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# New acaricide toxicity on tetranychus urticae koch, selectivity and side effect evaluations on the predatory mite *phytoseiulus persimilis* athias-henriot (Acari: Phytoseiidae)

**Hanan Salah El-Din Taha Diab**

*Central Agricultural Pesticide Laboratory, Agricultural Research Center, Dokki, Giza, Egypt.*
*Email: Hanansalah412@yahoo.com*

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## ABSTRACT

The novel mode of action and newer pesticides product molecules is a promising component for agriculture management programs. For this argument some acaricide toxicity evaluations were completed on the predatory mite *Phytoseiulus persimilis* Athias-Henriot (Acari: Phytoseiidae) in laboratory rearing for two generation under acaricide sublethal effect. Toxicity results showed that chlorfenapyr was the most toxic acaricide for *Tetranychus urtica* Koch and etoxazole was the lesast and for *P. persimilis*, etoxazole was the most toxic and fenproxymat was the least. Relative toxicity recorded was higher in etoxazole and fenproxymat (7.916 and 5.058 times) respectively. Selectivity data approved that abamectin was the most selective acaricide and etoxazole was the least (8.24 and 0.268) respectively. Effect on first generation of *P. persimilis* growth fertility and productivity declined, consequently, $R_o$ and *rm* values where in $LC_{25}$ attained values ranged from 0.59 to 0.66 for cyflumetofene and hexythiazox, *ri* data ranged from 0.29 to 0.36 for fenproxymate and cyflumetofene and $R_o$ ranged from 0.53 to 6.0 for cyflumetofene and hexythiazox respectively. But in the second generation similar results attained because declined toxicity where $r_m$ in $LC_{25}$ was from 0.93 and 1.13 for fenproxymat and etoxazole and in $LC_{50}$ was 0.90 and 1.18 for cyflumetofene and hexythiazox respectively. A high effect on No of eggs /female/day produced, shortened in total time of the generation at $LC_{50}$ level of treatment more than $LC_{25}$, and sex ratio resulted more male number emerged than female. The high acaricide concentrations used can kill more *T.urtica* than *P.persimilis*.

**Contribution/Originality:** The contribution of the instaneous rate of population increase $r_i$ equations were make data more precise than the ordinary life table parameters like $R_o$ and $l_xm_x$ (survival functions) because it measure the minute amount of differences on the intrinsic population increase $r_m$ that affected by insecticide treatment as a stress of population exposure.

## 1. INTRODUCTION

The two-spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae), is a worldwide destructive pest on many plant species and agricultural crops. This pest has series biological characteristics like outbreak or resurgence that causes severe plant damage. The effective control is using insecticides and acaricides that all mostly inefficient due to the resistance phenomenon build up and the suppression by natural enemies that considered the effective way [1, 2]. The *Phytoseiulus persimilis* Athias-Henriot (Acari: Phytoseiidae) is a predaceous mite which can provide effective biological control of *tetranychid* mites on a wide variety of crops. Beside the traditional way of acaricide toxicity quantifications to pest and to beneficial arthropods traditionally require the determination of the median lethal dose or concentration ($LC_{50}$), that refer to the deleterious effect of the toxicant exposure [3, 4]. However, the

sub lethal effects on pests and its natural enemies can affect physiology and behavior, that possible to measure [5]. Many scientist fingered on this point of searches in many reports of published papers like Kim and Yoo [6]. The discrimination between acaricides effect on non-target arthropods is selectivity tests to identify products that have low toxicity on beneficial organisms and natural enemies. Mite lifecycle can assess by a cohort life table, individuals born within the same short interval of time and continue passing developmental stages until death [7]. The population fluctuations over time as result of acaricide exposure repeat is necessary for achieving effective control operations in pest management programs Shaw [8]. Several authors evaluated the life table parameters, growth rate studies, rate of population increase and density dependent mortality factor that regulate population growth according to increasing mortality or decreasing fecundity (like Alipour, et al. [9]). The intrinsic rate of increase ($r_m$), and the instantaneous rate of increase, or ($r_i$), is a measure began from initial individuals stages to estimate population growth ability to increase exponentially or logarithmically in an unlimited environment and over time, occasionally used in the assessment of lethal and sublethal effects of acaricides on pests and natural enemies and give accuracy of data more than the traditional methods of lifetable analysis. It considered a direct measure of population growth, survival and fecundity trailer [10-12]. Adding more ecologically applicable than the traditional $LC_{50}$, because it integrates age-specific survivorship and fecundity into a single parameter Walthall and Stark [13] and Wyatt and White [14]. The modes of action of new insect control agents represent new chemistries that affect unique target sites in Unknown Systems as (Pyrroles, phenylpyrazoles, neo-nicotinoids and juvenoids), while others represent new target sites within Known Systems (Insect nervous system) as (Diacylhydrazines, oxadiazines) [15]. The newly introduced insecticides and acaricides as fenproxymat, etoxazole, cyflumetofene and hexythiazox are considered new modes of action non-similar to the old some as (inhibition of acetylcholinesterase by organophosphates and carbamates or opening of voltage-gated sodium channels by pyrethroids) and thus present new opportunities [16]. Cyflumetofen is a novel benzoylacetonitile acaricide developed by Otsuka Agri Techno Co., Ltd. it has excellent efficacy and exhibited long persistence against mites even that developed resistance levels, mode of action is complex II in the mitochondrial electron transport chain inhibitor Hayashi, et al. [17]. The compound is safe to natural enemies and beneficial arthropods, and safe for the environment, Takahashi, et al. [18] and no cross-resistance were detected between cyflumetofen and other acaricides, It highly selectively against *Tetranychus*, but did not to lepidopteran or homopteran insects. The $LC_{50}$ values against *T. urticae* adults and larvae were 4.8 and 0.9 ppm, respectively, and treated adults were paralyzed within 24 hr [18]. In this study, evaluation of some new product acaricides effect on the development, reproduction, and population growth and selectivity on the predatory mite *P.persimilis* were investigated.

## 2. MATERIALS AND METHODS

### *2.1. Mite Sources and Maintenance*

The twospotted spider mite, *T. urticae* Koch and The *P.persimilis* collected from greenhouses eggplants heavily infested and abandoned from acaricide exposure. Each leaf contain adults and nymphs of both prey and predator individuals. The eggplant (*Solanum melongena* L.) leaf samples taken in plastic containers transferred to the laboratory and both spider adult and nymph stages transferred by fine brush separately under binocular to clean eggplant leaf that cut to discs at seven diameters for adult or larvae feeding through bioassay steps and acaricide response assessments that carried out immediately.

### *2.2. Acaricide Resources and Information*

Selected acaricides were obtained from the imported chemicals of the central agriculture pesticide laboratory manufactured by china agrochemical companies, belongs to different groups of chemicals and mode of actions and some information presented in Table 1.

**Table 1.** Acaricides information and application rate.

| Ai% | Common name | Trade name | Field rate | Chemical class | Structure | Site of action |
|---|---|---|---|---|---|---|
| 20%SC | Cyflometofene | Danisraba | 40cm/100l | Beta-ketonitrile | C24H24F3NO4 | Respiration targets |
| 10%EC | Hexythiazox | Minova | 50m/100l | Thiazolidinones | C17H21ClN2O2S | Growth regulators |
| 10%SC | Etoxazole | Barouq | 25ml/100l | Oxazoline | C21H23F2NO2 | Growth regulators |
| 5%SC | Fenproxymat | Artox | 50cm/100l | Pyrazole | C4H27N3O4 | Energy metabolism |
| 24%SC | Chlorfenapyr | Exmite | 600ml/l | Pyrroles | C15H11BrClF3N2O | Disrupting adenosine triphosphate (ATP) |
| 1.8%EC | Abamectin | Itamec | 50 ml/l | Actinomycete | C95H142O28 | Glutamate-gated-chloride channels blocker |

**Note:** Ai=Active ingredient, EC= Emulsifiable concentrate and SC=Suspension concentrate.

### *2.3. Acaricide Toxicity Evaluations on Both Mite*

The principal toxicity tests carried out by wide acaricide concentrations range preparations to get the limits of biological response to determine $LC_{50, 90}$ values (Lethal concentrations) on the short-term mortality count equal 24 hour on adult female each mites separately. Uninfected eggplant leaf discs in 7 cm diameters were sprayed by diluted concentrations and let to air dry for 1 h in laboratory. The leaf disks were placed gently on 1 cm agar-agar filled in Petri dishes (5 cm diameter) bottom, covered with other piece of the dish and tight with rubber band. Then 25 young adult females of *T.urticae* or *P.persimilies* were transfers by fine Bruch using binocular to each leaf disc. Five replicates were used for each species, and 5 concentrations. Pollen of *Resinus communis* was provided for *P.persimilies* dishes initially. Mortality counted after 24 h of treatment for both mites. Dishes were maintained in lab rooms at 20 ± 2 C°, 60 ± 10% R.H. and 14:10 (light/dark) photoperiod. The index of differential selectivity was obtained by dividing the $LC_{50}$ of the predator by the $LC_{50}$ of the prey and its confidence limits (95%) were calculated according to Takahashi, et al. [18].

### *2.4. Sublethal Concentration Experiment on P. Persimilis Population*

The experimental procedure of $r_i$ estimation procedures by using the plant leaf discs sprayed by the $LC_{25}$ and $LC_{50}$ separately that defined from the initial bioassay Table 2. In this experiment, the daily offspring assessed until 10 days following initial exposure (Long-term or sublethal effects). About 100 *P. persimilis* adult females and placed in an eggplant leaf discs were tested per replicate (10 leave), and left for 24 h (at 25°C room temperature), to get around 300 ovipositing eggs. After emergence, 10 adult female of *P.persimilis* was transfer from each leaf disc to a new one infested with *T.urticae*, infestation ratio was (1:1) and sprayed by acaricide concentrations using hand atomizer, and kept 10 days after treatment under laboratory conditions at 25±2°C and 14 h photoperiod. Control were sprayed by water only. Five replicates were performed per acaricide. Some male was added to each to fertilize the females. Small amounts of pollen from castor bean flowers *R.communis* were daily provided to feed the predators. The number of eggs, immatures and adults of *P.persimilis* counted daily until ten days, and the viability of eggs were checked.

### *2.5. Rate of Increase Statistics and Calculations*

The net reproductive rate ($R_0$) was calculated for *P.persimilis* according to Jia, et al. [19] is:

$R_o = Nn + 1/Nn$ Where Nn is the population quantity (neonate larvae number) of the parent generation and $Nn+1$ is that of the next generation. Moreover, the intrinsic rate of population increase, ($r_m$) was calculated according to Birch [10] is $R_m = R_o/T$, Where T is the growth time from eggs to adult. Survival analysis was performed according to basic formula, $R_o = (l_x.m_x)$ specific fertility ($m_x$) and survival probability ($l_x$). The Instantaneous rate of increase ($r_i$) calculated for *P.persimilis* according to Stark, et al. [20]; Walthall and Stark [13]: $r_i = ln (N_f /N_o)/\Delta t$. Where $N_f$ is the final number of mites at time 0, $N_o$ is the initial number of live mites at time t and $\Delta t$ is the time interval between the start and end of the bioassay or the change in time. Positive values of $r_i$ indicate that population is growing, $r_i = 0$ indicates that population is stable, and negative $r_i$ values indicate that the population is in decline according to Teodoro, et al. [21]; Sato, et al. [3]; Lima, et al. [4]; Van Leeuwen, et al. [2].

## 3. DATA STATISTICAL ANALYSIS

All data subjected to excel worksheet (2010) for calculation preformation. The mite mortality data were accessed by Probit analysis [22] using Polo (LeOra Software) to calculate the $LC_{50}$'s and $LC_{90}$'s. The $RT_{50}$ (Relative Toxicity) and $DSI_{50}$ (Differential Selectivity Index) were completed. The means, standard errors, and variance of the population parameters were calculated using Aca Stat Demo-statistical software program 2021-(version 9.1.8). Data for the instantaneous rate of increase were analyzed using one way ANOVA (Analysis Of Variance) and means were compared using Tukey's HSD (Honestly Significant Differences) test (a = 0.05) by SPSS [23] software.

## 4. RESULTS AND DISCUSSIONS

### *4.1. Toxicity Test for Both Mites*

Data for the initial toxicity bioassay of both mites, relative toxicity and selectivity index were found in Table 2. $LC_{50}$ values recorded for both mites approved that little amount of each acaricide used in this study can kill 50 % of the pest population *T.urtica*. However, the other side if this little amount of acaricide were doubled then it will be able to kill the same percentage of the natural enemy *P. persimilis*. Then we must obligate the recommended dose of any acaricide uses to control any pest. Results showed that chlorfenapyr was the most toxic acaricide and etoxazole was the less toxic for *T.urtica* and etoxazole was the most toxic and fenproxymat was the less toxic for *P. persimilis*. While data of relative toxicity recorded was too much in etoxazole and fenproxymat (7.916 and 5.058 times) respectively. Results of selectivity data approved that abamectin was the most selective acaricide and etoxazole was the less selective (8.24 and 0.268 from DSI index) respectively.

**Table 2.** Relative and selective toxicity of acaricides to T.urtica and P.persimilis.

| Acaricides | Slope | Intercept | $LC_{25}$ (95 % CI). | $LC_{50}$ (95 % CI). | $LC_{90}$ (95 % CI). | $\chi^2$ | RT | DSI |
|---|---|---|---|---|---|---|---|---|
| *T.urticae* | | | | | | | | |
| Cyflometofene | 1.27±0.16 | 5.6 | 0.16(0.079-0.33) | 0.56(0.27-1.13) | 5.9(2.9-12.1) | 0.867 | 2.333 | 2.589 |
| Abamectin | 1.47±0.13 | 5.9 | 0.086(0.047-0.155) | 0.25(0.14-0.44) | 1.8(1.0-3.27) | 0.45 | 1.041 | 8.24 |
| Etoxazole | 1.8±0.12 | 4.48 | 0.81(0.47-1.4) | 1.9(1.1-3.3) | 9.9(5.7-17.1) | 0.66 | 7.916 | 0.268 |
| Fenproxymat | 2.08±0.10 | 5.72 | 0.215(0.13-0.346) | 0.45(0.28-0.73) | 1.86(1.157-3.0) | 0.21 | 1.875 | 5.733 |
| Chlorfenapyr | 1.5±0.132 | 5.93 | 0.086(0.048-0.175) | 0.24(0.13-0.44) | 1.68(0.92-3.0) | 0.32 | 1.0 | 4.583 |
| Hexythiazox | 1.93±0.106 | 4.71 | 0.63(0.39-1.0) | 1.4 (0.87-2.28) | 6.5(4-10.56) | 0.992 | 5.83 | 2.71 |
| *P. persimilis* | | | | | | | | |
| Cyflometofene | 1.03±0.14 | 4.7 | 0.42(0.23-0.79) | 1.45(0.78-2.7) | 15.3(8.2-28.6) | 0.943 | 2.843 | -- |
| Abamectin | 1.88±0.12 | 4.9 | 0.9(0.44-1.36) | 2.06(1.37-2.7) | 9.8(6.7-18.8) | 3.12 | 4.039 | -- |
| Etoxazole | 1.18±0.20 | 5.3 | 0.137(0.054-0.34) | 0.51(0.2-1.2) | 6.1(2.4-15.3) | 0.72 | 1 | -- |
| Fenproxymat | 1.4±0.135 | 5.51 | 0.24(0.147-0.39 | 2.58(1.58-4.2) | 0.54(0.33-0.88) | 0.13 | 5.058 | -- |
| Chlorfenapyr | 1.68±0.12 | 4.9 | 0.43(0.25-0.75) | 1.1(0.63-1.9) | 6.3(3.6-11.0) | 0.94 | 2.156 | -- |
| Hexythiazox | 1.1±0.167 | 4.35 | 0.93(0.44-1.99) | 3.8(1.78-8) | 54.5(25.6-115.9) | 0.994 | 7.45 | |

**Note:** CI=Confidence intervals (95 % CI). The relative toxicity (RT) and differential selectivity index (DSI) estimated following Robertson and Preisler [24].

The status of acaricide resistances of any pest in any crop field mostly affect life table parameter and fitness of the pest, that giving changeable results. In such experiments worked about resistance and field efficacy comparison between acaricide applications status against *T. urticae* from Greece attained resistance folds ranged from 1000 to 5000 folds for abamectin clofentezine, etoxazole but slight resistance ranged from 20 to 30 folds for fenpyroximate, pyridaben, spirodiclofen and spirotetramat, respectively. But cyenopyrafen and cyflumetofen resistance, was 500 folds respectively [1]. Also in Khalighi, et al. [25] study a strains of *T. urticae* selected by cyflumetofen results showed high resistance in laboratory and negative cross resistance with cyenopyrafen was detected in field strains, and $LC_{50}$ values exceeding the registered field dose. Synergism experiments suggested that $P_{450}$ monooxygenases are involved in resistance, considered this compounds an appreciated new mode of action. The same result attained by Wang, et al. [5] where resistance ratio in *Tetranychus cinnabarinus*, reached 21.33 after selection by cyflumetofen, and resistant genes already existed in field populations thus activity of detoxifying enzymes were increased.

### *4.2. Demographic Analysis of Treated P. persimilis*

Data of net reproductive rate ($R_0$), Intrinsic ($r_m$) and instantaneous rate of increase ($r_i$) at two generation of *P. persimilis* individuals exposed to some selected acaricides were found in Table 3 and 4. It can be realized that data of $LC_{25}$ is different from the data of the $LC_{50}$ applied as a sublethal dose, where the fertile life table parameter was decreased or increased according to mortality percentage happens during two generation lifecycle that affected by acaricide concentration decreases or increases**.** Values of all parameters in the second generation was much similar to each other where $r_m$ in $LC_{25}$ was from 0.93 and 1.13 for fenproxymat and etoxazole but in $LC_{50}$ was 0.90 and 1.183 for cyflumetofene and hexythiazox. But in the first generation acaricide effect was much sharp that affect fertility and productivity that affect $R_0$ and *rm* values where in $LC_{25}$ attained values ranged from 0.59 to 0.66 for cyflumetofene and hexythiazox respectively, *ri* data ranged from 0.29 to 0.36 for fenproxymate and cyflumetofene and $R_0$ ranged from 5.3 to 6.0 for cyflumetofene and hexythiazox respectively.

Similar investigation study about prey and predator fitness under acaricide uses of control was for Abdel-Rahman and Ahmed [26] where in two-season experiment showed that abamectin was more toxic to the predatory mite, *P. persimilis* than other acaricides. While cyflumetofen was more toxic to spider mites *T. urticae* and followed by abamectin and bifenazate and in field trials cyflumetofen was not as harmful as other compounds. Additional results of him was in life-table parameters of both mites treated with $LC_{50}$ of cyflumetofen showed considerable negative effects on *T. urticae* life-tables but low effects on *P. persimilis*.

**Table 3.** The net reproductive rate, intrinsic and instantaneous rate of increase ($R_0$, $r_m$ and $r_i$) (Mean±SE) of *P. persimilis* first generation of individuals exposed to acaricides.

| Acaricides | Intrinsic rate of increase(rm) | | Instaneous rate ($r_i$) | | Net reproductive rate ($R_0$) | |
|---|---|---|---|---|---|---|
| | $LC_{25}$ | $LC_{50}$ | $LC_{25}$ | $LC_{50}$ | $LC_{25}$ | $LC_{50}$ |
| Cyflometofene | 0.59±0.025 | 0.59±0.0025 | 0.36±0.02 | 0.36±0.03 | 5.3±0.050 | 5.3±0.05 |
| Etoxazole | 0.66±0.015 | 0.68±0.0-15 | 0.31±0.015 | 0.35±0.015 | 0.59±0.051 | 6.1±0.15 |
| Fenproxymat | 0.54±0.015 | 0.63±0.010 | 0.29±0.025 | 0.35±0.015 | 4.8±0.252 | 5.7±0.2 |
| Hexythiazox | 0.66±0.01 | 0.70±0.025 | 0.32±0.010 | 0.35±0.02 | 6.0±0.20 | 6.3±0.15 |
| Control | 0.86±0.015 | 0.86±0.005 | 0.34±0.053 | 0.34±0.015 | 7.7± | 7.7±0.20 |

**Note:** Means followed by the same letter are not significantly different by Tukey HSD test (P0.05).

### *4.3. Insectcicide Effects on P. Persimilis Population Growth*

Data of *P. persimilis* population growth parameters measured according to treatments with sublethal acaricide concentrations were found in Table 5. Acaricide treatments gives high effect on number of eggs /female/day and shortened total time of the generation at $LC_{50}$ level of treatment more than $LC_{25}$, and sex ratio resulted more male number emerged than female with increasing concentration. Mostly, all acaricide tested gives high mortality to this predator (Figure 3).

**Table 4.** The net reproductive rate, intrinsic and instantaneous rate of increase ($R_o$, $r_m$ and $r$) (Mean±SE) of *P. persimilis* second generation of individuals exposed to acaricides.

| Acaricides | Intrinsic rate of increase(rm) | | Instaneous rate ($r$) | | Net reproductive rate ($R_o$) | |
|---|---|---|---|---|---|---|
| | $LC_{25}$ | $LC_{50}$ | $LC_{25}$ | $LC_{50}$ | $LC_{25}$ | $LC_{50}$ |
| Cyflometofene | 1.01±0.146 | 0.90±0.03 | 0.243±0.013 | 0.165±0.0015 | 9.0±0.40 | 8.12±0.24 |
| Etoxazole | 1.13±0.136 | 1.11±0.247 | 0.163±0.0025 | 0.18±0.002 | 10.2±0.30 | 10.04±0.38 |
| Fenproxymat | 0.93±0.025 | 1.09±0.156 | 0.165±0.0005 | 0.18±0.004 | 8.43±0.01 | 9.82±0.035 |
| Hexythiazox | 1.065±0.169 | 1.183±0.16 | 0.167±0.0005 | 0.182±0.0025 | 9.58±0.03 | 10.65±0.020 |
| Control | 1.36±0.07 | 1.36±0.12 | 0.177±0.002 | 0.177±0.002 | 12.31±0.04 | 12.31±0.19 |

**Note:** Means followed by the same letter are not significantly different by Tukey HSD test (P0.05).

**Table 5.** Sex ratio, generation time and no of egg/female/day (Mean ±SE) of the predator *P. persimilis* exposed to different acaricides.

| Acaricides | Sex ratio | | Generation time | | No.egg/female/day | |
|---|---|---|---|---|---|---|
| | $LC_{25}$ | $LC_{50}$ | $LC_{25}$ | $LC_{50}$ | $LC_{25}$ | $LC_{50}$ |
| Cyflometofene | 1.53±0.026 | 1.63±0.025 | 10.96±0.016 | 10.43±0.022 | 0.932±0.084 | 0.668±0.0168 |
| Etoxazole | 1.66±0.0118 | 1.68±0.048 | 10.23±0.011 | 9.78±0.023 | 1.0±0.269 | 0.95±0.319 |
| Fenproxymat | 1.85±0.016 | 1.8±0.026 | 10.22±0.01 | 10.0±0.016 | 0.78±0.134 | 1.0±0.336 |
| Hexythiazox | 1.75±0.0179 | 1.81±0.036 | 9.9±0.014 | 9.3±0.03 | 0.93±0.185 | 1.14±0.168 |
| Control | 1.88±0.0287 | 1.88±0.0287 | 10.0±0.02 | 10.0±0.041 | 1.25±0.219 | 1.25±0.219 |

Some factor affect the predation rate and ability of attacking prey that cited in literatures as Alipour, et al. [9] concluded that the performance of *P.persimilis and Amblyseius swirskii* as predators of *T.urtica* was better on the resistant rose cultivar (Roulette) than on the susceptible cultivar.

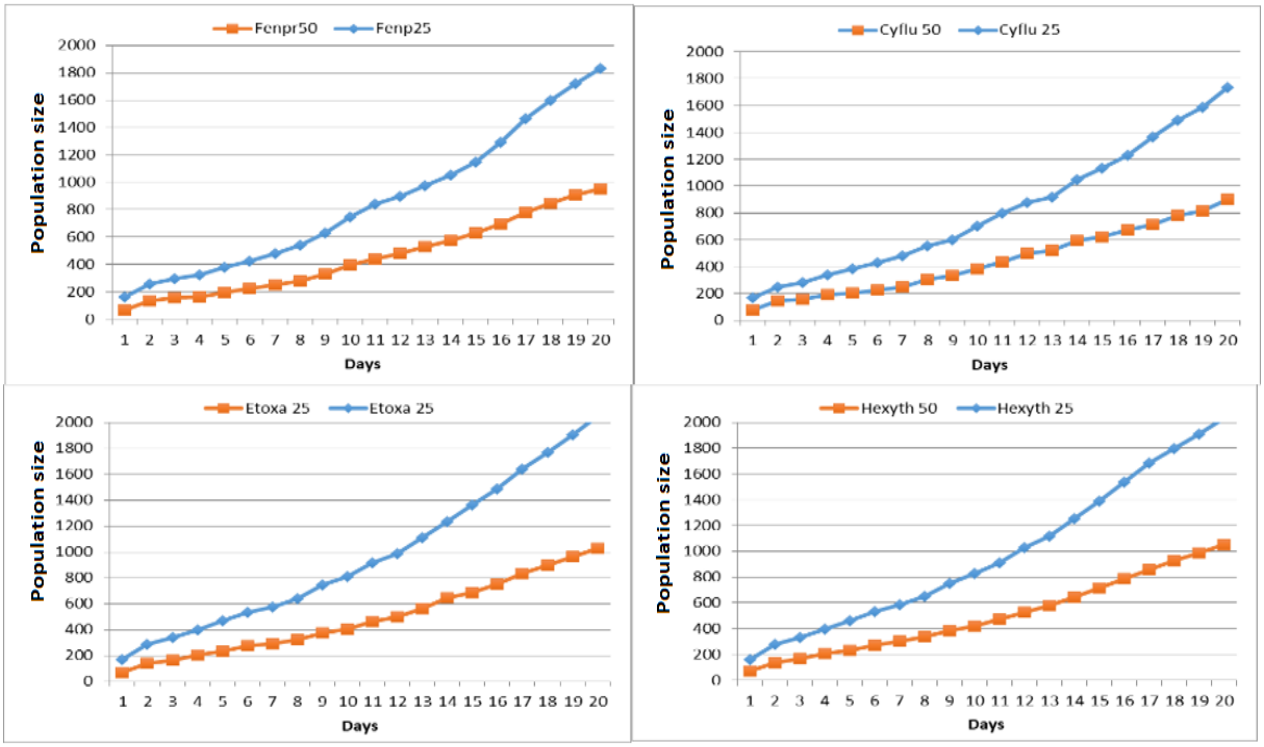


**Figure 1.** Exponential regression of *P. persimilies* population growth treated with two sublethal concentration ($LC_{25,50}$)of four acaricides (Cyflumetofene, Etoxzole, Hexythiazox and Fenproxymate) according to the equation of $\Delta=rN$, and achieved slight differences between each acaricide concentrations and how affect population dynamic from day one to day 20 after treatment.

### *4.4. Survival Analysis of P. Persimilis Individual in Treatments*

The box plot Figure 1 showed difference between acaricides treatment of *P.persimilis* and control mortality. The spread of group looks differences as well as the fill weight of acaricide treatment boxes (Figure 3). Median and general weight of groups not similar. In addition, there is differences between the centers of the group. Skewed

data, the majority of data located in high side of the graph. The the Kaplan-Meier graph is the hazard ratio of the survival individual count over time intervals (Survival function and hazard ratio statistics) until experiment finished and showed toxicity effect of acaricide treatment (Figure 2).

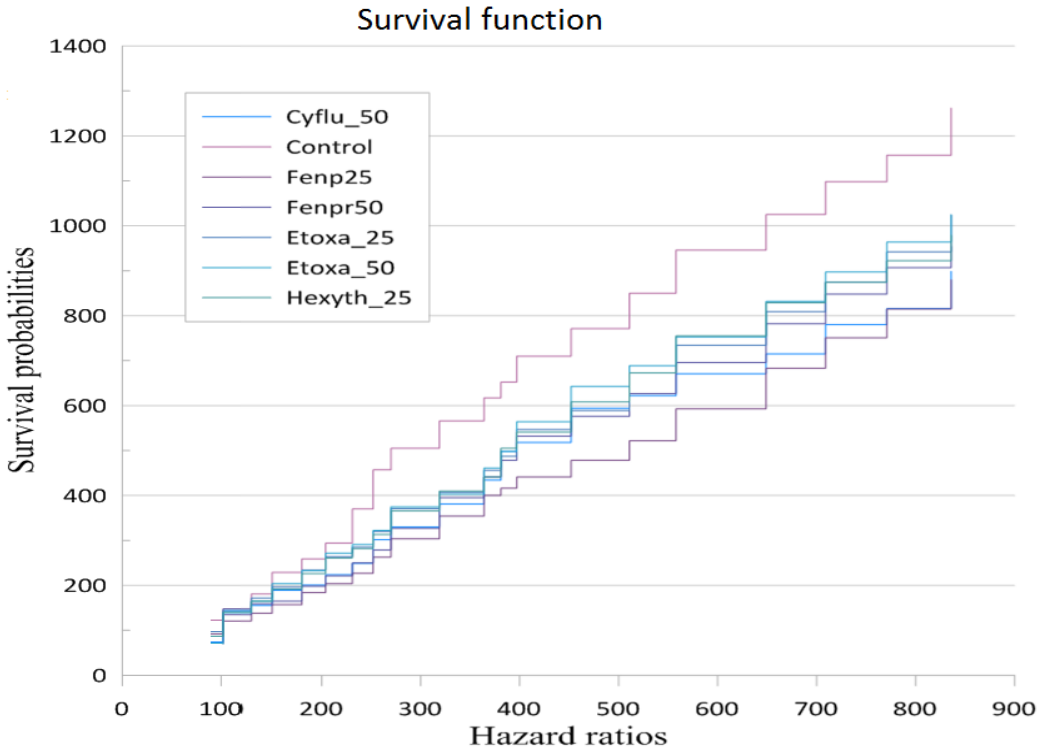


**Figure 2.** Survival analysis of each acaricide concentrations treatement for *P. persimilis* representd by hazard ratio and survival function of the experiment.

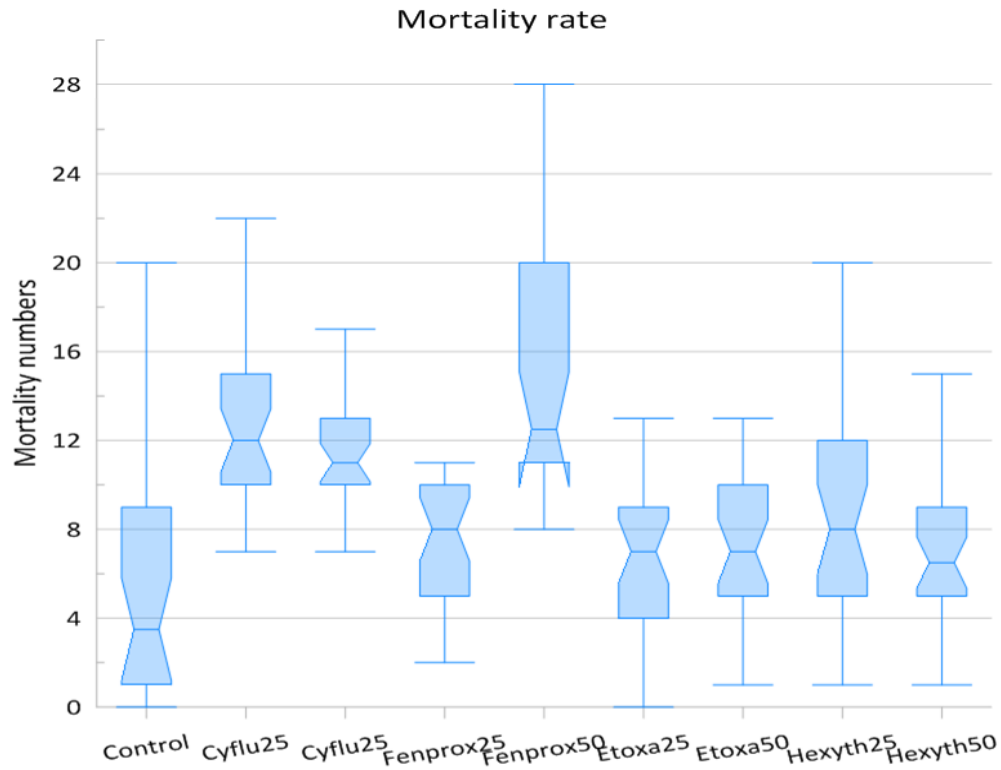


**Figure 3.** Mortality recorded at difference in acaricide concentrations of *P. persimilis* treated population plus control.

**Table 6.** Hypothesis testing statistics for detecting differences between acaricide treatments and the level of significance through the assumption of null (Ho) and alternative hypothesis (Ha) accepted or rejected.

| Acaricide | Coefficients | Standard error | T-stat | P-value | H0 (5%) |
|---|---|---|---|---|---|
| Cyflu25 | 0.27 | 0.10 | 2.59 | 0.02 | Rejected |
| Cyflu50 | -0.43 | 0.45 | -0.94 | 0.36 | Accepted |
| Fenprox25 | -0.13 | 0.27 | -0.47 | 0.64 | Accepted |
| Fenprox50 | 0.26 | 0.40 | 0.66 | 0.51 | Accepted |
| Etoxa25 | 0.82 | 0.51 | 1.62 | 0.12 | Accepted |
| Etoxa50 | 0.40 | 0.55 | 0.72 | 0.48 | Accepted |
| Hexyth25 | 1.41 | 0.45 | 3.11 | 5.58E-3 | Rejected |
| Hexyth50 | -1.24 | 0.42 | -2.94 | 8.04E-3 | Rejected |

Hypothesis testing (the maximum allowable probability of making a type I error) is a statistical procedure and calculation completed to analyze the data to finish analysis of variance accomplishment, to determine if the acaricide concentration as factor has a statistically significant effect on the response variable (Table 6).

**Table 7.** Analysis of variance (One-way ANOVA), between and within acaricide treatments and non-linear regression analysis with residual effect, F value and the standard errors.

| Source of variation | d.f. | SS | MS | F | P-value | F crit | Omega sqr. |
|---|---|---|---|---|---|---|---|
| Between groups | 21 | 1,568.3333 | 74.6825 | 1.7323 | 0.2558 | 3.8649 | 0.3545 |
| Within groups | 6 | 258.6667 | 43.1111 | | | | |
| Regression | 8. | 6,456.45 | 807.06 | 12.84 | 2.35E-6 | | |
| Residual | 20. | 1,257.55 | 62.88 | | | | |
| Residual standard error | 6.5659 | | | | | | |
| Hartley fmax (d.f. = 22, 2) | 289.0000 | | | | | | |
| Cochran C (d.f. = 22, 2) | 0.5866 | | | | | | |
| Bartlett chi-square (d.f.=21) | 6.8662 | | | | | | |
| P-value | 0.9984 | | | | | | |

The homogeneity similarity and consistency were detected from the regression analysis that give precise estimation between different variance, study relationships, and discover the changes in data properly studies (Table 7). Through the power of the Cochran is to test the slope function of the response probabilities over group score. *P* values decrease while result of linear regression remained stable. In addition to hypothesis testing (H0) for acceptance or rejection of the significance of the data validation and t test.

## 5. CONCLUSION

Insecticide and acaricides efficacy evaluations is the important laboratory and field work for assessing the significance of insecticide product, in addition the biological inquiries were the most precise examination to consider pest status that affected by the treatment particularly the life table analysis can predict actual minute changes in the proper population of the pest under study through time and space. In addition, survival analysis and selectivity test is the best tools to investigate toxicity effect to any pest and to its natural enemies under studies. This because following population growth over time and detect minute changes at a particular time and define when it happens, and detect the hazard of chemical compound residue long time maintenance and affect survival and growth.

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