrates heterogeneous response of the organism to the tested chemical.

Results obtained (Table 2) showed that Romectin gold was also more toxic than AgriFlix on the predatory mite *P. persimilis*, and LC_{50} values were 0.0185 and 2.211 ppm and toxicity index (Ti) 100 and 1.451 five days after exposure, respectively. The LC_{90} for the same two pesticides were 1.3931 and 1838.319 ppm, respectively. In this respect, results showed that Romectin gold was more toxic on the predatory mite than AgriFlix. Romectin gold also displayed higher slope (0.683) than AgriFlix (0.439).

These outcomes are in agreement with those of Elsadany *et al*. (2021) that hypothesized that one of the main signs in the development of a resistant strain is the reduction in the slope of the dosage mortality line, in this way one can expect that compounds with low slope value might prompt to improve resistance if utilized successively. Assessing the toxicity of a pesticide to phytoseiids by estimating female mortality alone underestimates the true effect of residual exposure (Irigaray *et al*., 2007). Indeed, numerous new pesticides have little impact on mortality but have considerable sub-lethal impacts. Laboratory procedures give a more reasonable tool for the assessment of these pesticides impact on predatory mites than semi-field and field experiments (Duso *et al.*, 2008).

Table 1. Toxicity of two tested insecticides against adult females of *Tetranychus urticae*, five days after treatment.

Tested insecticides	LC_{50} (ppm) Confidence intervals*		LC_{90} (ppm) Confidence intervals		Slope±S.E.	Toxicity index%
Romectin gold	0.0185		1.3931		0.683±0.128	100
	0.0068	0.0366	0.4852	11.0733		
AgriFlix	2.211		1838.319		0.439±0.123	1.451
	0.0907	8.462	268.621	63298.6205		

*Confidence intervals calculated at P=0.05.

Table 2. Toxicity of two tested insecticides against adult females of *Phytoseiulus persimilis,* five days after treatment.

Tested insecticides	LC_{50} (ppm) Confidence intervals*		LC_{90} (ppm) Confidence intervals*		Slope±S.E.	Toxicity index%
Romectin gold	0.0058		0.5888		0.639±0.135	100
	0.001	0.014	0.2165	4.7102		
AgriFlix	3262.016		99083834.700		0.286±0.124	0.0002
	293.64	352.19	47.639x10^4	7.3712x10^{15}		

*Confidence intervals calculated at P=0.05.

Results obtained in this study showed that Romectin gold 32.8% SC (Abamectin + imidaclopride) was highly effective in killing adults of the two-spotted spider mite (*T. urticae*), which is in agreement with those recently reported by Abd El- Rahman and El-keblawy (2016), who observed that among the five compounds tested against adults of *T. urticae*, the most toxic pesticide against this pest was abamectin. From the mortality responses of *T. urticae* adult females to various acaricidal molecules (LC_{50} values) it is obvious that abamectin was most toxic to adults with the lowest LC_{50} value of 0.01 ppm (Kavya, 2018). In addition, when Lu *et al.* (2017) compared 8 acaricides against adults and 5 acaricides against larvae of *T. urticae*, they observed that the most effective was Abamectin on both adults and larvae. Tarikul (2019) reported that abamectin gave highest harmful impact against *T. urticae* population as compared with other acaricides such as spinosad, azadirachtin, hexythiazox and emamectin benzoate. Vidrih *et al*. (2021) reported the emergence of resistance of two-spotted spider mites to the acaricide abamectin. In relation to the effect of imidacloprid, the results obtained are in concordance with those recently introduced by Ganai *et al.*, (2017) who claimed that the mean population of *T. urticae* after two sprays revealed that imidacloprid 0.008% and thiamethoxam 0.100% were at par and were effective against *T. urticae.* Abdelmaksoud *et al*. (2020) reported that Congest 15% CS (Abamectin + Imidacloprid) was effective against *T. urticae*.

Biological studies

Sublethal impacts study showed that the immature developmental time of T. urticae females and males were significantly affected when exposed to LC_{25} values of Romectin gold and AgriFlix, compared to the control (Table 3). Incubation periods of females and males were 3.9 and 3.5 days, respectively, after treatment with Romectin gold and 3.4 and 3.4 days when treated with AgriFlix, respectively. The total incubation period of females and males treated with Romectin gold and AgriFlix was reduced significantly compared to the control without significant difference between the two compounds.

The larval stage of *T. urticae* varied from female to male. Tested compounds had no significant effect on both active female and male larvae as well as quiescent male larvae, whereas quiescent female larvae were significantly decreased by the tested compounds as compared with the control. The AgriFlix decreased the quiescent female larvae by 25.00 %, whereas Romectin gold decreased them by 15.00 % as compared to the control treatment.

It was obvious (Table 3) that the duration of active female proto-nymphs were not significantly affected by the tested compounds, whereas active male proto-nymphs increased following treatment with with AgriFlix and decreased following treatment with Romectin gold. The quiescent proto-nymphs of *T. urticae* females and males were significantly decreased following treatment with the tested compounds as compared to the control. In addition, Romectin gold had significant effect on the duration of active deutonymphal stage of *T. urticae* females and males and were 1.15 and 1.20 days, respectively, compared to the control (Table 3).

Table 3. Influence of treatment with LC_{25} concentration of tested pesticides on duration of various stages of *Tetranychus urticae.*

Tested compounds	Sex	Incubation period (days)	*T. urticae* immature stages duration (Days) Active larva	Quiescent larva	Active protonymph	Quiescent protonymph	Active deutonmpl	Quiescent deutonmpl	Longevity (days)	Life cycle (days)	Life span (days)
Romectin gold	Female	3.90 b	0.90 a	0.85 ab	0.70 a	0.40 b	1.15 a	0.70 a	19.50 ab	8.45 b	27.95 b
	Male	3.50 b	1.10 a	0.60 a	0.45 b	0.48 a	1.20 a	0.95 a	18.40 a	8.28 b	26.68 a
AgriFlix	Female	3.40 b	0.95 a	0.75 b	0.75 a	0.70 b	0.95 ab	0.58 b	18.00 b	8.15 b	26.00 b
	Male	3.40 b	1.15 a	0.60 a	0.75 a	0.35 b	0.80 b	0.50 b	17.80 a	7.43 b	24.88 b
Control	Female	4.60 a	1.00 a	1.00 a	0.65 a	0.85 a	0.85 b	1.15 a	21.80 a	10.10 a	31.90 a
	Male	4.20 a	1.20 a	0.80 a	0.50 b	1.00 b	0.80 b	1.10 a	18.60 a	9.60 a	28.20 a

Means followed by the same letters in the same column are not significantly different at P=0.05 according to Duncan's multiple range test.

The finding of this study revealed that the sublethal concentration of Romectin gold 32.8% SC (Abamectin + imidaclopride) and AgriFlix 18.56 SC (thiamethoxam 15.24% + abamectin 3.23%) may influence the durability of pre-adult stages, longevity, and biological parameters of *T. urticae.* Significant high longevity of *T. urticae* females treated with Romectin gold and AgriFlix were observed (Table 3) as compared to the control, whereas no significant effect between the tested compounds and the control and was observed on the longevity of *T. urticae* males. The results obtained showed that *T. urticae* females lived longer than males under the conditions of the experiment. The duration of life cycle of both females and males decreased significantly compared to the control with no significant effect between the two tested compounds. Furthermore, Romectin gold produced the highest life cycle of 8.45 and 8.28 days for females and males, respectively. Results presented in Table 3 also showed that female life span took the same trend of the life cycle, that is decreased significantly following treatment with the tested the tested compounds as compared to the control with no significant effect between the two tested compounds, and Romectin gold produced the highest life span.

Treatment of adult females with sublethal concentrations of Romectin gold and AgriFlix significantly affected adult females during pre-oviposition, oviposition and post-oviposition periods as indicated in Table 4. It was apparent that AgriFlix significantly decreased the pre-oviposition period to its lowest time of 1.10 days compared with 2.00 days for the control, in contrast with Romectin gold which had no significant effect on pre-oviposition period.
On the other hand, treatments with both Romectin gold and AgriFlix decreased significantly the oviposition period compared with the control. The treatment of AgriFlix produced the lowest oviposition period of 11.50 days compared with 16.50 days for the control. Furthermore, Romectin gold and AgriFlix significantly decreased the post-oviposition period by 31.48 and 57.41 %, respectively, compared with the control (Table 4).

Table 4. *T. urticae* adult females as affected by Romectin gold and AgriFlix acaricides.

Tested compounds (days)	Romectin gold	AgriFlix	Control
Pre-oviposition period	1.80 a	1.10 bc	2.00 a
Oviposition period	14.00 b	11.50 c	16.50 a
Post-oviposition period	3.70 b	2.30 c	5.40a
Total number of egg	54.90 b	21.90 c	82.20 a
Dailey rate of egg	3.88 b	1.73 c	4.95 a

Means followed by the same letters in the same column are not significantly different at P=0.05 according to Duncan’s multiple range tests.

Treatment of adult females with sublethal concentrations of Romectin gold and AgriFlix significantly reduced the total number of eggs laid per female and daily rate of eggs laid. AgriFlix decreased the total number and the daily rate of eggs laid by 73.36 and 65.05 %, respectively.

Chemical control remains important for the management of *T. urticae* and other mites and insect pests in agricultural crops in Egypt. Many reports have showed that the utilization of an insecticide or acaricide at sublethal concentrations may increase pest numbers rather than decreasing them (Morse and Zareh, 1991; Zheng and Wang, 2010). The stimulation of populations caused by sublethal concentrations of pesticides is incompletely understood but may result from a suppression of natural enemies (Abedi *et al.*, 2014; Dutcher, 2007; Raupp *et al.,* 2010), a stimulation of reproduction, an enhancement of pre-imaginal survivorship and an increase in egg hatching (Zheng and Wang, 2010).

It can be concluded from the present study that Romectin gold was more toxic to *T. urticae* and *P. persimilis* than AgriFlix. In addition, AgriFlix had more impact on some stages of the mite than Romectin gold and accordingly can be recommend in controlling in active proto-nymph, total immature, life cycle stages of *T. urticae*.

The life table parameters R_o, T, r_m, exp_{rm} and sex ratio values were significantly different from each other as indicated in Table 5. Results obtained showed that exposure of females to sublethal concentrations of Romectin gold and AgriFlix reduced the net reproductive rate (R_0), while intrinsic rate (r_m) was increased compared to the control. Similarly, the finite rate of increase (exp_{rm}) for the control was significantly higher than those of for Romectin gold and AgriFlix. Additionally, the mean generation time (*T*) of the control was significantly shorter than that of Romectin gold and AgriFlix. The sex ratio was the same for the control, Romectin gold and AgriFlix.

Table 5. The effect of different acaricides/pesticides on the life table parameters of *T. urticae.*

Parameters	Control	Romectin gold	AgriFlix
R_0	5181.75	3458.7	1323.00
T	15.981	13.325	12.217
r_m	0.5351	0.6115	0.5882
exp_{rm}	1.707	1.843	1.800
% females/total	0.70	0.70	0.70

The current study showed that Romectin gold and AgriFlix had sublethal negative impact on life-table parameters of adult *T. urticae*. Intrinsic rate of increase (r_m) is the best factor to describe the impact of pesticides on pests (Hamedi *et al*., 2010; Stark and Banks, 2003), because it demonstrates the general consequences on both fecundity and survivorship (Li *et al.*, 2017). The consequences of this study showed that r_m in *T. urticae* was decreased by acaricides in contrast to the control indicating the adverse impact of the chemicals on this parameter. Our results uncovered that the population growth rate of *T. urticae* was impacted by LC_{25} of tested pesticides as consequence of negative impact on immature developmental time, reproduction period, fecundity and finally on the population parameters (r_m, λ, R_0, and T). Our findings are in concurrence with many studies on the impacts of pesticides on development, survival, and reproduction of *T. urticae* (Hardman *et al*., 2007; Hamedi *et al*., 2010 and Li *et al.,* 2017). Similar impacts on life-table traits were recorded by

Ako (2006) who uncovered that in all tested TSSM strains, intrinsic rate of increase (Rm), finite rate of increase (λ), and net reproduction rate (R_0) were higher in the control compared with imidacloprid as drench application, whereas in foliar application, R_m and λ did not show significant variations compared with the control treatment.

Likewise, the doubling time (Dt) for TSSM population was shorter in control treatments compared with drench but not with foliar applications. The mean generation time (T) did not vary among the treatments and TSSM strains with or without imidacloprid treatment. In addition, Saber *et al*. (2018) indicated that the females treated with abamectin at LC_{25} exhibited significantly reduced net reproductive rate (R_0), finite rate of increase (λ) and intrinsic rate of increase (r_m). The intrinsic rate of increase in abamectin treated groups and control were 0.0273 and 0.2481 female offspring per female per day, respectively. The results indicated that sublethal concentrations of tested pesticides strongly affected the life characteristics of spider mite and consequently may influence mite population growth in future generations. Havasi *et al*. (2020) reported that the intrinsic and finite rate of increase (r, λ) were not affected by the increase of sublethal thiamethoxam concentration. The net reproductive rate (R_0) reached its lowest level (36.71 offspring/individual) in the LC_{20} treatment.

Finally, it may be concluded that Romectin gold was the compound that had higher effect on adult females of *T. urticae* and its predatory mite *P. persimilis* than AgriFlix, whereas Romectin gold produced the highest life cycle and life span. AgriFlix significantly decreased the pre-oviposition period to the lowest time period.

الملخص

عبده، دينا، محمد البقل، أحمد عبد المجيد ومريم حبشي. 2023. التأثيرات المميتة وغير المميتة لخليط من مبيدات الآفات على أكاروس العنكبوت الأحمر العادي ومفترسه *Phytoseiulus persimilis*. مجلة وقاية النبات العربية، 41(1): 40–47.
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يعدّ أكاروس العنكبوت الأحمر العادي واحداً من أهم الآفات التي تؤثر اقتصادياً على مجموعة واسعة من المحاصيل في جميع أنحاء العالم. تعتمد مكافحة الأكاروسات بشكل كبير على استخدام المبيدات الأكاروسية. تمّت دراسة تأثير المبيدات: Romectin gold 32.8% SC (Abamectin 2.8% + Imidaclopride 30%) و AgriFlix 18.56% SC (Thiamethoxam 15.24% + Abamectin 3.23%) على مؤشر السمّية ومعاملات جدول الحياة لأكاروس العنكبوت الأحمر العادي. بلغ تركيز LC_{25} 0.0019 لـ Romectin gold و0.013 لـ AgriFlix. أظهرت جميع المبيدات تأثيراً معنوياً على أكاروس العنكبوت الأحمر. أشارت النتائج المتحصّل عليها إلى أن المبيد Romectin gold كان المركب ذو التأثير الأعلى على الإناث البالغة لأكاروس العنكبوت الأحمر والمفترس *P. persimilis*، ويليه AgriFlix. انخفضت مدّة دورة حياة كلّ من الإناث والذكور بشكل معنوي مقارنة بمجموعة الشاهد، مع عدم وجود تأثير معنوي بين المركبين المختبرين. في الوقت نفسه، أنتج مبيد Romectin gold أطول دورة حياة وعمر افتراضي، كما أدى مبيد AgriFlix إلى انخفاض معنوي في فترة ما قبل الوضع، مع أقلّ وقت (1.10 يوماً) مقارنة بـ 2.00 يوماً لمعاملة الشاهد. على العكس من ذلك، لم يكن لمبيد Romectin gold تأثير معنوي في فترة ما قبل وضع البيض. من ناحيةٍ أخرى، أدّت المعاملات باستخدام كلٍّ من Romectin gold و AgriFlix إلى انخفاض معنوي في فترة وضع البيض مقارنة بالشاهد. قلّل المبيدان Romectin gold و AgriFlix من إجمالي عدد البيض المنتج لكل أنثى بشكل كبير. أدى مبيد AgriFlix إلى خفض العدد الإجمالي والمعدل اليومي للبيض المنتج بنسبة 73.36 و 65.05%، على التوالي. أظهرت النتائج أن تعرض الإناث للتراكيز شبه المميتة من Romectin gold و AgriFlix قلّل من معدل التكاثر الصافي (R_0) ، بينما زاد المعدل الداخلي (r_m) مقارنة بمجموعة الشاهد. وكذلك كان معدل الزيادة المحدودة (exp_{rm}) للشاهد أعلى بكثير من معدل الزيادة للمبيدين Romectin gold و AgriFlix. بالإضافة إلى ذلك، وجد أن متوسط عمر الجيل (T) للشاهد كان أقصر بكثير منه في معاملة Romectin gold و AgriFlix. في الوقت نفسه، كانت النسبة الجنسية هي نفسها بالنسبة لمجموعه الشاهد، و Romectin gold و AgriFlix.

كلمات مفتاحية: التأثيرات غير المميتة، مؤشر السمّية، مدلولات جدول الحياة، أبامكتين، إيميداكلوبرايد وثياميثوكسام.

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