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Article

Lethal and sublethal impacts of cyflumetofen and bromopropylate on *Tetranychus urticae* Koch (Acari: Tetranychidae)

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ABSTRACT
The control of the two-spotted spider mite, *Tetranychus urticae* Koch as one of the most important key pests in agriculture, is basically dependent on the use of pesticides. The lethal and sublethal impact of cyflumetofen (Danisaraba®) and bromopropylate (Neoron®) were assessed. LC_{50} values of cyflumetofen and bromopropylate were 2.77 and 8.95 µg a.i./mL, respectively. The sublethal effect of LC_{30} concentration of these acaricides was evaluated on life table parameters of the pest at 25 ± 2 °C, 65 ± 5% relative humidity and a photo-period of 16:8 (L/D). The obtained data were assessed by two-sex life table theory. Both acaricides had significant effects on *T. urticae* biological parameters such as growth time, survival rate, as well as fertility. The exposure of female mites to LC_{30} decreased net reproduction rate (R_0), finite rate of increase (λ) and intrinsic rate of natural increase (r). The intrinsic rate of natural increase (r) in cyflumetofen and bromopropylate treatments and control group were 0.035, 0.045 and 0.21 female offspring/female/day, respectively. The results of this study revealed that the acaricides had sub-lethal impacts on life table parameters of *T. urticae* and might have an effect on the population growth and subsequently the plethora of future generations. The findings of this study can be used in *T. urticae* management programs.

KEY WORDS: Acaricide; bioassay; intrinsic rate of natural increase; spider mite, toxicity.

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INTRODUCTION

Tetranychus urticae Koch is one of the most important pests of estival, horticultural, ornamental and agricultural plants (Hell and Sabelis 1985) and found in many regions such as Europe (Fasulo and Denmark 2000), USA (Tuttle *et al.* 1976), Africa (Saunyama and Knapp 2003) and Asia (Ho 2000; Takafuji *et al*. 2000). *Tetranychus urticae* causes damages on the leaves through feeding on the plant sap and plant cells (Huffaker *et al*. 1969) and prevents transpiration and photosynthesis in the plant by weaving warp (Brandenburg and Kennedy 1987) which finally will lead to reduced performance (Huffaker *et al*. 1969).

During the past four decades, various strategies have been applied for controlling *T. urticae*, mostly based on the application of acaricides, particularly selective ones (Ruberson *et al*. 1998).

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Cyflumetofen is an acaricide of the benzoyl acetonitrile group that has shown excellent performance against all of the growth stages of *Tetranychus* and *Panonychus* mites. Previous studies have indicated that this acaricide is a complex II inhibitor in the electron transport chain in mitochondria (Takahashi *et al*. 2012; Hayashi *et al*. 2013). Bromopropylate is a relatively durable contact acaricide which is used on cotton, fruit trees, grapes and ornamental plants. This acaricide is effective in relatively high concentrations on resistant mites to phosphorus compounds (Talebi Jahromi 2010).

Pesticide bioassay tests which evaluate only the acute mortality, are not enough for assessing the total impact of pesticides on a pest (Brattsten *et al*. 1986). Today, life table parameters are presented as a reliable measure for specifying pesticides toxicity and the best time for fighting pests (Chi 1990) and a significant tool for studying pest population (Sakai *et al*. 2001). Indeed, life table specifies the impact of the toxin on survival and the factors which restrict the development rate of the pest population (Marcic 2003). Studies of sublethal effects of pesticides on the pests have mainly been aimed to find the negative, non-lethal impacts of pesticide on various life history parameters that might influence the population dynamics (Stark and Banks 2003). Life tables are traditionally prepared based on the female sex, only by considering the age of the creatures and without considering the male sex (Lotka 1907; Leslie 1945; Lewis 1977). Not considering the differences in the growth and developmental period of individuals in some insects and mites leads to errors in calculating population parameters, while not considering the male sex causes inadequacy of information obtained (Chi 1988). Therefore, with two-sex life table theory and the calculation of both males and females, errors can be eliminated and the difference between the biological stages as well as information related to male sex can be shown (Chi and Liu 1985). The present study aimed to assess the lethal and sub-lethal impacts of cyflumetofen and bromopropylate acaricides on life table parameters of *T. urticae* through two-sex life table theory to study the efficacy of such acaricides for using in form of integrated pest management programs.

MATERIAL AND METHODS

Mite rearing

A stock population of *T. urticae* was prepared from the infected leaves of bean, *Phaseolus vulgaris* L., at the agricultural research greenhouse at the University of Tabriz, Iran and continuously reared on bean plants in laboratory conditions at 25 ± 2 ℃, 65 ± 5% RH and a 16:8 h (L/D) photoperiod.

Acaricides

The acaricides used in this study included: Cyflumetofen (Danisaraba® 20SC, Otsuka AgriTechno Co, Japan) and Bromopropylate (Neoron® 25EC, Shimagro, Iran).

Toxicity bioassays

Concentration-setting tests were done for finding the concentrations causing about 10 and 90% mortality. Then the commercial formulation related to each acaricide was serially diluted in five concentrations (prepared with distilled water) which cover the mortality range of 10–90%. The concentrations were 12.80, 6.30, 3.10, 1.55, and 0.80 µg a.i/ml for cyflumetofen, and 37.5, 18.87, 9.50, 4.75 and 2.50 µg a.i/ml for bromopropylate. Concentration response bioassay was performed with the use of a modified leaf dip method. The experimental arena included a Petri dish (diameter = 6 cm) with a thin layer of wet cotton at the bottom and a ventilation hole (diameter = 1 cm) in the center of the lid covered by net. Pre-ovipositing females (< 1-day old) were used in bioassay tests. Leaf discs (diameter = 2 cm) were dipped in each specified concentration of either acaricide for 30 seconds and allowed to air dry for 1 h under laboratory conditions. The control leaf discs were placed in distilled water. Every leaf disc was transferred into the experimental arena and was

surrounded with saturated cotton in order to prevent the escape of the mites. After that, 20 adult mites of the same age were transferred onto the treated leaf discs for each concentration. Each test was replicated five times. The number of dead mites was recorded after 24 hours. Data was subjected to Probit analysis (Finney 1971). Concentration mortality curves were estimated through Probit analysis (SAS Institute 2007).

Sub-lethal study

In order to assess the sub-lethal impact of cyflumetofen and bromopropylate on the offspring of treated mites, bean leaf discs were treated with lethal concentration (LC_{30}) and allowed to dry for 1 h. In addition, 150 same-age females were used for each treatment. After 24 hours, the surviving females were separately put on clean and untreated bean leaf discs (diameter = 2 cm). In addition, the eggs laid by the treated females in each experimental arena were saved after 24 hours. All of the saved eggs (N = 75 to 100) were evaluated every day and their developmental time and survival were recorded. The newly emerged females were associated with a male in order to mate. The daily survival of each adult and the fecundity of females were recorded and the population parameters were measured regarding both sexes. The leaf discs which were treated with distilled water served as the control.

Data analysis

The data related to the raw life history of all individuals were analyzed based on the age-stage, two-sex life table theory (Chi and Liu 1985; Chi 1988, 2020) through the use of a user-friendly computer program, TWOSEX–MS Chart (Chi 2020). Accordingly, age-stage survival rate (S_{xj}, where x indicates age and j stage), age-stage specific fecundity (f_{xj}), age-specific survival rate (l_x), age specific fecundity (m_x), age-stage life expectancy (e_{xj}), age-stage specific reproductive value (v_{xj}) and the population parameters (r, intrinsic rate of increase; λ, finite rate of increase; R_0, net reproductive rate; *GRR*, gross reproductive rate; T, mean generation time) were estimated accordingly. The means, standard errors of developmental time, longevity and variances of the life-table parameters were calculated with the bootstrap (m = 100,000) method (Efron and Tibshirani 1993; Huang and Chi 2012). Differences among treatments were compared to each other through the use of the paired bootstrap test (Chi 2015). The intrinsic rate of increase (r) was estimated through the use of the iterative bisection method from the Euler–Lotka equation:

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

with the age which was indexed from zero (Goodman 1982). Gross reproductive rate was calculated as:

$$GRR = \sum m_x \quad (2)$$

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

$$R_0 = \sum_{x=0}^{\infty} l_x m_x. \quad (3)$$

Mean generation time was defined as the period which a population should increase to the R_0-fold of its size calculated as:

$$T = \frac{lnR_0}{r} \quad (4)$$

The finite rate of increase was calculated as:

$$\lambda = e^{r} \quad (5)$$

The value of l_x is the probability that a newborn nymph will survive to age x and is calculated through pooling all of the surviving individuals of different stages. It is calculated as:

$$l_x = \sum s_{xj} \quad (6)$$

in which ∞ indicates the last stage of the study cohort. In addition, m_x was estimated through the following equation:

$$m_{xj} = \frac{\sum_{j=1}^{\infty} s_{xj} f_{xj}}{\sum_{j=1}^{\infty} s_{xj}} \quad (7)$$

The age-stage life expectancy (e_{xj}) was calculated according to Chi and Su (2006) and defined as the time when an individual of age x and stage j is expected to live. The life expectancy for individuals in different age-stage-sex units can be calculated as:

$$e_{xj} = \sum_{i=1}^{n} \sum_{j=y}^{m} s'ij \quad (8)$$

The age-stage-specific reproductive value (v_{xj}) of *T. urticae* female was calculated for an individual of age x and stage j to the future population:

$$V_{(i,j,1)} = \frac{e^{(i+1)}}{s_{(i,j,1)}} \sum_{k=1}^{n} e^{-r(k+1)} \times \left| \sum_{y=1}^{m} s(k,y,1) f(k,y,1) \right| \quad (9)$$

RESULTS

The acute bioassay results indicated that the cyflumetofen and bromopropylate have strong toxicity against the adult females of *T. urticae*. The results of Probit analysis for LC_{30}, LC_{50} and LC_{90} values, 95% confidence limits, regression equations details and χ^2 values are shown in Table 1. The LC_{50} values at 95% confidence limits were estimated to be 2.77 and 8.95 µg a.i./mL for cyflumetofen and bromopropylate, respectively. According to LC_{50} and LC_{90} values, cyflumetofen was more toxic compared to bromopropylate. Based on regression analysis and r^2 values, a correlation between log concentration and mite mortality has been achieved. The steep slopes related to the concentration-response lines indicate homogeneity in response of the adult females of *T. urticae* to the acaricides (Fig. 1).

Table 1. Acute toxicity of cyflumetofen and bromopropylate against *Tetranychus urticae* female adults.

Acaricide	$\chi^2(df = 3)$	Slope ± SE	Lethal concentration (µg a.i/mL)		
			LC_{30} (95%FL*)	LC_{50}(95%FL*)	LC_{90}(95%FL*)
Cyflumetofen	31.21	1.66 ± 0.15	1.45 (1.15–1.75)	2.77 (2.21–3.26)	13.47 (10.25–19.56)
Bromopropylate	81.12	1.71 ± 0.25	4.65 (3.67–5.61)	8.95 (7.58–10.54)	44.47 (33.62–65.22)

* Fiducial limits

Sub-lethal effects

The effects of LC_{30} of cyflumetofen and bromopropylate on developmental time, longevity, and total life span of offspring from the treated and untreated females are shown in Table 2. The egg incubation period was affected by LC_{30} of both pesticides. It was 4.58 and 4.16 days for

cyflumetofen and bromopropylate, respectively in comparison to 2.69 days for the untreated females. There were no significant differences in the developmental periods of larva-nymph stage of *T. urticae* offspring from treated or untreated females and males (Table 2).

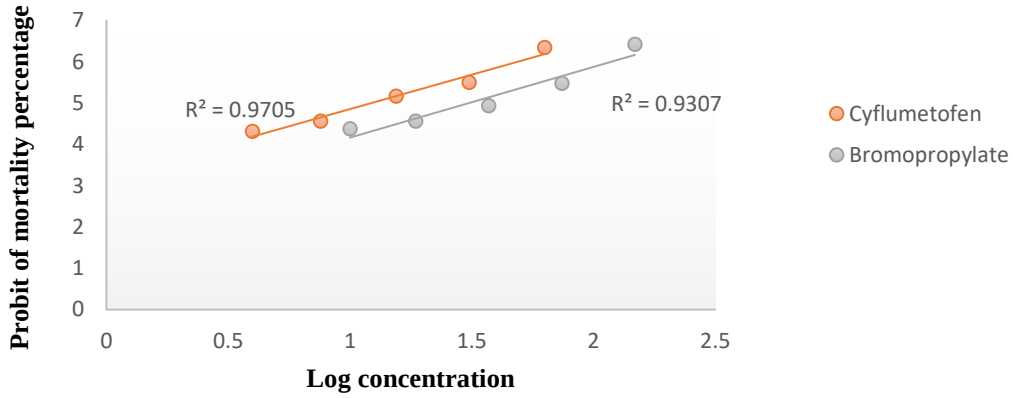

Figure 1. Concentration-mortality response lines for cyflumetofen and bromopropylate against *Tetranychus urticae* female.

The adult longevity of female and male *T. urticae* exposed to LC_{30} concentration of cyflumetofen or bromopropylate were shorter compared to the control. The longevity of female or male offspring from treated females considerably were decreased in comparison to the control.

LC_{30} concentration of the acaricides contributed to a significant decrease in total fecundity of *T. urticae*. The mean fecundity per female was 41.2, 5.79 and 6.52 eggs/female in control, cyflumetofen and bromopropylate, respectively (Table 3).

Table 2. Life-history traits [mean ± SE developmental time (days)] of offspring of *Tetranychus urticae* females treated with cyflumetofen and bromopropylate.

Sex	Stage	Control	Cyflumetofen	Bromopropylate
Female	Egg	2.69 ± 0.5c	4.58 ± 0.05a	4.16 ± 0.02b
	Larva-nymph	4.45 ± 0.14a	4.53 ± 0.07a	4.58 ± 0.04a
	Adult	12.07 ± 0.03a	5.25 ± 0.03c	5.80 ± 0.04b
	Total pre-adult	7.14 ± 0.14b	9.11 ± 0.07a	9.01 ± 0.05a
	Longevity	19.21 ± 0.1a	12.55 ± 0.82b	14.81 ± 0.04b
Male	Egg	2.95 ± 0.04b	4.60 ± 0.20a	4.53 ± 0.08a
	Larva-nymph	4.80 ± 0.03a	4.50 ± 0.13a	4.66 ± 0.26a
	Adult	9.73 ± 0.2a	3.86 ± 0.02b	4.13 ± 0.06b
	Total pre-adult	7.75 ± 0.9b	9.13 ± 0.03a	9.20 ± 0.20a
	Longevity	17.49 ± 0.19a	11.15 ± 0.10b	13.33 ± 0.24b

Treatments were estimated with the bootstrap technique through 100,000 replications; SEs were estimated through 100,000 bootstraps and compared with the help of paired bootstrap test (comparison of 95% CL). Means in a row followed by various letters are significantly different (the paired bootstrap test ($P < 0.05$)).

The adult pre-oviposition period (APOP) and the total pre-oviposition period (TPOP) of *T. urticae* were affected by the LC_{30} of cyflumetofen and bromopropylate. The significant differences were scored in the oviposition period among offspring from treated females in comparison to the untreated control group. It was 9.99, 2.26 and 2.73 days in control, cyflumetofen and bromo-

propylate, respectively (Table 3). Thus, LC_{30} concentration of cyflumetofen and bromopropylate showed harmful impacts on the daily rate of eggs/female during the oviposition period.

Table 3. Longevity and fecundity of offspring *Tetranychus urticae* from females treated with LC_{30} sub-lethal concentration of cyflumetofen and bromopropylate.

Parameters	Mean ± SE		
	Control	Cyflumetofen	Bromopropylate
APOP (day)	1.03 ± 0.37b	1.53 ± 0.06a	1.42 ± 0.10a
TPOP (day)	8.60 ± 0.08b	10.24 ± 0.06a	10.34 ± 0.17a
Oviposition days	9.99 ± 0.13a	2.26 ± 0.13b	2.73 ± 0.29b
Fecundity	41.2 ± 0.68a	5.79 ± 0.53b	6.52 ± 0.07b

APOP, Adult pre-oviposition period and TPOP total pre-ovipositional period. Means in each row with the same letters are not significantly different (Paired bootstrap test, $P < 0.05$).

The life table parameters of the treated mites are summarized in Table 4. The results indicated that the net reproductive rate (R_0) and intrinsic rate of increase (r) of females treated with LC_{30} of cyflumetofen and bromopropylate were reduced in comparison to the control. The net reproductive rate (R_0) values were 1.78, 1.60 and 17.15 offspring/individual for bromopropylate, cyflumetofen and control, respectively. The generation time (T) and gross reproduction rate (GRR) were influenced by the LC_{30} of bromopropylate, cyflumetofen and significant differences were observed at r, R_0 ,T and λ for the offspring from females treated by bromoprppylate and cyflumetofen (Table 4).

Table 4. Mean (± SE) life-table parameters of offspring of *Tetranychus urticae* females treated with cyflumetofen and bromopropylate.

Treatments	r	λ	R_0	T	GRR
Control	0.21 ± 0.2a	1.24 ± 0.26a	17.15 ± 0.41a	13.00 ± 0.09a	21.21 ± 0.41a
Cyflumetofen	0.035 ± 0.03c	1.03 ± 0.03b	1.60 ± 0.08b	12.46 ± 0.05b	3.36 ± 0.13b
Bromopropylate	0.045 ± 0.02b	1.09 ± 0.04b	1.78 ± 0.06b	12.49 ± 0.02b	3.63 ± 0.10b

Intrinsic rate of increase (r), finite rate of increase (λ), net reproductive rate (R_0), mean generation time (T) and gross reproduction rate (GRR).
Means in a column followed by various letters are significantly different between the treatments with the help of the paired bootstrap test ($P < 0.05$).

The daily survival (l_x) rates of offspring of the females treated with LC_{30} of bromopropylate and cyflumetofen are shown in Figure 2. Total lifetime was 20, 15 and 15 for control, bromopropylate, and cyflumetofen, respectively.

The maximum values related to m_x were 1.1 and 1.4 eggs/individual for the mites which were treated with LC_{30} concentrations of bromopropylate and cyflumetofen occurring on 11 and 12th days of the life span. In contrast, the maximum value of 2.36 eggs/individual was observed on 13th day of the life span for the mites which were untreated (Fig. 3).

The age-stage survival rate (s_{xj}) shows the probability that an egg of *T. urticae* will survive to age x and stage j (Fig. 4). Due to the variation in the growth time in individuals, a clear stage overlap exists in all of the treatments. The likelihood of a newly hatched nymph to survive until the adult stage was more in the control (0.85 for females and 0.5 for males) compared to the bromoprpylate and cyflumetofen treatments (0.5 and 0.4 for females and 0.1 and 0.2 for males), respectively.

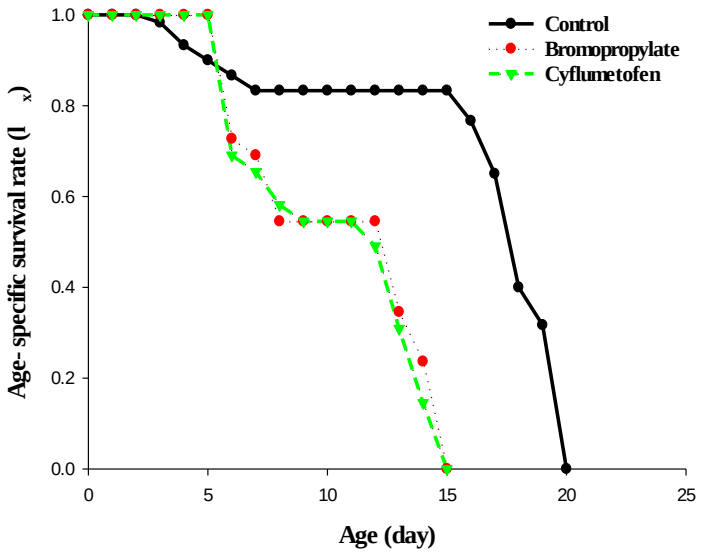

Figure 2. Age-specific survival rate (*lx*) of *Tetranychus urticae* treated with LC_{30} concentration of cyflumetofen or bromopropylate.

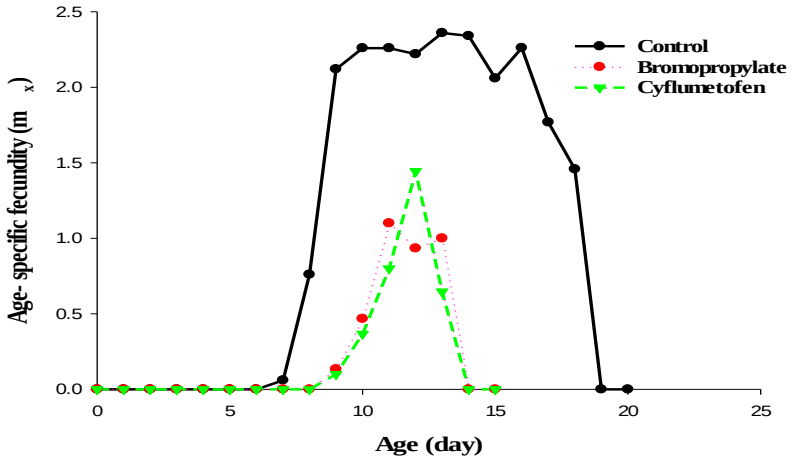

Figure 3. Age-specific fecundity (m_x) of *Tetranychus urticae* treated with LC_{30} concentration of cyflumetofen or bromopropylate.

Age-specific life expectancy (e_{xj}) in cyflumetofen, bromopropylate, and the control was 8.52, 8.04 and 13.57 days on the first day of the larval stage (Fig. 5). The specific age-biological stage fertility curve (v_{xj}) indicates the expectation of fertility in each *T. urticae* at each age *x* and stage *j*. The fertility value related to female mites in the control is more than that of the treated mites. When the females emerge, the specific age-biological stage fertility (v_{xj}) for the control, cyflumetofen and bromopropylate were 11.24, 5.31 and 5.63, respectively. In addition, it shows that the LC_{30} of cyflumetofen and bromopropylate reduced the reproduction value in the treated mites in comparison to the control (Fig. 6).

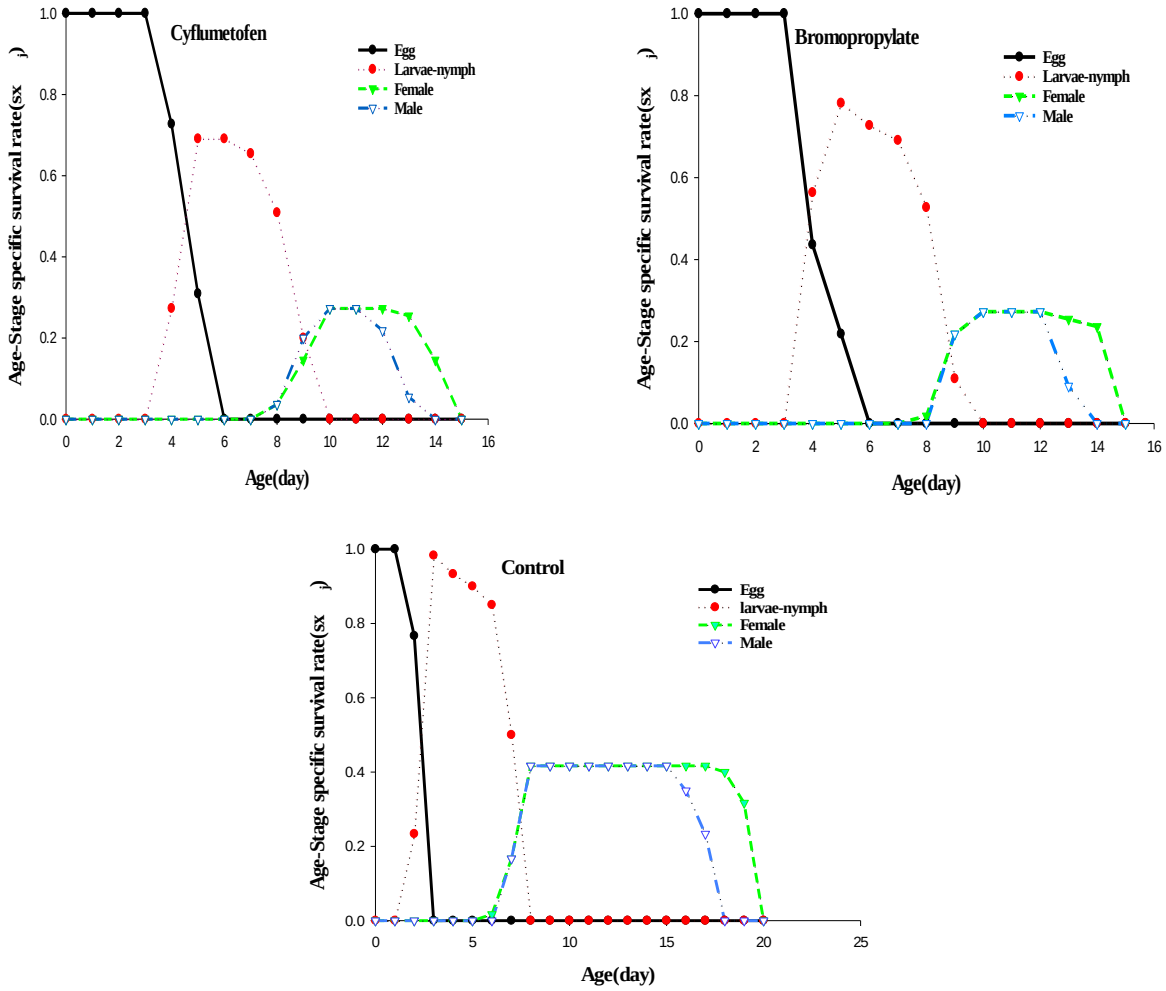

Figure 4. Age-stage-specific survival rate (S_{xj}) of offspring of *Tetranychus urticae* females treated with LC_{30} of cyflumetofen or bromopropylate.

DISCUSSION

Life table parameters are some powerful tools to analyze and perceive the effect of an external factor on the development, survival, reproduction, and increase rate of an insect population (Bellows *et al*. 1992). The present study assessed the efficacy of LC_{30} of cyflumetofen and bromopropylate through life table parameters as the measurements of survivorship quality, longevity, and total life span in both sexes of *Tetranychus urticae*. Similar trends for growth time and longevity were recorded for the same species while treated with hexythiazox, fenazaquin, and flufenzin acaricides (Marcic 2005). Marcic (2003) reported that clofentezine reduced both longevity and fertility of the two-spotted spider mite but did not the growth time. Such a difference can be attributed to the differences in the pesticide's mode of action or experimental conditions. The sub-lethal concentration of both acaricides decreased total fecundity and oviposition period, indicating that the potential of treated mites for population recovery would be slow. These results are consistent with the study by Martínez-Villar *et al.* (2005) for *T. urticae* treated with azadirachtin at the maximum tested concentration (80 ppm). In contrast, Sáenz-de-Cabezón *et al*. (2006) mentioned that the use of various dosages of the chitin synthesis inhibitor, triflumuron, had no impact on the fecundity of *T. urticae*. Such a difference is probably associated with the mode of action of the pesticide.

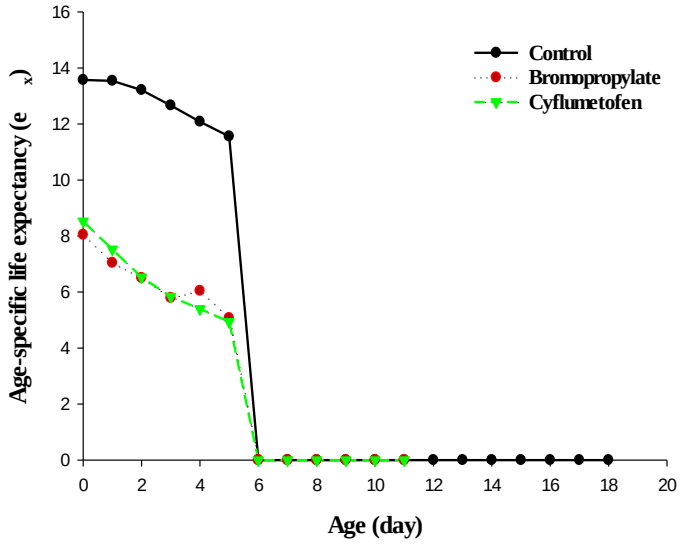

Figure 5. Age-specific life expectancy (*ex*) of *Tetranychus urticae* treated with LC_{30} concentration of cyflumetofen or bromopropylate.

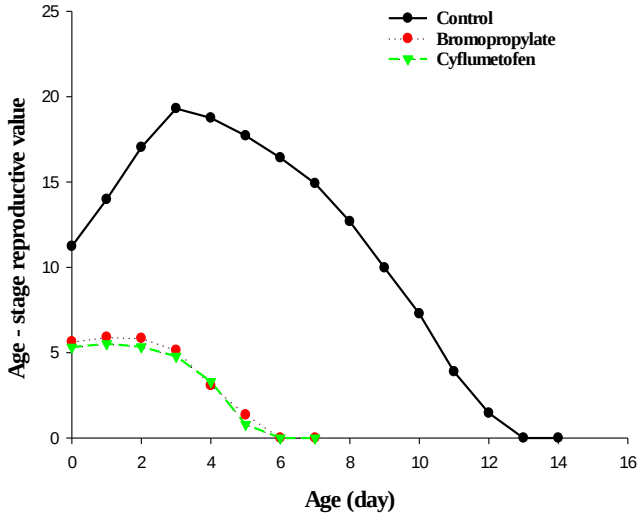

Figure 6. Age-stage reproductive value (v_x) of *Tetranychus urticae* treated with sub-lethal concentration (LC_{30}) of cyflumetofen or bromopropylate.

The age-specific fecundity and survival curves show that the sub-lethal concentration of cyflumetofen and bromopropylate led to decrease in the survival and fecundity of *T. urticae*. In accordance with Marcic *et al.* (2012), the sub-lethal impacts of spirotetramat on age-specific fecundity of spider mite showed that the females treated with 200 mg/L laid no eggs but the females treated with 20 mg/L and 2 mg/L laid significantly decreased numbers of eggs in comparison to females in the control. In this regard, the authors revealed that the exposure to sub-lethal concentrations of spirotetramat reduced the fecundity and survival of treated mites compared to the control, confirming the obtained results. Kavousi *et al.* (2009) mentioned the overlap between various stages of *T. urticae*, which is totally in agreement with the achieved results. The present study indicated that the age-stage, two-sex life table has the potential for revealing the stage differentiation of *T. urticae* due to the variable developmental rates among individuals.

Different studies revealed the life-table parameters of *T. urticae* being influenced by the sub-lethal concentrations of pesticides (Martínez-Villar *et al*. 2005; Li *et al*. 2006; Sáenz-de-Cabezón *et al.* 2006; Marcic *et al*. 2010, 2012). This study reported a significant decrease in the intrinsic rate of increase (r) for the mites treated with LC_{30} concentration of the acaricides. The measured r in the present study for cyflumetofen, bromopropylate and untreated mites was 0.035, 0.045 and 0.21 day^{-1}. Marcic (2007) mentioned that the values of r for *T. urticae* treated with 6 and 12 mg/L of spirodiclofen were 0.21 and 0.14 day^{-1}, respectively.

The finite rate of increase (λ) in the present study for cyflumetofen and bromopropylate was 1.03 and 1.09 day^{-1}, similar to that specified by Ibrahim and Knowles (1986) for the same species treated with amitraz (1.28 to 1.04 day^{-1}).

The mean generation time (T) for the spider mites treated by LC_{30} of cyflumetofen and bromopropylate was lower than the control. In comparison, the obtained results of this study are consistent with the results obtained by Sáenz-de-Cabezón *et al.* (2006), who realized that the mean generation time of the mites treated with various concentrations of triflumuron had not much difference from the untreated ones at 24 ± 1 ℃ and 65 ± 5% RH. Such a variation may be because of the mode of action of various acaricides.

The current study showed that exposure to sublethal dose of cyflumetofen and bromopropylate severely affects various life table attributes of *T. urticae*, i.e. survival, fecundity, *GRR*, mean generation time (T), net reproductive rate (R_0), increase rate of increase (r) and finite rate of increase (λ). Regarding the curves of survival and age-specific fecundity have a downward trend in l_x and m_x values. The results indicated an overlap between the various stages of two-spotted spider mite life regarding the curve of the age-stage-specific survival rate (s_{xj}).

The present findings could help to suppress the population of *T. urticae*. Before selecting any pesticide, one should look for its effectiveness against both pest and predatory mites. This will help proper suppression of pest mite while not affecting natural predatory mites. From the present study, it appears that cyflumetofen and bromopropylate could be good options because of their strong efficacy and persistent control against *T. urticae*. Nevertheless, it is required to regard other significant aspects, especially development of resistance in order to forecast the fate of a population over several generations. Clearly, the frequent application of the same compound enhances the likelihood of resistance emergence in *T. urticae*. More studies are required to evaluate whether the sub-lethal concentrations of cyflumetofen and bromopropylate in consecutive treatments could be of interest in resistance management programs. The impacts of cyflumetofen and bromopropylate on *T. urticae* propose that the combination of toxic and sub-lethal impacts could result in the incorporation of such compounds in IPM programs against this important pest.

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اثرات کشندگی و زیرکشندگی سایفلومتوفن و بروموپروپیلات بر کنهٔ تارتن دولکه‌ای *Tetranychus urticae* Koch (Acari: Tetranychidae)

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چکیده

مهار کنهٔ تارتن دولکه‌ای، *Terranychus urticae* Koch به‌عنوان یکی از مهم‌ترین آفات کلیدی در کشاورزی بر اساس استفاده از آفت‌کش‌ها است. اثرات کشندگی و زیرکشندگی سایفلومتوفن (دانی‌سارابا) و بروموپروپیلات (نئورون) مورد بررسی قرار گرفت. مقادیر LC_{50} سایفلومتوفن و بروموپروپیلات به‌ترتیب ۲/۷۷ و ۸/۹۵ میلی‌گرم ماده موثره بر میلی‌لیتر بود. اثر زیرکشندگی غلظت LC_{30} این کنه‌کش‌ها بر فراسنجه‌های جدول زندگی در دمای ۲ ± ۲۵ درجه سلسیوس، رطوبت نسبی ۵ ± ٦٥ درصد و دوره نوری ١٦:٨ (تاریکی:روشنایی) ارزیابی شد. داده‌های به‌دست آمده با استفاده از تئوری جدول زندگی دوجنسی بررسی شد. هر دو کنه‌کش اثرات زیادی بر فراسنجه‌های زیستی مانند طول دوره رشدی، میزان زنده‌مانی و باروری داشتند. در کنه‌های ماده‌ای که تحت تاثیر غلظت LC_{30} قرار گرفتند میزان خالص تولیدمثل (R_0)، میزان متناهی افزایش جمعیت (λ) و میزان ذاتی افزایش جمعیت (r) کاهش یافت. میزان ذاتی افزایش جمعیت (r) در تیمارهای سایفلومتوفن، بروموپروپیلات و شاهد به‌ترتیب ۰/۰۳۵، ۰/۰٤٥و ۰/۲۱ماده/ماده/روز به‌دست آمد. نتایج این مطالعه نشان داد کنه‌کش‌ها بر فراسنجه‌های جدول زندگی *T. urticae* تاثیر داشته و ممکن است بر رشد جمعیت و در نتیجه نسل‌های آینده تاثیر بگذارد. از نتایج به‌دست آمده از این پژوهش می‌توان در برنامه‌های مدیریتی مبارزه با *T. urticae* استفاده کرد.

واژگان کلیدی: کنه‌کش؛ زیست‌سنجی؛ میزان ذاتی افزایش جمعیت، کنهٔ تارتن، سمیت.

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