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EVALUATING SIDE EFFECTS OF THREE PESTICIDES AND FIVE HEAVY METALS ON PREDATORY MITES IN IPM PROGRAMS

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ABSTRACT

Integrated Pest Management (IPM) is a crucial point in awareness of pesticides and heavy metal's side effects on non-target beneficial arthropods. Studies on the toxicity of selected pesticides and heavy metals to predatory mite species: Phytoseiulus persimilis and Amblyseius swirskii (Athias-Henriot) have been carried out. insecticides were used: (greeno 10% Hexathiazox), Agri-Flex® 18.56% (abamectin,Thiamethoxam) and Baylor - 24 % (Chlorfenapyr) beside many of concentrations of heavy metals (As, Cu, Pb, Mn, and Zn). Acalypha wilkesiana (Müll. Arg). The results showed that the highest effect of chemical acaricides on predators Baylor - 24% with a percentage of 90.6%, and the lowest mortality was Agri-Flex® 18.56% with a percentage of 47.5% in dose 2ml double of the recommended dose. Also, in dose (0.25,0.5 and 1ml), the highest toxicity was Baylor - 24 % in second-level greeno 10% finally was Agri-Flex® 18.56%. In P. persimilis, the effective dose 0.25 ml with a mortality rate of 7.5%. Also, results showed that the highest mortality rate against A. swirskii were Baylor - 24 %in concentration 2 ml was 90.6 % mortality, and lowest mortality rate in the concentration of .025 ml was 11.30 then greeno 10% the highest mortality was 44%, and the lowest conc in .025 ml was 5%.results showed that the highest or most toxic heavy metals of death rate on *P. persimilis* also *M. Swerskii* in Cd treatment, and the lowest mortality was Zn treatments among Mortality rate and repellent rate.

Keywords: *Amblyseius swirskii, Phytoseiulus persimilis*, predatory mites, side effects of pesticides, heavy metals, Predatory Mites, IPM programs

INTRODUCTION

A. wilkesiana leaves represented as ornamental plants that are planted and controlled by many pesticides and fertilization. This occurs accumulations of heavy metal elements. *A. wilkesiana* and many ornamental plants are infested with *Tetranychus Uritica*, and occurs losses in production. In this case, predatory mite species *A. swirskii* and *P. persimilis* were using to control and decrease a high number of *T. Uritica* in IPM programs. There is an overlap between the different methods such as chemical, biological, and agricultural controls, which leads to a contradiction and a negative impact on how each of the different methods mode of action. To study The safest methods on each other to achieve the maximum benefit from various control methods Many pesticides are very dangerous to predatory mites and other predators when applying generally recommended dosages (Boller *et al.,* 1989). A significant aspect of IPM systems is the combination of biological and chemical protection against mite organisms. Farmers may select a pesticide that is toxic to pests and harmless to natural enemies. (Blümel *et al.,* 1999; Norris *et al.,*2003). Planting practice indicated that plant security's principal objective against hurtful living beings could not be accomplished solely by the mass use of pesticides. Various burdens of synthetic medicines are a quick increment in pesticide creation costs, an unsettling influence in the environmental funds to be paid to the mortality of different valuable living beings (Wright and Verkerk 2006). The impression of insecticides on predatory mites is significant in Integrated Pest Management (IPM). The approval of a new pesticide is subject to its impact evaluation on beneficial species, including a range of beneficial ones. These assessments would be conducted at various levels (e.g., laboratory and semi-field) where sufficient knowledge is gathered (Bakker 1995; Sterk *et al.,* 1999). One of the most commonly used predatory mite species, *Amblyseius swirskii* Athias-Henriot (Acari: Phytoseiidae) (Calvo *et al.,* 2015). Besides, population-specific responses may also be observed, among different populations of the same species (Tirello *et al.,* 2013; Zhao *et al.,* 2013). In this study, we tested the lethal effects of many pesticides and heavy metals. These have different modes of action, and they have been registered to be used to ornamentals, vegetables, and other fruit crops to control various pests that include either phytophagous mites or aphids and thrips (Putter *et al.,* 1981; Dekeyser 2005 and Allam *et al.,* 2017).

The main objective was to research the side effects of insecticides and heavy metals on the predatory mites: *Phytoseiulus persimilis*, and *Amblyseius swirskii* Athias-Henriot (Arachnida: Mesostigmata: Phytoseiidae) to evaluate some pesticide (greeno 10, Agri-Flex® 18.56% and Baylor - 24 %)) besides many concentrations of heavy metals (As, Cu, Pb, Mn, and Zn). *Acalypha wilkesiana* leaves are used for controlling spider mites in greenhouse crops.

MATERIALS AND METHODS

To study the side effects of insecticides and heavy metals on the predatory mite species, separate laboratory experiments were established. Ten individuals of each predatory mite were placed on *Acalypha wilkesiana* leaves in Petri dishes (10 cm in diam.) containing moistened cotton layers. To be of the same age until the start of the trial to enter the adult stage. In the treatment evaluation, predatory mites were released on tomato leaves 1, 3, and 5 days after treatments. The insecticide was used only in the recommended dosages. The Petri dishes were only sprayed with purified water to manage predatory mites. Both varieties were incubated at a temperature of 25°C and 60 percent humidity under stable conditions. Observations were rendered 2, 5, and 7 days after treatment, respectively. The number of predators alive and dead has been documented. One design was known to be a Petri dish containing tomato leaves infected with ten predatory individuals of one genus. Five replications of the experiment were set up. after that pesticides and heavy metals were prepared to many concentration for using in the experiment 0The following insecticides were used: (greeno 10% Hexathiazox), Agri-Flex® 18.56%(abamectin,Thiamethoxam) and Baylor - 24 %(Chlorfenapyr) beside concentrations (12.5, 25, and 50) PPM of heavy metals (As, Cu, Pb, Mn and Zn). pesticides were treated with the recommended dose, half dose, and one and a half dose of the tested insecticides. Spraying was done using a hand sprayer. Each Petri dish, with a leaf, was coated with 2 ml of distilled water. Mites were released, and the mites are held in clear plastic jars (10 × 5 × 5 cm) at 26±1°C, and the relative humidity (RH) was 65±5%. Various salts were separately dissolved to form a stock solution of 2,000 ppm. To make a series of distinct quantities, each stock solution was then diluted. The chosen concentration of heavy metals was based on the toxicity amount reported in plants from various reports (Liu *et al.,* 2007; Nazir *et al.,* 2011). For copper and zinc: 25, 50, and 100 mg/kg were used, and for cadmium: 12.5, 25, and 50 mg/kg were used. Newly hatched larvae were reared in a plastic container (15 × 10 × × 5 cm)

The classification of a pesticide's side-effect (mortality/reduction in beneficial capacity) was based on the parameters provided by the International Association for Biological and International Regulation (IOBC): harmless 0-25%, slightly harmful harmless 0–25%, slightly harmful 25–50%, moderately harmful 50–75%, harmful > 75%.

Statistical analysis All data are presented as means ±SE. Data were subjected to analysis of variance (ANOVA) using SAS software (SAS Institute 1997). The least significant among treatments were compared using Tukey's multiple range tests. Differences among means were considered to be significant at $p \leq 0.05$.

Predators Mites: results showed that the highest or most toxic heavy metals of death rate on P. persimilis was in 50 ppm with a percentage of 16% in Cd treatment. The lowest mortality was zn with a ratio of 3% in 12.5PPM .also results showed that the highest or most toxic heavy metals of death rate was as on M. Swerskii in 50 ppm with a percentage of 22% in cd treatment. The lowest mortality was Zn with a percentage of 1% in 12.5 PPM . results showed that the highest repellent effect rate against P.persimils was in Cd 50 ppm with a percentage of 69%,and the lowest mortality was Zn with a percentage of 7% in 12.5PPM . Cd treatment was highest or most toxic heavy metals of death rate as on M. Swerskii in 50 ppm with a percentage of 33% ,and the lowest mortality was Zn with a percentage of 2% in 12.5 PPM.

RESULTS AND DISCUSSION

The results showed that the highest effect of chemical acaricides on predators with the highest or most toxic pesticide of death rate was Baylor - 24% with a percentage of 90.6%, and the lowest mortality was Agri-Flex® 18.56% with a ratio of 47.5% in dose 2ml means double of the recommended dose. Also, in dose (0.25,0.5 and 1ml) the highest toxicity was Baylor - 24 % in second-level greeno 10% finally was Agri-Flex® 18.56%. In *P. persimilis,* the effective dose 0.25 ml with a mortality rate 7.5%. Also, results showed that the highest mortality rate against *A. swirskii* was Baylor - 24 %in concentration 2 ml was 90.6 % mortality, and lowest mortality rate in conc .025 ml was 11.30 then greeno 10% the highest mortality was 44%, and the lowest conc in .025 ml was 5%.

These results may be beneficial for the collection of pesticides and their use in Poland's vegetable crop IPM programs. In comparison to the predatory mites chosen, the tested pesticides have shown varying degrees of toxicity. Information on studies on pesticide selectivity in relation to predatory mites in different crops can be found in the review literature (Piątkowski

Table.1 Effect of Different Concentration of Pesticide against *P. persimilis* and *M. Swerskii* Predators Mites.

		0.25ml	**0.5ml**	**1ml**	**2ml**
P. persimilis	greeno 10%	11.3_{a}	51.4	61.2	90.6
	Baylor - 24 %	58.1	73.8	88.3_{b}	90.6_{b}
	Agri-Flex® 18.56%	7.5	26.5	35.1_{c}	47.5c
M. Swrskii	greeno 10%	11.3_{b}	51.4	61.2_{ab}	90.6
	Baylor - 24 %	5.0a	20.0_{b}	40.0	44.0
	Agri-Flex® 18.56%	5.5	18.5	25.1_{ab}	21.0c
SD	20.3				
AVRE	43.13				

Within columns, means followed by the same letter do not differ significantly at $p < 0.05$

1989; Niemczyk 2002; Williams *et al.,* 2003; Nash *et al.,* 2010). Blümel *et al.,* (2002) In addition, acaricides such as abamectin are harmless to predatory P. persimilis mites. Awareness of insecticide selectivity for beneficial arthropods is important when evaluating their use in IPM programs. (Sterk *et al.,* 2003; Sohrabi *et al.,* 2012 and Allam *et al.,* 2018). In this aspect, laboratory bioassays are used to evaluate the side effects of pesticides on natural enemies and draw conclusive assumptions about whether a pesticide is consistent with predators. (Lefebvre *et al.,* 2011; Pozzebon *et al.,*2011). In this situation, the test organisms are exposed to pesticides in small leaf-discs. The worst-case scenario may always be supposed (Bostanian *et al.,* 2009a). In several countries, the toxicity of pesticides on aggressive mites and insects has been extensively studied, using various pesticides at various concentrations in different growth stages (Zon and Geest, 1980; Tuovinen, 1992; Edland, 1994). According to previous studies, the response of phytoseiid mites to pesticides depending on the species can be very variable (Villanueva and Walgenbach 2005; Bostanian *et al.,* 2010; Lefebvre *et al.,* 2011, 2012; Fernández *et al.,* 2017)., Mortality seems to have stabilized about 20 percent for adult females in five straight days. Abamectin was shown to be harmful to a number of natural enemies, including phytoseiid mites, because of its wide range of action. Among them, estimated mortality rates ranged from 75% to 100% for adult females. *A. swirskii* (Koppert®, Spain), *A. womersleyi* Schicha, *A. degenerans* (Berlese), *N. californicus*, and *N. fallacis* and *P. persimilis* Athias-Henriot in lab conditions (Shipp *et al.,* 2000; Kim and Seo 2001; Bostanian and Akalach 2006; Kaplan *et al.,* 2012; Fernández *et al.,* 2017). In contrast, abamectin had a favorable selectivity for a commercial population of A. Swirskii (Biobest®, Canada) (less than 50% mortality in the lab, no effects in the field) (Gradish *et al.,* 2011) and for another phytoseiid mite *Typhlodromus pyri* Scheuten (50–75% mortality), whereas it was detrimental to plant feeding schlechtendali (Nalepa)and *Panonychus ulmi*(Koch) (75–100% mortalities), in the field conditions(Hardman *et al.,* 2003). It also contributed to nearly a half-decrease in N.longispinosus (Evans) fecundity relative to city-treated control (Ibrahim and Yee 2000). In our research, adult females of the mites tend to be more tolerant to Agri-Flex than either commercial or any other native phytoseiid species, most likely due to the spraying habit ornamental grower where the *A. Swirskii* have been collected. Unfortunately, A full history of the pesticide spray for this orchard could not be accessed. However, due to its low cost, Agri-Flex has been used two to four times per growing season and, in general, may not be exchanged with other acaricides with different modes of action in the region. Like all other pesticides, their effects for phytoseiid mites ranged from mildly toxic to highly toxic, Parameters for life table like commercial A fecundity. *A.swirskii* population has not been affected by spirodiclofen sub-lethal concentrations (LC10, LC20, and LC30) (Alinejad *et al* . 2016). Likewise, this acaricides had no adverse impact on either mobile stage (including immatures) or egg production of *N. californicus* (Kaplan *et al.,* 2012). In addition, it was harmless to *G. occidentalis*, except for fecundity, for which a half-decrease was observed (Bostanian *et al.,* 2009b). In compare, toxic effects of spirodiclofen on life-table parameters of *N. californicus* were reported by (Sarbaz *et al.,* 2017). Definitely, this result showed the A. Infield conditions, the swirskii population may be subject to Agri-Flex selection. In more research, this should be studied. Our findings were comparable to the results recorded by Hare (1992), who noted that "non-essential" elements such as Cd, Pb, and Hg are toxic to species even at low concentrations. At lower concentrations, metal elements like Cu, Fe, and Zn are considered important and essential nutrition elements for the organisms. However, they can be very toxic at higher concentrations (Warrington 1987; Tian and Lu 2009; Lu *et al.,* 2011; Zan *et al.,* 2011). Chang *et al.,* (2000). Copper and zinc are metals of great significance

Table 2. Respective LC50 and LC90 values, slopes, and 95% C of *A. swirskii* and *P.persimils* adults females for (greeno 10%, Agri-Flex® 18.56% and Baylor - 24 %)

Treatment*	n†	Slope ± SE	LC50 mg a.i L^{-1} (95%)	df	χ^2
greeno 10%	100	2.322 ± 0.145	34.781 (23.76–47.65)	3	10.324
Agri-Flex® 18.56%	100	1.657 ± 0.112	13.921 (9.554–17.884)	3	9.3425
Baylor - 24 %	100	2.759 ± 0.295	72.442 (42.554–96.324)	3	12.332

*Mortalities recorded 72 h following the treatments

†Total number of the individuals used in the study

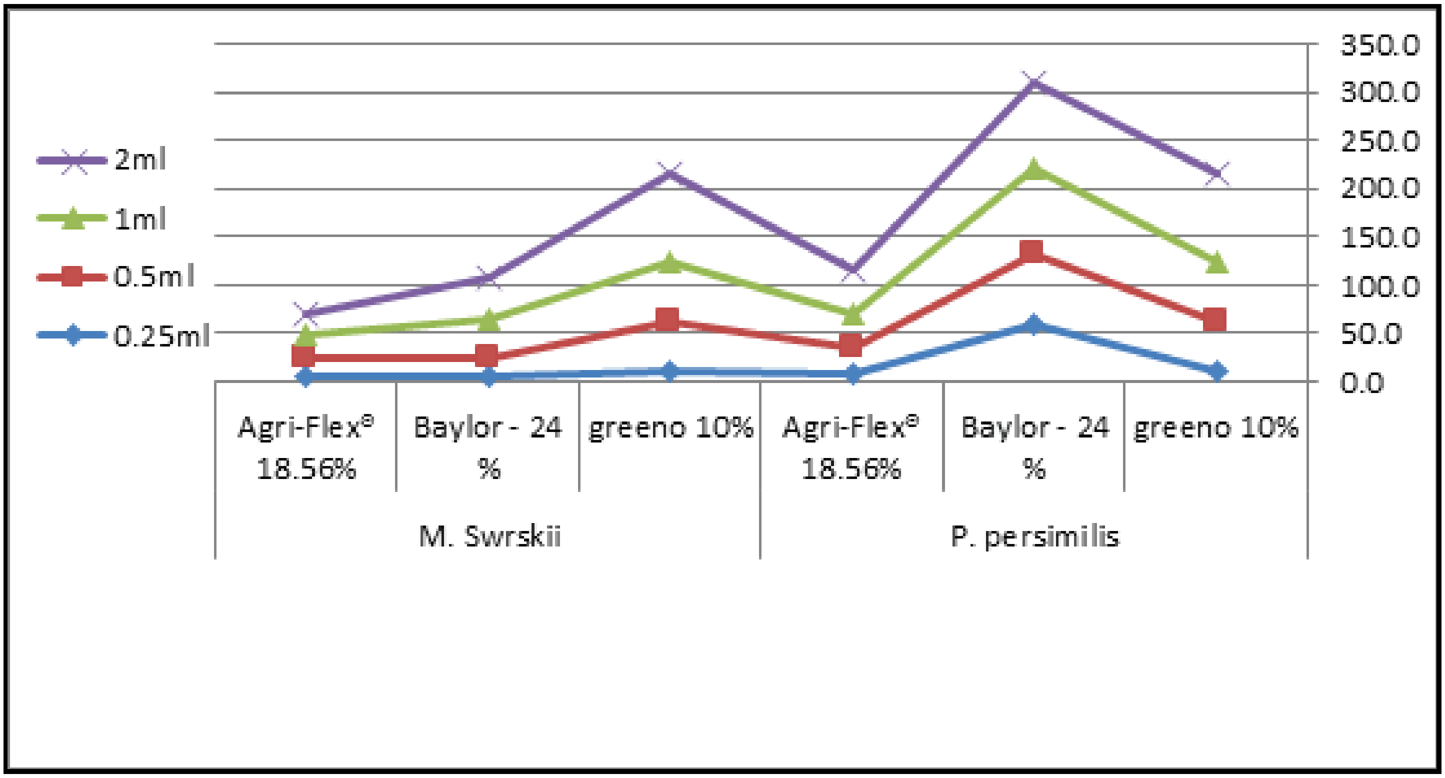

Fig.1 Effect of different pesticides against two predators mites

Table 3. Effect of Different Concentration of heavy metals against *P. persimilis* and *M. Swerskii*

		Mortality rate%		Repellent rate%	
		P. persimilis	***A.Swrsski***	***P. persimilis***	***A.Swrsski***
Cd	control	0	0.1	0.2	0.01
	12.5ppm	7	10	12	13
	25ppm	9	13	25	18
	50ppm	16	18	69	33
Zn	control	0	1	0	0
	12.5ppm	0	1	7	2

	25ppm	3	5	7	5
	50ppm	5	6	9	13
Ca	control	0	0	1	0
	12.5ppm	2	6	11	9
	25ppm	7	10	20	11
	50ppm	14	35	22	19
As	control	1	3	2	1
	12.5ppm	6	11	10	12
	25ppm	12	15	11	22
	50ppm	12	22	14	28
	Mean	5.875			
	SD	5.427			
	t	1.4273			

as they are enzymatic elements in biological processes and metabolism (Cass and Hill, 1980). With previous findings of decreased life cycle time by Cd, our findings are regular; growth reduction has been observed in *Aiolopus thalassinus* Fabri- cius, *Lymantria dispar* Linnaeus, *Chironomus riparius* Mei- gen, *Oncopeltus fasciatus* Dallas, *Poecilus cupreus* Linnaeus, and *Boettcherisca peregrine* Robineau-Desvoidy (Schmidt *et al.,* 1992; Ortel 1996; Sildanchandra and Crane 2000; Maryanski *et al.,* 2002; Cervera *et al.,* 2004; Wu *et al.,* 2006). The previous statement regarding heavy metals concentration in predatory mites is clearly verified in the present research. Such an accumulation can impede production by suppressing feeding indices or by increasing heavy metal accumulation. The true result of heavy metals should, however, be considered as various physiological processes working together. For example, if the life cycle is promoted, the predators cannot overcome the attack of parasites.

CONCLUSION

As a result of the present study, many spider mites on the leaves of studied oaks were found. These mites' highest densities the highest effect of chemical acaricides on predators Baylor - 24% represented in the chemical group (Chlorfenapyr). Results showed that the highest or most toxic heavy metals of death rate on *P. persimilis* also *M. Swerskii* in **Cd** treatment. The lowest is Zn for using IPM strategies on ornamental, medicinal, and aromatic plants.

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